402954

Department of Energy
Washington, D.C. 20545

JUL 11 1978

189's loaned for J Deal E tak trip Dec '78

Enewetak Advisory Group Member

In accordance with the requests for information made during the meetings of June 7 and 8, 1978, at LLL, I am enclosing for your use the following items:

A. Package of eleven schedule 189's which identify DOE work in the Marshall Islands.

B. Letter of December 9, 1974, from Dr. J. Liverman to W. Johnson, DNA, concerning the Draft Environmental Impact Statement on the Enewetak cleanup operation.

C. Memorandum of February 28, 1975, from T. McCraw to Dr. M. Biles (OES) concerning the interpretation of ocean dumping regulations.

D. Memorandum for Record of February 25, 1974, from A. Futral (DNA) on the interagency meeting of February 24, 1974, discussing disposal methods for the Enewetak cleanup operation.

E. Summary of Bikini Whole Body Counting Results for 1977 and 1978. This is the raw data prepared by BNL.

Tom McCraw

T. F. McCraw, Acting Chief
Surveillance Projects Branch
Division of Operational and
Environmental Safety

Enclosures:
As stated

Tom 6/30

Enclosed are 11 copies of the 189's that I could identify as belonging to Marshall Islands work by OES and BER. These 189's are:

Sponsor Division	RPIS Control Number	Title	Lab
OES	600003	Marshall Islands Radiological Safety Program	BNL
OES	600004	DOE/EI Baseline	U of Wash
OES	600146	Marshall Island Dose Assessment	LLL
BER	000032	Medical Studies of the People of the Marshall Islands Accidentally Exposed to Fallout	BNL
BER	000472	Medical Surveys of Marshallese	H&N
BER	001168	Research Vessel Operation	H&N
BER	001521	Hydrogeochemistry of Eneuetak Atoll	U of Hawaii
BER	000661	Operations of the Mid-Pacific Marine Laboratory	U of Hawaii
BER	001508	Biogeochemical Cycling of the Transuranics and Other Radionuclides in the Marshall Islands	LLL

Please note that the funding levels for these

2

projects may not be as they are shown on the 189's. Applicable project officers should be consulted on these levels. Should you choose to be more precise for the Bair committee, please DO NOT give out FY1980 levels, regardless of the apparent finality which such numbers may appear to have. (For OES projects, the currently approved levels are:

RPIS Control Number	Lab	FY1978	FY1979
600003	BNL	194	211
600004	U of Wash	50	53
600146	LLL	50	55)

I recommend that you check with BER to make sure I have found all the pertinent 189's. If I have missed any, let me know and I will get them for you.

W F Wolff

80-015
600003

DEPARTMENT OF ENERGY

ENERGY - OPERATING EXPENSES AND CAPITAL ACQUISITION

SCHEDULE 189

ADDITIONAL EXPLANATION FOR OPERATING OBLIGATIONS

Brookhaven National Laboratory — GK-Multi-Resource

Laboratory — Mission Resource

1. Contractor: — Contract No.: — Task No.:

Associated Universities, Inc. — EY-76-C-02-0016

2. Project Title: — 189 No.:

Surveillance of Facilities and Sites
Marshall Islands Radiological Safety Program

3. Budget Activity No.:

GK-01-01-~~52-3-(a)~~ 68-4
(600003)

4. Date Prepared:

March 1978

5. Method of Reporting:

Annual Report to Division of Safety Standards and Compliance (SSC)
Monthly Visits to SSC
Scientific Journals and Meetings

6. Working Location:

Brookhaven National Laboratory

7. Person in Charge:

C. B. Meinhold

Principal Investigator:

N. A. Greenhouse (664-4250)

8. Project Term:

Continuing

From: To:

9. Person-Years:

	FY 1978	Pres.Bud. FY 1979	Rev.Req. FY 1979	FY 1980
Direct Person-Years				
Scientific & Professional	2.0	3.0	3.0	3.0
Others	2.5	2.0	4.0	4.0
Guests & Research Collaborators	---	---	---	---
Total	4.5	5.0	7.0	7.0

10. Costs (In Thousands of Dollars):

	FY 1978	Pres.Bud. FY 1979	Rev.Req. FY 1979	FY 1980
Research Costs	150	211	400	420
Total Research Obligations	198	218	369	427
Equipment Obligations	11	20	20	50

11. Reactor Concept:

12. Materials:

GK-115

Surveillance of Facilities and Sites

Project Title: Marshall Islands Radiological Safety Program GK-01-01-52-3-(a)

13. Publications:

Greenhouse, N. A. and Miltenberger, R. P. Radiological analyses of Marshall Islands environmental samples from 1974 through 1976. BNL Report (in press).

Greenhouse, N. A. and Miltenberger, R. P. External radiation survey and dose predictions for Rongelap, Utirik, Rongerik, Ailuk, and Wotje Atolls. BNL Report (in press).

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14. Scope:

(a) 200 Word Summary: A comprehensive radiological safety program will be maintained for the inhabitants of atolls in the northern Marshall Islands contaminated as a result of the U.S. Pacific Testing programs. The following items and services will be provided:

1. Environmental and personnel monitoring to provide data for BNL dose assessments and determination of radiological trends.

2. Individual and population dosimetry based on actual measurements. These data will be used to modify dose commitment predictive models so that they accurately reflect future trends.

3. Suggestions based on field experience to mitigate doses via the more critical pathways.

4. A flexible resource of radiological expertise to independently review radiation protection programs associated with rehabilitation efforts in the northern Marshalls, and for related health physics interests of OES in the Pacific Basin.

Program activities for the coming fiscal year will emphasize the following:

1. In vivo counting of Bikini and Enewetak residents. These efforts will define baseline body burdens of gamma-emitting nuclides for new residents at both atolls, and will periodically assess changes in body burdens over time which might result from various exposure pathways.

2. Urine bioassay to define radionuclide excretion patterns from individuals, and to estimate ^{90}Sr and transuranic nuclide burdens.

GK-116

(See Continuation Sheet)

Surveillance of Facilities and Sites

Project Title: Marshall Islands Radiological Safety Program GK-01-01-52-3-(a

14. Scope: (continued)

3. Definition of the annual contributions to dose via the inhalation pathway at Bikini, Rongelap, and Utirik. Special emphasis will be placed on continuous air sampling for wind-mediated resuspension of radionuclides in local soils; and on special measurements to define aerosol contributions resulting from human activity.

4. Development of radiological dose predictive models which involve both human and environmental monitoring data.

(b) Supplement to 200 Word Summary: The FY 1979 budget request contains a significant increase over the FY 1978 allocation. This increase reflects a realistic assessment of operating costs imposed by the in vivo counting, bioassay, and air monitoring activities begun in FY 1978. Additionally, field trip activities and analytical laboratory services have substantially exceeded original estimates for the basic radiological safety program, and these costs are expected to continue. Finally, there are a number of peripheral programs of mutual interest to BNL and OES which will be cost-effective if included with the basic efforts, manpower and budget permitting. These include in order of importance:

1. Definition of local diet patterns at all atolls of interest, and continuous monitoring of diets for seasonal changes and long-term trends which might impact on realistic dose predictions.

2. Incorporation of public information and education programs into the total BNL effort to minimize the adverse psychological and sociological impacts of local radiological conditions and of our efforts to understand them.

3. Retrospective assessment of the radiological picture in the northern Marshalls prior to the establishment of the BNL program in FY 1975.

4. Continued collaboration with UW/LRE on OES radiological programs.

15. Relationship to Other Projects:

This program will be logistically coupled wherever possible to the BNL Medical Program in the Marshall Islands. Technical collaboration will continue on matters of mutual interest. The radiological safety program will also bear directly on a retrospective reassessment of thyroid and whole body doses to the BRAVO fallout victims at Rongelap and Utirik, a new program for which funding is expected in FY 1978. The program will also interact cooperatively with related efforts at the University of Washington (LRE) and at Lawrence Livermore Laboratory.

GK-117

(See Continuation Sheet)

Surveillance of Facilities and Sites

Project Title: Marshall Islands Radiological Safety Program GK-01-01-52-3-(

16. Technical Progress in FY 1978:

Several reports are in press or in progress for publication in FY 1978. These reports will summarize all BNL radiological program activities to date and identify the technical issues to be addressed in FY 1979 and 1980. Two field trips were made in October 1977 to initiate the BNL air monitoring programs at Bikini, Rongelap, and Utirik; and to establish the in vivo counting program. Sufficient field monitoring data will become available to assess average radionuclide body burdens for residents of Bikini, Rongelap, and Utirik, and to make a preliminary analysis of the inhalation pathway at these atolls.

Personnel and analytical laboratory resources are being mobilized to provide technical program support for the "13 Atoll Survey" which is expected during FY 1978.

At least two additional field trips are planned for FY 1978 to continue environmental surveillance programs at Utirik, Rongelap, and Bikini, and the study of trends in ^{137}Cs body burdens at Bikini. Field trip scheduling continues to be hampered, however, by uncertainties over logistics support.

17. Expected Results in FY 1979:

At least three field trips will be made to Bikini, Rongelap, and Utirik Atolls to conduct routine environmental surveillance and personnel monitoring activities. In addition, two or more field trips will be made to Enewetak to continue baseline in vivo counting and bioassay activities begun in FY 1978, and to initiate a new environmental surveillance program consistent with the return of control of the atoll to the Marshallese.

Average baseline radionuclide body burdens will be established for typical residents of uncontaminated atolls. Additional contributions to body burdens from environmental pathways on contaminated atolls will be determined for individuals and populations at Bikini, Rongelap, and Utirik. Definition of the inhalation pathway at the aforementioned atolls will be completed, and a working predictive model will be developed which incorporates environmental and pathway analyses with actual human uptake experience.

18. Expected Results in FY 1980:

Continuation of programs described in FY 1979.

(See Continuation Sheet)

19. Description and Explanation of Major Materials, Equipment and Subcontract Items:

Capital Equipment - FY 1980:

Two phantoms ($10,000) are required to provide adequate calibrations for the Marshall Islands In Vivo Counting program. A computer-based pulse height analyzer ($40,000) is needed to maintain the division counting laboratory at state-of-the-art, and to provide independent analytical facilities for ultra-low-level sample counting.

20. Proposed Obligations for Related Construction Projects:

None.

...OFFICE ...TIONS

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND ...SS DEVELOPMENT ACTIVITIES

SCHEDULE 189

DOES I
PROGRAM Pacific Radioecological

1. Contractor: University of Washington Laboratory of Radiation Ecology	Contract No: EY-76-S-08-0269	Task No:
2. Project Title: DOES I Baseline	RPIS No:	189 No:
3. Budget Activity No:	4. Date Prepared: 28 February 1978	
5. Method of Reporting: Annual and Special Reports	6. Working Location: Laboratory of Radiation Ecology Seattle, Washington	
7. Person in Charge: Allyn H. Seymour Principal Investigator: (Acting) " "	8. Project Term: Continuous From: To:	

9. Man-Years:	FY 1978	FY 1979	FY 1980
a) Scientific	0.67	0.67	0.67
b) Technical/Other	1.00	1.00	1.00
TOTAL	1.67	1.67	1.67

10. Funding: Summary	FY 1978	FY 1979	FY 1980
a) Operational	$50,000	$53,000	56,000
b) Capital Equip.	-	-	0
TOTAL	$50,000	$53,000	56,000

NOTE: INCLUDE JUSTIFICATION & DETAIL ON PROPOSED CAPITAL EQUIPMENT PURCHASE AS AN ATTACHMENT

DATE

BOOK PAGE:
SCHEDULE PAGE:

600004

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

SCHEDULE 189

NEVADA OPERATIONS OFFICE

DOES I
PROGRAM: Pacific Radioecological

10.1 Funding: Detail	FY 1978	FY 1979	FY 1980
DIRECT			
Salaries	$ 24,000	$ 26,000	$ 27,000
Fringes	3,000	3,000	4,000
- Subtotal	$ 27,000	$ 29,000	$ 31,000
Travel Subsistence	1,000	1,000	1,000
Other Direct	9,000	10,000	10,000
TOTAL	$ 37,000	$ 40,000	$ 42,000
INDIRECT	13,000	13,000	14,000
TOTAL OPERATING COSTS	$ 50,000	$ 53,000	$ 56,000

11. Scope: (To be written by principal investigator - approximately 400 words) The laboratory has collected marine, terrestrial, and soil samples for radiological analyses at the former Pacific Test Site since 1946 and some of these samples have been prepared and stored for later use. A list of samples by date and area of collection and by sample type that are now on hand is given in the five tables that are attached. Reports of the results of analyses of most of the samples have been reported but all of the methods and techniques of analyses that are now available were not available when the samples were originally analyzed. For example, prior to 1954 the only analysis performed was for gross beta and gamma radiation; the analyses for ^{90}Sr began in 1954 and, by gamma spectrometry, in 1956; and, for plutonium, the first analysis was in 1964.

It is now proposed that selected archive samples be analyzed for ^{90}Sr, ^{137}Cs, and Pu for the baseline program for FY's 79 and 80. As a result of this program, the 31-year history of these radionuclides at Bikini and Enewetak, their 24-year history at Rongelap, and their 20-year history at these three areas, as well as other areas, after conclusion of the test program could be established. It is unlikely that similar information can be obtained for any other area of the world. The number of analyses will be approximatey 200 for Pu, 200 for ^{90}Sr, 200 by gamma spectroscopy (^{137}Cs and other radionuclides if present) and 20 (of the more recent fish samples) for ^{55}Fe per year.

In FY 1978, the analyses of all of the samples collected in 1976 and 1977 for DOES that have not been previously analyzed will be completed. The results of analyses will be included in two reports - one, on the 1975 radiological survey in Micronesia and the other on 1976 and 1977 radiological surveys in the Marshall Islands. The latter, essentially, will be an updating of NVO-269-32.

DATE:

BOOK PAGE:

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...DA OPERATIONS OFFICE

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT PROCESS DEVELOPMENT ACTIVITIES

SCHEDULE-

DOES I

PROGRAM Pacific Radioecological

12. Dates & Titles of Publications
13. Relationship to Other Projects

1. Annual Report 18 July 1977.
2. Radiological Survey of Plants, Animals and Soils in Micronesia, Nov. 1975 (in preparation).
3. Radiological Survey of Plants, Animals and Soils in the Marshall Islands Progress Report for 1976-1977 (in preparation).

14. Progress in FY 1978 Complete the analyses of all samples for the DOES collected in 1975, 1976 and 1977. Prepare reports of the results of analyses.

15. Expected Results in FY 19 79 Begin analyses of selected archive samples; prepare progress report.

16. Expected Results in FY 19 80 Continue analyses of selected archive samples; prepare progress report.

17. Proposed Obligations for Related Construction Projects None

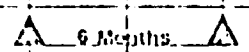
18. Project Milestone Chart

Complete analyses of all 1975-77 samples ... 19 months ...

Prepare reports of 1975-77 samples

Analyze selected archive samples

Progress report " "



Indicate Activities & Task Duration, ie.
A. Field Research

DATE

BOOK PAGE:

SCHEDULE PAGE:

NEVADA OPERATIONS OFFICE

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

SCHEDULE 19

DOES I
Pacific Radioecological
PROGRAM

Two sets of 189's were prepared on 29 April 1977, "Pacific Radioecological Program (SSC Section) Baseline and Aerial Survey" and "Pacific Radioecological Program SSC Section Fish Tagging." This year three sets have been prepared for the same programs - "DOES I, Baseline," "DOES II, 13 Atoll Survey," and "DOES III, Enewetak Fish Tagging and Monitoring."

The programs remain essentially the same with one exception. The baseline program for FY 78 is unchanged but for FY 79 and FY 80 the analysis of archive samples is proposed. The addition of the archive samples is complemented by a slight reduction in the number of analyses of samples from the 13 Atoll Survey. The total budget for all programs for FY 79 and FY 80 are approximately the same as given in last year's 189's, and for FY 78 is significantly less because of the delay in initiating DOES programs II and III.

ARCHIVE SAMPLES
Laboratory of Radiation Ecology
University of Washington

TABLE 1: Bikini Atoll

	1948	1949	1954	1955	1956	1957	1958	1964	1967	1969	1970	1972	1974	1975	1976	1977
LAND PLANTS																
Coconut	2		1	3	3	3		11	2			16	2	15	5	
Scaevola	2				1	2	2	14	7							
Papaya	1			6	4	3						4			2	
Pandanus				1		1	1	2	2			5	1	2	8	
Arrowroot			1	2	1	3										
Messerschmidia	1				1	2	2	18	1				1			
Breadfruit														2	9	
Other	7				1	1	4	39	6			1	1		3	
SOIL																
Island Soil			13	5	3	5	2	72	36	31	166	23	94	62	1	
Beach Sand			1	2												
Lagoon Sediment			1					7		5	1	30			10	8
LAND ANIMALS																
Coconut Crab				3	4			9	19	44		43	3			
Rats								20	14	4	21					
Birds			6	2				142	36	9						
MARINE BIOTA																
Tridacna	4		10		3	1		85		4		8		4		
Other Molluscs	11			1		6		40		7		9				
Tuna				3	3	8			6	74		18			1	12
Mullet								11	3	14		25	4		3	6
Goatfish						1		3	1	8	10	22		1		4
Surgeonfish			1	3			2	32	1	14		7	2	3		
Other Fish				3	6	26	5	147	4	20		52		5	41	
Crustaceans				2	7	16	1	74	14	35	1	12			1	6
Coral/Sponge	30	1		1	4	2		33				14				
Echinoderms						2		64				9				
Plankton	4					8		7								
BENTHIC ALGAE																
Halimeda		2		1	4	2	1	8				13				
Other					3	8		27		1	3	1				

ARCHIVE SAMPLES
Laboratory of Radiation Ecology
University of Washington

TABLE 2: Enewetak Atoll

	1948	1949	1951	1952	1954	1955	1956	1957	1958	1959	1961	1964	1972
LAND PLANTS													
Coconut							3		17			3	
Scaevola					1	2	11	4	12	1	1	15	
Papaya									1				
Pandanus							4	1	1				
Arrowroot													
Messerschmidia							5	5	15	2	1	15	
Breadfruit													
Other	1						12	11	19	4	6	33	
SOIL													
Island Soil			9	11	114	41	20	6	14	43	6	44	19
Beach Sand				1	42	10	7		1				
Lagoon Sediment				3	33	15	8	1	7	2	1	3	16
LAND ANIMALS													
Coconut Crab							18	6		7			
Rats						3	2				9	35	
Birds	1				1				6			38	
MARINE BIOTA													
Tridacna	2				68	3		7	31	2	17	45	27
Other Molluscs	2				13	1	1	2	4	1	4	13	5
Tuna					26	7	6	120	8		5		24
Mullet					1	3						14	40
Goatfish					1	1		2	3			11	35
Surgeonfish					2			5	7		6	34	31
Other Fish					9		1	95	56		68	145	81
Crustaceans						1	24	18	52		9	61	3
Coral/Sponge	20			1	12	3	2	7	1		1	16	1
Echinoderms				13		3	6	1	32		3	76	22
Plankton	2	2			1			13	35		5		
BENTHIC ALGAE													
Halimeda	1				1	2	4	3	7	1	3	11	1
Other					3	1	19	10	16	3	1	27	1

ARCHIVE SAMPLES
Laboratory of Radiation Ecology
University of Washington

TABLE 3: Rongelap, Ailinginae, and Rongerik Atolls

	1954	1955	1956	1957	1958	1959	1961	1963	1964	1967	1971	1972	1974	1976
FOOD PLANTS														
Coconut	1	8	6	5	28	45	126	100	34		1		5	10
Scaevola				7	13	59	84	29	2					
Papaya	1	1	1		1	7	3	5						
Pandanus		4	2	2	28	90	52	50	4		6		10	1
Arrowroot	2	1	1	1	5									
Messerschmidia				5		54	67	15	2					
Breadfruit			3	2	2	14	10	11	3		1		1	1
Other		3	4	5	125	260	173	118	5		11			
SOIL														
Island Soil	7	21	11	10	258	340	270	163	17		24		106	82
Beach Sand	2	6	4	1										
Lagoon Sediment		12		2	10								3	
LAND ANIMALS														
Coconut Crab		8		10	90	112	17	75	30	4	8		29	12
Rats								1						
Birds	4	9			2	2		48	12				2	
MARINE BIOTA														
Tridacna		1		10	61	9		34	15				2	10
Other Molluscs	4		1	8	46	7	5	29	27				3	
Tuna		7			1	4		17			6		5	1
Mullet													7	3
Goatfish		1	1	3		45	70	50			8	1	3	4
Surgeonfish					6	6		11					2	
Other Fish		1	2	35	4	21	30	145					10	
Crustaceans			1	4	13		1	106	4					
Coral/Sponge				9	20	3	1		10					
Echinoderms		3		9	14	56		14	17					
Plankton					4	11	1							
BENTHIC ALGAE														
Halimeda		9	1	3	12	1	1	16	4					
Other		2		2	26		3	40	4		1		1	

ARCHIVE SAMPLES
Laboratory of Radiation Ecology
University of Washington

TABLE 4: Other Marshall Islands

	1949	1954	1955	1956	1958	1959	1963	1972	1974	1975	1976
LAND PLANTS											
Coconut			4	2	5	2				6	9
Scaevola					1	1					
Papaya			1	3	2	2				2	6
Pandanus			2	2	3	5	8		2	9	21
Arrowroot		1		2	1						
Messerschmidia				1	1						
Breadfruit		1		5	3					5	15
Other				1	2	5	1		1		4
SOIL											
Island Soil			5	3					17	17	105
Beach Sand			5								
Lagoon Sediment									2		
LAND ANIMALS											
Coconut Crab				2	8	9	4			5	
Rats											
Birds			4								
MARINE BIOTA											
Tridacna					9				3		
Other Molluscs					8	1					
Tuna								13			
Mullet									1	1	
Goatfish							5				
Surgeonfish					2			2			2
Other Fish					6			7	2	3	1
Crustaceans				9	8						
Coral/Sponge											
Echinoderms				3	27						
Plankton	1										
BENTHIC ALGAE											
Halimeda				3	2						
Other			1		1						

ARCHIVE SAMPLES
Laboratory of Radiation Ecology
University of Washington

TABLE 5: Micronesia and Polynesia

Area	Year	Sample Type				
		LAND PLANTS	SOIL	LAND ANIMALS	MARINE BIOTA	BETHIC ALGAE
Hawaii	1951					1
Ponape	1954	5	1			
	1956	13	1			
	1958	9			21	2
	1975	15	11		4	
Kusaie	1956	7	4		6	2
	1958	13			16	2
Tarawa	1956	6	3		5	1
	1958	1			19	
Guam	1956				9	
	1958				5	4
	1959				27	7
	1975	25	13		7	
Yap Is.	1956				4	
Palau	1956				3	
	1958			3	4	
	1959				17	3
	1975	19	15		1	
Kapingamarangi	1958	3			11	
Thailand	1958				2	1
	1959				7	1
Canton	1961		1			
	1962	1	13		34	2
Christmas Is.	1962	7	34		1	2
	1975	20	8		27	1
Pago Pago	1962		1			
Line Islands	1962	10	12		21	
Tongatapu	1962	9	8		11	4
Samoa	1962	10	12		3	
Fiji	1962	5	6		2	1
Johnston Is.	1962	27	67		199	14
	1966	4	7		65	3
	1967	3	6		24	
Roratonga	1962	15	5		3	
Hong Kong	1963				3	
Galapagos	1966		1		2	
Truk	1975	25	16		2	

OES/LLL Proj.

