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

Marshall Islands Planning Group
May 1986

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, primarily 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 and tries to keep pace with scientific and medical 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.

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SUMMARY CONCLUSIONS

- DOE, through BNL, provide monitoring and health care for exposed Rongelap and Utirik persons.

- DOE, through LLNL, complete Bikini rehabilitation experiments; Eneu, Enjebi, and Rongelap dose assessments. Completion target, September 30, 1988.

- DOE, through BNL, complete Pu analyses; completion target September 30, 1988.

- DOE, through LLNL, maintain data bank for possible use under "Changing Conditions" clause of subagreement for Compact Section 177, and for waste management purposes.

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RECOMMENDATIONS FOR A MEDICAL PROGRAM TO CARE FOR THE RADIATION-EXPOSED POPULATIONS OF RONGELAP AND UTIRIK

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March 6, 1986

With the passage of the Compact of Free Association, the radiologic health care program identied under Section 177 may now be implemented. Under this program an agency will be identified which will "continue to provide special medical care and logistical support thereto for the remaining 174 members of the population of Rongelap and Utrik who were exposed to radiation....". 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 principal assumption on which the following Plan rests, of course, is that the established Brookhaven program will be permitted to continue.

For at least the past five years, planning for the medical program has, for practical purposes, been one year at a time. There has been no guarantee of a long-term program despite the repeated but necessary efforts expended to plan for one. With the Compact agreement an 11 year program can now be funded. It is the first 5 years of such a program which this Plan addresses.

In years past, a continuing source of confusion and misunderstanding has been the requirement, under public law, for

general medicine, the new definition of the medical program commitments under the Compact will not change greatly the content of the present program except in one area. That area is the referral, outside the Republic of the Marshall Islands, of medical problems in the exposed without consideration of a possible radiation etiology. Therefore, funding for referrals will increase significantly; the decision as to whether to refer or to not refer becomes, however, a straight-forward and noncontentious one. It is important that funding for referrals and funding for medical program operations remain separate budget items. This will obviate competition between the two components during the fiscal year.

Although the requirement that the Department of Energy continue to maintain a radiologic health care program was deleted in the final wording of the Compact, statements in other parts of the document and in communications from the Marshall Islands government indicate a preference that the present program continue. It is not stated, however, that the present program is acceptable to the exposed, a feature which would seem to be particularly relevant. Even if continuation of the program were the choice of the exposed, it is possible, if not probable, that the choice was made because of the lack of reasonable alternatives. One should not conclude, therefore, that the present program, while acceptable, is good enough, and an extension of the scope of the program is planned. The core of the program will continue to be directed at radiation-relatable disease, however, and the extended scope of the program will not include unrealistic ventures which would be irresponsible in the use of the limited funds allocated to the program. But certain areas of medicine which may improve the health of the exposed will be developed more fully. Examples include greater attention

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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 (Mejato) 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. The

present policy of referring selected medical problems in unexposed persons to the Marshallese Health Services will be continued.

A hallmark of the BNL program has been the high rate of compliance among the exposed persons for annual medical examinations which remain, as they have since the 1950's, voluntary. 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 comprise 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 followup of special diagnostic and therapeutic problems. It cannot be expected that the 4AHCP will be able to adequately attend to all the special needs of the exposed, even though a medical record system indicating those needs may be on hand. A third visit in the course of a year will be carried out by one or two of the BNL staff to distribute and collect medical record information, document adequate followup of special medical problems, and maintain close working relations with the 4AHCP, PASO, and the Marshallese Health Services.

As the medical program prepares for a long-term commitment and an expansion of health care to the exposed, a number of adjustments should occur. One is the updating of medical examination facilities aboard the Likiaur III. Diagnostic facilities are now excellent in view of the new x-ray equipment and convenient laboratory space. Medical record management is to be streamlined, primarily by increased use of computerization. Except for the annual examination mission it will be unsatisfactory to transport bulky medical records. Computerization of pertinent clinical data is well under way; a portable computer will be used for data input and clinical care in the field. Hard copies of examination forms, however, will be maintained and copied for use by the Marshallese Health Services and the 4AHCP. If the latter program is planning to use computerized records on visits to distant atolls, compatible systems should be evolved to facilitate transfer of records to and from BNL.

