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MAY 22 1986

Maj. Gen. George K. Withers, Jr., USA, Director
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NV RECOMMENDATIONS - DOE POST COMPACT, MARSHALL ISLAND PROGRAM INVOLVEMENT

The Marshall Islands Planning Group (MIPG) was established at Defense Programs' (DP) direction to review and make recommendations on the technical content of our Marshall Islands programs, to ensure our legal obligations were met, and to undertake long-term planning, recognizing the changing political relationship between our government and that of the Republic of the Marshall Islands (RMI).

The enclosed MIPG document was formulated to serve DP as a resource to help make decisions relative to U.S. commitments under the Compact of Free Association (P.L. No. 99-239). Basically, it recognizes the obvious - that certain commitments track or overlay programs or program elements which are currently being carried out effectively by an integrated DOE/national laboratory/contractor team.

More specifically, the recommendations are that DOE continue to provide the special health care program for the remaining 174 people exposed to the 1954 BRAVO test and that DOE complete environmental assessments and dose predictions for the next three years to meet Compact commitments relating to Bikini, Enjebi Island and Rongelap Atoll. After that, our technical assistance would be made available to RMI on a reimbursable basis.

NV has been planning and managing these programs for DP over the past four years and prior to that for ES&H. My staff, along with some of the highly respected medical and technical people, both inside and outside the DOE community, has been formulating plans geared toward this change in our relationship with the RMI. The Marshall Islands Planning Group recognized that organizations other than DOE-affiliated could carry out Compact commitments. However, the combination of the coordinated, DOE-managed program(s), the in-place logistical network, and, perhaps even more important, the painstakingly built political relationship between DOE and all levels of the RMI government, suggest no reasonable alternative which would not sharply disrupt the entire decision-making process with respect to restoring the habitability of certain land areas and U.S. commitments thereto.

*DOE
John Rudolph's files*

Maj. Gen. George K. Withers

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NV endorses these recommendations. We hope you find them useful for the interagency decision-making process to determine who will be dealt program responsibility to meet Compact commitments.

ORIGINAL SIGNED BY
D. T. SCHUELER ✓

Thomas R. Clark
Manager

Enclosure:
Recommendations on Post Compact of
Free Assoc. Progs. by USDOE, Relative
to Past Nuclear Testing on Marshall
Islands, FY 87-89 (2)

cc:
J. E. Rudolph, MA, HQ (DP 22.1) GTN w/encl.



RECOMMENDATIONS ON POST COMPACT OF
FREE ASSOCIATION PROGRAMS BY THE
U.S. DEPARTMENT OF ENERGY
RELATIVE TO PAST NUCLEAR TESTING
IN THE MARSHALL ISLANDS

FY 1987-1989

MARSHALL ISLANDS PLANNING GROUP
MAY 1986

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I. GENERAL STATEMENT

This booklet has been prepared following a March 1986 meeting of the Marshall Islands Planning Group (MIPG) and reflects the best judgment of the below-listed people as to the U.S. commitments under the Compact of Free Association, in particular the agreement to implement Section 177, and which of these will likely fall to DOE because of unique qualifications or historical circumstances.

The plan contained herein also suggests programs or program elements that are not compact requirements, per se, but, in the opinion of the MIPG, should be implemented or continued by either the Republic of the Marshall Islands (RMI) Government or the U.S. Government for their own purposes.

This plan is one which has evolved over the past four years to keep pace with medical and other accomplishments over that period, as well as the changing political arrangements between the U.S. and RMI Governments. It is intended as a resource and planning guide to the Manager, NV, for his review and input to DP to help focus departmental decisions when discussing compact implementation with other federal agencies.

It must be pointed out that while we have endorsed work by DOE, the planning group recognizes that other entities have or could have the ability to perform the work that needs to be done. The key to our recommendations is that DOE program planning and management has succeeded in producing an integrated program conducted in cooperation by various components of different national laboratories. This is cost-effective and it would take many years at great expense to replace.

Finally, the work proposed, especially that pertaining to such matters as the environmental half life of ^{137}Cs and the remedial work at Bikini may have broad applications as has been brought painfully to the attention of the world most recently through the Soviet reactor mishap. All other reasons aside, it appears obvious that these projects should be brought to completion for our own best interests.

PARTICIPANTS

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II. BACKGROUND

The U.S. Government, after almost 20 years of negotiations with the people of the Trust Territory, is prepared to end its United Nations Trusteeship responsibility for that vast island area, and enter into a new political relationship. The formal instrument to govern this change is the Compact of Free Association with the Federated States of Micronesia and the Republics of Belau and the Marshall Islands. Basically, these entities have complete control of their internal and external affairs and in exchange for U.S. funds, defense obligations, and programs the entire area will be unavailable to countries other than the U.S. for military purposes. The Compact was signed by President Reagan and is now incorporated into P.L. 99-239 (H. J. RES. 187); January 14, 1986, Compact of Free Association Act of 1985.

Relative to the legacy of the nuclear tests in the Marshall Islands, P.L. 99-239, which we will refer to as the "Compact," makes provision for funding and programs which address the special problems and needs arising out of that test program.

The Compact, including the Agreement Subsidiary to Section 177, provides the following U.S. commitments as they relate to programs now conducted in the Marshall Islands by DOE:

1. Special medical care for the remaining 174 persons from the Atolls of Rongelap and Utirik exposed to fallout from 1954 test BRAVO;
2. Funding to the RMI Government to review the DOE radiological data and to establish the habitability of Rongelap;
3. Restoration of Rongelap, if necessary, to habitability;
4. Reporting within one year after Compact implementation when the people of Enjebi Island on Enewetak Atoll can resettle their island; and

II. BACKGROUND

5. Funding to restore Bikini Atoll to habitability.

Currently, DOE conducts an integrated program in the northern Marshalls, which deals with certain of the Compact commitments:

1. Medical examination and treatment of persons on the islands of Rongelap and Utirik that were exposed to fallout from the BRAVO event in 1954;
2. Evaluation of plutonium in urine from residents of Enewetak, Bikini, and Rongelap for retrospective dose assessment and for prospective dose evaluation; and
3. Studies of transport of radionuclides in the environment, including the effect of remedial actions on environmental availability of these radionuclides for human consumption.

