402971

July 25, 1974

SECY-75- 81

POLICY SESSION ITEM

SUMMARY SHEET

Subject: RADIOLOGICAL CRITERIA FOR ENEWETAK ATOLL

Purpose: To obtain Commission approval of proposed radiological criteria for cleanup and rehabilitation of Enewetak.

Category: This paper covers a major policy issue requiring Commission approval.

Issue: The paramount issue is whether and under what conditions the Enewetakese can be returned safely to their Atoll which is contaminated with debris and fallout from some 43 weapons test explosions.

The staff recommends radiation criteria and plutonium soil contamination limits that provide a conservative margin of safety for people living there. Meeting these criteria will require that village sites be confined to the southern (low level contamination) islands, growing of all food (except coconuts) be limited to the southern islands and the quarantine of YVONNE be continued until the plutonium contamination is removed. No restrictions are required on visits to the other islands and on seafood.

Those Enewetakese whose homes were on the northern islands will be disappointed with the restrictions on village sites in the north. JANET was a major village site.

The Defense Nuclear Agency (DNA), has taken exception to the proposed criteria, although by letter dated June 7, 1974, to the Chairman, the Director of DNA states that he "will not contest the standards recommended by the Commission." DNA believes that radiation standards applicable to the general public are not appropriate for the small Enewetak population and that such use could establish an undesirable precedent for other situations of environmental contamination from nuclear explosives. In their view, application of standards for the general public does not allow adequate consideration of the desires of the people, especially as to establishment of a village on JANET. The DNA also recommended a risk-benefit analysis that they believe would justify the selection of higher radiation dose levels for the cleanup criteria. Standards for radiation workers, or comparisons with situations where people live in higher ambient radiation, i.e., monazite sands areas of India are cited as precedence for use of higher doses.

The Environmental Protection Agency (EPA) has commented favorably stating that they accept the proposed criteria on an interim use basis. The Department of the Interior (DOI) has deferred to AEC judgement.

Comments received from DNA, EPA and DOI are included in Appendix 1.

Decision Criteria:

Neither national nor international bodies have established radiation standards or criteria for cleanup that would apply specifically to the Enewetak situation. Currently, cleanup criteria are developed on an ad hoc basis with consideration given to such pertinent factors as: exposure levels, food chains, pathways to man, land use, cost, feasibility of cleanup, impact of cleanup, etc. The staff has applied the principle that cleanup of contaminated property for use by the general public must (1) keep predicted radiation dose levels within a conservative interpretation and

application of Federal guidance on radiation protection, and (2) meet the "as low as practicable" criterion considering factors of practicality and effectiveness.

These principles were followed in the Bikini Atoll cleanup, the most appropriate precedent for Enewetak. The Enewetak cleanup and rehabilitation recommendations, including the restrictions, are similar to those for Bikini. About the same order of conservatism was used in applying the standards.

While there are no national or international criteria for plutonium cleanup, the staff recommendations are consistent with a recent, independent study performed by LASL entitled, "A Proposed Interim Standard for Plutonium in Soils," LA-5483-MS, dated January 1974. EPA plans to develop cleanup guides for plutonium contaminated land but these will not be available for some time. Plutonium contamination on the islands of Enewetak is confined principally to well defined and relatively small areas. The exception is the contamination on YVONNE; about half of the 94 acres of this island is highly contaminated. There is a wide range of particle sizes, and the distribution in the soil is not uniform. The recommended criteria for cleanup of plutonium in the soil are intended for use throughout the islands of the Atoll. Specific recommendations for cleanup of YVONNE are also given. Decontamination of YVONNE is seen as an iterative process to be conducted by a team of experts. There remains the difficult problem of disposal of the contaminated soil which is a responsibility of DNA. However, by the time cleanup is started, a method for disposal may be available. If not, then the plutonium debris throughout the Atoll should be retained on YVONNE and the quarantine of that island continued until contamination is removed. Further study is needed on possible removal of the plutonium contamination

from soil to reduce the bulk of material requiring disposal. AEC should be prepared to take the lead in any such studies that are made.

Alternatives:

(1) Apply radiation criteria with the objective of maintaining exposure and radioactivity levels in the natural background range and equivalent to pre-test conditions. (Such criteria are equivalent to prohibiting occupancy of the Atoll.)

(2) Apply maximum levels allowable for individuals within the general population as contained in current Federal standards such as 500 mRem/yr, and 5 Rem in 30 years whole body doses and inhalation and dietary intake of radionuclides equivalent to those doses.

(3) A middle course based on maintaining exposures "as low as practicable," and limited to a conservative fraction of the Federal standards for individuals within the general population in order to account for uncertainties in dose estimates.

Discussion:

Weapons tests were conducted at Enewetak Atoll from 1948 to 1958. The remaining contamination from 43 explosions includes fallout, fission debris, neutron activation products, plutonium debris from safety tests and buried waste. Test locations are shown in the attached map with names of tests enclosed in boxes.

In April 1972, the U.S. announced that Enewetak Atoll would be placed under Trust Territory control at the end of 1973. Resettlement of the Enewetakese people would depend upon the results of a survey of the Atoll using the same pattern followed at Bikini, i.e., radiological survey, cleanup, rehabilitation and resettlement. The responsibilities were divided among Federal

agencies at an interagency meeting on September 7, 1972, as follows: AEC-radiological survey and cleanup and rehabilitation criteria; Defense (through DNA) - cleanup; and DOI - rehabilitation and resettlement. EPA opted not to become involved formally, but agreed to advise and assist.