Closing the Ebeye unit cuts an important link between BNL and the exposed people which has existed for 14 years. While clinical justification for maintaining the unit will disappear when the 4AHCP and Marshallese Health Services are in full

operation, other functions of the unit should be continued. These include the liaison function which aids in the transportation and communication pertaining to patients, and laboratory maintainance. The present BNL Marshallese laboratory technician will be retained at 50% time, inclusive of the time spent on the medical missions, so that those and other nonclinical activities continue.

Complex medical activities require persistent care and attention to detail to avoid unintentional errors. A formalized mechanism to guard against these and other potential mistakes is found in quality assurance programs now in operation in most hospitals. The Medical Department Hospital at BNL has been accredited by the Joint Commission on Accreditation of Hospitals, the foremost accrediting authority in the U.S. Clinical laboratories, medical records, pharmacy services, patient care and many other items are included in a survey by the JCAH. Recently the JCAH has begun accrediting ambulatory care units, and the BNL Clinical Research Center, an ambulatory care unit, is planning to obtain JCAH recognition. The Marshall Islands medical program needs similar approval from an outside body. If possible, this will be done as part of the BNL Clinical Research Center.

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, 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: prevention and 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 basic requirement for carrying out a survey of this sort will continue to be that it have clinical relevance to exposed population.

The serious health effects of diabetes, hypertension and other illnesses in the exposed population, as well as the Marshallese in general, make the delayed effects of radiation relatively insignificant. It is clear that there has developed in the exposed a serious loss of perspective as to what are the real threats to health. It has taken many years of reinforcement from the outside to imprint the notion that radiation illness is all-pervasive. It will take years to undo this harm. But the attempt must be made because far more serious health threats proceed apace. Educational efforts toward this end will continue

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funding somewhat less than that of recent years. This is because the increase in care to the exposed will be more than counterbalanced by decreased primary care expenditures.

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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."

1. DOE, through BNL, conduct 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.

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

PATIONALE FOR DOE TO PROVIDE THIS PROGRAM

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, affecting economies of scale.

4. Funding is authorized and it should be a Department of the Interior (DOI) responsibility to obtain appropriations; thus the DP budget is not impacted.

ALTERNATIVES

1. Private U.S. Firm

This could be done, presumably through the DOI. 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 would most certainly cost more to run. Also, a lengthy 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.

Could continue BNL

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, provide a familiarity with exposed individuals and their families which can, in many ways, be considered a "doctor-patient" relationship.

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 Liktanur III or an equivalent vessel. Transportation of the exposed persons 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 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

inhabitants on the island at the time of the visits to Rongelap (Mejato) 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 among the exposed persons for annual medical examinations which remain, as they have singe the 1950s, voluntary. 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 comprise 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. 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, even though a medical record system indicating those needs may be on hand. A third visit in the course of a 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 Marshallese Health Services.

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

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should be minimized.

3. On Atoll medical care for all Rongelap and Utirik residents at the time of the annual visits should be continued.

PLANS

1. Maintain present examination procedures by ship for at least the next five years.

2. Trim primary care involvement; close Ebeye unit; discontinue the large autumn survey; trim pharmacy.

3. All adult inhabitants of Rongelap and Utirik will be offered the same diagnostic and therapeutic options as the exposed at the time of the surveys, except the medical referrals of nonexposed persons will be to and funded by either the RMI or 4AHCP.

NECESSARY PROGRAM ADJUSTMENTS

1. Modify medical record management.

   a. More reliance on computerized records.

   b. Develop communication scheme for BNL, Four Atoll HCP, 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.

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.

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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.

RECOMMENDATIONS ON ENVIRONMENTAL PROGRAMS

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.