The recommendations for DOE funded involvement, post-Compact, are essentially a "wrap-up" of current programs which will fulfill a large segment of U.S. Compact commitments at least as far as DOE can contribute. Except for the medical program, it is expected that after FY 1989, programs provided by DOE will be in the form of RMI funded technical assistance.

III. SUMMARY CONCLUSIONS

- o DOE, THROUGH BNL, PROVIDE MONITORING AND HEALTH CARE FOR EXPOSED RONGELAP AND UTIRIK PERSONS.

- o DOE, THROUGH LLNL, COMPLETE BIKINI REHABILITATION EXPERIMENTS; ENEU, ENJEBI, AND RONGELAP DOSE ASSESSMENTS. COMPLETION TARGET, SEPTEMBER 30, 1988.

- o DOE, THROUGH BNL, COMPLETE ANALYSES FOR PU IN URINE SAMPLES; COMPLETION TARGET SEPTEMBER 30, 1988.

- o DOE, THROUGH LLNL, MAINTAIN RADIOLOGICAL DATA BANK, WITH COST SHARING FROM RMI BEGINNING FY 1988.

IV. MEDICAL

RECOMMENDATIONS ON DOE MEDICAL PROGRAM

1. Through BNL, conduct annually one major vessel-supported mission to Ebeye, Majuro, Utirik, and Mejatto to provide specialized examinations and medical care to the exposed people.
2. Conduct an annual follow-up on selected patients, with a small medical team supported by scheduled aircraft.
3. Conduct an administrative trip by one or two persons to coordinate medical data with other health care providers.
4. Provide full medical care to the exposed population, with patients using Marshall Islands health care facilities to the extent possible, and referrals to medical facilities elsewhere as necessary.

AUTHORITY

"Compact of Free Association Act of 1985," a joint resolution, Title I; Approval of Compact, Interpretation of; and U.S. policies regarding Compact, Supplemental Provisions.

". . . The President (either through an appropriate department or agency of the United States or by contract with a United States firm) shall continue to provide special medical care and logistical support thereto for the remaining 174 members of . . . Rongelap and Utirik who were exposed to radiation resulting from the 1954 . . . "Bravo" test . . . Such medical care and its accompanying logistical support shall total \$22,500,000 over the first 11 years of the Compact."

IV. MEDICAL

DURATION

Eleven years, per the cited authority, and probably through the lifetime of that population thereafter, funded by Section 177 monies.

RATIONALE FOR DOE TO PROVIDE

1. The Republic of the Marshall Islands has formally requested of the U.S. Government that DOE continue the program.
2. BNL has provided this for 32 years and has extensive medical records. Its physicians and staff are well acquainted with the health problems of the exposed group. The program is comprehensive, yet specialized in terms of radiation exposure.
3. There is an experienced logistical support network set up through the area through the DOE base in Hawaii, which provides service to Johnston Island and other Safeguard C facilities, effecting economies of scale.
4. Funding is authorized and it should be a Department of the Interior (DOI) responsibility to obtain appropriations (see Section IX); thus the DP budget is not impacted.

ALTERNATIVES

1. Private U.S. Firm

This could be done, presumably through the DOI. However, because most of the BNL physicians are volunteers, largely from universities, and because of economies of scale in utilizing DOE Pacific logistics support, the program through DOI would most certainly cost more to run. Also, a lengthy

IV. MEDICAL

transition period would be necessary because of the need to transfer much specialized knowledge, both medical and nonmedical, to a new provider.

2. Another Federal Agency

To our knowledge, no other agency is readily equipped to provide the specialized requirements. U.S. Public Health Service could undertake this, probably through a contract with a private organization. As with a private U.S. firm above, a lengthy transition period would be required.

V. RADIOLOGICAL SAFETY

RECOMMENDATIONS AS TO THE RADIOLOGICAL SAFETY PROGRAM

1. DOE, through BNL, fund the completion of the Pu in urine analysis (through FY 1988) to verify assessments of the total contribution of Pu in overall dose to the populations which are looking to resettlement of Enjebi, Bikini, and Rongelap.
2. RMI Government fund periodic bioassay verification for resettled communities.

AUTHORITY

"Compact of Free Association Act of 1985," a joint resolution, Title I.

- Commitment to fund resettlement of Enjebi, if feasible
- Commitment to restore Bikini Atoll to habitability
- Commitment to restore, if necessary, Rongelap to habitability

DURATION

1. Through FY 1988 if data provide sufficient information for informed decisions; if not, through FYs 1989 or 1990.
2. As requested by RMI for duration of Compact.

RATIONALE FOR DOE TO PROVIDE

1. Fulfills DOE commitment to report on radiation conditions for protective actions and resettlement.

V. RADIOLOGICAL SAFETY

2. Can remain integrated with DOE Environmental program and utilize common support assets.

ALTERNATIVES

1. The capability to analyze for Pu in urine at low concentration levels is not known to exist outside BNL at this time.
2. Whole-body counting could be provided by a university or other private source with attendant difficulties in gearing to a remote environment, a different culture, and data transfer.