During September 1972 to March 1974, AEC conducted an extensive radiological survey. A Task Group was established to evaluate the survey results and to prepare recommendations for cleanup and rehabilitation. The Task Group report was coordinated with DNA, DOI, and EPA.

SECY 74-542, Outline of a Staff Paper on Enewetak Atoll, was discussed with the Commission at Session 74-74 on April 23, 1974. The Commission generally accepted the proposed staff rationale which would allow the people to occupy part of the Atoll with certain practical restrictions on living sites, food sources, etc. This is consistent with the staff position that exposures should be "as low as practicable" and based on conservative interpretation of Federal Radiation Council (FRC) guidelines.

The Task Group report is available in the Secretariat and is summarized in Appendix J. Key conclusions and recommendations are as follows:

(1) FRC guides for whole body, bone, and gonads for the individual, and the philosophy of Alternative (3) should be used to evaluate predicted radiation doses. Owing to uncertainties in dose estimates, the values used to evaluate cleanup alternatives were the FRC guides reduced by 50 percent for annual doses to individuals and by 20 percent for the 30-year gonadal doses. Thus:

Whole body and bone marrow	- 0.25 Rem/yr
Thyroid and bone	- 0.75 Rem/yr
Gonads	- 4 Rem/30 yrs

(2) Plutonium soil cleanup should be handled on a case-by-case basis considering all radiological conditions. Cleanup of contaminated soil should be implemented by a team of experts in the field using the following general guidance applicable to this specific operation.

Below 40 pCi/gm	- no action
40-400 pCi/gm	- appropriate action
Over 400 pCi/gm	- cleanup

(3) Decontamination of YVONNE is seen as an iterative process that amounts to a search for the higher plutonium levels in soil with removal and storage according to the guidance provided. If a method of plutonium disposal is not available during the cleanup phase, the quarantine of the island should be continued.

(4) Villages should be located on southern islands, ALVIN through KEITH.

(5) Visits may be made to all islands except YVONNE.

(6) Commercial and subsistence food production should be limited to southern islands, except for coconuts.

(7) Fishing is permitted anywhere.

(8) Radiation levels on JANET prohibit re-settlement now. Resettlement may occur when test plantings of subsistence and commercial crops show radioactivity levels within FRC standards.

(9) There should be base-line surveys of body burdens of selected radionuclides for the Enewetak people prior to return and periodic resurvey of the people and environment after return.

(10) The above restrictions result in the following calculated radiation doses:

Maximum whole body dose - 0.13 Rem/yr
Maximum bone marrow dose - 0.15 Rem/yr
Estimated 30-year dose -

gonads - 2.2 Rem
bone - 11.5 Rem

(11) In contrast, unrestricted living on JANET would result in the following radiation doses:

Maximum whole body dose - 0.76 Rem/yr
Maximum bone marrow dose - 1.1 Rem/yr
Estimated 30-year dose -

gonads - 14 Rem
bone - 135 Rem

Staff recommendations were derived following consideration of various options for reduction of radiation dose below the criteria including modification of the diet, plowing and removal and replacement of layers of contaminated soil. Associated ecological damage and soil disposal problems are unavoidable consequences of large scale decontamination actions. The Task Group did not view partial soil removal as an effective and dependable method of reducing radiation doses. Consideration of restrictions on food production locations, although undesirable, is absolutely necessary if radiation doses are to be reduced to acceptable levels.

DNA has recommended that a risk-benefit study should serve as a basis for the decision on dose criteria. The Task Group did consider estimates of risks associated with radiation criteria derived from FRC guidance. Because of many uncertainties associated with predictions of effects of long-term low level doses from

external and internal emitters for a base population of a few hundred people, the Task Group had severe reservations about the validity of the estimates. The recommendations of the Task Group are considered to be practicable and feasible. The largest cost item for the recommended cleanup would be the support base; the second largest item would be removal and disposal of contaminated and uncontaminated scrap and the cleanup, removal and disposal of plutonium contaminated soil. Since the recommendations do not contemplate extensive decontamination of residual radioactivity in soil of northern islands such as JANET, the cost should be less than any approach involving extensive soil removal, disposal, and replacement actions.

Following consideration and approval of the Task Group findings, the staff will inform DNA and DOI. A briefing will then be developed and rehearsed for presentation to the people of Enewetak and their advisors during a joint AEC-DNA-DOI trip to the Pacific. This presentation will be designed to be a vehicle for U.S. Government consultation with the people on the AEC recommendations and the proposed DNA-DOI Draft Environmental Impact Statement (DEIS). Opening remarks at the briefing would be delivered by senior AEC, DNA, and DOI officials. In more detailed discussions to follow, AEC recommendations and the DEIS would be discussed by the AEC and DNA technical representatives. After the visit, AEC staff will inform the Commission of results of these discussions.

Recommendations:

1. That alternative 3 and the associated criteria be approved.

2. Note that the responsibility for disposal of contaminated material, including plutonium, rests with DNA.

3. Note that action on reducing the quantity of plutonium contaminated material requiring disposal has been deferred for further study. The AEC should be prepared to take the lead in conducting a study to see if such reduction is feasible and practical.