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

1. Bikini Atoll: DOE, through LLNL, update Enyu dose (FY 1987); complete remedial experiments (FY 1989); complete environmental half-life assessment (FY 1989); provide post-cleanup dose assessment for Bikini.

2. Rongelap: DOE, through LLNL, process recent samples and factor data into current dose assessment (FY 1987).

3. Enewetak: DOE, through LLNL, update Enjebi dose assessment (FY 1987).

4. DOE, through LLNL, maintain environmental data bank.

5. RMI government fund applied research geared to enhance further use of food crops and subsequent dose assessment.

Rationale: Is a part of U.S. commitment to fully understand radiological conditions on atolls to be resettled with U.S. assistance.

Alternatives: (Bill Robison)

ENVIRONMENTAL

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 its program at Bikini Atoll with the congressionally-created Bikini Atoll Rehabilitation Committee (BARC) and are conducting remedial experiments which will enable 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.

Rehabilitation of Bikini Atoll (Bikini and Eneu Islands).

LLNL has a continuing effort at each of the three identified Atolls and is prepared to respond to the requirements layed forth in the compact.

RONGELAP REASSESSMENT

This reassessment is 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."

Why is this a concern? The reasons are the following:

1. The external gamma exposure and the soil concentration of ^{137}Cs is higher by about a factor of 2 at Rongelap than at Eneu.

	External Gamma 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	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. The ratio of the ^{137}Cs concentration in coconut on Rongelap to that on Eneu is thus about 0.4.

3. This difference was assumed to 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 trees and ^{137}Cs distribution in the soil column could not be discounted, however.

4. This result 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. Thus, the uptake of ^{137}Cs in "Yap Variety" coconuts on Rongelap must be determined and compared with the uptake in young and old "old variety" coconuts.

7. An evaluation could then be made if consumption of "Yap Variety" coconuts on Rongelap could lead to higher doses that we 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 our sampling during the NMIRS was predominately "old variety." However, the issue of the increased use of the "Yap Variety" coconut and the impact on doses could be raised and that question must be answered.

ENJEBI DOSE REASSESSMENT

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

Data from 1976 and 1977 for papaya, banana, sweet potato, squash, etc., are available and will be updated to avoid criticism that we do not have 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 evaluated at Bikini Atoll will be applicable, if necessary, at Enjebi Island.

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 could 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 prior and subsequent to 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 carefully 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 nutrient 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.

Crops planted in February, May, and July of 1985.

Limited analytical results now.

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 long-term food crops (coconut, breadfruit, and pandanus) will not begin until FY 1988; this will not include edible fruit.

Basic results will be available in FY 1987 from annual and some perennial crops to show 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.

EXCAVATION EXPERIMENT - BIKINI ISLAND

IN SITU GAMMA SPECTROSCOPY RESULTS

	μR/H		
	BEFORE EXCAVATION	AFTER EXCAVATION	BEFORE/AFTER RATIO
EXCAVATION SITE	68	5	13.6

^{137}Cs pCi/G WET WEIGHT

PLANT TYPE	EXCAVATION SITE	EXCAVATION CONTROL SITE
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 would 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 ^{40}K concentration 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.

In addition, we still do not know 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 will have to 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 could be accomplished by FY 1989.

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

Preliminary experiment started on Eneu Island - January 1981 - four trees.

Experiment expanded on Eneu Island and Bikini Island - May 1983 - five trees on Eneu and five trees on Bikini.

Large scale field trial started with BARC on Bikini Island - February 1985. Factorial experiment with N, P, and 2 rates of K; 120 trees in experiment.

IMPLICATIONS

1. Eneu coconut uptake of ^{137}Cs reduced below natural levels; but how low can Bikini ^{137}Cs coconut concentrations be gotten?

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.

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 Ratio, Control Site/Irrigation Site
Plant Species	pCi/g Wet Weight Control/pCig Wet Weight Irrigation
Grass	256
Morning Glory	26
Messerschmidia	20
Corn	27

Interpretation - Exchangeable Pool of ^{137}CS.