VI. ENVIRONMENTAL

RECOMMENDATIONS ON ENVIRONMENTAL PROGRAMS

1. Bikini Atoll: DOE, through LLNL, update prospective dose estimates for population returning to Eneu Island (FY 1987); complete remedial experiments (FY 1989); complete environmental half-life assessment (FY 1989); provide post-cleanup dose assessment for Bikini Island.
2. Rongelap: DOE, through LLNL, process and integrate recent samples to ensure dose assessment is current for "independent scientists" review.
3. Enewetak: DOE, through LLNL, update Enjebi dose assessment (FY 1987) to satisfy commitment to report when that island can be reinhabited.
4. DOE, through LLNL, maintain environmental data bank.
5. RMI Government fund applied research geared to optimizing future use of agricultural crops and subsequent dose assessment.

AUTHORITY

"Compact of Free Association Act of 1985," a joint resolution, Title I.

- Commitment to fund resettlement of Enjebi, if feasible.
- Commitment to restore Bikini Atoll to habitability.
- Commitment to restore, if necessary, Rongelap to habitability.

VI. ENVIRONMENTAL

Subsidiary Agreement to Compact Section 177, Article VI, "The Government of the United States reaffirms its commitment to provide funds for the resettlement of Bikini Atoll . . ."

DURATION

Through FY 1989

RATIONALE

Is part of U.S. commitment to fully understand radiological conditions on Atolls to be resettled with U.S. assistance

ALTERNATIVES

There are no reasonable alternatives given cost and the delays in transferring data. For a new group, for example from another national laboratory or a university, to mount a field team and develop adequate data and understanding would be extremely costly, would delay experiments, updating of the data bank, and dose assessments.

VII. LOGISTICAL SUPPORT

RECOMMENDATIONS ON LOGISTICAL SUPPORT

1. Support for above work be provided by DOE to include:
 - a. Multiuser charter vessel;
 - b. Purchase and maintenance of common equipment such as trucks, forklifts, loaders, and generators;
 - c. Staff Bikini field camp (FY 1988); and
 - d. Medical Referral Support.

RATIONALE FOR DOE TO PROVIDE

DOE has a multifaceted logistics support office in Honolulu, basically to support the joint DNA/DOE programs at Johnston Island. To utilize this network for Marshall Islands programs has proven effective by using in-house expertise and effecting economies. People in this existing network are experienced and program knowledgeable; very valuable assets when dealing with a vast and remote work area.

ALTERNATIVES

This support could be contracted out to private enterprise. The costs to demobilize the current network and reestablish a new one would be cost prohibitive and would take several years to be effectively integrated with DOE and contractor mission personnel and programs.

VIII. SELECTED CANDIDATES FOR RMI "BUY BACK"

The Agreement to implement Section 177 of the Compact provides, in part, \$2 million annually to RMI to obtain U.S. technical assistance on a reimbursable basis. It is difficult at this juncture to determine exactly what RMI will request. This will be a dynamic set of needs based on future government to government discussions. However, there are some potential RMI needs that are addressed below. No attempt has been made to attach cost estimates, as MIPG determines that this would be speculative and unproductive at this time.

ENVIRONMENTAL DATA BASE

RMI may expect questions to arise from time to time from communities, claims tribunal, and individual claimants, which require both current and historical data, as well as current interpretation. These requirements can probably best be satisfied by RMI contributing a measure of support to maintain and update the LLNL Data Bank.

SUPPORT TO LAND UTILIZATION MANAGEMENT

Beyond the specific areas which are named in the Compact legislation as U.S. commitment areas, certain other areas in the northern Marshalls are today not recommended for unrestricted use. As time passes, as understanding improves, and as technology advances, it may be appropriate that the restrictions be relaxed, or otherwise updated.

Under the terms of the Compact (Section 177 Subsidiary Agreement), the authority and responsibility for land use restrictions lies with the RMI. Technical input to the decision-making process can be made available to the RMI if it so requests and funds (both environmental and radiological safety).

VIII. SELECTED CANDIDATES FOR RMI "BUY BACK"

REMEDIAL TECHNOLOGIES

Once support to the Bikini Atoll Rehabilitation Committee (BARC) has been terminated and U.S. commitments re Rongelap and Enjebi are satisfied, there may still be a suite of investigations and applied science efforts which the RMI may wish to fund. This could include alternate (nonfood) uses for agricultural products from certain islands.

DOSE MONITORING AND EVALUATION

With a Bikini resettlement and possibly an Enjebi resettlement, it will be prudent to monitor the radiological dose to returning inhabitants.

EDUCATIONAL SUPPORT

Regardless of the finality of the Compact settlement, there remains the likelihood that some population groups in the northern Marshalls will be uneasy about their future. The mystique of radiation has already taken its toll (e.g., the early seventies Utirik boycott of the medical program; the 1985 evacuation of Rongelap). Probably several decades must pass before all of these population groups will feel at ease in their environment. RMI might well request that DOE assist them in giving the people a thorough, factual, and reasoned appreciation of their circumstances.

IX. FUNDING SOURCE

Currently, there are two draft Executive Order proposals within the administration, which define management responsibilities to implement the provisions of the Compact. Both versions seek to clarify the roles and responsibilities of the Secretaries of State and Interior in that regard.

In both drafts, it is the clear responsibility of the Secretary of Interior to seek funds to fulfill obligations of the United States under Public Law 99-239, including Titles I and II which address the recommendations contained herein by the MIPG.

It is therefore acknowledged and recommended by the Marshall Islands Planning Group that funding for all DOE-run programs pursuant to obligations incurred as a result of PL. No. 99-239 be provided through DOI.