4. Note that the follow-on radiological surveys and monitoring of the Atoll and people will be conducted by AEC to insure exposure criteria are not exceeded and to determine when JANET and other northern islands become habitable.

5. That consultation with the Enewetak people as discussed be approved.

Coordination: This paper has been concurred in by DMA, BER, and OGC, and has been noted by PA.

Scheduling: For consideration at the August 6, 1974 policy session.

John A. Eisenine
General Manager

Contact:
M. B. Biles, OS
X-3157

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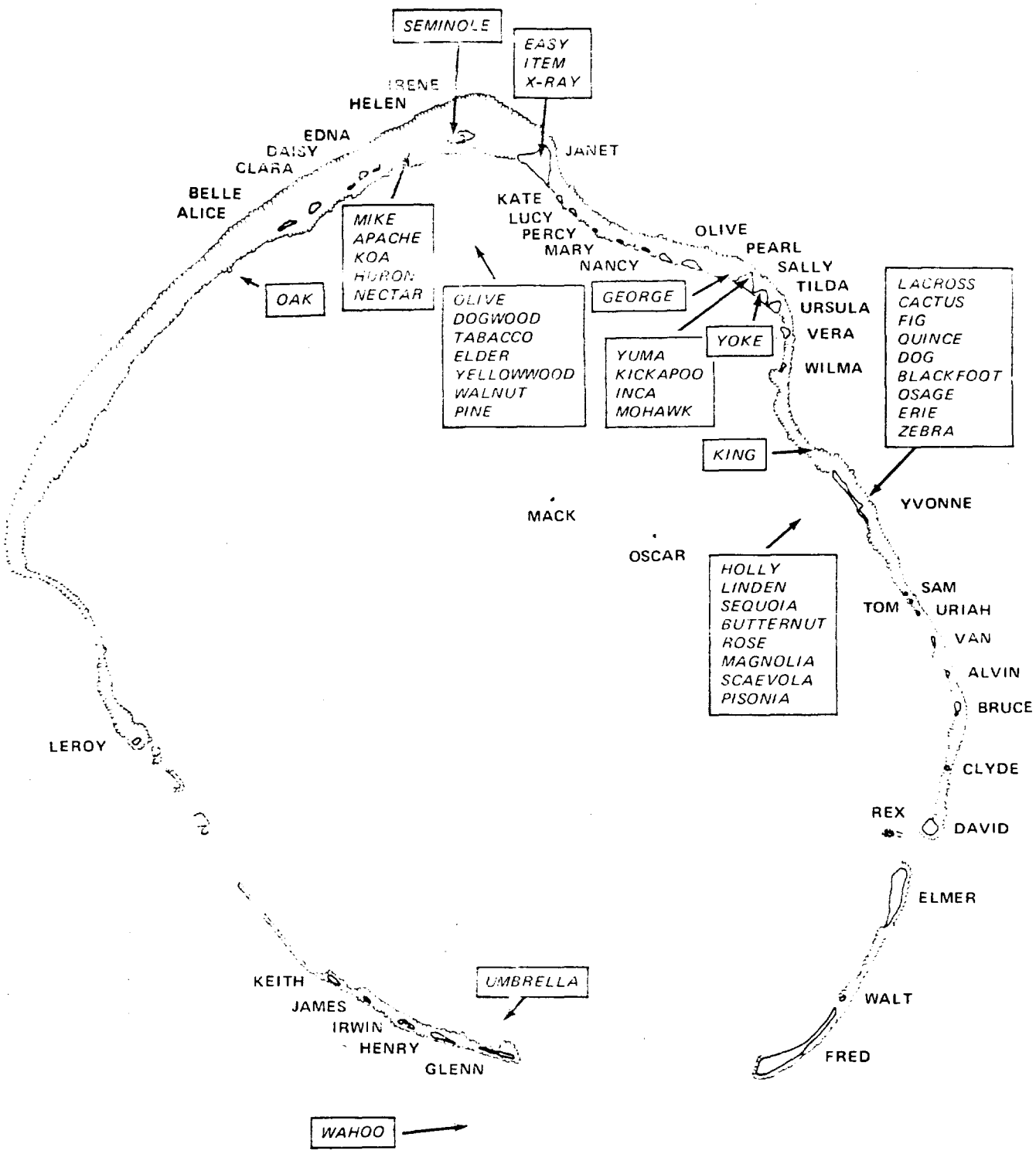

ENEWETAK ATOLL - TEST LOCATIONS

DEFENSE NUCLEAR AGENCY
WASHINGTON, D.C. 20305

DIR

7 June 1974

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OFFICE OF THE SECRETARY

Dr. Dixy Lee Ray
Chairman, US Atomic Energy Commission
Washington, D. C. 20545

Dear Dr. Ray,

Soon the AEC staff will present to the Commission recommendations for cleanup and rehabilitation of Enewetak. DoD has charged the Defense Nuclear Agency with the responsibility for the cleanup phase. How we go about the cleanup will depend on the radiological standards established by the AEC.

I am concerned with several aspects of this project. Of course, our primary concern must be the health and welfare of the Enewetak people. If this were not so there would be no reason for the entire effort and the United States could simply maintain the status quo. However, this major concern is complicated by diverse objectives:

a. assurance that no Enewetakese receives radiation doses which will adversely affect him or future generations,

b. accommodation of the strong desire of the Enewetakese to return to Enjebi, one of the islands with a level of radioactivity which some say cannot be reduced to acceptable levels for residence and agriculture.