SCHEDULE 189

Lawrence Livermore Laboratory
University of California
Livermore, California

[X] Environment
[ ] Life Science Research Biomedical Applications

1. CONTRACTOR: University of California, Contract #W-7405-eng-48

2. PROJECT TITLE: Continuing Marshall Island Radiological Dose Assessment

2c. RPIS No. 600146

2b. ABSTRACTED TITLE: Marshall Island Dose Assessment

2d. 189 No. LLL/ASEV-80-22

3. BUDGET ACTIVITY NO.:	4. DATE PREPARED:	5. METHOD OF REPORTING:	6. WORKING LOCATION:
GK-01-01-03-4	March 1978	Annual	Livermore, California

7a. PERSON IN CHARGE: M. L. Mendelsohn /E.M. Morimoto

7b. PRINCIPAL INVESTIGATOR: W. Robison

8. PROJECT TERM: Continuing

9. MAN YEARS:

	FY 78	FY 79 Pres. Budget	FY 79 Reprog.	FY 79 New	FY 79 TOTAL	FY 80
(a) Scientific	0.7	0.7	0	0	0.7	0.7
(b) Other Technical	0.1	0.1	0	0	0.1	0.1
Total	0.8	0.8	0	0	0.8	0.8

10. FUNDING (Thousand $):

	FY 78	FY 79 Pres. Budget	FY 79 Reprog.	FY 79 New	FY 79 TOTAL	FY 80
Operating Costs:						
(a) Manpower	22	24	0	0	24	27
(b) Materials, Services, etc.	11	12	0	0	12	33
(c) Indirect Expenses	17	19	0	0	19	20
Total Operating Costs	50	55	0	0	55	80
Capital Equipment not Related to Construction	0	0	0	0	0	0

11. REACTOR CONCEPT: Not Applicable

12. MATERIALS: Not Applicable

13. PUBLICATIONS:

1. W.L. Robison, W.A. Phillips, and C.S. Colsher, Dose Assessment of Bikini Atoll, Lawrence Livermore Laboratory, Rept. UCRL-51879, Pt. 5 (1977).

2. W.L. Robison, V.E. Noshkin, and W.A. Phillips, Assessment of Potential Doses to Populations from the Transuranic Radionuclides at Enewetak Atoll, Lawrence Livermore Laboratory, Rept. UCRL-52408 (1978).

3. V.E. Noshkin and W.L. Robison, Consideration of the Impacts of Soil Disposal on Northern Runit (Yvonne) Island and the Marine Environment, Report to DOE Headquarters, 8 p. (1977).

14. SCOPE:

This project will evaluate the radiological problems associated with the resettlement of Bikini Atoll in the Marshall Islands including:

- alternate living patterns involving Bikini Island,
- alternate islands, e.g., Eneu Island and Nam Island in the northern section of Bikini Atoll, for primary residence,
- radiological implications of copra produced at Bikini Atoll on the world market,
- economic impacts to the Bikini people and the Marshall Islands if such crops are restrained from the world market,
- long-term use of Bikini as more time-dependent data become available.

We will maintain the data files and information both from Bikini and Enewetak so that we can respond rapidly to DOE needs for Marshall Island assessments.

15. RELATIONSHIP TO OTHER PROGRAMS:

This assessment program is closely related to the follow-up research programs at the Bikini and Enewetak Atolls (189 Nos. LLL/ASEV-80-5 and -22), to the continuing assessment of Enewetak Atoll, and to past surveys at both atolls. Results from this program will be integrated closely with any future atoll surveys.

16. TECHNICAL PROGRESS IN FY 1978:

The initial dose assessment of Bikini and Eneu Islands at Bikini Atoll (see publication No. 1) was completed. The predicted doses for living patterns involving Bikini Island are more than double the

Federal Guidelines. The predicted dose for Eneu Island living patterns is marginally in line with Federal Guidelines. The terrestrial food-chains pose the greatest potential contribution to the population dose.

A Marshall Island data bank was initiated. This data bank will include data generated in our field programs and data published by others.

We also have supplied DOE with two reports on Enewetak Atoll (see publication Nos. 2 and 3). The assessment of the potential doses due to the transuranics at Enewetak atoll indicate that predicted lung and bone dose rates at Enewetak Atoll may exceed the new EPA guidance.

17. EXPECTED RESULTS FOR FY 1979:

Our goals for FY 1979 are fivefold. We will:

- Continue to update assessments of potential doses for alternate living patterns at Bikini Atoll as new data become available from the test plots established on Eneu Island.
- Reevaluate all of the living patterns and potential long-term use of the atolls as more time-dependent data become available.
- Develop the assessment of the radiological significance of copra produced on Bikini and entered into the world market.
- Expand the Marshall Island data bank so we can respond rapidly to needed assessments of Bikini Atoll.
- Assess proposed changes in living patterns as suggested by DOE, Department of Interior (DOI), the Trust Territory, the Bikini and Enewetak people, and ourselves. Many of the needed assessments will be identified as the resettlement proceeds and questions arise.

18. EXPECTED RESULTS IN FY 1980:

Additional assessments considered necessary by DOE, DOI, the Trust Territory, the Bikini people, and ourselves will be conducted. These will include evaluations of alternate living patterns, annual dose and body burden estimates, alternate diets, and remedial actions directed toward reducing either uptake or radionuclide inventories at Bikini. Evaluation at Bikini Atoll of islands other than Bikini and Eneu also may be necessary. Delineation of the possible long-term use of the atoll will be of particular importance.

19. MAJOR MATERIALS, EQUIPMENT, AND SUBCONTRACT ITEMS:

None.

20. PROPOSED OBLICATIONS FOR RELATED CONSTRUCTION PROJECTS:

None.

DEPARTMENT OF ENERGY

ENERGY - OPERATING EXPENSES AND CAPITAL ACQUISITION

SCHEDULE 189
ADDITIONAL EXPLANATION FOR OPERATING OBLIGATIONS

Brookhaven National Laboratory — GK-Multi-Resource

Laboratory — Mission Resource

1. Contractor: — Contract No.: — Task No.:

Associated Universities, Inc. — EY-76-C-02-0016

2. Project Title: — 189 No.:

Human Health Effects from Energy Generation
Medical Studies of the People of the Marshall
Islands Accidentally Exposed to Fallout

3. Budget Activity No.:

GK-01-02-01-1-(a)
(000032)

4. Date Prepared:

March 1978

5. Method of Reporting:

Scientific Meetings
Scientific Journals

6. Working Location:

Brookhaven National Laboratory

7. Person in Charge:

R. A. Conard (664-3577)

Principal Investigator:

R. A. Conard
K. D. Knudsen
H. S. Pratt
W. J. Grant

8. Project Term:

Continuing

From: To:

9. Person-Years:

Direct Person-Years	FY 1978	Pres. Bud. FY 1979	Rev. Req. FY 1979	FY 1980
Scientific & Professional	5.0	3.5	4.0	3.5
Others	7.0	4.0	7.0	7.0
Guests & Research Collaborators	2.0	2.0	2.0	2.0
Total	14.0	9.5	13.0	12.5

10. Costs (In Thousands of Dollars):

	FY 1978	Pres. Bud. FY 1979	Rev. Req. FY 1979	FY 1980
Research Division	305	317	462	472
Hospital Division	115	103	103	111
Research Costs	420	420	565	583
Total Research Obligations	420	425	570	589
Equipment Obligations	1	5	5	10

11. Reactor Concept:

12. Materials:

GK-129

Project Title: Human Health Effects from Energy Generation
Medical Studies of the People of the Marshall
Islands Accidentally Exposed to Fallout GK-01-02-01-1-(a)

13. Publications:

The following citation was previously listed only as submitted:

Conard, R. A. Summary of thyroid findings in Marshallese 22 years after exposure to radioactive fallout. Radiation-Associated Thyroid Carcinoma, L. J. DeGroot, Editor, pp. 241-257, Grune & Stratton, New York, 1977.

14. Scope:

a) 200 Word Summary:

The primary objective is the determination of the life-time effects of fallout radiation on the Marshallese who were accidentally exposed to radioactive fallout on March 1, 1954. Medical Surveys of these people are conducted at quarterly intervals, and an unexposed Rongelap population is examined for comparison. The surveys, carried out jointly by Brookhaven National Laboratory under the auspices of the Department of Energy, and the Trust Territory of the Pacific Islands, are of great importance in view of the development in this population of growth impairment in some exposed children, thyroid lesions, and one case of acute leukemia.

b) Supplement to 200 Word Summary:

Post-exposure surveys in the Marshall Islands have been conducted for 23 years. In addition to the 244 people orginally exposed, a group of 150 unexposed Marshallese are examined for a "comparison population" to assess late effects of radiation from fallout. The continuing development of thyroid neoplasms, and the appearance of one case of acute leukemia, indicate the need for frequent examinations. In addition to routine physical, hematological, and other laboratory examinations, the surveys involve special studies related to aging, malignancy, reproduction and measurement of body burdens of radionuclides resulting from the slight contamination remaining on the islands. Thyroid patients are returned to the United States for complete hospitalization and surgical treatment. In view of the diverse medical problems and their management, a Physician and a Physician's Assistant are in residence at Kwajalein and make regular trips to Rongelap, Majuro and Utirik to supervise care and perform interim examinations of the exposed Marshallese.

15. Relationship to Other Projects:

The studies of the exposed Marshallese are closely related to the Radiation Effects Research Foundation studies in Japan and to the studies of the 23 Japanese fishermen exposed at the same time as the Marshallese to fallout. Radiation still ranks as one of the more important hazards that must be considered in the DOE program. The effects of fallout exposure in the Marshallese provide valuable information, particularly with regard to thyroid effects from radioiodine exposure, that may relate to a reactor accident in the remote event that such should occur. The Marshallese data are used in

(See Continuation Sheet)

GK-128

15. Relationship to Other Projects: (Cont'd)

analysis of such accidents, such as for the Rasmussen report. The data are also quoted in other reports such as the NCRP, ICRP, BIER, and those of the United Nations.

The Safety and Environmental Protection Division of this Laboratory conducts radiological personnel and environmental surveys of contaminated Marshall Islands and inhabitants. These studies are closely coordinated with the Medical Surveys.

16. Technical Progress in FY 1978:

In response to requests by the people of Rongelap and Utirik, DOE agreed (February 1977) to assist the Trust Territory in an expanded health care program for the people living at Rongelap and Utirik Atolls. Accordingly during the March 1977 survey (23 years post-exposure) all Marshallese living on these atolls, who wished it, were given complete medical and laboratory examinations similar to those in the exposed group. Greater physician-patient relationship was attained by lengthening the stay on these islands. Quarterly visits were also conducted at Rongelap and Bikini, but due to misunderstandings between the Utirik people and the Resident Physician, the latter was requested not to return. Recently, however, the people have requested that he return and it is expected the quarterly visits to Utirik will be resumed.

The health status of the people examined was found to be generally good. Thyroid abnormalities continued to be the only definite findings related to radiation exposure. During the past year, thyroid surgery was done on two exposed Marshallese (a 43-year-old Rongelap man and a 50-year-old Utirik man) and on one 66 year-old unexposed Rongelap man. The latter had a thyroid cancer but the two exposed people had benign lesions.

There have now been 39 thyroid abnormalities (32 with surgery) among the 244 exposed Marshallese (35% of the Rongelap people and 5.8% of the Utirik people). The occurence of three thyroid cancers in the exposed Utirik population (compared with four in the Rongelap group) appears to implicate radiation exposure in the etiology but the high incidence is puzzling since it is greater than would be predicted based on Rongelap and Japanese data, and there does not appear to be any increase in benign thyroid tumors in the group compared to the much greater prevalence in the Rongelap group. Because of the uncertainty of the incidence of thyroid tumors in unexposed Marshall Islanders and in order to obtain better statistics, during the past year thyroid examinations were included on all unexposed Rongelap and Utirik people on any of the Marshall Islands visited. It is hoped that this study will be extended to include thyroid surgery when indicated. Also in order to help solve the Utirik dilemma re-evaluation of radiation doses from fallout to the Utirik people, including the thyroid, has begun.

(See Continuation Sheet)

GK-129

Project Title: Human Health Effects from Energy Generation
Medical Studies of the People of the Marshall Islands Accidentally Exposed to Fallout GK-01-02-01-1-(a)

16. Technical Progress in FY 1978: (Cont'd)

During the past year the bill authorizing compensation to certain of the Utirik and Rongelap people for radiation injuries has been signed by the President and preparations are under way to initiate these payments.

A study of diabetes, a serious disease in the Marshall Islands, was initiated several years ago and continues. During the past year an intestinal parasite survey was started at Rongelap Atoll with studies of stool specimens and serological testing (immunofluorescence).

Anthelmintic therapy (Vermox) has been started on nearly the entire population. A large percentage of the people had positive stools for parasites and it is hoped that these parasites may be virtually eliminated in this island group by the treatment regimen.

As part of the expanded medical studies a trailer is being obtained for laboratory purposes at the Hospital at Ebeye and will be used by the Resident Physician and his assistant.

A program to educate the people of Rongelap and Utirik regarding radiation and its effects was implemented during the past year. During the time of the annual surveys lectures were given to the people by members of the medical team and in addition Dr. Naidu, of Brookhaven remained on Rongelap island for over a month indoctrinating the people about radiation.

Radiological monitoring of people living on Rongelap, Utirik, and Bikini, including radiochemical analyses of urine samples and whole body gamma-spectrographic analyses, was done. Evaluation of low-levels of plutonium detected in the urines of Bikini and Rongelap people continues. It is still uncertain if contamination of urine samples may be a factor. A disturbing finding was a sudden increase in the ^{137}Cs levels in the Bikini people although still well below the MPBB. It was apparent that the people had been eating the locally grown breadfruit and pandanas. The course of action to be taken with regard to the Bikini people is uncertain at this time.

Two new physicians are being hired for the program. Dr. W. Grant will replace Dr. K. Knudsen as the Resident Physician and Dr. H. Pratt will eventually replace Dr. R. Conard when he retires. In addition, a Physician's Assistant, Mr. Richard Coppola, has been hired and will join the Resident Physician at Kwajalein to assist in medical care in the islands. This acquisition is in relation to the expanded medical program described above.

The attitudes of the Rongelap and Utirik people toward the examinations has improved, due partly to a better understanding of the objectives of the medical team as a result of the increased educational program, and partly to an improved attitude of the Marshallese politicians. However, activist groups from Japan and a law firm in the United States continue to cause unrest among the people.

GK-130

(See Continuation Sheet)

17. Expected Results in FY 1979:

In view of the serious late effects of fallout exposure, continued medical surveillance of the exposed populations is mandatory. Special examinations for the thyroid abnormalities, as well as for neoplasia of other organs and tissues, and other late effects must be continued. Other studies that will be pursued include:

A. Thyroid Control Study: It is hoped that DOE funds will be approved for carrying out thyroid surgery in the United States on unexposed Rongelap and Utirik people in the extended control study where such surgery is indicated.

B. Re-evaluation of dosimetry of the Utirik people, including thyroid doses.

C. Study of the nature and treatment of diabetes in the Marshallese.

D. Intestinal parasite study in the Rongelap people and the treatment program with possible expansion of the treatment program to other atolls.

E. Studies with Dr. Raymond Popp (Oak Ridge) for frequency of isoleucine substitution in hemoglobin of Marshallese blood as an index of somatic mutations associated with radiation exposure and aging.

F. Studies of polymorphism and rare protein variants in the blood cells from children of exposed and unexposed parents. Dr. James Neal at the University of Michigan has expanded his battery of tests for these variants and has agreed to reactivate these studies in Marshallese children.

G. An expansion of the educational program for the Marshallese living on the contaminated islands of the northern Marshalls. Dr. Naidu has agreed to visit Utirik for a month, and lectures at the time of the visits by the medical team are planned. A booklet on radiation and its effects is planned. This program is carried out in collaboration with the Safety and Environmental Protection Division at BNL.

H. Evaluation of body burdens of radionuclides in the people living in the northern Marshall atolls will be done jointly with Safety and Environmental Protection Division of this Laboratory who have recently been assigned the monitoring responsibilities.

18. Expected Results in FY 1980:

Continuation of the medical surveys of the Marshallese is anticipated on an indefinite basis. Emphasis will be placed on examinations for thyroid abnormalities, cancer, hematologic disorders, and other possible effects of radiation exposure. Evaluation of internal body burdens of radionuclides in

(See Continuation Sheet)

18. Expected Results in FY 1980: (Cont'd)

personnel and environmental radiological monitoring will continue to be an important part of the program.

19. Description and Explanation of Major Materials, Equipment and Subcontract Items:

Capital Equipment - FY 1980:

None

20. Proposed Obligations for Related Construction Projects:

None.

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FY , BUDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE
ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Holmes & Narver, Inc.
Pacific Test Division
Contractor

Date: February 15, 1978
Schedule 189

1. Contractor:	Holmes & Narver, Inc. Pacific Test Division	Contract No:	EY-76-C-08-0020 Task No:
2. Project Title:	Human Health Effects from Energy Generation (Medical Surveys of Marshallese)	RPIS No:	189 No:
3. Budget Activity No:	GK-01-02-01-1	4. Date Prepared:	February 15, 1978
5. Method of Reporting:	Monthly & Annual Cost Reports	6. Working Location:	Pacific Area
7. Person in Charge:	W. J. Stanley, Director, PASO	8. Project Term:	Continuing Program
Principal Investigator:	Brookhaven National Laboratory	From:	To:

9. Man-Years:	FY 1978	FY 1979	FY 1980	5 YEARS
a) Scientific				
b) Technical/Other				
TOTAL	-0-	-0-		

10. Funding: Summary	FY 1978	FY 1979	FY 1980	5 YEARS	TOTAL
a) Operational	65.0	70.0	75.0		
b) Capital Equip.	-0-	-0-	0		
TOTAL	65.0	70.0	75.0		

FY 1980 BUDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE
ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Holmes & Narver, Inc.
Pacific Test Division
Contractor

Date: February 15, 1978
Schedule 189

10.1 Funding: Detail	FY 19 78	FY 19 79	FY 19 80
DIRECT			
Salaries			
Fringes	0	0	0
– Subtotal	0	0	0
Travel & Subsistence			
Other Direct	65.0	70.0	75.0
TOTAL	65.0	70.0	75.0
INDIRECT			
TOTAL OPERATING COSTS	65.0	70.0	75.0

11. Scope: (To be written by principal investigator - approximately 400 words)

The submission of the basic justifications and budget estimates for this program are the responsibility of the Brookhaven National Laboratory.

Holmes & Narver has been requested to provide logistic support in the Pacific area. This submission includes the scope and funding for the H&N effort.

Many support requirements arise on a day-to-day basis and cannot be accurately forecast in detail. The general scope, however, has been similar in recent years, permitting reasonable predictions of total costs.

The following estimates are based on recent history and an outline of the general program scope. The estimates include an assumption that both scope and costs will increase slightly in each year.

GK-01-02-01-1 Medical Surveys of Marshallese

Direct labor is so seldom involved that no man-years of effort are anticipated.

		FY 1978	FY 1979	FY 1980
1.	Support MD at Kwajalein	9.0	10.0	11.0
2.	Patients' Mainland Trips for Treatments	13.0	14.0	15.0
3.	Support Medical Surveys	25.0	27.0	29.0
4.	M&R Facilities at Island Sites	18.0	19.0	20.0
	Total	65.0	70.0	75.0

1. The program maintains a full time doctor and assistant at Kwajalein, and H&N support cost estimates cover their home and office rental, medical and office supplies and island transportation.

2. Patients' mainland trip expenditures involve commercial air fares, living expenses, miscellaneous purchases of clothes and the cost of accompanying interpreters/escorts.

3. Support of Medical Surveys - Each year the Kwajalein doctor makes four trips to the outlying islands, and at least twice a year teams of specialists travel from New York to conduct an in-depth check of the Marshallese, especially those who are considered patients. Support costs involve air fares, shipping costs, costs for Trust Territory medical assistants, special transportation, gift food for island populations, et cetera.

4. Facilites maintained consist of trailers or other structures, boats, vehicles and other equipment located on the islands of Kwajalein, Majuro, Ebeye and Rongelap.