Duration? Time dependent; one year evaluation so far. We will need 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 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 exchangeable ^{137}Cs with active root zone of trees in tact.

  2. Coconut trees and most vegetation other than breadfruit will survive the required irrigation.

- Test plot cleared - February 1986.

- Experiment to start - May 1986

- Sample collections (coconut, groundwater) will continue through FY 1988.

- 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.

The 1981 assessment was based on limited data. A greatly expanded data base is available for Eneu Island as a result of the continuing program at Bikini Atoll. Also, major resettlement will not occur before 1988.

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, we 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. 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.

ENEU ISLAND DOSE ASSESSMENT

Resettlement of Eneu Island is the likely first step in the Bikini Atoll rehabilitation.

The last dose assessment (1981) was based on limited data and resettlement in 1981.

Significantly, more data for Eneu Island are now available from our continuing program at Bikini Atoll and resettlement obviously will not occur before about 1988.

Thus, an updated and refined dose assessment of Eneu Island is needed.

The data are available and the dose assessment can be completed in FY 1987.

ENVIRONMENTAL HALF-LIFE OF ^{137}CS

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

Environmental processes do eliminate ^{137}Cs from the ecosystem to the groundwater. Effective half-life $\lambda E = \lambda radiological + \lambda environmental$.

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.

No historical data to evaluate λE (or T_E).

T_E is a time dependent process; thus, evaluating T_E takes time.

Current experiments

1.) Six trees on Enewetak Atoll first sampled in 1973. Sampled periodically since then. Last sampled in February 1986.

2.) Approximately 30 trees on Bikini Atoll first sampled in 1978-1979. Sampled at least annually since then.

3.) About eight sites first sampled in 1959 by the University of Washington have been resampled in February of this year. Thus, we could gain 27 years, respectively.

ENVIRONMENTAL HALF-LIFE OF ^{137}Cs (CONTINUED)

- Significance

  1.) Can greatly alter the predicted doses over 30, 50, or 70 y and the maximum annual predicted dose.

  2.) Could alter the scope of cleanup on some islands and eliminate others from consideration.

  3.) This $T_{1/2}$ effect would be applicable to all three atolls called out in the compact.

- 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

MILESTONE TIME LINE SUMMARY

Project	Sampling	Processing	Analytical	Prodcut
Rongelap Dose Review	-	-	-	FY 1987
Rongelap Reassessment	FY 86	FY 87	FY 87	FY 7-88
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 (Sooner if possible)

LOGISTICAL SUPPORT

Recommendations:

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)

RATIONALE FOR DOE TO PROVIDE

DOE has a multifacted logistics support office in Honolulu, basically to support the joint DNA/DOE programs at Johnston Island. To use and extend this network for Marshall Islands programs has proven effective by using in-house expertise and effecting economics thereto. 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.

FUNDING

Executive Order No. _____ , creates the organizations and defines management responsibilities to effectively implement the provisions of this Compact legislation. It creates an Interagency Group on Freely Associated State Affairs, and an Office of Freely Association Affairs.

The Order also helps define responsibilities of the Secretaries of State and Interior. "Responsibility of the Secretary of the Interior includes . . . all other United States assistance specified in the Compact and its related agreement . . .. The Secretary of the Interior shall coordinate the provision of the United States' services and program to the freely associated states, and shall provide . . . to the executive departments and agencies of the United States the fiscal resources for such provision. The Secretary shall seek the appropriations[1/] of the funds necessary to carry out the provisions . . . . as they relate to the obligations of the United States under the Compact and its related agreements."

It is thus clear to and recommended by the MIPG that funding for all DOE-run programs pursuant to obligation from the Compact or related agreement be provided through DOI.