There is some controversy over what constitutes an acceptable level. Indeed, the people themselves might well prefer a small risk to denial of their cherished home. Important in this respect is a doubt (at least in my mind) that we can keep the Enewetakese from living on Enjebi once they are resettled on the other nearby islands.

I understand your staff will present to the Commission some arguments we have raised; thus, the Commission should receive the advantage of different viewpoints. I want to assure you that I will not contest the standards recommended by the Commission. However, I hope they will consider the entire problem: biological - political - and fiscal, as well as the social and economic effects on the Enewetakese people if the standards are such that we cannot resettle them on one of their major home islands. Finally, I am sure that the Commission will want to assure itself that marginal health benefits do not override the substantial benefits the Enewetakese would enjoy from more complete use of their land.

APPENDIX 1

74-362

Once these decisions are reached they must be explained to the Enewetakese. They must understand any constraints as well as the fact the project is subject to Congressional approbation. Perhaps that might prompt the trip I previously suggested we make jointly to Enewetak. Of course, we would also want to invite the appropriate official from the Department of the Interior.

I will look forward to discussion of this matter after the Commission has considered it. Meanwhile, the staff and resources of DNA are available if further information is required in the decision-making process.

Regards,

WARREN D. JOHNSON
Lieutenant General, USAF
Director

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAY 8 1974

Dear Dr. Biles:

Thank you for the latest version of the Task Group report for Enewetak Atoll. We found that although the Enjibe situation was more fully discussed and various options were explored, the recommendations have not substantially changed from your report of February 1, 1974.

Although we are disappointed that the return to Enjibe appears to be postponed for an undetermined time, we defer to the technical experts as to the safety aspects.

We look forward to a final report and recommendations from the Atomic Energy Commission along with an Environmental Impact Statement which will enable the Defense Nuclear Agency, Department of the Interior, and Atomic Energy Commission to undertake the cleanup, rehabilitation and resettlement before too much more time passes.

I want to take this opportunity to express my appreciation to the Task Group and advisors for their diligent efforts put forth on this project.

Sincerely yours,

Stanley S. Carpenter
Director of Territorial Affairs

Martin B. Biles
Director
Division of Operational Safety
U.S. Atomic Energy Commission
Washington, D.C. 20545

DEFENSE NUCLEAR AGENCY
WASHINGTON, D.C. 20305

DDOA

14 MAY 1974

Dr. Martin B. Biles, Director
Division of Operational Safety
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Biles,

We are pleased to present our comments upon "Report by the Task Group on Recommendations for Cleanup and Rehabilitation of Enewetak Atoll" dated 19 April 1974 and sent to us by you on 2 May 1974. We take strong exception to the recommendations of this Report and the philosophies on which these recommendations are based. On the other hand, we commend the AEC upon the thorough scientific work in this Report and in the backup volumes NVO-140 on the Enewetak radiological survey.

In addition to being troubled about regulatory matters, we disagree with the recommendations of this Report because it is not in accord with wishes and probable needs of the Enewetak people. As a result of U.S. actions, parts of their lands were altered and the Enewetak people were displaced to accommodate U.S. weapons testing. We should now make every effort to allow them a living pattern to fit what they view to be their needs. The radiological and other safety conditions upon their return should apply to those local conditions, not necessarily those of the U.S. population with its different radiological conditions and its greater uncertainties of exposures. In fact FRC 1, para 7.7 and 7.8, emphasizes that "there is no single permissible or acceptable level of exposure without regard to the reasons for permitting the exposure." Within this context, the numerical values should be considered as guides which might be appropriate for a particular action under certain circumstances. Since permissible levels of exposure for the Enewetak conditions are not clearly established, the U.S. government function for Enewetak would be primarily to assure that national policies are not being exceeded

or that no harmful effects would result from the proposed action. Contrary to this, the recommendations of this AEC Report can be viewed as non-compliance with the needs that the Enewetak people have clearly stated, specifically to occupy Enjebi Island. Unfortunately, the justification for these restrictions seem to be an unduly restrictive application of criteria that are largely arbitrary and probably inapplicable.

First let us consider the applicability of criteria. With the radioactive contamination being beyond our ability to turn off or wholly eliminate, it is an uncontrolled localized contamination event in the definition of the Federal Radiation Council (FRC). Being the release of radioactive material from nuclear explosions of many years ago, the Enewetak situation is Category III of p. 30 of FRC Staff Report No. 7. For this category, protective action is to be considered on a case-by-case basis (p. 38). Any situation resulting in a bone-marrow dose greater than 0.5 rad per year is to be appropriately evaluated. FRC Report No. 7 does not include any criterion for bone dose for this Category III, but the present AEC Report numerically uses bone dose criteria to advise against the desired return of the Enewetak people to the island of Enjebi and to advise against full use of other islands. This particular case of Enjebi should instead be individually evaluated on such bases as relative risks or cost vs. benefit that are recurrently requested in FRC reports. The present AEC Report seems wholly inadequate in such evaluations.