X. PROJECTED COSTS THROUGH DOI

(\$000 in FY 87 Dollars)

<u>Medical</u>		<u>FY 87</u>	<u>FY 88</u>	<u>FY 89</u>
One ship-supported mission	Operations	889	812	790
One follow-up mission	Capital	10	10	10
One Admin. mission	Medical referrals	<u>250</u>	<u>250</u>	<u>250</u>
Medical referrals				
Maintain records				
Support four full-time employees				
	Total Medical	<u><u>1,149</u></u>	<u><u>1,072</u></u>	<u><u>1,050</u></u>
<u>Radiation Safety</u>				
Process 600 (annually) samples for Pu	Operations	313	313	313
Support 2.75 man-years	Capital	<u>25</u>	<u>25</u>	<u>25</u>
	Total Radiation Safety	<u><u>338</u></u>	<u><u>338</u></u>	<u><u>338</u></u>
<u>Environmental</u>				
Three missions per year	Operations	1,900	1,900	1,300
Sample analyses	Capital	50	50	10
Maintain data bank				
Support nine full-time personnel				
Bikini Field Station				
	Total Env.	<u><u>1,950</u></u>	<u><u>1,950</u></u>	<u><u>1,310</u></u>
<u>Logistical Support</u>				
Vessel	Operations	1,000	1,000	1,000
O&M, Procurement	Capital	<u>50</u>	<u>50</u>	<u>50</u>
	Total Logistics	<u><u>1,050</u></u>	<u><u>1,050</u></u>	<u><u>1,050</u></u>
	Total Program	4,487	4,410	3,748

MEDICAL

BACKGROUND AND PROPOSED SCOPE OF WORK

The Brookhaven National Laboratory (BNL) medical program has been providing medical care to the exposed population for 32 years. It has on file the extensive medical records obtained during this period, and its physicians and support staff have an acquaintance with the health problems of the exposed group which is both comprehensive and yet specialized in terms of radiation exposure. It has at hand noted authorities in radiation medicine and radiation physics. Many of these individuals have been involved with the Marshall Islands medical program first-hand. The personal contact which has existed over many years has permitted a relationship to evolve which, while having had its ups and downs, provides a familiarity with exposed individuals and their families which can, in many ways, be considered a "doctor-patient" relationship.

The DOE has provided the leadership in program planning, funding, and implementing consistent U.S. governmental representation in the Marshalls. This teamwork has proven effective and allows the medical program to function virtually free of "local politics."

The format of the annual examinations will not be changed. Reliance on subspecialists, primarily university-based, will guarantee a continually updated program. Laboratory, radiographic, and other diagnostic techniques will be maintained and updated as necessary. To optimize the accessibility to the exposed persons of the sizeable medical teams at the time of the annual examinations, there must be continued dependence on the DOE chartered Liktanur III or an equivalent vessel to travel to the affected people. Transportation of the exposed persons from their islands to Majuro for examination is, for the time being, an unsatisfactory alternative. It is disruptive of island lifestyle, an inconvenience to the elderly and disabled, and an unnecessary shift of part

MEDICAL

of the responsibility to provide accessible medical care from the program to the beneficiaries of the program.

While the annual examination mission will not decrease in size, other aspects of the primary care effort of the present medical program will be trimmed. It is not the purpose of the BNL program to duplicate efforts of other health care programs. The purpose is, instead, to provide optimal care to the exposed as circumstances permit. The BNL program will continue to offer the same examinations and diagnostic and therapeutic options to all inhabitants on island at the time of the visits to Rongelap (Mejatto) and Utirik. The one difference between exposed and unexposed is that only the former will be eligible for direct referral outside the Marshall Islands, and the costs will be borne by the medical program.

A hallmark of the BNL program has been the high rate of compliance by the exposed persons who have responded to the annual medical examinations which have been offered to them since the 1950s. To assure continued availability of the examinations to all exposed persons who desire them, a second medical mission will be carried out several months after the first. It is unrealistic to think that all exposed persons desiring examinations will be available at the time of a single mission. The second trip is designed to include these individuals and will be comprised of a physician, nurse, laboratory technician, and administrator. Their work will be performed at Marshallese facilities on Ebeye and Majuro. Nevertheless, if travel situations permit and clinical justification exists, the option to travel to Rongelap and Utirik should be available. The latter islands would be visited to ensure adequate medical follow-up of special diagnostic and therapeutic problems.

MEDICAL

Although only about 170 persons remain of those who were exposed to fallout from the BRAVO test, the Congress has mandated a 4-Atoll health care program to provide primary, secondary and tertiary health care to the populations of Rongelap, Utirik, Enewetak, and Bikini. It is estimated that 7,000 people may be eligible for the benefits of this program. The proposed BNL effort is neither duplicative of or in competition with the 4-Atoll program. The 170 exposed people are entitled to thorough and specialized examination, evaluation, and treatment. These special needs were clearly addressed in P.L. 99-239 (H. J. Res. 187). It cannot be expected that the 4-Atoll Health Care Program (4AHCP) will be able to adequately attend to all the special needs of the exposed. A third visit each year will be carried out by one or two of the BNL staff to distribute and collect medical record information, document adequate follow-up of special medical problems, and maintain close working relations with the 4AHCP, DOE/PASO, and the RMI Health Service.

As the scope of medical care provided to the exposed now increases, the previously defined program directed at neoplastic diseases and other unique problems possibly induced by the exposure will continue to be carried out. These include a cancer-oriented examination, with special attention to endocrinologic disorders, hematologic testing, and other items detailed in the long-term plan of the medical program as presented in May 1985. The BNL program will continue to evaluate the exposed population for evidence of increased risk of disorders which might be indirectly related to their exposure. The goal of this effort is a clinical one: early diagnosis and treatment. For the most part, these will be serologic surveys of the type performed in the past for hepatitis B, toxoplasmosis, and prolactinomas. The justification for carrying out surveys of this sort is that they have clinical relevance to the evaluation and treatment of the exposed population.