FY _ _ BUDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE

Holmes & Narver Inc.
Pacific Test Division
Contractor

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Date: February 15, 1978
Schedule 189

12. Dates & Titles of Publications — None

13. Relationship to Other Projects — N/A

14. Progress in FY 19

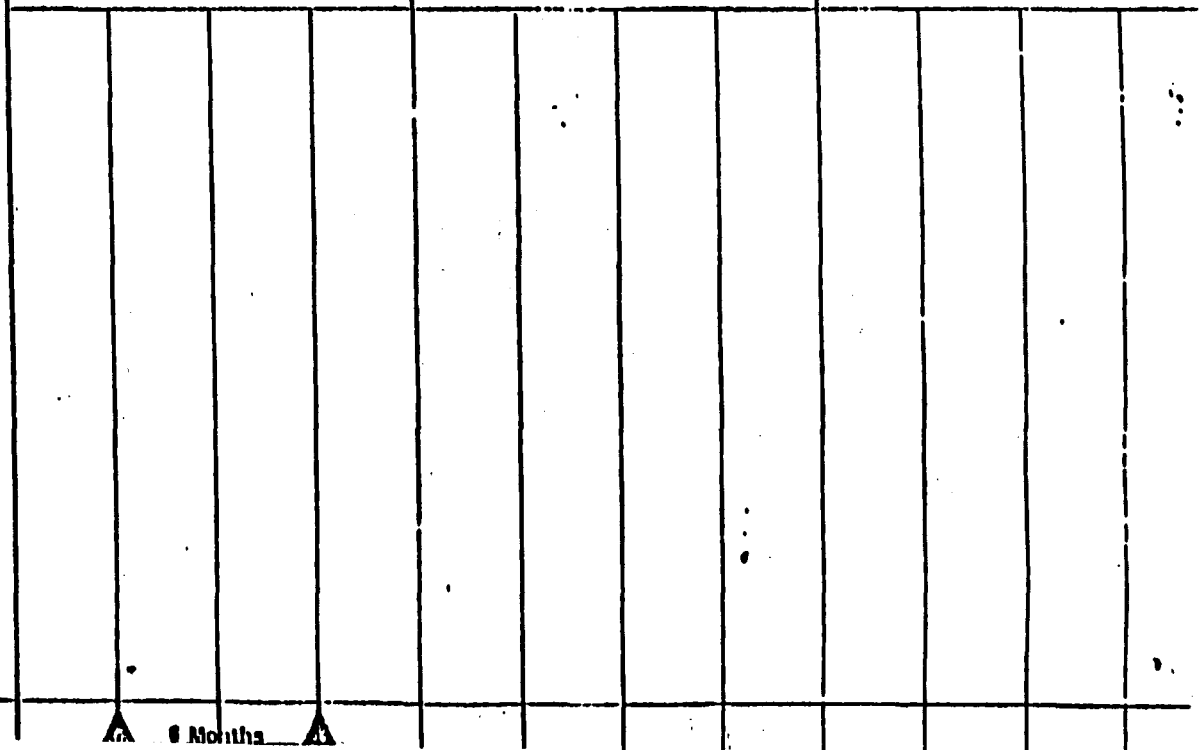
15. Expected Results in FY 19 — N/A

16. Expected Results in FY 19

17. Proposed Obligations for Related Construction Projects — None

18. Project Milestone Chart

N/A



Indicate Activities & Task Duration, ie.

001168

FY 19__ BUDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE
ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Holmes & Narver, Inc.
Pacific Test Division
Contractor

Date: February 15, 1978
Schedule 189

1. Contractor:	Holmes & Narver, Inc. Pacific Test Division	Contract No: EY-76-C-08-0020	Task No:
2. Project Title:	Human Health Effects from Energy Generation (Research Vessel Operation)	RPIS No:	189 No:
3. Budget Activity No:	GK-01-02-01-1	4. Date Prepared:	Feb. 15, 1978
5. Method of Reporting:	Monthly & Annual Cost Reports	6. Working Location:	Pacific Area
7. Person in Charge:	W. J. Stanley, Director, PASO	8. Project Term:	Continuing Program
Principal Investigator:	N/A	From:	To:

9. Man-Years:	FY 1978	FY 1979	FY 1980	6 YEARS
a) Scientific				
b) Technical/Other				
TOTAL	0	0	0	N/A

10. Funding: Summary	FY 19 78	FY 1979	FY 19 80	6 YEARS	TOTAL
a) Operational	400.0	800.0	675.0	N/A	N/A
b) Capital Equip.					
TOTAL	400.0	800.0	675.0	N/A	N/A

FY 1980 BUDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE
ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Holmes & Narver, Inc.
Pacific Test Division
Contractor

Date: February 15, 1978
Schedule 189

10.1 Funding: Detail	FY 1978	FY 1979	FY 1980
DIRECT			
Salaries			
Fringes			
- Subtotal	0	0	0
Travel - Subsistence	0	0	0
Other Direct	400.0	800.0	675.0
TOTAL	0	0	0
INDIRECT	0	0	0
TOTAL OPERATING COSTS	400.0	800.0	675.0

11. Scope: (To be written by principal investigator - approximately 400 words)

The DOE controlled vessel, LCU-26, RV Liktanur was damaged by rough seas in October 1977 and declared unfit for further open sea travel. This vessel supported four trips throughout the northern Marshalls for the Brookhaven National Laboratory medical program, plus seven additional trips to support LLL, Univ. of Hawaii, Univ. of Wash. and BNL programs dealing with cycling characteristics of radionuclides. The FY 1978 schedule called for 240 sailing days to support this effort.

A search is underway to locate, acquire and refit a similar type vessel in order that long term programs may maintain necessary continuity.

Following are general assumptions which govern the budget estimate:

1. A comparable dedicated vessel is required.

2. The vessel will be located in FY 1978 in time for modifications to be made early in FY 1979.

GK-01-02-01-1 Research Vessel Operation (continued)

3. The vessel will be based at the Kwajalein Missile Range and will require a dedicated crew.

4. Altered FY 1978 plans can be accomplished through interim use of TTPI vessels on a reimbursable basis.

Due to the sudden inactivation of the LCU it has been necessary to curtail the FY 1978 program, so it now appears that the current funding of 400K may be sufficient for the whole fiscal year. Otherwise, the amount was calculated to be about 150K short. Furthermore, the LCU was on loan from the Army, and final arrangements have not yet been completed as to what repairs will be paid for by DOE. Should the repairs be extensive, FY costs may still exceed the 400K.

In line with the above assumptions, preliminary estimates indicate that FY 1979 operating and maintenance costs will approximate 600K. An additional 200K of cost is anticipated for modifications necessary to accommodate scientific facilities and install additional life support systems.

In fiscal year 1980 modifications probably will be in the 25K range and costs for fuel, crew, drydocking, supplies and other support, are expected to approximate the '79 cost of 600K with an escalation of 8% for labor and 6% for material.

FY 198[illegible] UDGET
U. S. DEPARTMENT OF ENERGY
PACIFIC AREA SUPPORT OFFICE

Holmes & Narver Inc.
Pacific Test Division
Contractor

ADDITIONAL EXPLANATION FOR OPERATING COSTS
RESEARCH AND DEVELOPMENT AND PROCESS DEVELOPMENT ACTIVITIES

Date: February 15, 1978

12. Dates & Titles of Publications — None

13. Relationship to Other Projects — N/A

14. Progress in FY 19 — N/A

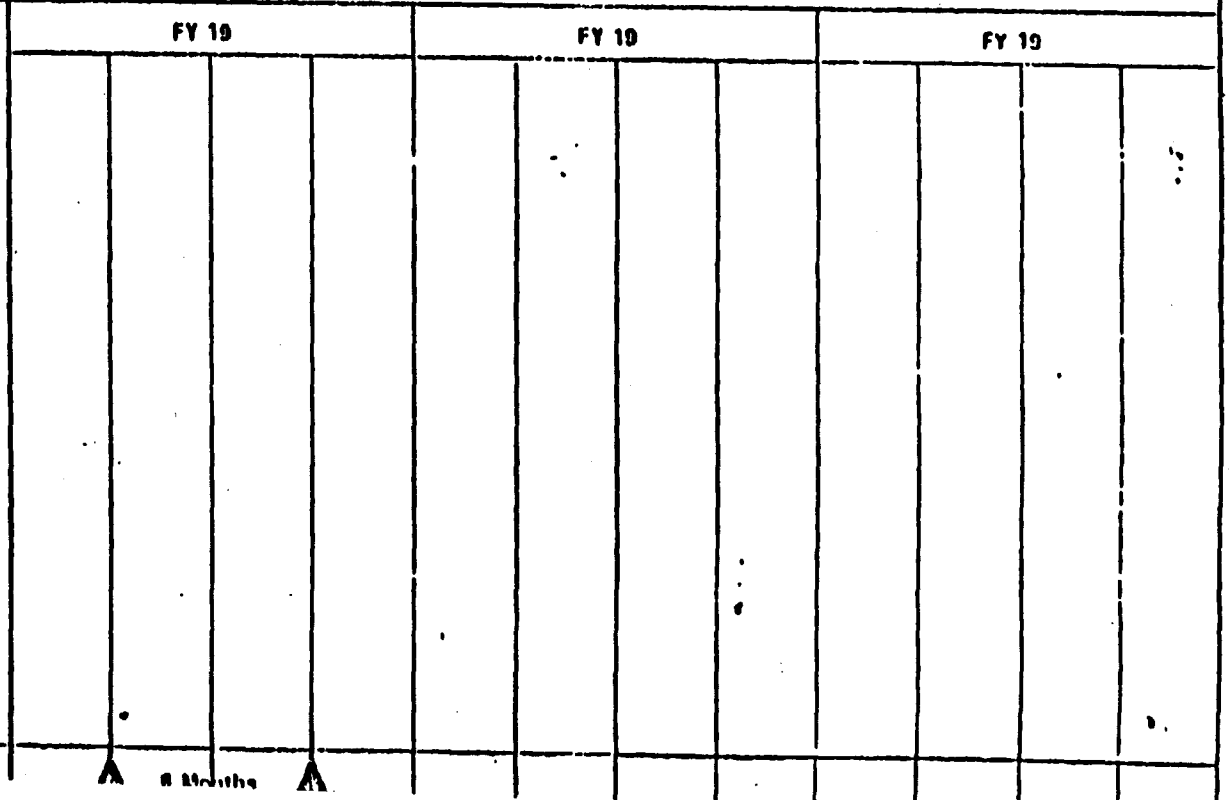
15. Expected Results in FY 19 — N/A

16. Expected Results in FY 19 — N/A

17. Proposed Obligations for Related Construction Projects — N/A

18. Project Milestone Chart

N/A



PRIVACY ACT MATERIAL REMOVED

001521

CONTINUATION RESEARCH PROPOSAL SUBMITTED TO THE
DEPARTMENT OF ENERGY

BY

UNIVERSITY OF HAWAII, HAWAII INSTITUTE OF GEOPHYSICS
2525 Correa Road, Honolulu, Hawaii 96822

"HYDROGEOCHEMISTRY OF ENEWETAK ATOLL"

Principal Investigator

NAME: Robert W. Buddemeier
TITLE: Associate Professor of Oceanography
SOCIAL SECURITY NO.:
DEPT. AFFILIATION: Department of Oceanography and
Hawaii Institute of Geophysics

New or Renewal Request: Renewal

Proposed Starting Date: 10/1/78-9/30/79 (FY 79) 10/1/79-9/30/80 (FY 80

Amount Requested: FY 79: $73,028 FY 80: 83,144

Proposed Duration: FY 79: 12 months FY 80: 12 months

Endorsements:

Principal Investigator	Department Head
Name Robert W. Buddemeier	Edward D. Stroup
Signature Robert W. Buddemeier	Edward D. Stroup
Title Associate Professor	Chairman
Telephone No. (808) 948-7169	(808) 948-7633
Date February 1, 1978	February 1, 1978

Institute Head	Institutional Admin. Official
Name Charles E. Helsley	Philip Helfrich
Signature Charles E. Helsley	Philip Helfrich
Title Director, HIG	Associate Dean, Research
Telephone No. (808) 948-8761	(808) 948-8658
Date	

PRIVACY ACT MATERIAL REMOVED

SCHEDULE 189

1. Contractor: University of Hawaii
   Contract No.: EY-76-C-08-0703

2. Project Title: Hydrogeochemistry of Enewetak Atoll

3. Budget Activity No.: N/A

4. Date Prepared: 1 February 1978

5. Method of Reporting: Annual & monthly fiscal reports & scientific literature

6. Working Locations: Enewetak, Marshall Islands; Honolulu, Hawaii

7. Person in Charge: Robert Buddemeier (Principal Investigator)

8. Project Terms: Continuation Project (present contract started from July 1, 1976)

9. Man Years

	FY 79	FY 80
Scientific		
R. W. Buddemeier	0.4	0.4
B. Tilbrook	1.0	1.0
TOTAL	1.4	1.4

10. Funding:

	FY 79	FY 80
Operating Costs:		
a. Direct salaries	10,710	11,245
b. Materials, services, & other direct costs	57,146	66,479
c. Indirect costs	5,162	5,420
TOTAL OPERATING COSTS	73,028	83,144
Capital Equipment	-0-	-0-

11. Reactor Concept: N/A

12. Materials: N/A

13. Publications: (Note: the following list contains only those not already reported in final form in previous 189 submissions)

1) R. W. Buddemeier and G. Holladay, "Atoll Hydrology: Island Groundwater Characteristics and Their Relationship to Diagenesis," p. 167-173 In Proceedings, Third International Coral Reef Symposium, v. 2, University of Miami, Florida, 1977.

2) R. W. Buddemeier, C. Gatrousis, and A. H. Bierman, "Alpha-Sensitive Cellulose Nitrate Track Detectors: Applications to the Study of Environmental Contaminations," submitted to the Plutonium Information Conference, NAEG, 1978.

3) R. W. Buddemeier and W. A. McConachie, "Fallout Tritium as a Long-Term Tracer for Atoll Soil-Water Processes," (abs.), submitted to the International Symposium on Isotope Hydrology, IAEA, 1978.

4) Hawaii Institute of Geophysics Data Report (in press, 1978).

14. Scope: The general objectives remain as stated in the initial proposal: the description and quantitative understanding of the hydrology and groundwater geochemistry of Enewetak Atoll, and the use of these results to interpret groundwater radioactivity in terms of leaching, cycling, transport and residence time models, both for the groundwater-soil-vegetation system of specific locales, and for the atoll as a whole.

The initiation of clean-up and rehabilitation operations has significantly altered the environment of Enewetak Atoll, and added new problems and opportunities for study. Specifically, the principal objectives for FY 78 will be:

1) Investigation of the effects of denudation of the islands on the hydrogeochemical regime. LLL (Noshkin) studies are expected to address the radiological aspects of the effects on ground- and soil water of the bulldozing and burn-off of the vegetation from Enjebi and other islands, while Robison's group continues to investigate vegetative recycling of radionuclides. The UH effort will be directed toward a study of alterations in the recharge rate of the groundwater, and chemical changes occasioned by lack of plant activity and the breaking of the plant-soil recycling path. Both of these may be expected to increase the leach rate of soil radionuclides, and the artificial denudation of the islands therefore represents an outstanding opportunity to investigate the recycling and leaching mechanisms.

2) Investigation of the effects of the Runit I. encryptment of radioactive scrap. In addition to monitoring the integrity of the containment, the encryptment will dramatically alter both the surface and subsurface hydrologic regimes of the island. Although direct study will probably have to await completion of the clean-up, we expect to be planning for this contingency during FY 78.

3) Monitoring the effects on water quality and subsurface storage caused by withdrawal of water from the airstrip wells on Enewetak (for laundry supply) and the Japtan wells used by the Enewetak people.

4) Monitoring chemical and hydrologic characteristics of selected existing and newly-installed wells as is deemed necessary for construction of the most useful model of atoll hydrology.

5) Continued evaluation of tide signals and water levels in the ocean and lagoon and on the reef to determine exterior forcing functions for island groundwater movement.

6) Incorporation of existing data and partial models into an overall model describing the hydrology, geochemistry and species residence times in the atoll environment, and ultimately predicting environmental half-lives for the various radionuclides in the different ecosystem "compartments."

Visits to Bikini atoll have provided valuable data on that location and have additionally provided extremely valuable opportunities to test and validate observations or models originating in the Enewetak study. We propose to continue such participation in any Bikini atoll survey/research visits.

With the loss of LCU support, we anticipate that major field trips to Enewetak will be made only 2 or 3 times per year; these will be supplemental, however, by the work of the on-site technician and occasional 1-2 man visits. Bikini trips will be undertaken when joint use of ships of opportunity is feasible.

15. Relationship to Other Projects: This project is directly integrated with the LLL Enewetak-oriented projects (V. E. Noshkin and W. Robison, P.I.'s). The total output of the combined projects is directed toward a complete description and predictive model of the biogeochemical cycles and processes controlling radionuclide distributions and transport in the atoll environment.

In addition, there is strong interaction between the hydrology aspect of this study and the DOE-funded lagoon circulation study (S. V. Smith and E. D. Stroup, P.I.'s), with both projects directly concerned with tidal characteristics and cross-reef transport of water and water-borne species. The two UH projects and the Robison LLL project currently support a joint-use field technician at Enewetak to provide ongoing support for all projects between major field trips.

Logistic support and scientific coordination is also shared with the Mid-Pacific Marine Lab.

16. Technical Progress in FY 1978: Because tropical storm Nadine inflicted significant damage on Enewetak during January, 1978 and forced cancellation of research trips scheduled during that period, FY 78 results are running approximately 3 months behind the anticipated schedule. It is questionable whether

this delay can be made up during the current FY. Accomplishments to date include: a) participation in a joint LLL-UH field trip to Bikini, where chemical and bacteriological water quality was tested for a variety of groundwater and cistern sources, and additional hydrologic observations were made as well as field tests of alpha-dosimetry films; b) a portable drilling system was purchased, assembled, field tested and shipped to Enewetak, where it awaits a field trip now rescheduled for March; c) ^{3}H and related data obtained over the course of the project has been assembled, interpreted, and is currently being written up for publication; and d) hydrologic modelling efforts have been intensified.

17. Expected Results in FY 1979: During FY 79 we expect to complete the drilling and basic hydrologic testing of the additional shallow wells designed to provide the necessary data for a refined hydrologic model of Enjebi island. As mathematical model development is already in progress, we expect that model refinement will yield publishable results in FY 79. On Enjebi and other islands we will obtain chemical, hydrologic, and radiological data on the groundwater changes associated with vegetation removal and other recharge surface alterations associated with cleanup. Plans, and if possible, preliminary experiments will be carried out to prepare to monitor the effects of the Runit I. scrap encapsulation on the surrounding reef, island and lagoon area. When the lagoon circulation study is completed we will integrate our island and lagoon tidal data with those results to provide a general but detailed description of the interactions between the island groundwater systems and tidal patterns in the ocean and lagoon. Continued monitoring of Enewetak I. and Japtan I. wells will provide practical estimates of the potential for long-term utilization of the fresh groundwater resources on these islands.

18. Expected Results in FY 1980: FY 80 will be the year of conclusion for most of the "normal" modelling and data interpretation efforts. However, field observation of stress responses and changes in the hydrogeochemical system as a result of cleanup, rehabilitation and resettlement will continue. The results of these observations will be used to test the models already developed, and to provide practical assessment of the effects of the various activities and their implications for the Enewetak people.

19. Description of Major Materials, Equipment & Subcontract Items: None

20. Proposed Obligations for Related Construction Projects: None

PRIVACY ACT MATERIAL REMOVED

DETAILED BUDGET

HYDROGEOCHEMISTRY OF ENEWETAK ATOLL

FY 79
1 Oct 78- 30 Sept 79

A.	Salaries and Wages		
	1. Principal Investigator, R. W. Buddemeier, SS# , full-time, 2 summer months	$	
	2. Graduate Assistant, B. Tilbrook, SS# . half-time, 12 months, (grade 1, step 2)		
	TOTAL SALARIES AND WAGES		$
B.	Fringe Benefits (2% of item 1, 6% of item 2)		456
C.	Total Salaries, Wages and Fringe Benefits		
D.	Expendable Supplies and Equipment		4,000
E.	Travel and Shipping		
	1. Research travel to Marshall I. Airfare, subsistence and shipping	7,500	
	2. Travel to W. Coast (LLL) for project coordination and consultation; airfare and per diem	1,200	
	3. Travel to scientific meetings; airfare and per diem	1,500	
	TOTAL TRAVEL AND SHIPPING		10,200
F.	Publication Costs		1,500
G.	Computer Costs		1,000

PRIVACY ACT MATERIAL REMOVED

PRIVACY ACT MATERIAL REMOVED

DETAILED BUDGET

HYDROGEOCHEMISTRY OF ENEWETAK ATOLL

		FY 80 1 Oct 79-30 Sept 80
A.	Salaries and Wages	
	1. Principal Investigator, R. W. Buddemeier, SS# , full-time, 2 summer months	$ ---
	2. Graduate Assistant, B. Tilbrook, SS# , half-time, 12 months, (grade 1, step 2)	
	TOTAL SALARIES AND WAGES	
B.	Fringe Benefits (2% of item 1, 6% of item 2)	479
C.	Total Salaries, Wages and Fringe Benefits	
D.	Expendable Supplies and Equipment	5,000
E.	Travel and Shipping	
	1. Research travel to Marshall I. Airfare, subsistence and shipping — 8,000	
	2. Travel to W. Coast (LLL) for project coordination and consultation; airfare and per diem — 1,500	
	3. Travel to scientific meetings; airfare and per diem — 2,500	
	TOTAL TRAVEL AND SHIPPING	12,000
F.	Publication Costs	2,000
G.	Computer Costs	1,000

PRIVACY ACT MATERIAL REMOVED

DETAILED BUDGET (continued)

	FY 80 1 Oct 79-30 Sept 80	
H. Other Costs		
1. Communications	300	
2. Shop costs	700	
3. Analytical and field sampling service fees	45,000	
TOTAL OTHER COSTS		46,000
(Note: A reorganization of the mechanisms for providing technical services--almost all chemical and isotopic analyses and many routine field sampling procedures--through the Research Corporation of the University of Hawaii has caused most routine work to be charged against projects on a fee-for-service basis; hence, the magnitude of budget item H-3.)		
TOTAL DIRECT COSTS		77,724
INDIRECT COSTS, 48.2% of $11,245		5,420
TOTAL BUDGET AMOUNT		$83,144

DETAILED BUDGET (continued)

		FY 79 1 Oct 78-30 Sept 79	
H.	Other Costs		
1.	Communications	200	
2.	Shop costs	800	
3.	Analytical and field sampling service fees	39,000	
	TOTAL OTHER COSTS		40,000
(Note:	A reorganization of the mechanisms for providing technical services--almost all chemical and isotopic analyses and many routine field sampling procedures--through the Research Corporation of the University of Hawaii has caused most routine work to be charged against projects on a fee-for-service basis; hence, the magnitude of budget item H-3.)		
TOTAL DIRECT COSTS			67,866
INDIRECT COSTS, 48.2% of $10,710			5,162
TOTAL BUDGET AMOUNT			$73,028

000661

CONTINUATION RESEARCH PROPOSAL SUBMITTED TO THE
UNITED STATES DEPARTMENT OF ENERGY

BY

UNIVERSITY OF HAWAII
HAWAII INSTITUTE OF MARINE BIOLOGY
P. O. Box 1346, Kaneohe, Hawaii 96744

PROPOSAL FOR CONTINUED MANAGEMENT OF THE MID-PACIFIC MARINE LABORATORY, ENEWETAK ATOLL, MARSHALL ISLANDS

Principal Investigator:

NAME: Ernst S. Reese
TITLE: Principal Investigator
SOCIAL SECURITY NO.:

New or Renewal Request: Renewal

Proposed Starting Date: 10/1/78 - 9/30/79 (FY 79) 10/1/79 - 9/30/80 (FY 80)

Amount Requested: FY 79: $254,708 Oper. Funds FY 80: $ 308,585 Op. Funds
$ 64,295 Cap. Equip Funds $ 64,000 Cap. Eq. Funds

Proposed Duration: FY 79: 12 months FY 80: 12 months

Endorsements:

Principal Investigator	Office of Research Adm.
Name Ernst S. Reese	Philip Helfrich
Signature Ernst S. Reese	Philip Helfrich
Title Principal Investigator	Associate Dean, Research
Telephone No. (808) 948-8617, 247-6631	(808) 948-8658
Date FEB 22 1978	

Institute Head

Name William R. Coops
Signature W R Coops
Title Interim Director
Telephone No. (808) 247-6631
Date FEB 22 1978

SCHEDULE 189

1. Contractor: University of Hawaii
   Contract No.: EY-76-C-08-0703

2. Project Title: Operations of the Mid-Pacific Marine Laboratory

3. Budget Activity No.: N/A

4. Date Prepared: 22 February 1978

5. Method of Reporting: Annual & monthly fiscal reports & scientific literature

6. Working Locations: Enewetak, Marshall Islands; Kaneohe, Hawaii

7. Person in Charge: Ernst S. Reese (Principal Investigator)

8. Project Terms: Continuation Project (present contract started from July 1, 1976)

9. Man Years

	FY 79	FY 80
a. Principal Investigator	1.0	1.0
Scientific Support	3.0	3.0
Research	1.0	1.0
b. Other Technical	0.0	6.75
TOTAL	5.0	5.75

10. Funding:

Operating Costs		
a. direct salaries	73,871	96,982
b. materials, services, & other direct costs	152,160	174,930
c. indirect costs	28,677	36,673
TOTAL OPERATING COSTS	254,708	308,585
Capital Equipment	64,295	64,000

11. Reactor Concept: N/A

12. Materials: N/A

13. Introduction to 1979-1980 Proposal:

This proposal covers a most important and challenging period in the operation of the Mid-Pacific Marine Laboratory, namely the transition from the current manner of operation, as reflected in the FY 79 budget, in which the MPML relies on Holmes and Narver for its life-support system, to the future status in which the laboratory must be self-sustaining in all aspects of its operation. This transition is scheduled to occur in mid-1980. Although it is impossible to identify all the exigencies which may arise, we have attempted to do so in the FY 80 budget and the supporting narrative sections of the proposal.