Leaving aside this genuine question of whether quantitative application of criteria are grounds for decisions, one can review the bases of the numerical values of the radiological criteria on p. 5 of the present AEC Report. These are later used in the AEC Report to restrict the Enewetak people. The Federal Radiation Council Report No. 1 establishes an occupational dose criteria which has been reduced from the level at which biological damage occurs by a factor of 10. Both the Federal Radiation Council and the International Commission on Radiation Protection further reduce the dose levels for individuals in the population from the occupational level by a factor of 10. For Enewetak, the AEC recommended exposure levels for individuals have been arbitrarily reduced by another factor of 2. This reduction results in an overall reduction from the levels at which minor biological effects have been observed by a factor of 200. Further the 4 rems limit in 30 years for gonadal exposure, an 80% reduction from the recommended genetic exposure, does not seem to apply since the half lives of the isotopes of concern are approximately 30 years. This then does not provide the recurrent genetic dose for future generations beyond the present generation which will return.

*Corrected to 20%

14 MAY 1974

DDOA
Dr. Martin B. Biles

Based on data in Tables 1, 2, 3 and 4 of the report it is inconsistent to exclude the people from Enjebi. In Table 1 with a living pattern (D) which requires importation of pandanus and breadfruit (III) the 30 year whole body dose is 4.4 rem. By importing pandanus, breadfruit, coconut and tacca (IV) the dose becomes 3.7 rem. This is lower than your 4 rem criteria. In Table 2, the same conditions apply. If Table 3 were used, and the FRC exposures were permitted to apply nothing would need to be done (Living pattern D, Current conditions I). Under AEC guides the importation of pandanus and breadfruit would be required. By going to Table 4 and using the guidance applicable to Category III, FRC Report No. 7 it appears that Living Pattern D under current conditions would be applicable. Even with the more restrictive AEC interpretation, Living Pattern D with the importation of pandanus, breadfruit as in IV would apply.

Your present AEC Report rejects an undelayed occupation of Enjebi, as is desired by the Enewetak people, even though the reduction factor of two in your proposed criteria is vulnerable to accusations that this factor conveniently delays the desired habitation, particularly in view of (1) the unusually well-measured and well-known radiological situation for Enewetak, (2) the small likelihood of other radiation sources being introduced into Enewetak at a rate faster than the decay of present radioactivity, (3) the questionable validity of applying any criteria on bone dose, and (4) the lack of cost-benefit or relative risk analyses in this AEC Report.

Instead of the restrictive approach in the present AEC Report, a broader range of rehabilitation possibilities should be available to the Enewetak people for their judgment. The consequences of each of these possibilities should be clearly made with the U.S. role being to temper their judgment on the basis of well-established radiological effects. To enable such choices to be made objectively, the particularly prejudicial statements in your present AEC Report should be modified accordingly. Among these are:

p. 22: statement that corrective actions ".... would constitute an experiment involving Enjebi people"

p. 23: statement about "Heroic actions would be required to reconstitute the remaining soil ...." on Enjebi after corrective actions

p. 23: statement about a period as long as 16 to 20 years (two - eight to ten year periods) .... before the island could support its inhabitants"

DDOA

14 MAY 1974

Dr. Martin B. Biles

p. 25: statement about being ".... unable to determine any way in which exposures can be brought within the acceptable criteria, that is both reliable and feasible, in order to resettle Enjebi ...."

p. III-1: the opinion that ".... recommendations should be specific and unequivocal ...." for methods of resettling Enewetak Atoll.

Warm regards,

JOHN W. McENERY
Major General, USA
Deputy Director
(Operations and Administration)

1 Encl
Detail Comments on
Task Group Recommendations

Copy furnished:
DASTA, DOI
ASD(ISA)

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Dr. Martin B. Biles, Director
Division of Operational Safety
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Biles:

Thank you for your May 2 letter and the opportunity to comment on the April 19 draft of the "Report by the AEC Task Group on Recommendations for Cleanup and Rehabilitation of Enewetak Atoll."

This draft contains many improvements over the February 1, 1974, draft and we appreciate the consideration given to our earlier comments. In general we can accept (1) the radiation protection criteria as listed on page 5, and (2) the recommendations as listed on pages 24-30 for the specific activity related to the cleanup and rehabilitation of Enewetak Atoll on an interim use basis. EPA is developing a program to address cleanup guides for land restoration and such guides may impact on the above conclusions.

It is our understanding that the DoD in cooperation with AEC and DOI will implement the final recommendations in the cleanup operations. We would like to emphasize the point that the cleanup criteria are considered as upper limits or guidance to DoD and the resultant radiation doses to the Enewetak people should be kept to the minimum practicable level. As we mentioned in our February 28 letter to Mr. Tommy McCraw:

> It should be understood and stated that any proposed guidelines or numerical values for the dose limits are only preliminary guidance and that a cost-benefit analysis must be undertaken to determine whether the projected doses are really as low as readily achievable and practical before proceeding with the relocation project. On the basis of such analysis it may be prudent to lower dose guidelines for this operation.

It is also our understanding that DoD will thoroughly discuss this matter in its draft EIS on this activity.