MEDICAL

NECESSARY PROGRAM ADJUSTMENTS

1. Modify medical record management.
 - a. More reliance on computerized records.
 - b. Develop communication plan for BNL, 4-Atoll HCP, DOE/PASO.
2. Maintain high level of follow-up and program visibility (locally).
 - a. Secondary clinical medical mission on small scale.
 - b. Administrative visit.
3. Establish limited Ebeye liaison.
 - a. Patient management.
 - b. Laboratory equipment maintenance.
4. Formalize quality assurance.
5. Maintain an RMI compatible formulary handled through BNL.
6. Update diagnostic and therapeutic capabilities.

MEDICAL

CLINICAL ORIENTATION

1. Maintain a comprehensive program of prevention, diagnosis, and treatment of neoplastic disease.
2. Continue to look for evidence of increased risk of radiation-relatable disease, with the goal being prevention and early diagnosis and treatment.
3. Increase efforts to place nonradiation-related disease in proper health perspective for the exposed group.
4. Stress health maintenance.
5. Improve on care of diseases associated with aging.

RADIATION SAFETY

BACKGROUND AND SCOPE OF WORK

BNL Safety and Environmental Protection Division has been an integral part of the total program since 1974. From 1954 to 1974, radiation protection was conducted by the BNL Medical Department. Accurate assessment of dose requires a proper balance between monitoring the environment and monitoring the people directly. Direct monitoring of people is appropriate for uncontrolled exposure conditions since all conditions cannot be anticipated by monitoring the environment alone. The work to date includes:

1. Bioassay measurements and exposure assessments for persons at Rongelap and Utirik;
2. Thyroid dose assessment for persons at Rongelap and Utirik on March 1, 1954;
3. Bioassay measurements and exposure assessments for Bikinians;
4. Development and implementation of plutonium bioassay technique with appropriate sensitivity; and
5. Whole-body counting and urine bioassay for persons at Enewetak.

The plutonium bioassay technique was developed to determine if significant exposure to transuranics occurred. Problems related to sensitivity have been overcome by more recent developments in the BNL fission track technique for urine assay. The limit of detection is 50 attocuries in urine, and this corresponds to being able to measure today, a committed effective dose equivalent of 50 mrem to a person exposed 50 years ago. All other procedures available for Pu bioassay on individual urine samples are much less sensitive, in terms

RADIATION SAFETY

of dose, by a factor of 1000. Thus, BNL has developed a unique capability to assess previous Pu exposure, which can be compared to applicable limits or may be useful in the development of cleanup plans.

Samples of urine collected and analyzed prior to 1985 revealed some high, and probably incorrect, levels of Pu in individual urine samples. Because of analytical sensitivity problems, pre-1986 urine measurements were of questionable value.

BNL now expects at least 14 attocuries of Pu in urine from nonexposed persons from worldwide fallout, and has found significant concentrations of Pu-239 in chemical reagents. Because of these additional sources, Pu is found in each sample processed. An average of 60 attocuries was measured in daily urine samples from seven New York adults.

BNL Pu results to date, for Marshall Islanders, are listed on the next page. A lognormal distribution of Pu results is to be expected, thus hundreds of data points are required in order to estimate population dose. In order to define an individual's dose accurately, several urine samples are needed from a person over a period of time. Samples processed in FY-87 and FY-88 may produce candidates for follow-up plutonium analysis, because of higher than average results.

Currently, BNL has a capacity to process 600 samples per year. The limitation is availability of fume hoods (four currently available). In order to double output, lead time of one year will be needed. BNL currently has 2400 urine samples on hand; collected since 1978. Thus, at present capacity, the current inventory could be processed by the end of 1989.

RADIATION SAFETY

Pu RESULTS TO DATE, ATTOCURIES EXCRETED PER DAY

Population	1982		Population	1984	
	Age	aCi/Day		Age	aCi/Day
Enewetak	52	< BKG	Rongelap	24	120
Enewetak	55	5.2	Rongelap	26	62
Enewetak	58	2200	Rongelap	27	< BKG
Enewetak	62	120	Rongelap	29	< BKG
Enewetak	72	28	Rongelap	32 ^b	140
			Rongelap	41	240
Majuro	10	42	Rongelap	42	3500
Majuro	5 ^a	1300	Rongelap	45 ^b	330
			Rongelap	53	150
Bikini	22	270	Rongelap	63	2000
Bikini	27	410	Rongelap	69 ^b	< BKG
Bikini	28	190	Rongelap	76 ^c	1100
Bikini	29	400			
Bikini	36	< BKG			
Bikini	52	390			
Bikini	55	67			
Bikini	76	330			
Bikini	78	31			
Bikini	78	29			
Bikini	36	800			
Bikini	36	870			

RADIATION SAFETY

Population	1982		Population	1986	
	Age	aCi/Day		Age	aCi/Day
Bikini	37	11000			
Bikini	37	3400			
Bikini	38	1100			
Bikini	38	750			

^aInitial volume 70 ml.

^bExposed March 1, 1954, to BRAVO fallout at Rongelap.

^cExposed March 1, 1954, to BRAVO fallout at Ailingnae.

RADIATION SAFETY

Pu BIOASSAY AND Pu DOSE ESTIMATES FOR EACH YEAR OF EXPOSURE

<u>Population</u>	<u>Average (Highest) Estimate of Committed Effective Dose Equivalent, mrem per year of exposure</u>
Enewetak, 5 adult males	18 (51)
Bikini, 17 adult males	100 (840)
Rongelap, 12 adult males	10 (55)

NOTE: Estimate was based on average and (highest) results, and only a few samples have been processed. Thus, the estimate has a large uncertainty. The highest estimate at Bikini, 840 mrem per year, is associated with 4.5 years of exposure, which is a total committed dose of 3.8 rem. The average whole-body dose for Bikinians for ^{137}Cs was 100 mrem for each year of exposure. Thus, Pu may or may not represent a significant portion of the internal emitter hazard.