The proposal is different in another way as well. It introduces the plan that in the future the MPML will seek closer ties with appropriate agencies in Micronesia and will seek funding from agencies in addition to the U. S. Department of Energy, while at the same time continuing to provide a facility for the D.O.E. activities in the Marshall Islands and for continuing scientific research, both pure and applied, on all aspects of the natural history of the physical and biotic environments of atolls. These plans, of course, are dependent upon a successful transition to the stand-alone capability of the MPML during the latter half of 1980.

The management of the MPML has relied heavily on assistance from the D.O.E.'s Pacific Area Support Office and Holmes and Narver in estimating the scope of work and costs involved for converting the MPML facility to a self-sustaining unit.

A final thought, especially appropriate to this proposal, is that the name of the laboratory should be changed to the Mid-Pacific Research Laboratory to

more accurately reflect our broadened interest and concern for all aspects of the atoll environment. This suggestion will be made by the Director to the Scientific Advisory Committee at its next meeting.

14. Role of MPML after the "Clean-up" of Enewetak:

The "clean-up" of Enewetak Atoll is scheduled for completion in mid-1980. The question arises: What role will MPML play once the clean-up is completed and the Enewetak people have returned to justify its continued support by the Federal government through the auspices of the Department of Energy?

The continuing existence of MPML will provide a facility for surveillance and monitoring of the biota, including man, and the physical environment of the most intensively studied atoll in the world. More scientific base-line data exist for Enewetak than for Bikini. Eventually there will be a larger human population on Enewetak than on the other atolls affected in one way or another by the nuclear testing program. Furthermore, this population has not had previous exposure to radiation so that any subsequent effects which may appear must be traceable to the Enewetak environment. It is anticipated that the airstrip will be maintained which will make Enewetak accessible by air from Kwajalein and Majuro. Thus, the MPML will provide a window, so to speak, through which the situation in the Marshall Islands can be followed especially well.

Another role the MPML will play is in the area of service to the people of the Marshall Islands. Service will be in a number of forms. First is education. It is hoped to continue a program of teacher education which was started before the clean-up but is now in abeyance. Environmental protection, wisest and best management practices of limited resources, basic food

production and hygiene are stressed along with a growing awareness for a need for basic English language skills necessary for any development of trade and tourism. Second is to assist in solving problems. For example, the MPML currently is organizing a research effort aimed at the breadfruit blight and another one aimed at a better understanding of the processes involved in the production of atoll soils. A study of the availability of ground water is well underway at Enewetak. The findings of these studies should be applicable to other atolls as well. Surely, soil and fresh water are two of the most valuable terrestrial resources for the Marshallese. Support for this aspect of the laboratory's activities hopefully will be forthcoming from the Marshallese in the future and possibly from the Trust Territory Government in the interim. A precedent exists. The Micronesian Mariculture Demonstration Center in Palau receives support in the form of Japanese reparation funds released by the Trust Territory Government.

The third role is scientific research. More scientific work has been done at Enewetak than at any other atoll in the world. The published scientific papers alone fill four large volumes of collected reprints (the fourth volume is in preparation). Many papers on the coral reefs of Enewetak were presented at the recent International Conference on Coral Reefs held in Miami in June, 1977. If at all possible, this outstanding research should continue in the future. Additional areas of support, such as the National Science Foundation will be explored.

The fourth role is the establishment of an "Energy Park" in conjunction with MPML. It would serve as a demonstration center for alternate energy sources for the people of Micronesia. Certainly the future of these islands must be built on solar and wind power for electrical power for refrigeration,

air conditioning, lighting and desalinization of water. The cost of imported fossil fuels is simply prohibitively high for the economies of the Micronesian islands. This role is directly related to the long term goals of the DOE.

The development of the Energy Park proposal will be undertaken independently from MPML, but it will be physically located adjacent to the MPML and will supply energy to the laboratory.

15. Publications and Annual Reports:

MPML issued the first three volumes of collected reprints titled "Eniwetok Marine Biological Laboratory Contributions 1955-1974" in September, 1976. Volume four is in preparation. The Annual Report for FY 1976 is complete and work has begun on the Annual Report for FY 1977.

16. Missions, Scope of Activities, Research Areas, and Organization of MPML.

(a) Missions: The overall missions of the Mid-Pacific Marine Laboratory are under continual review and modification in order to respond to the concerns of the Department of Energy. The next extensive review will occur in spring of 1978 at the meeting of the Scientific Advisory Committee. The proposed new roles for MPML after the "clean-up", as outlined above (section 14), will be discussed carefully. At present the missions fall into four categories:

(1) Biology, Geology, Chemistry and Oceanography of the Atoll Environment

The study of the biological and physical parameters and processes operating in the atoll ecosystems should provide a better understanding of the mechanisms affecting the distribution, cycling, fixation, transfer and removal of radionuclides in atoll environments.

(2) Food Chains and Possible Radionuclide Pathways to Man

The study and evaluation of trophic pathways in the atoll ecosystem that ultimately lead to man, may provide significant information for the wisest and best use of the atoll's resources in order to block or minimize radionuclide uptake by man.

(3) Man's Place in the Atoll Ecosystem

To study those problems that will lead to a better utilization of the human and natural resources of the marine and terrestrial environment for the benefit of atoll inhabitants is a goal or mission which needs emphasis although its essence is incorporated in (1) and (2) above.

(4) Support to Investigators

MPML provides scientists with laboratory facilities, vessels, technical and logistical support, and advice and assistance for studying the unique characteristics of the atoll ecosystem. In addition, MPML maintains natural history records, physical descriptions, a scientific library, a reference collection of the local biota, and a weather station to facilitate specialized research efforts of visiting investigators. The MPML monitors levels of radioactivity when directed by DOE, and routinely records oceanographic and atmospheric phenomena to support studies aimed at a better understanding of long-range environmental trends.

All of the above missions are performed with due regard for the social, economic and cultural significance of the laboratory's presence in the

Marshalls island community. Every effort will be made to see that the investigators and the physical presence of the laboratory are positive influences upon the Marshallese society. The laboratory hopes to become increasingly responsive to their needs.

(b) Scope of Activities: MPML is closely allied to the operation of the Hawaii Institute of Marine Biology of the University of Hawaii at Manoa. The University of Hawaii provides the following:

(1) An active scientist to serve as Principal Investigator and Director with ultimate responsibility for the University of Hawaii's obligations under the contract with DOE. The University pays 9 months of the Director's salary while DOE pays the remainder.

(2) Advice and recommendations on the utilization of MPML facilities and resources to accomplish the missions of MPML.

(3) Review of research proposals with regard to their relevance to MPML objectives, technical feasibility of the proposed programs, scientific validity of the programs as they are presented, and the ability of MPML to provide logistic and material support. This is accomplished with the aid of the Proposal Review Committee.

(4) With the aid of the Scientific Advisory Committee, provides advice on present and future laboratory operation.

(5) Provides information and logistic support for investigators working at Enewetak.

(6) Publishes Annual Reports which summarize research undertaken through MPML and which provide information concerning the operation and progress of MPML.

(7) In accordance with approved budget and terms of the contract, procures supplies and equipment and maintains a supply inventory consistent with laboratory needs.

(8) Publicizes the MPML program and the attributes of Enewetak Atoll as a research site.

(9) Identifies gaps in knowledge about atoll environments, and suggests, designs, and coordinates programs needed to fill those gaps. Encourage appropriate research programs.

(10) Maintains liaison with D.O.E. and its PASO staff, in order to insure the efficient operation and utilization of MPML.

(c) Research Areas of MPML: Research areas that reflect the missions of MPML are as follows. Proposals in any of these areas are welcome.

(1) Quality research of any kind dealing with the physical as well as biotic atoll environment.

(2) Studies of water movements in the lagoon and immediately adjacent to the atoll. Extensive off-shore oceanographic studies are not at present possible; however, with the acquisition of a larger research vessel (currently being acquired) with adequate navigational equipment, it will be possible to extend the sphere of our operation to a radius of 25 to 50 miles from the atoll, should a need for this capability arise. Research within the lagoon will be greatly facilitated.

(3) Studies of trophic relationships will provide insights on pathways of radioactive contaminants to man. Such studies include selective up-take of radio isotopes by organisms and their cycling in the ecosystem, and the movements of organisms such

as important food fishes within the atoll.

(4) Studies relating to soils and the production of food on land. Included here are studies on ground water, soil producing microorganisms and the biochemistry of soil production.

(5) Studies dealing with any aspect of human ecology in the atoll ecosystem. These studies could range from socio-cultural to economic. They would, however, have to be carefully planned with the knowledge and acceptance of the Enewetak people.

(6) Studies dealing with agriculture and mariculture.

(7) Studies dealing with the development of alternate energy sources for atoll living.

(8) Studies dealing with global environmental assessment such as the measurement of man made contaminants, such as industrial wastes, in the atmosphere over remote oceanic locations, like Enewetak.

(d) Organization of MPML: MPML is faced with changing operational conditions that relate to the return of the people of Enewetak and the cleanup and rehabilitation activities. These events have dictated a realignment of the laboratory's missions and a change of emphasis in some of its programs. These are reflected in the previous section as well as in the introductory comments and those on the proposed future role of MPML (see sections 13 and 14 above).

There are two standing committees to assist in the planning and operation of the laboratory. The Scientific Advisory Committee provides for overall guidance on long-range planning as deemed

necessary by the DOE and the Director of the MPML. Under the current operating conditions, this committee includes, but is not restricted to, representatives from the DOE, the Director or Associate Director of Research of the University of Hawaii, the Administrator of RCUH, and other persons familiar with problems of Enewetak Atoll and the Marshallese people. The Proposal Review Committee includes persons familiar with both the scientific programs and the facilities at Enewetak and the possible problems that various kinds of programs may encounter. The committee has the flexibility to call on other disciplines in order to determine the merit of a given program. It is the committee's task to advise the Director on a continuing basis on proposals as to their (1) scientific merit, (2) relevance to the mission of MPML, (3) feasibility under current conditions at Enewetak, and (4) expected socio-cultural and environmental impact. On the basis of the committee's recommendations, the Director decides on the priority to be given to each research program.

In accordance with the new demands on the MPML operation, the following changes in personnel are reflected in the budgets for FY 79 and FY 80. The position of Scientific Project Coordinator is up-graded to reflect the increased responsibility of this job. The position of Research Associate is again requested. A new position, Facilities Maintenance Engineer, is proposed. Justifications for these positions are as follows.

(1) Scientific Project Coordinator (SPC)

As the MPML moves into its more diversified and hence complex

role, the job of the Scientific Project Coordinator (SPC) also becomes increasingly complex. This person essentially serves as an operations officer putting into effect the policies of the director, as they are developed in conjunction with the lab's Scientific Advisory Committee. In addition, the SPC must coordinate the sending out, evaluation and processing, of research proposals, and then arrange the scheduling and logistic support of those proposals which are approved by the Proposal Review Committee.

Experience has shown that to operate effectively in this position, the SPC should be a person with experience in both science and administration. In order to attract a qualified person it has been necessary to increase the salary so that it is appropriate to a person with a Master's or Doctoral degree in science with five to seven years experience in research and administration. Fortunately for MPML, due to the poor job market, persons with these qualifications are available.

A subject for discussion at the next MPML Scientific Advisory Committee meeting (which is tentatively being scheduled for late spring or early summer, 1978) will be the possibility of phasing out the part-time director and upgrading the Scientific Project Coordinator's job to that of full-time director. This person would have faculty affiliation with the University of Hawaii. Although there are pros and cons to this idea, it seems appropriate to the new, more independent "stand-

alone" capability of MPML after 1980. Furthermore, it will constitute a savings in the budget which will be an increasingly important matter.

(2) Research Associate

The Research Associate position was included in previous budgets but has not been funded. The position is again included in the present proposal. The justification for this position is to provide the MPML with the capability for carrying out in-house research in areas which are especially relevant to the needs of the Marshallese people. We wish to be responsive to their needs.

The position would be at a postdoctoral level and would be advertised nationally. Examples of the types of research the Research Associate would pursue are as follows: (1) Using sonic tagging techniques, the population dynamics of certain important food fishes, such as mullet, would be studied. Since mullet have been found to contain radioactivity, it is important to know the integrity of local populations and the extent of their movements. Similar data would be obtained for other species such as certain acanthurids and scarids (surgeon and parrot fishes) which are also important food species. This work would be closely coordinated with the University of Washington. (2) Giant clams of the genera *Tridacna and Hippopus* provide both food and valuable shells. The shells are prized as decorations. Recently it has been demonstrated that spawning can be induced experimentally and successful settling of the larvae and subsequent growth

in the laboratory are possible. Although most natural resources are in short supply, atolls do have extensive shallow water areas with lots of sunshine. These areas should be ideal nursery grounds for growing clams. The research would involve developing techniques for a form of mariculture particularly well suited for the atoll environment.

(3) Facilities Maintenance Engineer

The FY 80 budget reflects a new position: a Facilities Maintenance Engineer. The justification for this position is based on the need for a full time person to maintain the MPML facilities following the departure of all other personnel upon the completion of the clean-up in mid-1980. The salary figure is based on recommendations from Mr. Roger Loftfield of Holmes and Narver. He does not believe a competent man with the necessary skills can be gotten for less. We have requested .75 man years in 1980 on the basis that he will need 3 months to familiarize himself with the MPML facility before maintaining it on a fully operational self-sustaining basis.

Major operations will be the fueling maintenance of the generators, the effective maintenance and use of the water-catchment and cistern system, the upkeep and periodic use of a back-up fresh water supply system, routine maintenance of air conditioners, pumps, drying ovens, boats and motors, and a vehicle. To these tasks must be added maintenance, including corrosion control, and minor repair of the buildings. Obviously

this will require an individual with considerable innovativeness and mechanical, electrical and carpentry skills. Although the assistant laboratory manager will be able to assist him at times when there is not a heavy demand by visiting scientists, the laboratory manager must devote himself fully to providing research facilitation to visiting investigators. Both individuals must be responsible for the paperwork involved in their portion of the operation.

Since it is unlikely that one person will have the overall knowledge and skills to perform all the maintenance and repairs, another ½ man year is included for emergency specialized repairs. Such a person could be sent out to cover vacation periods of the full-time person.

At this time it is difficult to foresee how best to plan for this portion of the operation, and we will benefit from our initial efforts in 1980. We have tried to identify and budget for exigencies as we understand them now.

17. Relation of MPML to Other Projects:

(a) During FY 1977 and FY 1978, MPML activities have coordinated with several other major DOE-sponsored activities at Enewetak. Chief among these are:

(1) Hydrogeochemistry of Enewetak Atoll (U.H. and LLL). Dr. Robert Buddemeier is the scientist in charge.

(2) Enjebi farm project (LLL). Dr. William Robison is the scientist in charge.

(3) Enewetak/Bikini ciguatoxic fish surveys (U.H.). This program terminated in FY 1977.

(4) Marshall Island Research Vessel Program (PASO). Since the Liktanur is no longer available, programs are being supported by the use of Trust Territory ships to the extent possible and PASO is working on obtaining a replacement vessel.

(5) Enewetak Lagoon Circulation Study (U.H.). Drs. Stephen Smith and Richard Stroup are the scientists in charge.

18. Progress in FY 1977 and FY 1978.

(a) Laboratory operation has continued on a year-round basis. In January, 1978, the laboratory moved to the former Coast Guard facility at the north end of Enewetak Island. Renovation of the former Coast Guard buildings is under way. It was not completed at the time of the move due to storms in December, 1977 and January, 1978. We will be fully operational by mid-March, 1978.

(b) In addition to the resident laboratory manager and assistant, there is a resident technical assistant funded through LLL to work on the Enjebi farm program.

(c) Upgrading of supplies, equipment, the library, and the biological reference collection continues.

(d) Two audio-visual slide shows have been completed. The first entitled "The Mid-Pacific Marine Laboratory - 1978" provides an account of the operations of MPML since its inception. The second show entitled "Enewetak Atoll - its Natural History" was developed as a service to the Defense Nuclear Agency.

(e) MPML personnel will continue to provide advice and information as it relates to conservation at Enewetak and the Marshall Islands, general

atoll ecology, and other matters related to the cleanup of Enewetak Atoll and resettlement of its people.

19. Expected Results in FY 1979 and FY 1980.

This period is expected to present special challenges to the MPML operation in relationship to the return of the people of Enewetak to their ancestral home and the massive cleanup operations now underway. It is expected that MPML will provide continuing information on the atoll's biota, lagoon circulation, ground water dynamics, aquatic hazards, etc., that will be needed during the cleanup and rehabilitation operations. The second slide show is an example of the kind of informational services we can provide.

Due to budgetary constraints in the face of rising travel and subsistence costs, we anticipate changing the MPML mode of operation somewhat. The laboratory will reduce the number of individual investigators supported by MPML funds by requesting investigators to make a longer time commitment to their research at Enewetak. Since priority will be given to support research most closely identified with DOE interests, we feel that the net result will be a productive program of research relevant to the goals of MPML.

20. Description of Capital Equipment Items for FY 79.

(1)	Mako SCUBA Diesel Compressor, Model KA51-DH	$ 3,295.
(2)	"Outrage" 21' Boston Whaler with center console and accessories, or equivalent Radon hull (replacement)	10,000.
(3)	Johnson 140 hp motor, or diesel equivalent (replacement)	3,000.
(4)	Boat Trailer for 21' "Outrage" or equivalent (replacement)	1,500.

(5)	17' Boston Whaler with steering console and accessories (replacement)	5,000.
(6)	Johnson 35 hp motor (replacement)	1,500.
(7)	Electrophoretic equipment (supplemental to existing equipment)	10,000.
(8)	Underwater Communication System (underwater event recorder, "wet phones," "wet beacon," "wet finder" - ultrasonic communications system subsurface system with subsurface to surface capabilities)	4,000.
(9)	Salinity/temperature/trasmissivity/0_2 meter	16,000.
(10)	Tide Level Recorder (2 @ 3,000.) (replacement)	6,000.
(11)	Refrigerator-Reefer (for chemical isolation)	1,000.
(12)	Vacuum/Drying Oven, thermoregulated (replacement)	1,000.
(13)	Calorimeter	2,000.
	Total	$64,295.

Justification of Major Equipment Items

The portable, diesel compressor is a back-up for our present air compressor and in addition it can be used aboard the research boat which is being acquired. The use of diesel fuel is desirable both from the standpoint of shipboard use and our efforts for energy conservation in FY 1980 and beyond.

Items 2 through 6 are replacements. Efforts are being made to replace high performance outboards with diesel powered work hulls. So far a suitable substitute, with the possible exception of the new Radon hull designed boat, has not been found. Consequently, the Boston Whaler "Outrage" remains our "safest bet" at this time. Regardless of our conversion to more serviceable diesel powered boats, two 17' Boston whalers with 35 hp conventional outboard motors should be maintained for near-shore work in the southeast corner of the

atoll adjacent to the laboratory.

The remaining items are all standard research equipment items necessary for the kinds of research projects which are carried out at the MPML. An exception is the Underwater Communications System. In view of the extensive amount of underwater research being conducted at MPML, acquisition of this system would be of great potential benefit. The subsurface to surface communication capability would be particularly useful. The "wet beacon" and "wet finder" hardware would enable a diver to mark a particularly important area and then return to it for subsequent work.

Capital equipment items for FY 80 are not included in this proposal. In part this is because we will have a much better idea of our needs as we begin operation in our new quarters in the former Coast Guard buildings, and, second, there will be accessories needed for the complete operational effectiveness of the new research boat. Thus, the figure given on page 1 of this proposal should be viewed as an estimate only.