On page 16 of the draft, reference is made to the possible disposal of plutonium contaminated soil and radioactive scrap in the deep lagoon or deep ocean. Title I, Sec. 101(c) of PL 92-532 states, "No office, employee, agent, department, agency, or instrumentality of the United States shall transport from any location outside the United States any radiological, chemical, or biological warfare agent or any high-level radioactive waste for the purpose of dumping it into ocean waters." Section 227.21 of EPA's Final Regulations and Criteria also prohibits the dumping of these materials. Although the plutonium and other radioactive materials that may be dumped in the Enewetak lagoon or near-by deep ocean, may not strictly be covered by the definitions of "radiological warfare agents" or "high-level radioactive wastes," it was surely the intent of PL 92-532 and the EPA regulations to rigidly control or even prohibit such dumpings. We believe this is a matter that requires further discussion between EPA, AEC, DoD, and DOI.

Another important consideration for the proposed alternative of ocean dumping of Enewetak contaminants is the international implications. The few countries disposing of radioactive materials in the oceans do so under the international supervision of the Nuclear Energy Agency. The draft recommendations for ocean dumping of radioactive wastes being developed by the International Atomic Energy Agency also recommend international supervision of such dumping operations. The current Enewetak recommendations provide for unilateral action with no international supervision. The U.S. has had a national policy of no ocean dumping of radioactive wastes since 1970. Any proposal to reverse such a policy now would have to involve the U.S. Department of State in view of the United States having already ratified the International Ocean Dumping Treaty.

We will be glad to meet with you or your staff to discuss these matters if you so desire.

Sincerely yours,

W. D. Rowe, Ph.D.
Deputy Assistant Administrator
for Radiation Programs (HM-558)

cc:
Mr. R. W. Musser, EPA
Mr. R. Leachman, DNA

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAY 8 1974

Dear Dr. Biles:

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Sincerely yours,

Stanley S. Carpenter
Director of Territorial Affairs

Martin B. Biles
Director
Division of Operational Safety
U.S. Atomic Energy Commission
Washington, D.C. 20545

July 9, 1974

SUMMARY OF TASK GROUP RECOMMENDATIONS

ENEWETAK ATOLL

INTRODUCTION

The Atomic Energy Commission agreed to provide radiological criteria for cleanup and rehabilitation of Enewetak Atoll to the Department of Defense (DOD) and to the Department of the Interior (DOI). A comprehensive survey of the radiological environment of Enewetak was made to serve as a basis for judgements and recommendations. The survey data show that the northern islands have the greater amount of radioactive contamination and there are plutonium problems.

The Director, Division of Operational Safety, appointed a Task Group and through it staff liaison representatives of DNA, DOI and EPA were kept informed of progress toward completion of recommendations. Current radiation protection guidance containing numerical standards and radiation protection philosophy of national and international standards bodies was used to develop recommended criteria:

- Population dose to the Enewetak people should be as low as practicable.

- The Federal Radiation Council (FRC) Radiation Protection Guides (RPG) for individual and gonadal exposures will be used to evaluate exposure options. The values should be reduced by 50 percent for individual exposure and 20 percent for gonadal exposure to allow for uncertainties in dose predictions. The guides for cleanup planning become:

	Exposure
Whole body and bone marrow	0.25 Rem/yr
Thyroid	0.75 Rem/yr
Bone	0.75 Rem/yr
Gonads	4 Rem in 30 yr

Cleanup of soil containing Pu can be handled on a case-by-case basis using the following:

a. < 40 pCi/gm of soil - corrective action not required.

b. 40 to 400 pCi/gm of soil - corrective action determined on a case-by-case basis considering all radiological conditions.

c. > 400 pCi/gm of soil - corrective action required.

DOSE ASSESSMENT AND CORRECTIVE ACTION ALTERNATIVES

For comparison with population dose guidelines, evaluations were made for the following conditions:

- Dose without cleanup.
- Dose reductions obtained by diet modification.
- Dose reductions achieved by removal of contaminated soil.

In addition, estimates were made for representative living patterns plus corrective actions:

- Plow the village island, and gravel the village area for radiation shielding.
- Import pandanus and breadfruit from the southern islands (ALVIN-KEITH) for inhabitants of the northern islands to control ingestion of radionuclides.
- Import pandanus, breadfruit, coconut and tacca from the southern islands.
- Import pandanus, breadfruit, coconut, tacca, and domestic meat from the southern islands.

DISPOSAL OF CONTAMINATED MATERIAL

Contaminated material is composed of soil, debris and scrap. At some places there is Pu including pieces of Pu metal. Contamination is distributed on and below the surface; some is in rad waste burial sites.

Fission products and induced radioactivity found on such scrap and debris, particularly scrap metal, should be made unavailable to the returning people. Possible approaches are:

1. Disposal in water-filled and underwater craters.

2. Land burial where the radiation level of the scrap is not significantly above that on land.

3. Disposal in deep water.

Pu excepted, the Task Group has not made recommendations for removal of contaminated soil. For any disposal there should be no pathway to people; periodic followup surveys are necessary. Disposal of Pu in any form is a greater problem, and disposal must protect against exposure for the future.

OBSERVATIONS AND CONCLUSIONS

The consensus of the Task Group reflects consideration of a range of options and the benefits of reviews and comments.

Choice of the method which will optimize reduction of exposures is a matter of judgement. Action such as use of imported foods could be effective but is not recommended. Although engineering actions, e.g., soil removal and replacements may appear to be preferable to restricting use of land for living and agriculture, these actions can otherwise adversely affect the environment and for some the effectiveness is uncertain. The extent of compliance by the people with restrictions has been considered, and an acceptable level of cooperation is expected so that they may use land where the radiation environment is or can be made acceptable.