These preliminary numbers should be regarded as qualitative at this time due to the small number of samples analyzed, and the higher values may be orders of magnitude too high.

RADIATION STANDARDS FOR THE GENERAL POPULATION

In Section 103.(k)(2) of Public Law 99-239, the U.S. Government will, at the request of the Government of the Marshall Islands, evaluate the radiological

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condition at Enjebi such that persons reinhabiting the island will "meet whole body Federal radiation protection standards for the general population." Subsection (1)(1) specifies that, "the United States will fulfill its responsibility for restoring Bikini Atoll to habitability." The following Federal and International standards may apply:

International Commission
for Radiation Protection
(ICRP) Section 26

100 mrem per year of lifelong,
whole-body exposure.

National Council for
Radiation Protection
(NCRP) 39.

500 mrem per year for any critical organ of an individual member of the public. Average population dose limit of 170 mrem.

NCRP (Proposed)

For continuous or repeated exposure, the annual effective dose equivalent is not to exceed 100 mrem, or 7 rem for 70-year lifetime.

DOE 5480.1A
(Interim Rule)

100 mrem per year for prolonged period of exposure (over 5 years) to planned releases.

ICRP Publication 39

1,000 mrem per year upper bound for future exposures to natural radiation (specific for radon).

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SCHEDULE FOR COMPLETION OF Pu ANALYSIS

<u>Samples</u>	<u>Completed By</u>	<u>Sample Results By</u>	<u>Dose Report</u>
1-600	March 1987	June 1987	September 1987
601-1200	March 1988	June 1988	September 1988
1201-1800	March 1989 (if required)	June 1989	September 1989
1801-2400	March 1990 (if required)	June 1990	September 1990



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BACKGROUND AND SCOPE OF WORK

LLNL has been working on the radiological characterization of the northern Marshall Islands with resultant dose assessments since 1975. In addition to field work, sample analysis and dose assessments, LLNL has created a unique data bank, pulling together radiological data from all the various organizations which have done environmental sampling and dose work since 1954.

Recently, DOE, through LLNL, integrated elements of its program at Bikini Atoll with the congressionally-created Bikini Atoll Rehabilitation Committee (BARC). Working together, LLNL and the BARC are conducting a suite of experiments designed to establish criteria for informed decisions on how Bikini can best and most cost-effectively be resettled.

There are three specific tasks identified in the compact which are related to dose assessments and environmental research and monitoring which LLNL performs for DOE. These are:

A review of the Rongelap dose assessments and restoration of rehabilitability of Rongelap if required;

A dose assessment of Enjebi Island at Enewetak Atoll and recommendations on resettlement; and

Rehabilitation of Bikini Atoll (Bikini and Eneu Islands).

LLNL has a continuing effort at each of the three identified Atolls.

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RONGELAP REASSESSMENT

This reassessment was prompted by information obtained during a February 1986 visit to Rongelap. Considerable quantities of "Yap Variety" coconuts are being grown on Rongelap even though the majority of the coconuts on the island appear to be of the "Old Variety." The reasons for concern are:

1. The external gamma exposure and the soil concentration of ^{137}Cs are higher by about a factor of 2 for Rongelap compared with Eneu.

	External Gamma $\mu\text{R/h}$	Decay corrected to 1987 Soil ^{137}Cs Concentration pCi/g	
		0-5cm	0-40cm
Rongelap	4.5	12	4.1
Eneu	2.3	5.9	2.9
ratio (Rong./Eneu)	2	2.0	1.4

2. The ^{137}Cs concentration in coconut meat and fluid, however, is about 15 pCi/g wet weight at Eneu and about 5.5 pCi/g wet weight at Rongelap, an apparent ratio reversal.
3. The difference between ^{137}Cs ratio in the soil and that in coconut may be due to the two different varieties of coconuts on the island; i.e., "Old Variety" on Rongelap and "Yap Variety" on Eneu. Age of the

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trees and ^{137}Cs distribution in the soil column cannot be discounted, however.

4. The different uptake of ^{137}Cs has been confirmed by evaluating both varieties of trees that are near neighbors at Eneu and Bikini Islands. However, the effect of age cannot be discounted in this observed difference.
5. The importance of coconut in the diet is reflected in the maximum annual and integral doses which for Eneu are about two times those of Rongelap.
6. Studies are proposed which will determine and compare the uptake of ^{137}Cs in young and old "Old Variety" coconuts on Rongelap. An evaluation may then be made of whether consumption of "Yap Variety" coconuts on Rongelap may lead to higher doses than were estimated in the Northern Marshall Islands Radiological Survey.

Prediction of body burdens using the NMIRS data agree very well with the BNL wholebody measurements. This probably is because most of the coconut consumption is still from "Old Variety" trees and the sampling during the NMIRS was predominately "Old Variety." However, the expected dose of increased use of the "Yap Variety" coconut remains to be determined

ENJEBI DOSE REASSESSMENT

Current data for ^{137}Cs concentration in coconut, breadfruit, and pandanus are available from test plots established in 1974 on Enjebi Island and will provide the basis for the updated dose assessment.

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Data from 1976 and 1977 for papaya, banana, sweet potato, squash, etc., are available and will be updated to allow an evaluation to be based upon current data on annual crops. This project could be started in August of 1986 with results in FY 1987. The updated dose assessment for Enjebi Island should be completed in late FY 1987 or early FY 1988.