21. Operations Budgets for FY 1979 and FY 1980.

FY 1979 - 1 October 1978 through 30 September 1979

A.	SALARIES AND WAGES	
	Operational Staff:	
	1. Director	$ 8,273
	2. Scientific Project Coordinator	17,652
	3. Laboratory Manager	14,416
	4. Assistant Laboratory Manager	11,162
	5. Casual Help (2,080 hrs @ $3.90/hr)	8,112
	Research Staff:	
	1. Research Associate	14,256
	TOTAL SALARIES AND WAGES	73,871
B.	FRINGE BENEFITS (23% on full-time employees and 2% for casual help & summer overload)	13,550
C.	TOTAL SALARIES AND WAGES AND FRINGE BENEFITS	87,421
D.	EXPENDABLE SUPPLIES & OPERATING EQUIPMENT LESS THAN $500	23,500
E.	TRAVEL AND SUBSISTENCE	
	Staff Travel:	
	1. Director (1 RT HNL-Wash DC-Las Vegas @ $650) (1 RT HNL-Majuro-Saipan @ $450) (4 RT HNL-Enewetak @ $300 ea)	2,300
	2. Scientific Project Coordinator (1 RT HNL-Wash DC-Las Vegas @ $650) (2 RT HNL-Enewetak @ $300 ea)	1,250
	3. Laboratory Manager (3 RT HNL-Enewetak @ $300 ea)	900
	4. Assistant Laboratory Manager (3 RT HNL-Enewetak @ $300 ea)	900

5. Research Associate (3 RT HNL-Enewetak @ $300 ea)	900
6. Administrative Assistants - 2 (4 RT HNL-Enewetak @ $300 ea)	1,200
Staff Subsistence:	
1. Director (per diem 17 days @ $40/day) (per diem 48 days @ $12/day)	1,256
2. Scientific Project Coordinator (per diem 10 days @ $40/day) (per diem 16 days @ $12/day)	592
3. Laboratory Manager (per diem 300 days @ $12/day)	3,600
4. Assistant Laboratory Manager (per diem 300 days @ $12/day)	3,600
5. Research Associate (per diem 300 days @ $12/day)	3,600
6. Administrative Assistants - 2 (per diem 64 days @ $12/day)	768
TOTAL STAFF TRAVEL & SUBSISTENCE:	20,866
Research Support Travel and Subsistence:	
1. Travel	54,000
2. Subsistence (50 wks x 2.5 persons/wk = 125 man weeks x $84/wk = 10,500)	10,500
TOTAL RESEARCH SUPPORT TRAVEL & SUBSISTENCE:	64,500
GRAND TOTAL TRAVEL & SUBSISTENCE:	85,366
F. PUBLICATIONS COSTS	5,400

G. OTHER DIRECT COSTS

1. Consultants (taxonomic, reference collection, library, other)	5,400
2. Communications (maintenance of communications system by UH-HIG personnel)	5,184
3. Miscellaneous (services, repairs, etc.)	4,100
4. Film: Importance of Pure to Applied Science	6,000
5. Generator maintenance/operation (12 man dys x $50/day)	600
6. Routine building maintenance	1,700
7. Users fees (to HIMB) (4% of on campus salaries)	1,360
TOTAL OTHER DIRECT COSTS	24,344
TOTAL DIRECT COSTS	226,031
Indirect Costs (on campus = 48.2% x 34,037) (off campus = 31.68% x 39,834)	28,677
GRAND TOTAL BUDGET AMOUNT	$ 254,708

FY 1980 - 1 October 1979 through 30 September 1980

A.	SALARIES AND WAGES	
	Operational Staff:	
	1. Director	$ 8,769
	2. Scientific Project Coordinator	18,711
	3. Laboratory Manager	15,281
	4. Assistant Laboratory Manager	11,832
	5. Casual Help (40 hrs/wk x 52 wks = 2,080 manhrs x 4.10 hr)	8,528
	6. Facilities Maintenance Engineer (.75 manyrs @ $25,000/yr = $18,750)	18,750
	Research Staff:	
	1. Research Associate	15,111
	TOTAL SALARIES AND WAGES:	96,982
B.	FRINGE BENEFITS	
	1. Regular payroll (23% on full-time employees & 2% for casual help & summer overload)	18,674
C.	TOTAL SALARIES AND WAGES AND FRINGE BENEFITS	115,656
D.	EXPENDABLE SUPPLIES & OPERATING EQUIPMENT LESS THAN $500	28,000
E.	TRAVEL AND SUBSISTENCE	
	Staff Travel:	
	1. Director (1 RT HNL-Wash DC-Las Vegas @ $700) (1 RT HNL-Majuro-Saipan @ $450) (4 RT HNL-Enewetak @ $350 ea.= $1,400)	2,550
	2. Scientific Project Coordinator (1 RT HNL-Wash DC-Las Vegas @ $700) (2 RT HNL-Enewetak @ $350 ea = $700)	1,400
	3. Laboratory Manager (3 RT HNL-Enewetak @ $350 ea = $1,050)	1,050
	4. Assistant Laboratory Manager (3 RT HNL-Enewetak @ $350 ea = $1,050)	1,050

5. Facilities Maintenance Engineer (2 RT HNL-Enewetak @ $350 ea = $700)	700
6. Research Associate (3 RT HNL-Enewetak @ $350 ea = $1,050)	1,050
7. Administrative Assistants - 2 (4 RT HNL-Enewetak @ $350 ea = $1,400)	1,400
Staff Subsistence:	
1. Director (per diem 17 days @ $40/day = $680) (per diem 48 days @ $12/day = $576)	1,256
2. Scientific Project Coordinator (per diem 10 days @ $40/day = $400) (per diem 16 days @ $12/day = $192)	592
3. Laboratory Manager (per diem 300 days @ $12/day =$3,600)	3,600
4. Assistant Laboratory Manager (per diem 300 days @ $12/day = $3,600)	3,600
5. Facilities Maintenance Engineer (per diem 180 days @ $12/day = $2,160)	2,160
6. Research Associate (per diem 300 days @ $12/day = $3,600)	3,600
7. Administrative Assistants - 2 (per diem 64 days @ $12/day = $768)	768
TOTAL STAFF TRAVEL AND SUBSISTENCE:	24,776
Research Support Travel and Subsistence:	
1. Travel	57,000
2. Subsistence (50 wks x 2.5 persons/wk = 125 manwks. x $84/wk = $10,500)	10,500
TOTAL RESEARCH SUPPORT TRAVEL SUBSISTENCE:	67,500
GRAND TOTAL TRAVEL & SUBSISTENCE:	92,276

F. PUBLICATION COSTS	5,800
G. OTHER DIRECT COSTS	
1. Consultants (taxonomic, reference collection, library, other)	5,800
2. Communications (maintenance of communications system by UH-HIG personnel)	5,500
3. Generator maintenance/operation (1st 6 mos.)	300
4. Routine building maintenance (1st 6 mos.)	850
5. Power generation (22,000 gals/half-yr x .45 gal x 1.1 x 1.5 + 5% for lube oil, parts, etc.)	12,700
6. Surface transportation (fuel = 70 drums/mo = 15 measure tons x $20 = $300/mo = $1800/half-yr.) (subsistence = 7 measure tons/mo x $20 = $140/mo = $840/half-yr.) (misc. = 5 measure tons/mo x $20 = $100/mo = $600/half-yr.)	3,240
7. Backup water supply (half-yr)	350
8. HIMB User's Fees (4% of on campus salaries)	1,440
TOTAL OTHER DIRECT COSTS	30,180
TOTAL DIRECT COSTS	271,912
Indirect Costs (on campus 48.2% x 36,008 + $17,356) (off campus 31.68% x 60,974 = $19,317)	36,673
GRAND TOTAL BUDGET AMOUNT	$308,585

Justification of Changes and Additions to the Operating Budgets.

Excepting for the up-grading of the Scientific Project Coordinator's position, the request for funding for the Research Associate position, and the new Facilities Maintenance Engineer position (see 16.d.1,2,3), the educational documentary film (requested in the FY 79 budget), and the laboratory user's fees, all the changes and additions are related to the "stand-alone" capability of the MPML after mid-1980. Costs for fuel consumption, travel and subsistence must be viewed as "best estimates" at this time. The following statements should further clarify these additions.

(1) Educational Documentary Film

In the future, as the MPML seeks to gain support from granting agencies in addition to the DOE. it will become increasingly important for the laboratory to tell its history of supporting both pure and applied research and how the "best" results from a fruitful mixture of the two broad areas of research. For example, applied agriculture methods for relatively poor atoll soils may have their basis in pure research on soil microorganisms, or the development of giant clam mariculture may be based on pure research on larval settlement and growth.

This problem was discussed with Dr. Richard A. Boolootian, President of Science Software Systems, Inc., a Los Angeles based company which specializes in audio-visual materials for education in science and medicine. Dr. Boolootian is a scientist, he knows Enewetak, and he has helped us with our two recent audio-slide shows "Mid-Pacific Marine Laboratory Briefing 1978" and "Enewetak - the Natural History of an Atoll." He believes that a short 16mm motion picture film would be the most effective way to

graphically tell our story of "pure research in support of applied research." The nature of this film would be such that it would have wide applicability and could be used by other organizations within the D.O.E. as well. The amount of $6,000 requested in the FY 79 budget is an estimated top-side figure. We will not exceed that amount.

(2) Laboratory Users Fees.

The "parent organization" for the MPML within the University of Hawaii has always been the Hawaii Institute of Marine Biology (HIMB). This has been a productive relationship with a number of investigators carrying out comparative research at both laboratories. Indeed, in the world of coral reef biology, the two laboratories are often thought of as the best locations to work on tropical Pacific reefs. The MPML office in Hawaii is located at HIMB and all of our operations are conducted from this location. We derive many benefits directly from HIMB in the form of secretarial and bookkeeping services, shipping and handling of supplies and equipment, and general support of the MPML office - supplies, electricity, etc.

Recently, the HIMB instituted user's fees to help meet costs. The fees are based on 4% of on-campus (in Hawaii) salaries. The estimated amounts are shown under the category of Other Direct Costs in the FY 79 and FY 80 budgets.

(3) Administrative and Maintenance Assistance.

Traditionally two persons from the Hawaii Institute of Marine Biology have gone to Enewetak twice each year to assist in the biannual inventories of equipment and supplies, including chemicals and radio isotopes, and to

help with repairs, maintenance and minor renovations of the laboratory. These four visits (two each for two persons) are two weeks in duration. In the past the funds for this travel and subsistence were included in the manager's costs. However, in order to identify our costs more effectively, we have placed them in a separate budget category entitled "Administrative and Maintenance Assistance."

It is probable that during the latter half of 1980 and thereafter, when a full time maintenance man is hired, it will no longer be necessary to schedule and budget for this assistance.

(4) Expendable Supplies and Operating Equipment.

The increase in this budget category in FY 80 is based on planning discussions with D.O.E. and Holmes and Narver personnel in regard to the "stand-alone" capability of the MPML beginning in mid-1980. They recommend that a spare parts inventory be developed during the first six months of 1980 when regular freight flights are still available to Enewetak.

(5) Generator Operation and Maintenance and Routine Building Maintenance.

These are shown as separate budget categories in both the FY 79 and FY 80 budgets. Their justification is based on the need to operate and maintain the two large generators, and to purchase materials and labor, when necessary, for routine building maintenance. The estimated amounts are for the full 1979 year but only 6 months of 1980, since a full time maintenance man will be hired for the latter half of 1980 and thereafter. The estimates are based on figures from Mr. Roger Loftfield, an engineer with Holmes and Narver. Mr. Loftfield knows the MPML operation and is most helpful.

(6) Power Generation and Surface Transportation.

These are shown as separate budget categories in the FY 80 budget. They represent the cost of diesel fuel for the generators and shipping and handling of same for the second six months of 1980 when MPML will be operating on a stand alone capacity. Diesel fuel will thus no longer be available through Holmes and Narver at that time. The estimates are based on figures from Mr. Roger Loftfield, an engineer with Holmes and Narver.

(7) Backup Water Supply.

This category in the FY 80 budget is based on the probability that, over a year's time, it will be essential to periodically produce water to supplement the monthly rainfall catchment. The estimate considers the use of an Aqua Chem unit and is based on figures prepared by Mr. Roger Loftfield, an engineer with Holmes and Narver.

(8) Travel and Subsistence.

It is important to consider that air fare estimates for FY 80 are based on present MAC costs and that MAC will no longer be flying to Enewetak in the last six months of FY 80. Accessibility to MPML for the latter part of FY 80 is thus dependent on the establishment of reasonably priced air travel between Kwajalein and Enewetak, via commercial carrier of some type. Costs are highly speculative and it is essential to have some financial flexibility in this area.

Similarly, the per diem food cost at Enewetak of $12/day, used for both the FY 79 and FY 80 budgets, is based on present costs which have been held quite constant. What will happen to these costs in the latter

half of FY 80 is also highly speculative. Conceivably, the cost of serving a much smaller group could result in significantly higher costs per person. Also the logistics of food preparation are uncertain. Financial flexibility is essential in this area also.

001508

SCHEDULE 189

Lawrence Livermore Laboratory
University of California
Livermore, California

[X] Environment
[ ] Life Science Research Biomedical Applications

1. CONTRACTOR: University of California, Contract #W-7405-eng-48

2. PROJECT TITLE: Biogeochemical Cycling of the Transuranics and Other Radionuclides in the Marshall Islands

2c. RPIS No. 001508

2b. ABSTRACTED TITLE: Marshall Islands - Transuranics

2d. 189 No. LLL/ASEV-80-43

3. BUDGET ACTIVITY NO.:	4. DATE PREPARED:	5. METHOD OF REPORTING:	6. WORKING LOCATION:
GK-01-02-03-01	March 1978	Annual	Livermore, California

7a. PERSON IN CHARGE: M. L. Mendelsohn/E. M. Morimoto

7b. PRINCIPAL INVESTIGATOR: V. Noshkin

8. PROJECT TERM: Continuing

9. MAN YEARS:

	FY 78	FY 79 Pres. Budget	FY 79 Reprog.	FY 79 New	FY 79 TOTAL	FY 80
(a) Scientific	4.8	4.5	0	0	4.5	4.5
(b) Other Technical	0.9	0.9	0	0	0.9	0.9
Total	5.7	5.4	0	0	5.4	5.4

10. FUNDING (Thousand $):

	FY 78	FY 79 Pres. Budget	FY 79 Reprog.	FY 79 New	FY 79 TOTAL	FY 80
Operating Costs:						
(a) Manpower	158	167	0	0	167	180
(b) Materials, Services, etc.	70	76	0	0	76	92
(c) Indirect Expenses	122	128	0	0	128	138
Total Operating Costs	350	371	0	0	371	410
Capital Equipment not Related to Construction	23	49	0	0	49	40

11. REACTOR CONCEPT: Not Applicable

12. MATERIALS: Not Applicable

13. PUBLICATIONS:

1. V. Noshkin, "Transuranium Radionuclides in Components of the Benthic Environment of Enewetak Atoll," prepared for DOE publication, Transuranic Elements in the Environment, W.C. Hanson, Ed. (1978).

2. K.W. Wong, G.S. Brown, and V.E. Noshkin, "A Rapid Procedure for Plutonium Separation in Large Volumes of Fresh and Saline Water by Manganese Dioxide Coprecipitation," J. Radioanal. Chem. 42, 7 (1978).

3. R.B. Spies, K.V. Marsh, and J. Colsher, "Dynamics of Radionuclide Exchange in the Calcareous Algae, Halimeda," submitted to Liminol. and Oceano. (1978).

4. K.M. Wong, V.E. Noshkin, and T.A. Jokela, "Preconcentration of Plutonium Radionuclides from Natural Waters," prepared for presentation at Annual Plutonium Information Conference of the Nevada Applied Ecology Group, February 28 - March 2, 1978.

14A. SCOPE ABSTRACT:

The objective of this study is to develop an understanding of the transport rates and redistribution mechanisms of radionuclides (emphasizing the transuranium elements) in biogeochemical processes occurring at the Marshall Islands. We require this knowledge to develop recommendations for minimizing the passage of radionuclides to human populations, to evaluate the cycling of radionuclides through critical processes essential for the establishment and continuity of life at the atolls, to develop a fundamental data base from these contaminated environments that will be used to predict future transuranic impacts on the aquatic environment from different global sources (i.e., reactors, reprocessing facilities, and accidents), and to furnish data and recommendations to assist in providing usable sources of groundwater for future generations at the atoll. Because of the relatively high plutonium levels in the marine environments of Enewetak and Bikini, these locations are unique ecosystems from which reliable data can be generated on several processes that regulate the recycling and rate of movement of plutonium. Especially critical to these topics are some of our recent assessments that reveal that the atolls may be the only global locations where plutonium intake via ingestion (rather than inhalation) contributes the major fraction of man's plutonium body burden.

14B. SCOPE:

The general objectives of this project are outlined above in the abstract. During FY 1978, the DBER-funded LCU for Marshall Island research activities supported our effort at Bikini during the period 11 to 29 November 1977. Eight man-weeks of effort were devoted to the

program. Since the Liktanur is out of operation, we had scheduled a trip to Enewetak in late January 1978 using island support. However, a local storm damaged many aspects of site operations forcing us to reschedule this trip to March 1978.

In FY 1975 we initiated detailed radiological studies of the hydrology and groundwater geochemistry at Enewetak and Bikini. These first detailed investigations of their kind at the atolls, have given us new insights into the transport mechanisms and cycling rates of radionuclides between the terrestrial and aquatic environments. The circulation and redistribution processes of plutonium and other radionuclides are investigated by interpretive analysis of radiochemical and physical data from the lagoon environment. Plutonium levels in the environment and organisms are being compared to distribution in species and environments that receive plutonium from other sources, including world-wide fallout, reactors, reprocessing facilities, and Thule. Biological samples are carefully analyzed to determine the radionuclide distributions in body tissues and to calculate the relevant concentration factors.

15. RELATIONSHIP TO OTHER PROGRAMS:

The Enewetak and Bikini groundwater programs are carried out in close cooperation with R. Buddemeier (University of Hawaii); Buddemeier is conducting a program to investigate the cycling of the major elements and nutrients in the groundwater. Data generated from his studies have been helpful in our interpretation of the radionuclide cycling in the island groundwater.

There is also a close relationship between the groundwater and marine studies and the LLL agricultural experiments (Marshall Island Radioecology, 189 No. LLL/ASEV-80-63) and assessment program. The loss of the R.V. Liktanur forced us to modify our field efforts for this next year. Presently we are exploring ways to coordinate our program and the agricultural project to fulfill program requirements at the atolls with minimum ship-time support. The advantage in dollar savings is obvious; and it requires now only to work out problems related to logistics.

Our programs provide significant data in support of the rehabilitation efforts at the atolls. We have provided data and assessments relevant to cleanup operations at Enewetak and will continue to do so whenever our data are needed. Last year, we fulfilled DOE-DNA requests for information related to the disposal of the remains from the multistory structure on Enjebi, the impact of soil disposal on Northern Runit and the marine environment, the radioactive hazards created by removing underwater cables from Enewetak, the establishment of a meaningful sampling program for the proposed multi-atoll survey, and the review of plans for plutonium cleanup at Enewetak Atoll.

The first Marshall Island workshop was organized and hosted at LLL in June 1977 to discuss long-range planning for the DOE Marshall Island programs. An open exchange of information between all program participants provided a valuable overview of the radiological problems presently being investigated and those remaining to be studied.

In early summer of 1978, we plan to participate in a Woods Hole Oceanographic Institution (WHOI) cruise to the Marshall Island region. Along with Dr. V.T. Bowen of WHOI, we will conduct a variety of plutonium biogeochemical studies in several regions around the atolls.

16. TECHNICAL PROGRESS IN FY 1978:

We completed the publications listed in Sec. 13, and, with the data generated by FY 1977, we began writing several other documents describing the results of our Marshall Islands program. These reports, in various stages of completion, include the following:

- Renewal Rates of Cactus Crater Water. We describe the use of rhodamine dye to estimate the tidal flushing characteristics of Cactus crater. A simple model is developed to explain the water residence time as well as the fate of the crater water and its dissolved constituents. Cactus crater is being considered as the disposal site for radioactive waste accumulated during cleanup operations. The results of this study permit us to evaluate the impact and fate of any radionuclides remobilized to solution in the groundwater after the crater is filled.

- Remobilization of Plutonium Radionuclides from Cactus Crater Sediments at Enewetak Atoll. Data related to the rate of plutonium remobilization from sediments to the water are provided. The remobilized plutonium has solute-like behavior, passing readily through 0.45-μm nucleopore filters and dialysis membranes, and can be traced in solution for considerable distances along the reef.

- Plutonium Concentrations in Reef Fish at Enewetak and Bikini Atolls. We compare concentrations in mullet tissue samples from different locations at both atolls. Plutonium available to man from the aquatic environment should be most highly concentrated in food organisms with the smallest number of plutonium transfers between abiotic sources and man. Mullet are inshore fish and in their adult stage feed on detritus extracting organic matter from sediments. This species is an excellent indicator since the plutonium levels in mullet would be expected to be highest among reef fish commonly caught. Concentration factors, isotopic ratios in the tissues, and other relationships between plutonium concentrations in fish and in the environment are discussed. Concentrations in fish at Bikini differ from those at Enewetak but the average

concentration factor for plutonium in fish muscle is similar at both atolls. Thus plutonium concentrations determined in fish at one atoll can be used to predict levels at other atolls.

- Gamma-Emitting Radionuclide Concentrations in the Reef Fish, Mullet, from Enewetak and Bikini. We describe radionuclide concentrations, other than the transuranics, in fish tissue at the atolls. Bikini mullet have higher ^{137}Cs levels associated with muscle tissue than average values found for Enewetak fish. The mean ^{60}Co levels in muscle tissue of fish from both atolls is similar, and the highest concentrations are associated with reproductive organs. In addition, ^{207}Bi levels in Enewetak fish exceed those in comparable fish tissue at Bikini, whereas levels of ^{102m}Rh above detection limits are found in fish from the islands of Enidrik and Iroij of the Bikini Atoll.

- Residence Time of Radionuclides in the Groundwater of Enewetak Atoll. Results are summarized on the rates of radionuclide recharge and migration in the groundwater at islands of Enewetak Atoll. The chemical characteristics of plutonium remobilized to groundwater solution are different from those of plutonium found in solution in the lagoon.

- Radionuclides at Pacific Atolls - Concentrations in the Sedimentary Components and Benthic Organisms at Enewetak and Bikini. We report on all available radionuclide data for sediment cores, surface sediments, and benthic organisms. Much of the data presented in our report for the forthcoming DOE publication Transuranic Elements in the Environment (see Sec. 13) were derived from this document.

- An Improved Thiocyanate Anion-Exchange Procedure for the Separation of Americium from the Rare Earths. We describe a pressurized separation procedure developed in 1977 that requires less than 2 h to purify americium from 10 to 50 mg of rare earths with an average recovery greater than 90%.

- Assessment of Potential Dose to Populations from the Transuranic Radionuclides at Enewetak Atoll. This is an expanded report of an assessment requested by DBER in 1977 and written with W. Robison and W. Phillips, describing the expected transuranic doses to population from the various pathways at the atolls. Data from our work on plutonium concentrations in mullet at Bikini and Enewetak Atolls were used to evaluate the potential dose via the marine foodchain. As a result of a more detailed and careful analysis, computed plutonium doses from the marine food chain were revised to well below the levels established during the 1972 radiological survey.

Several of these reports will be completed this year; the remainder (and some not listed above) will be nearly finished in FY 1979.