Return of people to live on the southern islands, ALVIN through KEITH, is expected to result in radiation doses within the recommended criteria. JANET (Enjebi), which the people desire for a residence island is a special case of the category of islands having radiation and radioactivity levels which preclude living and agriculture. Steps to make this island completely or partially available in the near term are important from the social as well as scientific viewpoint.

Predicted radiation doses associated with the Task Group recommendation that people live only on the southern islands, ALVIN through KEITH, are given in the following table. The Bikini Atoll estimates and typical natural background levels in the U.S. are given for comparison.

PREDICTED RADIATION DOSE IN REM WITH ADOPTION OF TASK GROUP RECOMMENDATIONS

Maximum Annual Dose*

Whole Body		Bone Marrow	
Child	Adult	Child	Adult
0.125	0.128	0.148	0.149

Thirty Year Doses*

Whole Body	Bone**
2.2	11.5

Predicted Radiation Dose for Bikini Atoll

Thirty Year Doses***

Whole Body	Bone Marrow
5.3	9.4

Measured Terrestrial Gamma Dose - Rates in U.S.

0.04 to 0.13 Rem/yr

*See Option III, Table 11, of the Task Group report. Dose includes contribution from natural background, about 0.03 Rem/yr, and 0.90 Rem/30 yrs.

**The dose to bone marrow is about one-third the dose to bone.

***Presented in "Additions to Radiological Report on Bikini Atoll, P. F. Gustafson, Division of Biology and Medicine," May 1968. Estimates do not include contribution from natural background.

RECOMMENDATIONS

The Task Group reached the following conclusions:

1. Observing precautions, the people may safely return after certain actions are taken. Exposures will be somewhat above current levels in the U. S., but the small risk seems permissible in relation to the desire of the people to return.

2. To assure exposures that will be as low as practicable:

   a. Villages and residences to be located on ELMER, FRED, DAVID, or other southern islands (ALVIN-KEITH).

   b. Travel and visits may be unrestricted to all islands except YVONNE. When Pu contamination on YVONNE is removed, the restriction of travel to that island may be lifted.

   c. Coconut excepted, growth of animal and vegetable subsistence crops to be limited to southern islands ALVIN-KEITH.

   d. Subsistence and commercial coconut may be grown without remedial measures except on ALICE, BELLE, CLARA, DAISY, IRENE, JANET, and YVONNE.

   e. Fishing permitted anywhere.

   f. Wild birds and eggs may be collected anywhere.

   g. Coconut crabs may be collected only on the southern islands (ALVIN-KEITH).

   h. Wells to provide lens water for human consumption or for agricultural use to be drilled only on the southern islands (ALVIN-KEITH). Water from any well to be assayed for bacterial, salinity, and radioactivity content before approved for use.

3. Enjebi (JANET) is a special case, and the people have a strong desire to live there. Three ground zeroes were on Enjebi and high yield events were fired nearby, with the result that this was the most heavily contaminated of the larger islands. The Task Group has been unable to determine a reliable, feasible way to bring exposures within the acceptable criteria and permit

resettlement of Enjebi on the same schedule as southern islands. The island can be resettled sometime in the future when radionuclide ingestion is no longer a problem. To develop the facts, test plantings with and without soil removal may be made. Construction and agriculture would be deferred until produce from test plantings showed acceptably low levels of radioactivity. Test plantings without soil removal would have least adverse impact on the island environment.

4. Concurrent with the Enjebi work, radioactivity levels should be measured in coconut and other food crops grown on PEARL, CLARA, ALICE, and BELLE. Produce from YVONNE should be included after removal of plutonium contamination.

5. All radioactive scrap metal and contaminated debris now or later identified should be removed. This includes three locations on SALLY and one on ELMER where buried contaminated debris should be exhumed and removed.

6. YVONNE, quarantined by the USAF in 1972, should remain quarantined until plutonium contamination on that island has been cleaned up. An authority responsible for enforcement of the quarantine should be identified and in residence in the Atoll if people return to the Atoll before cleanup is completed.

7. Only general recommendations for cleanup of Pu on YVONNE can be presented at this time. An accurate picture of this contamination should develop as the decontamination proceeds. The area observed to have small pieces of plutonium and the highest soil concentrations is about 30% of the island. A background for plans for the recovery of Pu will require:

   a. Assembly of a team of experts to interpret field radiation and radioactivity measurements, advise on cleanup actions and provide necessary health physics support. A Public Health Service group, now part of EPA, provided radiological assistance for cleanup of Bikini Atoll. Similar support should be sought from EPA for Enewetak.

   b. Decontamination of YVONNE is seen as an iterative process. This amounts to a search for and removal of the higher plutonium levels in soil.

c. The objectives of the cleanup are two:

(1) Recovery of the pieces of plutonium that have been observed on or near the island surface.

(2) Recovery of plutonium contaminated soil.

d. Recovery of plutonium in soil at concentrations greater than 400 pCi/g $^{239, 240}$Pu at any depth these levels are found. Also, recovery of contaminated soil sufficient to reduce surface levels to a value well below 40 pCi/g $^{239, 240}$Pu. After soil removal, all areas should be resurveyed to ensure no pieces or hot spots of plutonium remain.