Remedial measures proven effective as a result of the work done at Bikini Atoll may well be valid for and used to improve Enjebi.

BIKINI EXCAVATION EXPERIMENT

The object of this experiment is to demonstrate the effectiveness of soil removal on reducing the concentrations of ^{137}Cs in the soil, and thus plants, at Bikini Island and whether crops can be grown on the remaining nutrient deficient soil.

A 1.5 acre plot was cleared of all trees and excavated to 40 cm depth. A control plot of the same size, where only trees were removed and no excavation occurred, was established immediately adjacent to the excavation site. In situ gamma spectroscopy measurements were made before and after excavation. Soil profiles were also taken before and after excavation. About 30 different plant species were planted in the excavation and control plots.

All plants in the excavation plot received micro-nutrients and N, P, K, with the exception of one row of various plants which received only micro-nutrients. All plants were irrigated and fertilized as required.

The plants generally did very well with this careful attention to nutrient and water supply. The unfertilized row is vastly inferior to the fertilized rows. Thus, plants can be grown on the nutrient deficient soil if adequate nutrients

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and water are applied correctly. This requires a significant commitment for a long period of time if excavation is the selected cleanup option.

The in situ gamma measurements and the analysis of samples from the excavation and control plots show a significant decrease in ^{137}Cs to levels at or below that of Eneu Island.

SCHEDULE FOR EXCAVATION EXPERIMENT - BIKINI ISLAND

Excavation completed February 1985 with crops planted in February, May, and July of 1985.

Processing and analysis of about 200 annual crop samples will continue into mid-FY 1987. Processing and analysis of perennial crops, (papaya, banana, and citrus) will continue through FY 1987 and perhaps into FY 1988.

Processing and analysis of samples from long-term food crops (coconut, breadfruit, and pandanus) will not begin until FY 1988; this will not include edible fruit as it will not yet be available.

Basic results which will be available in FY 1987 from annual and perennial crops, are expected to verify that excavation will indeed reduce the ^{137}Cs in plants to concentrations at or below those of Eneu Island. Demonstration of ability to grow plants after excavation will be complete in FY 1987 for annual and some perennial crops. The effectiveness of growing long term crops in excavated areas will be more clear in FY 1988-89.

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EXCAVATION EXPERIMENT - BIKINI ISLAND

IN SITU GAMMA SPECTROSCOPY RESULTS

	BEFORE <u>EXCAVATION</u>	R/h AFTER <u>EXCAVATION</u>	BEFORE/AFTER <u>RATIO</u>
EXCAVATION SITE	68	5	13.6

^{137}Cs pCi/g WET WEIGHT

<u>PLANT TYPE</u>	<u>EXCAVATION SITE</u>	<u>EXCAVATION CONTROL SITE</u>
CORN	4	29
WINGED BEAN	1.8	
ZUCCHINI	2.1	

BIKINI N, P, K EXPERIMENT

The purpose of this experiment is to determine, under field conditions, whether significant additions of potassium (K) to the atoll environment will reduce the uptake of ^{137}Cs into a major food crop such as coconut.

Three separate experiments are underway. Results from the first two indicate that the uptake of ^{137}Cs is definitely reduced by adding K at rates of about 600 lbs per acre per year. The ^{137}Cs concentration in coconut on Eneu Island has been reduced below the natural activity ^{40}K in coconut. It is still to be determined how long this effect will last. In other words, the frequency of application and the rate of application to produce and maintain the effect must still be evaluated and will take two to three years.

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In addition, it is still not known to what level the ^{137}Cs concentration on Bikini Island can be reduced where concentrations are ten times those on Eneu Island. A continued sampling over the next two years will resolve this issue.

The field trial to demonstrate the K effect on a large scale and to evaluate the effectiveness of one large annual application of K must be monitored over the next two years.

A small scale study on the effect of several rates of K on ^{137}Cs uptake in garden vegetables has been implemented. These results will be complete in mid-FY 1987.

It is prudent to demonstrate the effect of added K on ^{137}Cs uptake in breadfruit which is perhaps the second most important local food. There are several breadfruit trees available on Bikini which have been sampled for several years. This can be accomplished by FY 1989.

SCHEDULE OF N, P, K EXPERIMENT - BIKINI AND ENEU ISLANDS

Preliminary experiment started on Eneu Island in January 1981 using four trees. It was expanded on Eneu Island and Bikini Island in May 1983 with five trees on Eneu and five trees on Bikini.

A large scale field trial was started on Bikini Island in February 1985 with 120 trees.

IMPLICATIONS

1. Eneu coconut uptake of ^{137}Cs is reduced below natural levels; but must be ascertained how low a ^{137}Cs level can be obtained for Bikini Island coconuts.

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2. Two to three years of work are required to determine the extent of the reduction and duration of effect.

IRRIGATION/LEACHING EXPERIMENT - BIKINI ISLAND

Premise: Irrigation with sea water will remove ^{137}Cs from the soil column and root zone of the plants into the groundwater.

Conditions: Active root zone removed. Thus, in the initial experiment (Phase 1) the trees were cleared from the 1 hectare (2.5 acre) test plot.

Short Irrigation: Started - June 1982 (4 days)

Short Irrigation: Continued - December 1982 (8 days)

February 1983 (9 days)

May 1983 (7 days)

December 1983 (14 days)

Long Irrigation: Started - February 1984

Stopped - April 1984 (44 days)

Coconut and pandanus trees planted - May and August 1984.

Other food crops planted - February, May, and July 1985.

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PRELIMINARY RESULTS PHASE I

Approximately 3 to 5 percent of inventory was moved to the groundwater. Preliminary results for the 2.5 acres cleared of vegetation show a reduced uptake of ^{137}Cs , by plants grown subsequent to irrigation.