During November 1977, we resampled ground and cistern water at Bikini to evaluate the environmental residence times of several radionuclides. The main supplies of cistern drinking water were contaminated with coliform bacteria. This was reported hastily to DBER and Trust Territory officials, who will have health officers investigate the source of contamination. Air samplers were established and operated on the ocean reef at Bikini and Eneu Islands. This effort was motivated by our inability to explain reasonably the higher-than-fallout plutonium concentrations in Bikini cistern waters and on the catchment roofs supplying the cisterns. We must determine if the higher concentrations result from airborne plutonium particulates injected into the atmosphere as marine aerosol aggregates by wind and wave action on the ocean reef. Water and suspended material were also collected from the reef near the air samplers for comparative anlaysis. The samples are still being analyzed.

Our planned trip to Enewetak in January 1978 was cancelled because storm damage now limits site operations; the trip is rescheduled for March 1978.

17-18. EXPECTED RESULTS IN FY 1979 AND FY 1980:

The WHOI joint cruise to the equatorial Pacific currently is scheduled for 18 June to 13 July 1978. Sampling locations are established and are concentrated along the trajectories of the major fallout clouds so we can study the history of down-wind, down-current distributions of the close-in fallout. A major water sampling program is planned and more samples than one laboratory can handle adequately will be collected for analysis. Water from closely spaced depths off the bottom will be analyzed to determine if remobilization from bottom sediments is occurring. These results should benefit evaluations of any disposal procedures for radioactive wastes into the deep ocean. A number of sediment cores will provide data on redistribution processes of surface-deposited, close-in fallout debris. Manganese nodules, plentiful in certain regions that received high levels of close-in fallout, will be collected for anlaysis to determine if fallout radionuclides were incorporated in the nodules. This study should provide significant information about the growth rates and processes of these deep sea nodules.

Our recent data from fish show a large discrepancy with the result reported on plutonium in fish during the 1972-1973 survey. We believe a large part of the discrepancy was in the analyses because water and other samples analyzed since 1973 show little temporal variations. Our plutonium concentrations in fish are significantly lower than the reported 1973 levels and are being used to update dose estimates to populations using the marine food pathway. However, to ensure that our results are representative of concentrations and doses that can be

expected to pass to man via the marine food pathway, verification is required. We will first sample mullet again from the same islands sampled in 1976 during a different season. The fish will be dissected into tissues as before and analyzed for plutonium and other radionuclides to assess any changes in concentration that might have occurred during the intervening years. At two islands where fish are plentiful, a large variety of reef fish will be caught for analysis to insure that concentrations in mullet are representative of other edible species. As stated previously, it is impossible to analyze samples of the 600 species of fish in the Marshall Islands from all islands of the atolls. Thus we must restrict our evaluation to data generated from analysis of the most representative species available. In addition, ^{241}Am levels will be evaluated carefully to provide a complete transuranic assessment in marine food products.

We will continue experiments to evaluate the generation of marine plutonium-labelled organic particulates resuspended by wind and wave action on the ocean-side reef at the atolls. Although no data were available for evaluation during a recent private conversation with a knowledgeable DOE representative, it was not at all encouraging to learn that a similar resuspension process might be generating small quantities of airborne marine plutonium aerosols at some coastal regions near Windscale. Because there are few regions in the world contaminated with levels of plutonium sufficiently high to be measured precisely, a continuation of this study in the Marshall Islands is essential. Any positive results will require carefule evaluation.

We have terminated sampling at some of the groundwater sites on Enewetak but, at the same time, are redirecting our efforts toward a more detailed assessment of the groundwater processes at our remaining sites. These include wells and locations containing usable freshwater as well as sites related to the agricultural experiments on Janet Island. This spring, storms permitting, we will drill additional test wells on Janet to perform hydrologic tests and measurements on the wells including dynamic pump tests, tidal response measurements, dye injections, and detailed sampling in these and our other wells for chemical and radionuclide analysis. Soil from the well sites will be separated into size fractions and equilibrated with water to determine the distribution coefficients for plutonium and other radionuclides between the solid and solution phases. The purpose of these latter experiments is to evaluate the amount of plutonium that is selectively mobilized to solution from different soil types.

When ship support is available for Bikini, we will continue the studies begun in FY 1978. We also hope to initiate similar groundwater studies at Rongelap if ship support is available. Dye studies provided an estimate of the rate of groundwater movement that varies throughout the island and changes with season. Radionuclide groundwater concentrations are more variable at Bikini, but the reasons for these variations are not yet understood. Additional temporal experiments are needed to evaluate the radionuclide dynamics in the water.

Lagoon studies of transuranics will continue, providing adequate ship support is available. The atoll seems to have reached a chemical steady-state condition with respect to the partitioning of $^{239,240}Pu$ between solution and solid phases of the environment. Using an experimentally determined K_d for $^{239,240}Pu$, the dissolved quantity predicted in equilibrium with the concentrations in sediment agrees well with recently average measured concentrations in water at both Enewetak and Bikini Atolls. The remobilized $^{239,240}Pu$ has solution-like characteristics. Over the next 250 y, an estimated 50% of the present $^{239,240}Pu$ sediment inventory will be remobilized to solution and discharged to the north equatorial Pacific. It has yet to be determined if biological components of the sediments are an important link in the remobilization process. Additional temporal data are needed to verify our estimates of the rate of regenerated plutonium. Our evidence that plutonium is remobilized from the sediment to the water is substantial and leads to the conclusion that similar processes must be occurring in coastal and other aquatic areas. We are now modeling our data to show the extent of remobilization that may be occurring in coastal and other waters contaminated only with global fallout.

Less significant marine radiological pathways to man also require study. For example, the highest plutonium levels in fish were found, unexpectedly, in samples collected from the ocean reef of Sally Island. The gut samples contained contents with 150 pCi/g of $^{239,240}Pu$. However, the concentration of other radionuclides was among the lowest detected in fish at Enewetak Atoll. These are high isolated plutonium sources at the atoll available for uptake by marine organisms. As another example, a particle high in plutonium was isolated from the gills of fish caught near Yvonne. Using mass spectrometry we determined the ^{241}Pu and, with the measured ^{241}Am concentration, dated the particle. It originated in the 1958 test series from the non-nuclear test held at Yvonne. It is obvious that hot particles are still available to fish on the reef. If these nonedible parts of fish are recycled to the terrestrial environment by man, levels of plutonium of marine origin could be increased in village areas. An evaluation of the expected impacts from those less significant pathways will be made.

19. MAJOR MATERIALS, EQUIPMENT, AND SUBCONTRACT ITEMS:

	Estimated Cost	
Equipment	FY 1979	FY 1980
Groundwater sampling equipment (pumps, generators, and *in situ* conductivity meters)	$ 4,000	$ 3,000
Air samplers and generators for reef work	5,000	
In-situ filtration-preconcentration system		5,000

Equipment (continued)		FY 1979	FY 1980
ND 600 for interfacing 12 alpha detectors and new lab equipment - for new facility		$40,000	20,000
Drying and ashing furnaces			6,000
Pinger and Recorder System			6,000
	TOTAL	$49,000	40,000
Subcontracts			
Holmes and Narver for shipping and support in the Marshall Islands		$15,000	18,000
	TOTAL	$15,000	18,000

20. PROPOSED OBLIGATIONS FOR RELATED CONSTRUCTION PROJECTS:

None.

BER/LLL Proj.

SCHEDULE 189

Lawrence Livermore Laboratory
University of California
Livermore, California

[X] Environment
[ ] Life Science Research Biomedical Application

1. CONTRACTOR: University of California, Contract #W-7405-eng-48

2. PROJECT TITLE: Marshall Island Radioecology Studies for Dose Evaluation

2c. RPIS No. 001676 (L

2b. ABSTRACTED TITLE: Marshall Island Radioecology

2d. 189 No. LLL/ASEV-80- 6

3. BUDGET ACTIVITY NO.:	4. DATE PREPARED:	5. METHOD OF REPORTING:	6. WORKING LOCATION:
GK-01-02-03-4	March 1978	Annual	Livermore, California

7a. PERSON IN CHARGE: M. L. Mendelsohn/E. M. Morimoto

7b. PRINCIPAL INVESTIGATOR: W. Robison

8. PROJECT TERM: Continuing

9. MAN YEARS:

		FY 79				
	FY 78	Pres. Budget	Reprog.	New	TOTAL	FY 80
(a) Scientific	8.0	3.0	0	3.0	6.0	6.0
(b) Other Technical	1.6	1.0	0	1.0	2.0	1.2
Total	9.6	4.0	0	4.0	8.0	7.2

10. FUNDING (Thousand $):

		FY 79				
	FY 78	Pres. Budget	Reprog.	New	TOTAL	FY 80
Operating Costs:						
(a) Manpower	267	121	0	121	242	239
(b) Materials, Services, etc.	293	145	0	190	335	342
(c) Indirect Expenses	205	94	0	94	188	184
Total Operating Costs	765	360	0	405	765	765
Capital Equipment not Related to Construction	23	40	0	40	80	70

11. REACTOR CONCEPT: Not Applicable

12. MATERIALS: Not Applicable

13. PUBLICATIONS:

1. J.J. Koranda, W.L. Robison, S.E. Thompson, and M.M. Stuart, Enewetak Atoll Radioecology and Dose Evaluation Program: Ecological Studies on Engebi Island 1975-76, Lawrence Livermore Laboratory, Rept. UCRL-52409-1 (1978)
2. J.J. Koranda, W.L. Robison, S.E. Thompson, and C. Tafoya, Enewetak Atoll Radioecology and Dose Evaluation Program: Laboratory Studies of Radionuclide Availability in Plant and Soil Compartments, Lawrence Livermore Laboratory, Rept. (1978).

14A. SCOPE ABSTRACT:

A program of radionuclide measurements in soil water, biota, and radioecological transport modeling in the Marshall Islands is designed to fulfill two immediate objectives of meeting high-priority needs for developing information on radionuclide transport and cycling to delineate the effective resettlement of Enewetak Atoll, and supporting the ongoing evaluation at Bikini Atoll. The long-term goals are to identify the key parameters affecting the dose to man, determine the residence time of key radionuclides in the atoll environment, and provide information required for the implementation of resettlement in both regions.

14B. SCOPE:

The Enewetak people, the Micronesian Legal Services, and the Trust Territory were told in 1976 that within a 5-y period we could produce more definitive information concerning the time-dependence of the radionuclides in the environment and a timetable for the use of the northern part of Enewetak Atoll. More recently, DOE and LLL agreed to evaluate closely the possible use of Eneu Island at Bikini Atoll Therefore, our program is designed to ensure that the appropriate data are obtained for these evaluations. Specifically, we will:

- Make measurements to delineate the rates of uptake, redistribution, and removal of radionuclides in the ecosystem, and to develop or refine the concentration factor for the critical radionuclides.
- Develop further understanding of radionuclide cycling in the terrestrial foodchains and derive guidelines for agricultural practices that will minimize population exposure via terrestrial foods.
- Employ these new data and constants as input to the assessment program for refining the projected doses published in NVO-140 (Enewetak Radiological Survey, 1973) for Enewetak and in the preliminary assessment report for Bikini (see publication Nos. 1 and 2).

- Define the need and develop guidelines for any long-term radioecological surveillance on Enewetak and Bikini.
- Produce an ecological systems model of radionuclide transport, recycling, and fate for the long-lived radionuclides in these coral island environments.
- Evaluate the resuspension pathway as a potential source of exposure to the transuranics.
- Provide a data base to support a continuing evaluation capability for estimating dose to man so that DBER and DSSC can use our predictive approach.

15. RELATIONSHIP TO OTHER PROGRAMS:

The data developed in this program are the basis for assessments of resettlement plans at both atolls. These assessments are described in 189 Nos. LLL/ASEV-80-5 and -22. The expertise developed in past resuspension program studies will now be applied to the Marshall Island assessment. Also, data obtained in two other divisional programs, "Biogeochemical Cycling of the Transuranics and Other Radionuclides in the Marshall" and "Personal Plutonium Resuspension Studies," will contribute to the progress of the project.

16. TECHNICAL PROGRESS IN FY 1978:

Bikini Atoll

Bikini and Eneu Islands Dose Assessments. The dose assessment for Bikini and Eneu Islands, completed during FY 1977, revealed that the predicted doses for living patterns involving Bikini Island exceeded Federal Guidelines and that predicted doses for Eneu Island were very near Federal Guidance.

Eneu Island Test Gardens. Test gardens of subsistence crops have been established on Eneu Island so the potential doses to a population living on Eneu can be better defined and directly evaluated before any major relocation is permitted. Banana, papaya, squash, watermelon, pandanus, sweet potato, and breadfruit root stock were planted in August 1977. In addition, three full-grown breadfruit trees were transplanted from Bikini to Eneu Island. We expect to have data on the transplanted breadfruit 5 y before data are available from the root stock plantings.

Bikini Island Breadfruit Trees. We have been able to take advantage of the breadfruit trees that grow on Bikini Island to determine the uptake of ^{137}Cs and to develop concentration factors for use in predictive models. The mean concentration factors (pCi/g fruit per pCi/g soil) observed for ^{137}Cs for the four breadfruit trees analyzed (three of which were then transplanted to Eneu Island) was 6.4 pCi/g ± 20%.

Transuranic Resuspension Studies. Resuspension studies are being formulated to determine the potential dose from transuranics to residing populations via the inhalation pathway and will be initiated in April and May 1978. The basic program will consist of air sampling with super high-volume samplers, standard high-volume samplers, personal samplers, and a variety of other samplers. Our goals are to develop a basic understanding of the resuspension process in the atoll ecosystem, to evaluate the major source of observed mass-loading (i.e., marine or terrestrial in origin), and to develop a resuspension model that can be applied to other islands and atolls.

Radionuclide Content of Coconut Products. In FY 1978, we will begin our analysis of the coconut oil and dried pulp (processed at the Majuro plant) obtained from coconuts grown on Bikini Island and from those grown on other uncontaminated atolls. We must determine whether the ^{137}Cs and ^{90}Sr appear in the coconut oil or whether the radionuclides remain in the dried pulp. The coconut crop from Bikini Atoll could presently double the output of copra from the Marshall Islands. The dried pulp is sold on the world market as a major feed for livestock and the sale of coconut oil offsets the cost of planting, harvesting, transporting, and processing the coconut at Majuro. Thus the profit for the Marshall Islands and its people comes from the sale of the dried pulp for feed. It is critically important to evaluate and understand the distribution of radionuclides in the coconut products and to assess the impact of such coconut pulp sales on the worldwide dose to man.

Dietary Intake of Plutonium. Initially, we had planned to analyze native food samples to determine the dietary intake of plutonium and compare the values with urine levels and body burdens of plutonium observed by the medical program in the islands. However, when we visited the islands (November 1977) to initiate this study, the Trust Territory Government had just started a massive food subsidy program. Sufficient food is being shipped in to supply the entire diet and no locally grown food is to be eaten. We are now attempting to determine whether any significant data can yet be obtained to help interpret previous data at Bikini Island and whether some locally grown food products (e.g., coconut) will still be used and therefore lead to continued plutonium intake via diet. Final decisions on this study will be made this year.

Enewetak Atoll

Enewetak Test Gardens. At Enewetak Atoll, we have continued to develop the test plots which were initiated in August 1975. We have collected considerable ^{137}Cs data on the annual crops (papaya, banana, and sweet potato). Many samples from these test plots are presently being processed for analysis and, by the end of this fiscal year, we should have a data base of concentration factors for the three crops.

Plutonium and ^{90}Sr Data Base. McClellen Laboratory completed the ^{90}Sr and plutonium analysis of the Enewetak Atoll soil samples. However, before they could begin to analyze the vegetation samples, their "mission work" was increased and they had to terminate their support of our project. As a result, we have not been able to develop our data base on concentration and correlation factors for the two radionuclides. Currently, we are trying to coordinate and establish wet chemistry analytical support with other organizations to complete the analysis and evaluate the uptake and potential doses for all major radionuclides found at the atolls.

Effect of Fertilizer on ^{137}Cs Uptake. We have initially evaluated the impact of fertilizer on the uptake of ^{137}Cs into the leaves and fronds of pandanus and coconut. Preliminary data show the average uptake in coconut fronds to be 67 pCi/g ± 75% for hot soil without fertilizer and 22 pCi/g ± 50% for hot soil with fertilizer. These early results are significant and indicate that a fertilizer program may indeed reduce the uptake of ^{137}Cs. No data are yet available for ^{90}SR and plutonium.

Radionuclide Residence Time. We have continued our sampling of coconut and pandanus trees on other islands at Enewetak Atoll to evaluate the residence time of radionuclides in the atoll environment. The data for ^{137}Cs appear to indicate a residence time significantly less than 30 y, but seasonal fluctuations need to be determined in order to make an exact interpretation.

Engebi Island Studies. Our studies on Engebi Island have been directed toward determining the cycling mechanisms of radionuclides in the atoll environment. We have collected nearly 2 y of data from several locations on the island, including radionuclide concentrations in various compartments, canopy growth, rate of litter production and litter decay, leaching of radionuclides from each compartment, and radionuclide residence times. However, in August, 1977, without consulting any of the ongoing programs, the military and DOE teams bulldozed and completely denuded Engebi Island of all vegetation other than our test plots. All of the long-term follow-up sites were destroyed. Now we can only sample the vegetation which reestablishes itself to see if the clearing procedure produced any major changes in the radionuclide concentrations and evaluate the potential of the new trees as part of our long-term cycling and residence time studies.

Comparison of Radionuclide Resuspension on Engebi and Bikini Islands. The clearing of Engebi Island does offer the opportunity to evaluate and compare the resuspension process on this denuded island with Bikini Island which is well vegetated. Such clearing will occur on many islands as housing is built and subsistence and cash crops are planted. We believe that a significant increase in radionuclide resuspension may be seen for the first several years after the island is cleared. Depending on the availability of support for Marshall

Island research (e.g., boat support), we will field a resuspension study on Engebi Island late this fiscal year or in FY 1979.

Distribution of ^{137}Cs. In addition to the data presented in the publication list, we completed the evaluation of ^{137}Cs distribution in the canopy, small wood, trunk, roots, and litter of the major trees on Engebi Island. The leaves contained about 20% of the activity in the entire plant; wood less than 2.5 cm in diameter, 20%; wood between 2.5 and 7.5 cm in diameter, 10%; and wood greater than 7.5 cm in diameter, 35%. Dead wood contained the remaining 15% of activity. The total activity in the tree was only 6% of that contained in the soil column under the canopy. Our evaluation of the litter revealed that ^{137}Cs is leached rapidly from fresh litter and is bound into the organified fraction of the soil. In this form, the ^{137}Cs is again available for recycling into the growing vegetation. The canopy and litter are therefore crucial steps in the cycling of radionuclides.

Soil Moisture and Water Flow. As a result of the clearing of Engebi Island, we lost most of our sensors and monitors of soil moisture and water flow in the soil column. The water flow in the soil column and the seasonal changes in soil moisture are most important in evaluating the availability, uptake, and cycling of radionuclides in the atoll ecosystem. We will reestablish the necessary field equipment to obtain these data.

17. EXPECTED RESULTS FOR FY 1979:

Bikini Atoll

We will maintain the test gardens and evaluate the uptake and concentration factors for the subsistence crops on Eneu Island. During this year, we will generate a data base sufficient to refine the initial dose estimates for Eneu Island developed from the 1975 survey.

In addition, the data from our initial resuspension experiment on the atoll will be evaluated. We plan to field a follow-up experiment to provide the final data base for developing the general resuspension model and for refining the dose assessments via the inhalation pathway. We also will take advantage of our presence on the atoll to collect more data on the uptake, concentration, and time-dependence of radionuclides in the pandanus fruit which will be maturing on Bikini Island. Next to breadfruit, pandanus is the subsistence crop for which there is the least available data. The subsistence crops on Bikini Island will continue to be used as permanent sampling stations to help evaluate the time-dependence of radionuclide removal from the Bikini environment.

Because Bikini and Eneu Islands are much less disturbed than the Enewetak Atoll, we will initiate studies of soil-water movement and the soil-water availability to plants on Bikini Atoll. Knowledge of the

soil-water cycling and the associated cycling and availability of radionuclides to plants is essential for accurate dose assessments and estimates of the potential long-term use of the atolls. Additionally, we will conclude the analysis of the coconut oil and dried pulp and develop a final dose assessment during FY 1979.

Enewetak Atoll

We will maintain the test gardens of the long-term subsistence crops (pandanus, coconut, and breadfruit). These plants are being fertilized as part of our experiment and they appear to be growing much more rapidly than the unfertilized plants. Therefore, we may be able to harvest the edible products from these crops during FY 1979 and determine uptake and concentration factors for the fruits. In addition, we will continue to sample and analyze the coconut and pandanus trees on Belle, Clara, Irene, Janet, Sally, and Tilda Islands to determine the residence times of ^{137}Cs, ^{90}Sr, and plutonium in the atoll ecosystem.

We also will field either the initial or the follow-up resuspension study on Engebi Island. Continued sampling of soil moisture, water cycling, radionuclide concentrations in soil, humus, litter, and canopy as well as the measurement of micrometeorological parameters at Engebi Island will provide the necessary input to thoroughly evaluate the controlling mechanisms of radionuclide transport and cycling in the atolls.

18. EXPECTED RESULTS IN FY 1980:

We should have sufficient data, even from the long-term crops, to develop a general model for predicting doses from other islands and atolls that do not now support subsistence crops but which may in the future.

We also will complete a general evaluation of the resuspension pathway and of the potential dose due to the transuranic radionuclides. By FY 1980, there should be sufficient data available to develop a model of radionuclide cycling in the atoll ecosystem so that more specific options for remedial action can be proposed and evaluated.

19. MAJOR MATERIALS, EQUIPMENT, AND SUBCONTRACT ITEMS:

	Estimated Cost	
Equipment	FY 1979	FY 1980
Aerosol particle analyzer (2)	$26,000	
Data logger/microprocessor (2)	6,000	$ 6,000
Wescor soil psychrometer (2)	2,400	2,400
Tape transcriber	600	600

Equipment continued	FY 1979	FY 198
TS 13500 respirable aerosol monitor	3,000	3,00
Wind power systems		10,00
Solar cells		10,00
9830 Calculator memory extension		6,00
Lister 20-kW mobile generator	5,500	5,50
Personal aerosol monitors (20)	14,000	
Hi-volume air samplers (10)	6,000	6,00
Memory system and printer for Hewlett-Packard 21 MX	16,500	
Outboard motors (135 H.P.) (2)		5,00
Wind sensor system (2)		2,50
Yanmar diesel generator (5-kW) (3)		4,50
Drying ovens (3)		3,60
Farm tractor		4,90
TOTAL	$80,000	$70,00

20. PROPOSED OBLIGATIONS FOR RELATED CONSTRUCTION PROJECTS:

None.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 9 1974

Warren D. Johnson
Lieutenant General, USAF
Director
Defense Nuclear Agency
Washington, D. C. 20305

Dear General Johnson:

This is in response to your letter of September 3, 1974, transmitting to the U. S. Atomic Energy Commission (AEC) the Draft Environmental Impact Statement (DEIS) prepared under supervision of the Defense Nuclear Agency (DNA) for the proposed cleanup, rehabilitation, and resettlement of Enewetak Atoll.