1/underlining by MIPG

PROJECTED COSTS THROUGH DOI

($000 in FY 87 Dollars)

		FY 87	FY 88	FY 89
Medical				
One ship-supported mission	Operations			
One follow-up mission	Capital			
One Admin. mission				
Medical referrals				
Maintain records				
Support four full-time employees				
Biossay				
Process 600 (annually) samples for Pu	Operations			
Support 2.75 man-years	Capital			
Environmental				
Three missions per year	Operations	1.8	1.8	1.2
Sample analyses	Capital			
Maintain data bank				
Support nine full-time personnel				
Logistical Support				
Vessel	Operations	1.0	1.0	1.0
O&M, Procurement	Capital	.44	.12	.39
	Total Operations			
	Total Capital	___	___	___

[redacted]

-- Commitment to restore, if necessary, Rongelap to habitability.

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

1. DOE, through BNL, fund the completion of the plutonium in urine analysis (through FY 1988) to verify assessments of the total contribution of Pu in overall dose to the populations in the northern Marshall Islands.

2. RMI Government fund periodic bioassay verification for resettled communities.

Duration: Through FY 1988 if data is sufficient; if not, through FYs 1989 or 1990.

RATIONALE FOR DOE TO PROVIDE THIS PROGRAM

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

Alternatives: The capability to analyze Pu in urine does not exist outside BNL at this time, and this contribution to total dose is necessary to ascertain.

RADIATION PROTECTION

BACKGROUND AND SCOPE OF WORK

BNL Radiation Protection Division has been an integral part of the total program since 1954. The work since that date includes:

1. Exposure assessments for persons at Rongelap and Utirik from day of return to 2007.

2. Thyroid dose assessment for persons at Rongelap and Utirik on March 1, 1954.

3. Exposure assessment for Bikinians from 1970 to 1978.

4. Development and implementation of plutonium bioassay with appropriate sensitivity.

5. Whole-body counting and urine bioassay for persons at Enewetak.

(Words by Ed Lessard on why samples are processed at 600 a year rate; significance to total dose, etc.).

PROPOSED SCHEDULE FOR COMPLETION OF Pu ANALYSIS

Samples	Completed By	Sample Results By	Dose Report
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

Pu RESULTS TO DATE

Population	Age	ACI/Day
Enewetak	52	BKG
	55	5.2
	58	2200
	62	120
	72	28
Majuro	10	42
	5	1300
Bikini	22	270
	27	410
	28	190
	29	400
	36	BKG
	52	390
	55	67
	76	330
	78	31
	78	29
	36	800
	36	870
	37	11000
	37	3400
	37	2200
	38	1100
	38	750

Pu BIOASSAY AND DOSE ESTIMATES

Population	Estimate of Committed Effective Dose Equivalent (mrem committed for each year of exposure)
Enewetak, 1 adult male	130
Bikini, 3 adult males	170

NOTE: Estimate was based on highest results to date and only a few samples have been processed. Thus, the estimate has a large uncertainty. The average whole-body dose for Bikinians for Cs-137 was 100 mrem for each year of exposure. Thus, Pu-239 may represent a significant portion of the internal emitter hazard.

SIGNIFICANCE TO REGULATIONS

ICRP, NCRP, EPA	100 mrem per year, for controllable sources.
DOE 5480.1A	100 mrem per year, except 500 mrem per year is retained for noncontinuous exposures.
ICRP Publication 39	2000 mrem per year, for remedial action for uncontrollable sources.

Pu BIOASSAY COSTS TO PROCESS SAMPLES ON HAND

($000)

Item	FY 1987	FY 1988	FY 1989	FY 1990
People	164	175	186	198
Travel	5	6	7	8
Supplies	50	54	57	61
Overhead	94	103	113	123
Total	313	338	363	390

SCHEDULE FOR COMPLETION

Samples	Completed By	Sample Results By	Dose Report
1-300	March 1987	June 1987	- - -
301-500	March 1988	June 1988	September 1988

NOTE: Uncertainties in dose estimates will be large due to fewer samples. Questions regarding unusual results will be impossible to follow up; in particular, dose estimates for the former Rongelap people may be overestimated due to Pu remaining from acute exposure.