Results from February and May 1985 collections.

^{137}Cs Concentration, pCi/g wet weight

Plant Species	Irrigation Site	Control Sites	Ratio Control/ Irrigation
Grass	2.0	537	270
Morning Glory	0.75	20	27
Messerschmidia	2.4	46	19
Corn	0.99	27	27
Scaveola	6.5	131	20

Interpretation: There is an exchangeable Pool of ^{137}CS . The duration of this exchange has not yet been determined as there is only a one year evaluation.

A need exists to evaluate the uptake in various plants in the irrigation plot (i.e., collect samples for processing and analysis) over the next 2-3 years. The duration of the effect will dictate the usefulness of this method as a cleanup option and the need for N, P, K application as the continuing treatment subsequent to irrigation.

Additional field and laboratory experiments are required to establish the basis of the observed effect and for predicting the possible duration beyond the

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next 3 years. Both the field and laboratory experiments anticipated now will be completed in FY 1987. It is possible that some carryover could occur in FY 1988.

IRRIGATION/LEACHING EXPERIMENT - BIKINI ISLAND

PHASE II

- Premise:
1. Irrigation with sea water will remove the exchangeable ^{137}Cs from the soil column and block the uptake of ^{137}Cs in trees with their active root zone intact;
 2. Coconut trees and most vegetation other than breadfruit will survive the required irrigation.

A test plot was cleared in February 1986, for an experiment to start in May 1986. Sample collections (coconut, groundwater) will continue through FY 1988, and sample processing and analytical work will continue through FY 1988 and into FY 1989. Initial results will be obtained in FY 1987, but the total effect may not be observed until FY 1988.

Duration of any observed effects would have to be evaluated through FY 1988-1989.

ENEU ISLAND DOSE ASSESSMENT

Plans are already underway for the Bikinians to establish a presence on Eneu Island. Thus, an updated dose assessment for Eneu Island is needed which factors in hard data available since the previous assessment was made in 1981.

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That 1981 assessment was based on limited data. A greatly expanded data base is now available for Eneu Island as a result of the continuing program at Bikini Atoll.

Other refinements will be made in the new assessment. For example, open air gamma exposure rates were used to estimate wholebody external doses in 1981. In the new assessment, LLNL will account for shielding by houses and by crushed coral put around the houses. Data for some food items are now available which were estimated, and estimated high, in the 1981 assessment. Thus, the end product will be a more realistic estimate of the doses a returning population might receive at Eneu Island. This can be accomplished in FY 1987.

ENVIRONMENTAL HALF-LIFE OF ^{137}Cs

Current dose estimates are based only on radiological decay ($T_{1/2}=30.1\text{y}$ for ^{137}Cs).

Environmental processes do eliminate ^{137}Cs from the ecosystem to the groundwater. Thus, there is some net environmental half life, T_E . As an example, if T_E is about 30y, the estimated doses would be half of the currently estimated doses. Thus, T_E is a very important parameter to know that there is no historical data to evaluate E (or T_E), therefore, some time period is necessary to quantify this loss of radioactivity availability.

Current experiments to accomplish this are:

- 1.) Six trees on Enewetak Atoll first sampled in 1973, and periodically thereafter, through February 1986, will be closely monitored;

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- 2.) Approximately 30 trees on Bikini Atoll first sampled in 1978-1979, are being monitored; and
- 3.) About eight sites first sampled in 1959 by the University of Washington have been resampled in February of 1986. An analysis of the differences could establish environmental decay over a 27 year period, thus adding considerable credibility to this factor.

Significance

- 1.) Can greatly and favorably alter the predicted doses over 30, 50, or 70 year periods and the maximum annual predicted dose.
- 2.) Could and probably will have a major level of effort and cost impact relative to resettlement of Bikini, Enjebi, and Rongelap.

Time-lines and Milestones

T _{1/2} based on Enewetak trees	- FY 1987
T _{1/2} based on Rongelap historical sites	- FY 1987
T _{1/2} based on Bikini trees	- FY 1988-89

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MILESTONE TIME LINE SUMMARY

<u>Project</u>	<u>Sampling</u>	<u>Processing</u>	<u>Analytical</u>	<u>Product</u>
Rongelap Dose Review	-	-	-	FY 1987
Rongelap Reassessment	FY 86	FY 87	FY 87	FY 87-88
Enjebi Dose Assessment	FY 87	FY 87	FY 87-88	FY 87-88
Bikini Excavation	FY 86-87	FY 86-87	FY 86-87-88	FY 87-88
Bikini N,P,K (14 Trees)	FY 86-87-88	FY 86-87-88	FY 86-87-88	FY 87-88-89
Bikini N,P,K (Field Trial)	FY 86-87-88-89	FY 86-87-88-89	FY 87-88-89	FY 88-89
Bikini Irrigation (Phase I)	FY 86-87-88	FY 86-87-88-89	FY 87-88-89	FY 87-88-89
Bikini Irrigation (Phase II)	FY 86-87-88	FY 87-88-89	FY 87-88-89	FY 87-88-89
Field/Laboratory Exp.	FY 86-87	FY 87	FY 87-88	FY 87-88
Environmental T _{1/2} (Rongelap)	FY 86	FY 86-87	FY 87	FY 87
Environmental T _{1/2} (Enewetak)	FY 86-87	FY 86-87	FY 87	FY 87
Environmental T _{1/2} (Bikini)	FY 86-87-88	FY 86-87-88	FY 87-88	FY-88
Eneu Dose Assessment	Continuous	Continuous	Continuous	FY 87
Updated Dose Assessments (Eneu, Enjebi, NMIRS)	Based on T _{1/2} Data			FY 88-89