We have reviewed the Statement and are providing the following comments, and the enclosure of supporting comments for your consideration in preparing the Final Statement for this proposed action:

In general, the DEIS reflects a careful and thorough study of the possible cleanup of Enewetak Atoll and the future return of the people. We agree that the Case 3 approach, as presented in the DEIS, should be the preferred option for the cleanup project. This approach is based on successful past experience, appears to be feasible, and ensures the health and safety of the people insofar as practicable. Further, the quantity of material requiring disposal is more manageable than in Cases 4 and 5, and the residual levels of contamination would not appear to be hazardous judging from present knowledge of contaminated levels in soils.

The presentation of the AEC radiation exposure criteria is satisfactory; however, the term "standards," as used throughout the DEIS is inaccurate to describe the AEC criteria and should be replaced by the word "guidelines." While these radiological criteria are based upon current national and international standards (see AEC Task Group Report, Volume II, Appendix B) we view them only as guides for the Enewetak cleanup project. The AEC Task Group report clearly indicates that ad hoc guidelines, derived from the existing recognized standards, were required and formulated for the particular conditions existing at Enewetak Atoll and because future human habitation was planned for there. We further note that the plutonium guideline numbers, while having no particular scientific basis for establishing a standard, appear to be reasonable for the particular conditions existing at Enewetak Atoll.

Dose estimates for use in the Section 5 matrix presentation (Volume I) should be those provided in the AEC Task Group report, not the estimates in NV-140 or estimates derived from equations presented in NV-140. The Task Group report presents estimates of maximum annual exposures for individuals considering the most sensitive members of the population, and estimates of 30-year exposures for population groups living in various parts of the Atoll. The NV-140 survey report does not contain all of these estimates. It is recommended that Tables 5-11, 5-12, and 5-13 be deleted, that Sections 5.6.1.1, 5.6.1.2 and 5.6.1.3 and Tables 5-8, 5-9 and 5-10 be revised using information from the Task Group report (Appendix IV, Section B, Volume II). It is also recommended that doses for bone marrow, not bone, be used in all tables presenting maximum annual marrow criteria, and that AEC estimates of 30 year and maximum annual doses for Belle, the island having the highest predicted doses, be used for Case 1 wherever this appears instead of exposure estimates for an average individual for the entire Atoll. Estimates of exposures averaged over the entire Atoll are not meaningful and should be deleted. Further detailed discussions on these points are presented in the enclosure.

With regard to Section 5.3.1 on biological risk, the BEIR report estimates represent upper limits of risk. The risk at low dose rates may be zero. (See paragraph IV, page 88, of the BEIR report.) It is recommended that estimates of risk in Table 5-14 be presented as upper limits and a footnote added indicating that at low dose rates the risk may be zero. The risk estimates should be recalculated to account for revisions needed for estimates presented in Table 5-8 in calculation of 30-year dose. Further, based upon the suggested revisions for the 30-year and maximum annual dose estimates, a revision of Table 5-16 is in order to reflect these changes.

The arguments presented in the statement opposing ocean dumping of contaminated wastes are in our opinion weak and unconvincing. The "difficulty of obtaining a permit and certainty of international complications," whether true or not, are insufficient grounds for rejecting ocean dumping as a viable waste disposal option. We note that the International Atomic Energy Agency (IAEA) Board of Governors' document, GOV/1688, of August 7, 1974, discusses in draft form the provisional definitions and recommendations concerning radioactive wastes ocean dumping. This document is in relationship to the responsibilities entrusted to IAEA under the Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter. For Case 3 in the

DEIS, even if one assumed that 79,000 cubic yards of Atoll soil containing an average of 1 nCi/gm of Pu^{239} were dumped into the ocean, it would represent only about 75 Ci for this one time action. This is far below the upper disposal limit of 10^{10} Ci/year for alpha wastes (based on Pu^{239}) in GOV/1688.

Without necessarily advocating ocean dumping, we note that it is considered by some to be the best solution to this problem and one of the least costly. Indeed, the ocean water already has a certain access to the plutonium in Enewetak Atoll and disposal in the deep ocean would only represent removal of the plutonium to a safer marine location which, because of its remoteness, would minimize the chance of human exposure. We therefore recommend that the pertinent sections on the DEIS be rewritten to leave the ocean dumping option open. Furthermore, we believe that return of this debris to the United States for burial would be unacceptable and that burial on an island in a concrete-capped crater would require periodic followup that for practical purposes would last forever. Specific comments related to ocean dumping and encryptment are included in the enclosed Staff Comments.

In the discussion of the "Impact of Blasting During Cleanup" (Section 8.16) it is not clear whether these blasting operations will open new channels that would pass completely through the reef from lagoon to ocean. If this is in fact planned, we would object in principle and would need to see much more information on the expected impact of new openings in the reef on the ecology of the Atoll.

As a matter of policy beyond the scope of this Statement, we recommend that the last sentence (lines 18-20) on page 5-35 of the fourth recommended study be deleted, since it is not germane for any environmental statement to address detailed responsibilities of other agencies which have not been formally agreed upon.

There appears to be some misunderstanding regarding Storage on Runit (Sections 5.5.2.5, page 5-48). As presented in the DEIS, it is indicated that as an intermediate step, contaminated soil will be stored on Runit pending a study and recommendation by AEC as to its ultimate disposal. AEC is not committed to provide any additional recommendation on the ultimate disposal of the contaminated soil. The disposal of debris is a DNA responsibility. The only open question is whether or not it may be feasible to reduce to some degree the amount of contaminated material

to be disposed by removing some of the plutonium from the soil. Whether such reduction is economically sound would depend on the final disposal method and its associated cost. Should deep ocean burial be the chosen method, the removal of plutonium from the soil would not be a cost effective action. In recognition of the above points, DNA should plan its cleanup and disposal actions as if no additional guidance from AEC may be forthcoming. Any results of a further AEC study to determine the possibility of reducing the volume of plutonium-contaminated material should be viewed as an added benefit.

Our discussions with staff of the Department of the Interior during the September 1974 visit to Enewetak Atoll indicated that a group of people from Ujelang Atoll will be allowed to return to Japtan Island before cleanup operations begin. In a July 18, 1974 letter to the Department of the Interior, AEC presented its views on the safety aspects of any proposed early return of people to Japtan. We view an early return as a significant step that should be treated in the DEIS.

Sincerely,

James L. Liverman

James L. Liverman
Assistant General Manager for
Biomedical and Environmental
Research and Safety Programs

Enclosure:
Staff Report

cc: Council on Environmental Quality, w/encl. (5)

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James L. Liverman

James L. Liverman
Assistant General Manager for
Biomedical and Environmental
Research and Safety Programs

Enclosure:
Staff Report

cc: Council on Environmental Quality, w/encl. (5)

Supporting AEC Comments on the Defense Nuclear Agency
Draft Environmental Impact Statement on the
Clean-up, Rehabilitation, Resettlement of
Enewetak Atoll - Marshall Islands

1. Dose Estimates

A severe deficiency in the DEIS concerns the dose estimates presented in matrix form in Tables 5-8, 5-9, 5-10, 5-12, 5-13, and 5-16 and the associated material in Sections 5.6.1.1, 5.6.1.2 and 5.6.1.3. The following estimates of radiation dose and an evaluation of these estimates using the recommended radiation criteria were provided in the AEC Task Group report:

30-year whole body dose (for a population living in various parts of the Atoll).

30-year bone dose (mineral bone).

Maximum annual whole body dose (considering the most sensitive individual).

Maximum annual bone marrow dose (considering the most sensitive individual).

These estimates appear in Section B, Volume II of the DEIS. We have anticipated that the dose most likely to be exceeded at Enewetak is the annual dose to bone marrow. Thus, bone marrow dose for the most sensitive individuals in the population is the critical dose for comparison with cleanup radiological criteria. Estimates of bone marrow dose were developed during Task Group deliberations and do not appear in NV-140.

The AEC Task Group rejected the concept of averaging annual doses over the entire Atoll or over the entire population. This is of particular importance for the case where it was assumed that there was no clean-up with islands used for permanent residence without regard to radiation and radioactivity levels (Case 1). The DEIS matrix presents no information on annual bone marrow doses, presents doses for an "average individual on entire Atoll" for some clean-up options (cases) and presents maximum annual values for bone that were calculated using an equation in NV-140 that is considered adequate only for determining 30-year doses. (Other models are now used in calculating maximum annual doses to bone and bone marrow that accommodate important changes that occur with time and with age of the individual.) The following examples show reasons why we cannot agree with the DEIS presentation of doses in Section 5, "Cleanup and Habitation Alternatives," unless the presentation is appropriately modified.

Table 5-8, page 5-50

DEIS Case 1 — WB= 6 Rem in 30 years
Bone= 60 Rem in 30 years

These were determined for an average individual in the entire Atoll.

AEC Case 1 — WB= 31 Rem in 30 years
Bone= 220 Rem in 30 years

See AEC estimates for a population living on Belle, Section B, Volume II, pages 32-33, current condition, living pattern F. This example shows that important features of the radiological picture at Enewetak can be missed if dose estimates are averaged over the entire Atoll.

Table 5-9, page 5-51

DEIS Case 1 WB= 0.3 Rem in one year
Bone= 2 Rem in one year (mineral bone)

These were determined for an average individual in the Atoll.

AEC Case 1 WB= 1.6 Rem in one year
Bone marrow= 2 Rem in one year

See data for an individual on Belle, Section B, Volume II, pages 34-35, current condition, living pattern F. The significance of a bone marrow dose as high as the bone dose is that, traditionally, the standard for bone marrow is one third that for bone.

Table 5-10, page 5-53

Annual dose for an average individual for the entire Atoll should not be used to develop ratios to indicate comparisions with AEC annual dose criteria. There are several problems with this approach. First, use of estimates for an average individual ignores the fact that children are thought to be more sensitive to radiation injury than adults. Maximum annual doses presented in the Task Group report for use in the DEIS were derived through consideration of doses to the fetus and newborn, as well as to adults. Treatment of this important consideration seems to be missing in the DEIS except in material provided in the Appendix. Second, there are no standards for doses to an average individual for a geographical area containing a wide range of dose rates. The nearest category of Federal recommendations are guides for a population group where annual average doses are to be determined giving due consideration to the most sensitive members. By way of comparison, basic dose guides for such a group would be one-third of the guides for the individual. AEC criteria for annual exposures apply only to exposures of individuals using the condition specified by the Federal Radiation Council, namely, that this may be used when there is a sufficient level of radiological monitoring that exposures, including those of the most sensitive individuals, will be known. AEC criteria for exposures at Enewetak do not apply to an average individual on the entire Atoll or to a population group within which there would be a wide range of doses that make up the average.

Tables 5-11, 5-12 and 5-13, pages 5-54, 5-57, and 5-59

We have not subscribed in the past to an approach that considers as alternatives, clean-up of islands to various external radiation isopleths such as F or K as

defined by the EG&G aerial survey. Such an approach is deficient in that it does not adequately treat the reduction, if any, of the more significant exposures that are expected to occur from internal emitters coming through the food chain for crops grown on the islands. Sections 5.6.1.1 and 5.6.1.2 and tables 5-11 and 5-12 are not consistent with the Task Group report.

2. Debris and Soil Disposal

Four other alternatives are mentioned, consisting of crater dumping (5.5.2.2), crater containment (5.5.2.3), return to the continental United States (5.5.2.4), and storage on Runit (5.5.2.5). Although a few advantages and disadvantages are mentioned for some of these alternatives, the specific environmental impacts of each are not discussed nor can the reader find which alternatives are proposed for which wastes.

In the section on returning radioactive debris to the continental U.S. (5.5.2.4), Richland, Washington is cited as an example of "one of the low-grade disposal areas in the western part of the United States." There are two radioactive waste burial areas which can be identified as being near Richland, Washington. One is operated by the AEC and ordinarily does not compete with private industry by accepting offsite-generated waste, either from private firms or from other Federal activities. The other is operated by a private firm which could or could not accept such wastes.

The statement that ocean dumping was rejected (5.5.2.1) is in contradiction to the later statement that "Pu contaminated surface soils would be removed from five islands and disposed of at sea" (first indented item, page 11-1). The quantities of radioactivity to be disposed of are not quantified, nor is the environmental impact discussed, in the remaining text of Section 11 (irreversible or irretrievable commitments of resources). Sea dumping is not mentioned in the description of the "proposed (preferred) cleanup operation" (Section 6) nor the discussion of adverse environmental impacts which cannot be avoided (Section 9). Radioactive sea dumping is not discussed in the section on environmental impacts, which is a conspicuous omission since Section 8.18 discusses the impact of dumping <u>noncontaminated</u> materials at sea.

Section 6.2.3 discusses the placement of plutonium-contaminated soil and scrap within a concrete matrix in LaCrosse crater. Section 8.19.1 states "maintenance of the crypt is a continuing problem" in referring to this plan, but neither section gives an indication of intent as to the responsibility for long-term surveillance and maintenance of this rather special case of transuranium waste storage.

The proposed method of disposal of Pu contaminated scrap and soil assumes that LaCrosse crater can be pumped out. Has it been clearly established that this can be done? The reef is often porous and cracks may have been caused by the detonation. We would suggest that DNA should consider whether the craters can and/or need to be pumped out for this particular option.

Page 2-1, Lines 14-15 - Should also include the fact that removal and disposal of plutonium-bearing soil in the 40-400 picocuries per gram range will be decided on a case-by-case basis. Suggest also include the following change: "Removal and disposal of plutonium-bearing soil which exceeds 400 picocuries per gram at all locations and 40 picocuries per gram on islands where housing may someday be located.

Page 2-2, lines 9-10 - the conclusion that plutonium debris will be encrypted in the LaCrosse crater seems premature at this point in the DEIS. Recommend deletion of this sentence.

Page 6-4, lines 10-11 - Recommend substitution of the words "appropriate disposal" in place of entombment with the radioactive scrap in LaCrosse center" and recommend deletion of the rest of the page. The text, as written, assumes that the entombment disposal action will be adopted.

Page 6-8, lines 10-11 - Recommend substitution of the words "and stored for eventual disposal" in place of "encapsulated in concrete in one or both of the craters on Runit."

Pages 8-29 and 8-30, Sections 8.18 and 8.19. Recommend that the ocean dumping option be left open as another possibility for disposal.

Page 11-1, lines 4-5. In referring to disposal at sea, this sentence is inconsistent with previous discussions in the DEIS concerning Pu contamination disposal. However, recommend that this ocean dumping option be retained as a possibility for disposal.

3. Miscellaneous Remarks

Page 3-10, last line on page - Delete the word "light."

Page 3-12, 6th line from the top - Delete "of water."

Page 3-15, Section 3.2.5, line 10 - Change "devastaged" to "devastated."

Page 3-44, 1st line - Change "life" to "live."

Page 3-46, Section 3.3.4.2, line 10 - Change "Engebi" to Enjebi."

Page 3-49, Section 3.5.1, 3rd paragraph - Change "patrilineal" to "ideally matrilineal" as per Tobin's paper "Land Tenure in the Marshall Islands, 1956." Essentially the iroij power comes from land holdings and land is owned by the women.

Page 3-52, Section 3.5.3, line 11 - Change "as island" to "an island."

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Page 3-57, 2nd paragraph, line 3 - Change "Enewakese" to "Enewetakese," or better yet "people."

Page 3-62, last sentence in Section 3.8.1.1.1 and 3.8.1.1.2 - Breadfruit should be included with pandanus. (This would be consistent with the statement in NVO-140, that in predicting ^{137}Cs and ^{90}Sr concentrations in breadfruit, it is assumed that breadfruit and pandanus fruit will experience the same uptake from soil.)

Page 3-63, Section 3.8.1.1.3, lines 1, 2 and 3 - This sentence should be changed to reflect the lack of completeness of conclusive data on this subject. Change to, "The available data indicates that the body's uptake and retention of Pu through the gastrointestinal tract is a small percentage of the Pu ingested. This pathway is therefore less significant than other potential means of ingress to the body."

Page 3-63, Section 3.8.1.2, last sentence: As presented the statement is not correct. Sentence should read: After 15 years of wind action on Enewetak Atoll, much of the dispersion of surface contamination has already occurred. Further significant redistribution due to wind action seems unlikely, although test related radioactivity is found in surface air at detectable levels. The dust raised by resident activities is expected to increase airborne concentrations with further redistribution of the radioactivity."

Page 3-84, Section 3.8.2 - The fourth sentence indicates that all the Be has been removed, but the sixth sentence indicates that there is still some Be that needs to be cleaned up. Suggest the paragraph be consistent.

Page 5-3, line 1 - Change "as" to "has."

Page 5-13, Option 2 - This should be clarified since it does not appear consistent with Table 5-6 in that it states "... may use food grown on Enjebi other than pandanus and breadfruit." Whereas table indicates these are the two that can be grown on Enjebi with the appropriate restrictions.

Page 5-21/5-22, Section 5.4.1.1, first line - Change "islanders" to "people of Enewetak" or "Enewetak people."

Page 5-25, Section 5.4.2.2 - This doesn't agree with Figure 5-2 in that 5.4.2.2 implies that the southern islands are Jinedrol through Kidrenen and limits inter-island visitation, agriculture, as well as collection of birds and eggs to these islands whereas the figure extends the allowable islands for these activities to include Boko, Munjor, Inedral, and Van, all of which are north of Jinedrol.

Page 5-32 and 5-33 - Figure 5-3 is not consistent with text for Case 3 in that: Text states that residence would be restricted to Jinedrol through Kidrenen yet the figure shows Boko, Munjor, Inedral and Van also as living islands; both the figure (which show Enjebi as only a picnic island) and text (page 5-34) agree that there will be no cultivation on Enjebi yet the

case summary on figure 5-3 shows "subsistance agriculture limited to southern islands plus Enjebi." It it is not clear what islands are included in the "southern islands."

Page 5-40, Section 5.4.4.3 - Change "does" to "dose."

Page 5-45, Section 5.4.5.3, next to last line - "solid replacement" should be "soil replacement."

Page 5-47, Section 5.5.2.1 - This section should be revised and updated to show that the possibility of ocean dumping is again being discussed.

Page 5-78, paragraph 2.h. - "pvoide" should be "provide."

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

December 23, 1974

Warren D. Johnson
Lieutenant General, USAF
Director
Defense Nuclear Agency
Washington, D. C. 20305

Dear General Johnson:

Please refer to my letter of December 9, 1974, transmitting AEC comments on the Draft Environmental Impact Statement for Clean Up, Rehabilitation, Resettlement of Enewetak Atoll - Marshall Islands.

It is requested that our comments be revised to include the following additional information:

During the last 8 years the Nuclear Energy Agency (NEA), formerly the European Nuclear Energy Agency (ENEA), has managed an ocean disposal program for radioactive wastes from the member countries. The following, by years, is a listing of the curies (Ci) of alpha activity in the materials so disposed. The alpha activity is assumed to be Pu 239.

1974 - 416	1970 - 233
1973 - 773	1969 - 390
1972 - 674	1968 - 721
1971 - 324	1967 - 92
	Total 3633 Ci - alpha

Other operations from 1949 to 1967, such as U.S. and U.K., disposed of wastes containing similar quantities of long-lived alpha active materials. Thus, a total of at least 7,000 alpha Ci have been disposed of into the ocean. If we assume 15 grams of Pu per Ci alpha activity, the total is at least 100 kilograms of Pu. Thus, it is evident the disposal of a few hundred grams of Pu from Enewetak Atoll would not materially add to the alpha activity already disposed in the deep ocean.

cc: H&N,Mr. Woolfenden) - 1/8/75
AFRRI, Mr. Slaback)

Reference is also made to paragraph 2, section 2, page 3, of the supporting AEC comments. Please delete the final sentence of that paragraph and replace with the following:

> The other is operated by a private firm licensed by the State of Washington. Under proposed regulations, this latter burial ground may not be permitted to accept plutonium-contaminated waste.

Sincerely,

James L. Liverman
Assistant General Manager
for Biomedical & Environmental
Research & Safety Programs

February 28, 1975

Martin B. Biles, Director
Division of Operational Safety

THRU: L. Joe Deal, Assistant Director
for Health Protection, DOS

DISCUSSION OF EPA INTERPRETATION AND APPLICATION OF CURRENT U.S. OCEAN DUMPING LEGISLATION AND REGULATIONS

During the past week, ERDA-OS staff have had opportunity to hear first hand how EPA staff are applying current domestic legislation related to dumping of radioactive contaminated materials into the ocean. These discussions took place within the context of unique circumstances of planning for cleanup of Enewetak Atoll, an action where DNA, DOI, and ERDA all have responsibilities.

Enclosure I is a Memo for the Record prepared by DNA staff of a meeting on this subject last Monday. This memo in my view is a faithful review of the comments at the February 24 meeting. Enclosure II is the recent guidance developed by IAEA for implementation of the agreement reached through the Ocean Dumping Convention of 1972 which we understand has been approved by the U.S. Enclosure III is the current domestic legislation hereafter referred to as the "Act." Enclosure IV is the EPA Regulations hereafter referred to as the "EPA Regs." Enclosure V is EPA comment on the AEC draft "Report by the AEC Task Group on Recommendations for Cleanup and Rehabilitation of Enewetak Atoll." Enclosure VI is AEC comments on the DNA EIS for cleanup of Enewetak. I believe this episode with EPA may be of far wider interest than just those of us who face the current dilemma of how to dispose of contaminated scrap and ^{239}Pu contaminated soil at Enewetak Atoll.

At the outset of our discussions, EPA representatives agreed that there were differences between the domestic and International Regulations, but quickly pointed out that the International Regulations allow any party to adopt more restrictive requirements. The first point I wish to make is that the Act and particularly the EPA Regs. are not just more restrictive, they are completely different; they are based on an entirely different policy and philosophy and contain elements not included and probably not intended by the International Regulations.

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The practical side of the Act and EPA Regs. is that they prohibit any U.S. agency or entity from dumping any radioactive debris into the ocean. This is accomplished by use of certain barriers and indeterminates that must be faced by anyone who considers ocean dumping as one of several possible disposal alternatives for radioactive debris. Implementation of this legislation appears to place EPA staff in the position that they prefer and recommend land burial of ^{239}Pu debris even with the certainty of future failure of containment with release of material into the surface environment and the possibility of some exposure of the Enewetak people. Land burial, recommended by EPA, is seen by them as only a temporary solution. This is quite different from their usual role of conservatism in applying regulations where exposures of people are concerned, and their strict adherence and support of the lowest practicable concept.

I believe that the EPA application of current domestic ocean dumping regulations relative to disposal of contaminated debris of Enewetak, is a classic example of cases where concerns for a particular part of the environment are in direct conflict with concerns for minimizing radiation exposures of a particular group of people. I can cite several examples in the discussions of the past several days to support the statements above:

1. EPA staff did not even want to talk about International Regulations or the recent new guidance from IAEA (Enclosure II).

2. The fact that disposal of contaminated debris and soil from the islands (an action yielding great benefit to Enewetak people) would be only a small contribution to similar material already on the nearby ocean bottom from past nuclear tests, is not a consideration according to EPA staff.

3. The fact that the current state of certain islands at Enewetak Atoll is now a bad situation from a radiological viewpoint (the island of Runit is quarantined) needing early remedial action, is not a consideration according to the Act. EPA staff agreed that the Act was not developed with the Enewetak situation in mind. (This in my view, is a very serious matter since it also means that dumping radioactivity contaminated material into the ocean cannot even be considered - because of the need for extensive studies, hearings, etc., that would take several years - in the face of a desperate situation such as could occur with accidental release of radioactivity into man's environment.)

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4. Different approaches are inherent in the domestic and international regulations:

   a. The Act applied by EPA requires containment of contaminated material after it reaches the ocean floor such that levels outside the container are "innocuous." The term innocuous in nowhere defined in any numerical way or otherwise. EPA will apparently hold to itself the determination of what is innocuous for a particular set of circumstances. This is one indeterminate mentioned earlier.

   b. The International Regulations require that packaged wastes reach the ocean bottom intact. Practical means are to be used to put the debris in a relatively insoluble form or to place it in a relatively insoluble matrix by designing containment to retain the material for an unspecified period, or to select an area with characteristics that facilitate retention in the site vicinity.

5. The Act and EPA Regs. provide that a permit may be granted by EPA after the request for a permit has survived a "hearing" and open debate where any person may appear whether or not represented by counsel or any other authorized representative. The Administrator of EPA is made the final judge of results from the Hearing. How he will do this is not indicated. (Even the provisions of NEPA, related to a Hearing on an Environmental Impact Statement, do not require this.)

6. The International Regulations require no public Hearing procedures nor is there a requirement to seek approval from any other nation's representatives. Item C.1.2 of Appendix II states, "It would be prudent for the appropriate national authorities to authorize dumping at the lowest rate which is reasonably practicable, having regard to the development of applications of nuclear energy."

7. Dr. Rowe of EPA states in Enclosure V that "The U.S. has had a national policy of no ocean dumping of radioactive wastes since 1970." He states further that "it was surely the intent of PL 92-532 and the EPA regulations to rigidly control or even to prohibit such dumping. Thus, it appears that EPA staff believe that it is U.S. policy to prohibit such dumping.

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8. Enclosure VI shows the quantity of alpha wastes, assumed to be ^{239}Pu, dumped into the ocean during the last eight years under a program managed by the European Nuclear Energy Agency. Thus, the International policy is to allow ocean dumping of limited quantities of radioactivity in a controlled fashion and there is an agency to facilitate and coordinate dumping by certain European nations.

The added features of the Act and EPA Regs., (compared to International Regulations) which in our experience prohibits only U.S. agencies from putting radioactivity into the ocean, are of questionable value in protecting the ocean environment and are of no use in solving any waste disposal problems in the U.S. These provisions are highly discriminatory against the U.S. considering that other nations are dumping radioactive wastes into the ocean. Ocean dumping by other nations will presumedly continue since such actions are allowed under the International Regulations without so much "red tape." For cases such as cleanup of old radioactive facilities and nuclear testing grounds, these regulations are in conflict with our requirement to keep exposures of people as low as practicable. In this context, U.S. regulations have a negative benefit for U.S. people.

As stated by Mr. Wastler in item 3c of Enclosure I ".... if you have a DEIS which states another feasible disposal method, it virtually eliminates one of the requirements for an ocean dumping permit, namely the lack of an alternate disposal method." This statement reveals probably the most serious difference of all between the Act and EPA Regs., and between EPA Regs. and International Regulations. The Act requires that the Administrator (of EPA) shall establish and apply criteria for reviewing and evaluating permit application including locations and methods of disposal and land-based alternatives, (see Sec. 102(a)(G) of Enclosure III). The Act does not state (if so I cannot find it) that the existence of some other alternative virtually eliminates the possibility of obtaining a permit. This is an EPA requirement additional to the Act that goes far outside the requirements of the Act.

The International Regulations state that in the environmental assessment that is to be made, consideration is to be given to the "justification for the proposed dumping, when weighed against land-based alternatives." Thus, the existence of other options, under these regulations, does not rule out obtaining an ocean dumping permit if ocean dumping is the best alternative. The International Regulations require that participating nations evaluate various alternatives and do what is practical and reasonabl

All of this discussion leads to one basic question, which is more important in a given situation, to protect the environment or to protect man? The current U. S. ocean dumping legislation, as interpreted by EPA, allows for no consideration of current conditions of environmental contamination, i. e., contamination of land from past events. It better fits the situation where the objective is to prevent the generation of wastes that would require disposal in the ocean.

While EPA staff said they would like to help where they could, no assurance of obtaining a permit and approved deep ocean site for disposal of Enewetak contaminated debris and soil could be given regardless of any benefit to the Enewetak people or their nearby environment. This is true even if all studies were conducted and all needed evaluations and information were provided as required under EPA Regs. This opinion, stated by those with the responsibility to grant or not grant permits, is in effect an absolute prohibition against ocean dumping conducted by any U. S. agency. The large cost to comply with the information requirements under the Act would likely be money wasted. The inflexible and narrow view on protecting the environment that is built into the Act, is being voiced by EPA staff as indicative of almost certain failure for any agency that would consider ocean dumping as one of several possible alternatives. I can only conclude that this is a carefully designed barrier framed by those who secured the U. S. legislation.

Others who may one day face a similar problem should know that these same restrictions will probably be applied regardless of any circumstances one could believe to be unique, and regardless of how uncertain or costly other disposal options may be. As with Enewetak, the facts of the case, i. e., the risk to people of near surface entombment of radioactive debris in a container with a limited service life (EPA staff have assumed that such containment may not last 50 years) and release of the contained debris and subsequent additional exposure of people and their descendants, does not deter EPA staff from recommending that an ocean dumping permit not be sought, that prospects are poor if a permit is sought, and that disposal of this debris should be on land at Enewetak. The explanation given is that EPA is bound by the Act.

Dr. Rowe stated that the U. S. law was not perfect but the best we have. I would argue that the U. S. law has certain features that make it appear to have been translated from the International Ocean Dumping Agreement, but the "public hearing" requirement of the Act and "sole option" requirement of EPA constitute a prohibition against any dumping of radioactive material into the ocean. These could not have been translated from the results of the International Convention. On the other hand, the recommendations of IAEA and their provisions and requirements for obtaining an

approved site and permit, are far more certain and implementable. There are no blind restrictions, no barriers or time consuming hearings, and decisions are to be made on the merits of the situation. This guidance in my view will lead to balanced judgements and actions, by other participating nations, which are reasonable and beneficial to man. By contrast, the U.S. Act and EPA Regs. are biased and unreasonable and not necessarily in the best interest of the U.S. people.

The U.S. Act and EPA Regs. in my view are preventing the interested and responsible Federal agencies from considering the real issues and merits of the case for protecting the Enewetak people, and are forcing an arbitrary decision to bury contaminated materials on land at Enewetak Atoll when the best solution by far for the Enewetak people is burial in the nearby deep ocean.

It appears to me, that the one-time disposal of contaminated soil and scrap, at the levels we have found at Enewetak, is not really the kind of dumping the International Regulations were intended to control much less prevent. I make this final point to show how different the intent of International Regulations seems to be compared to what we have found in discussions with EPA.

Part A of Enclosure II shows that IAEA has selected 10 Ci/t for alpha wastes with a half life greater than 50 years, as the concentration above which such wastes would be considered unsuitable for dumping at sea. This concentration can be averaged over an amount of contaminated material not exceeding 100 tonnes. The dumping rate for such concentrations can be any amount up to 100,000 tons per year at any one site.

The highest level of ^{239}Pu in any soil sample analyzed from the island having the highest levels at Enewetak was about 3,000 pCi/g. The data in NVO-140 on alpha emitters in soil indicate that the ratio of $^{239-240}Pu/^{238}Pu$ varies widely having values from about 2/1 to 50/1. The ratio of $^{239-240}Pu/^{241}Am$ has a value of about 10/1. Thus, it would not result in too great an error to leave ^{238}Pu and ^{241}Am alpha activity out of waste disposal estimates. If my arithmetic is correct, (see Enclosure VII) 3,000 pCi of ^{239}Pu in a gram of soil is about 3,000 times less than the IAEA limit of 10 Ci/t averaged over 100 tonnes of soil.

To carry this further, the 100,000 tonnes permitted to be dumped at one site in one year at an average concentration of 10 curies per ton, would amount to 1,000,000 curies or 1 MCi. Since 1 curie of ^{239}Pu weighs 16 grams, 1 MCi would amount to 16,000,000 grams or 16,000 kg of ^{239}Pu. The total quantity of contaminated soil at Enewetak re-

quiring disposal is not known exactly, but the quantity that may have to be removed to meet the ERDA guides has been estimated by H&N to be about 79,000 yd^3. This would be:

$$79,000\ yd^3 \times .764\ M^3/yd^3 \times 10^6\ cm^3/M^3 = 60.4 \times 10^9\ cm^3$$

With the density of Enewetak soil at about 1.2 g/cm^3, this would be:

$$60.4 \times 10^9\ cm^3 \times 1.2\ g/cm^3 = 72.5 \times 10^9 g$$

If all Enewetak soil above 400 pCi ^{239}Pu per gram of soil is cleaned up plus some concentrations less than this, one could assume that the overall average level of ^{239}Pu in the 79,000 yd^3 of soil may be about 1,000 pCi/g. This should be a high estimate.

$$72.5 \times 10^9 g \times 1,000\ pCi/g = 72.5 \times 10^{12}\ pCi\ ^{239}Pu$$

This is about 73 curies of ^{239}Pu or:

$$73\ Ci \times 16\ Ci/g = 1,168 g \text{ or about } 1.2\ kg.$$

The net result of all of this is that the International Regulations would allow the dumping of 16,000 kg of ^{239}Pu into one site in one year. The total we would need to dump for Enewetak would be only about 1.2 kg of ^{239}Pu. These two numbers are four orders of magnitude apart.

The argument in behalf of ocean dumping of Enewetak Atoll debris I would like to make, is that 1.2 kg of ^{239}Pu mixed with 79,000 yd^3 of soil dumped in the deep ocean is an almost negligible amount considering the International Agreement and a tiny amount to worry about from the view of concern for contamination of the Pacific. However, it is not so unimportant if we think of a kilogram of ^{239}Pu located in one area in some limited life container near the surface on a small island under the feet of the Enewetak people.

Eleven miles northeast of Enewetak Atoll, the ocean is 12,000+ feet deep. This is the place for the Enewetak debris, put on the bottom in a concrete matrix, dropped there in simple steel containers vented to avoid crushing. In my opinion, land burial of this debris on Enewetak Atoll would be a serious mistake, a never ending expense to the taxpayer, and an unnecessary threat to the Enewetak people

and their descendants. I suggest that this matter should be brought to the attention of the State Department, OMB, and DOD. Since radiological contaminated debris is being dumped into the ocean by participants in the International Agreement, I urge that U.S. policy as stated by Dr. Rowe and interpreted by EPA has in effect been changed by the International Agreement signed by the U.S., and that U.S. agencies should establish liaison with other participating nations that have interests in dumping materials into the Atlantic and Pacific oceans. If you agree, I suggest we develop a short statement with this memo as background, for presentation of this problem to others.

Tommy F. McCraw
Special Assistant to the
Assistant Director for
Health Protection
Division of Operational Safety

Enclosures:
As stated

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DATE ➤	2/28/75	3/4/75				

PRIVACY ACT MATERIAL REMOVED

Summary of Bikini Whole Body Counting Results For 1977 and 1978

Page 1

Sex	Medical ID Number	1978 Tape ID Number	Weight in Kilograms	Number of Years living on Bikini Is	Age at Pass in Years	1977 Potassium Grams	1977 Co-137 nC	1977 Co-137/K Ratio nC/gram	1978 Potassium Grams	1978 Co-60 nC	1978 Co-137 nC	1978 Sr-90 nC	1978 Co-137/K Ratio nC/gram
M	80	878003	61	0.25	69				90.6	1.92	1.816	1.69	
M	6006	878004	93	0.75	37				130.7	3.32	1.961	0.59	
M	213	878006	67	4	32	1.46	0.739	7.9×10⁻³	155.9	4.93	2.335	1.60	
M	6070	878007	78	10	38	1.66	1.556	9.3×10⁻³	151.7	2.19	3.526	0.93	
M	6004	878008	55	0.25	28				121.3	1.58	1.933	3.05	
M	6033	878009	79	6	32	1.36.3	1.500	1.1×10⁻²	134.1	2.65	2.234	0.92	
M	6018	878010	74	4	34				180.2	19.24	5.672	9.93	
M	6006	878011	61	8	32				134.1	9.01	1.193	0.61	
M	6063	878012	72	6	34	139.2	0.779	5.6×10⁻³	141.3	6.97	3.062	5.97	
M	6019	878013	74	"	60				151.0	5.51	3.225	3.30	
M	84	878014	60	N.A	63	149.5	0.791	5.3×10⁻³	141.7	5.62	0.391	0.36	
F	6045	878020	53	0.25	28				94.8	1.77	1.151	1.92	
F	6006	878021	57	2	32				168.2	3.04	0.810	2.62	
M	6017	878022	80	2	42				151.4	13.28	5.932	8.62	
M	6019	878023	90	5	43	119.2	0.751	6.4×10⁻³	116.8	3.15	1.034	0.92	
M	6004	878024	85	5	60				126.3	3.35	1.926	0.96	
M	6013	878025	85	7	34	139.8	0.773	5.5×10⁻³	137.3	4.19	2.135	1.91	
M	6005	878026	76	1.5	58				132.6	5.90	2.053	2.59	
M	6008	878027	55	4	32	135.3	0.587	4.3×10⁻³	135.0	5.60	1.994	0.91	
M	6006	878028	75	8	46	149.1	2.140	1.4×10⁻²	151.3	7.92	3.568	14.75	
M	6011	878029	78	0.75	32				130.3	2.32	1.930	2.68	
M	6016	878030	67	3	34				126.5	6.64	3.235	2.42	
M	6012	878031	55	0.67	20				139.7	8.96	1.098		
M	813	878032	52	4	23	142.8	0.555	3.9×10⁻³	137.6	7.65	1.628	0.175	
M	6018	878036	52	6	24				102.3	1.92	0.631	0.681	
M	6126	878037	55	2	35	148.6	2.713	1.8×10⁻²	136.5	5.98	3.304		
M	6003	878038	75	8	22	141.4	0.923	6.5×10⁻³	132.2	5.69	2.459	3.91	
M	6017	878040	80	6	24	162.5	1.144	7.0×10⁻³	147.3	6.69	2.676	4.09	
M	6128	878042	53	7	31	148.6	1.214	8.2×10⁻³	118.8	4.72	1.125		
M	6125	878043	69	8	35	149.8	1.536	1.0×10⁻²	144.4	5.65	2.513	1.217	
M	6007	878045	82	0.58	35				137.3	3.58	1.933	3.35	
M	6136	878047	67	0.42	24				141.8	2.60	1.458	1.58	
F	6112	878048	70	11	35				95.9	2.16	1.757	0.91	
F	6114	878056	54	0.25	32				99.9	1.90	0.218	1.97	
F	6111	878059	54	0.5	32				119.9	3.11	1.311	4.19	
F	6122	878060	73	10	46				85.5	3.40	1.335	3.76	
F	6123	878062	77	4	30	102.1	1.530	1.5×10⁻²	92.5	3.21	1.407	3.85	
F	6057	878064	75	1	19				20.1	1.13	0.261		
F	6003	878067	59	4	46	29.6	0.797	2.7×10⁻²	22.3	3.16	1.515	1.11	

PRIVACY ACT MATERIAL REMOVED

Summary of Bikini Whole Body Counting Results For 1977 and 1978

	1	2	3	4	5	6	7	8	9	10	11	12	13
	S Medical	1978	Weight	Number of	Age	1977	1977	1977	1978	1978	1978	1978	1978
NAME	E ID	Tape	in	Years living	at Beam in	Potassium	Cs^{137}	Cs^{137}/K Ratio	Potassium	Co-60	Cs^{137}	Cs^{137} (Corrected)	Cs^{137}/K Ratio
	X Number	ID Number	Kgrams	in Bikini	Years	Grams	MC	MC/gram	grams	mC	MC	MC	MC/Gram
	F	[illegible]	53	0.58	54				70.7	1.29	0.92	0.35	
	F	[illegible]	72	4	24	92	0.100		93.0	2.18	0.739		
	F	[illegible]	60	5	12	78.8	0.060		77.6	4.63	2.07		
	F	[illegible]	54	4	25	91.7	0.557		91.3	2.33	1.03	0.51	
	F	[illegible]	51	4	9	101.4	0.734		93.9	2.39	1.05		
	F	[illegible]	53	4	19	92.5	0.408		90.2	2.15	1.23		
	F	[illegible]	50	4	25	104.1	0.631		97.8	1.93	0.791		
	F	[illegible]	85	1.75	43	94.3	0.273		100.2	3.21	2.03		
	F	[illegible]	60	3	16	90.4	0.761		93.4	2.32	0.854		
	F	[illegible]	53	2	22				81.4	2.00	1.39		
	F	[illegible]	50	0.44	27				73.9	1.51	1.53		
	F	[illegible]	77	2	32				95.2	3.92	1.50		
	F	[illegible]	58	0.93	37				104.3	2.94	2.35		
	F	[illegible]	60	7	20				83.0	1.55	0.967		
	F	[illegible]	63	6	32				80.5	3.62	2.33		
	F	[illegible]	50	5	29	93.9	0.535		82.3	2.45	1.90		
	F	[illegible]	74	6	43	98.8	0.534		103.5	10.84	5.47		
	F	[illegible]	54	4	21	96.3	0.216		78.2	2.53	1.99		
	F	[illegible]	77	6	30	113.7	0.553		101.9	4.34	2.76		
	F	[illegible]	52	7	43	95.4	1.154		80.3	4.86	3.26		
	F	[illegible]	70	7	40	93.7	0.755		93.1	6.52	3.89		
	M	[illegible]	70	7	28	144.8	1.931		145.8	4.32	1.51		
	M	[illegible]	70	6	45	149.5	1.036		115.6	2.21	1.25		
	M	[illegible]	93	6	19				93.7	4.13			
	M	[illegible]	57	11	18	132.4	0.491		109.1	4.52	1.33	0.19	
	M	[illegible]	33	2	12				30.6	4.05	2.23		
	M	[illegible]	72	6	14				87.2	4.07	2.11		
	M	[illegible]	90	6	11				69.6	1.63	1.69		
	F	[illegible]	34	6	10				67.6	3.21	2.19		
	F	[illegible]	35	6	2				71.1	5.36	3.65		
	M	[illegible]	70	9	21	132.5	3.432		130.3	5.99	3.04	6.58	
	F	[illegible]	53	9	23	87.1	0.552		92.0	1.70	1.31	1.16	
	F	[illegible]	44	0.58	7				72.6	0.92	0.697		
	M	[illegible]	3	7	13				69.2	3.10	2.32		
	F	[illegible]	37	7	2				75.7	2.17	1.629		
	F	[illegible]	62	3	42				80.9	5.92	1.901	2.46	
	M	[illegible]	50	4	10				92.6	1.12	1.503		
	M	[illegible]	93	3	18				99.0	3.62	2.091		
	F	[illegible]							51.2	1.64	1.266		

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114.72
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PRIVACY ACT MATERIAL REMOVED

Summary of Bikini Whole Body Counting Results for 1977 and 1978

SEX	Medical ID Number	1978 Tape ID Number	Weight in Kgrams	Number of Years living on Bikini Is	Age of Person Years	1977 Potassium Grams	1977 Cs 137 μCi	1977 Cs137/K Ratio μCi/gram	1978 Potassium grams	1978 Co-60 nCi	1978 Cs 137 μCi	1978 Sr90 (Estimated) μCi	1978 Cs137/K Ratio μCi/gram
M		B78102	23	6.25	7				52.2	1.22	1.373		
M		B78110	27	7	11				67.1	2.09	2.625		
F		B78111	[illegible]	3	9				65.3	1.92	1.627		
F		B78112	43	6	13				37.2	[illegible]	1.468		
M		B78113	20	[illegible].34	5				55.1	2.07	1.592		
M		B78114	24	7	7				55.2	6.05	1.523		
M		B78115	22	4	8				70.4	2.05	1.530		
F		B78116	40	6.25	13				81.5	3.11	2.529		
F		B78117	35	9	7				70.6	1.66	1.513		
F		B78118	34	7	10				73.7	3.64	2.246		
M		B78119	27	7	10				71.5	3.03	1.704		
M		B78120	18	2	5				[illegible]	1.62	1.190		
M		B78126	34	1.42	[illegible]				90.4	1.41	1.667		
F		B78123	22	2	6				52.5	6.97	1.327		
F		B78127	12	5	6				47.4	7.65	1.370		
F		B78128	21	3	5				53.5	1.77	1.227		
M		B78129	75	7	56	161.7	7.220 / 38 pCi/g K	1.037×10^{-2}	179.3	14.91	5.708	5.62	$3.[illegible] \times 10^{-2}$
F		B78130	26	0.67	8				67.2	0.62	1.213		
F		B78131	42	4	13				87.8	1.52	0.923		
F		B78133	22	3	6				44.0	6.58	0.743		
M		B78134	71	11	35				141.6	3.30	3.115	3.40	1.51×10^{-2}
M		B78135	6.5	0.42	0.42				20.6		0.363		

Highest Cs (≤15)

MPB Cs-137 3 μCi

MPB Sr-90 0.2 μCi