8. Plutonium contaminated soil on IRENE should be handled as on YVONNE. Pieces of Pu metal are not expected to be found.

9. Test plantings of food crops may be conducted on each of the "no crops" islands as designated by the Enewetak people. As edible parts of these plants become available, concentrations of significant radionuclides should be measured and compared with the radiological survey predictions. These studies will indicate times at which planting of subsistence and commercial crops can be safely resumed.

10. Lens water sampling and analysis should be conducted, samples to be taken over a period of at least 12 calendar months. Bacterial content, salinity, and radionuclide content should be measured. Radioactivity information will contribute to an understanding of processes operating - or which can be made to operate - to reduce the ecological half-life of ^{90}Sr and ^{137}Cs below the radioactive half-life on the northern islands, especially JANET.

11. A comprehensive air sampling program should be conducted over a period of 12 consecutive months under conditions closely approximating human habitation and expected soil disturbance to provide information on radioactivity levels in air. This program could be conducted coincident with and support cleanup.

12. Base-line surveys of body burdens and urine content of ^{137}Cs and ^{90}Sr should be made for the Enewetak people prior to return to Enewetak Atoll, and periodically thereafter. Re-surveys of the environmental radiation and radioactivity should be made in the first year of return and repeated, for example,

every other year.

13. Methods of disposal of plutonium contaminated soil and scrap will have to be decided. Pending a decision, it is recommended that cleanup should accomplish the recovery of plutonium contaminated soil and scrap with storage on YVONNE. If disposal is deferred for further study, such study should be initiated promptly.

14. The cleanup, with particular attention to removal and disposal of contaminated scrap, debris, and soil, should be documented in detail in a final report by those responsible in the field.

15. Advantage would be taken of experience gained during cleanup of Bikini Atoll. No objection should be made to employment of Enewetak people during cleanup.

PRELIMINARY RADIOLOGICAL REPORT ON BIKINI ATOLL

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Division of Operational Safety
U. S. Atomic Energy Commission
Washington, D. C.

May 1970

RADIOLOGICAL REPORT ON BIKINI ATOLL

Introduction

Reports on this subject were prepared by Philip F. Gustafson in April and May 1968 (Attachments 1 and 2). Since that time the decision has been made that the Bikini people may be returned to their Atoll but that certain measures should be taken to further reduce radiation exposures. These measures are described in the report of the AEC Ad Hoc Committee (Attachment 3).

During 1969, cleanup of Bikini Atoll, which was one of the Ad Hoc Committee's recommendations, was accomplished through a cooperative project funded by DOD and AEC. The Atoll has now been turned back to the Office of Trust Territories of the Pacific, Department of Interior. DOI is currently conducting a program of agricultural rehabilitation that has been under way about one year and construction of housing and community facilities is to begin in the near future.

The cleanup project provided an opportunity to obtain significant additional information on the levels of environmental radiation and radioactivity in the Atoll. Enough of the results from the 1969 monitoring and sample collecting activities are now available from Allen Smith and William Moore of SWRHL and from Edward Held of the University of Washington to make preliminary comparisons with the 1967 results and to determine what if any differences the 1969 data may make in radiation exposure estimates prepared by Dr. Gustafson. Comparisons

in this report will be directed to environment levels on Bikini and Eneu, the islands being rehabilitated by DOI.

Comparison of External Radiation Survey Results

Table I of this report is a summary of external radiation levels for Bikini and Eneu. These data indicate that the 1967 values for Bikini and Eneu were essentially correct. It is suggested that the values for 1969 are not different enough to warrant recalculating external exposures and that Dr. Gustafson's values in Table III of Attachment 1 and Table VIII of Attachment 2 still apply.

The estimates in the column labeled "Modified" in Table III of Attachment 1 are obtained by assuming that the village area or areas around homes are covered with a layer of clean coral gravel 1 to 2 inches in depth. A further reduction in external dose may be expected by a factor of two to ten for that exposure received during time spent indoors since homes are to be constructed from concrete blocks made from local materials. This reduction may be optimized by selecting sand and aggregate for making concrete from locations in the Atoll having the lowest levels of radioactivity.

The external exposure estimates in Table VIII of Attachment 2 are based on the assumption that 2 inches of clean coral gravel cover the ground around housing. However, a shielding factor for concrete block

houses has not been applied. To this extent dose estimates for these data are now expected to be more conservative than when first developed.

Internal Dose Comparisons

Table II of this report contains a comparison of 1967 and 1969 values for ^{90}Sr, ^{137}Cs, and ^{55}Fe, the radionuclides of most concern in the Bikini diet. The following comments apply to this comparison:

1. Fish - The 1969 values for eviscerated whole fish are somewhat lower than the 1967 values for muscle. However, the 1967 values for muscle would still appear to be applicable so Gustafson's intake values in the 1968 report would still apply.
2. Pandanus Fruit - The 1969 values for ^{90}Sr and ^{137}Cs are higher than the 1967 values lending even more support to the Ad Hoc Committee's recommendations for precautions to be taken in planting Pandanus.
3. Birds - The 1969 value for ^{55}Fe is in good agreement with the 1967 value. The 1969 value for ^{137}Cs in the curlew is higher than the 1967 average value for birds. However, the curlew is seldom caught. The 1969 average value of ^{137}Cs for birds eaten most often is in close agreement with Gustafson's value and his intake level would still apply.
4. Arrowroot - The 1969 values for prepared arrowroot flour (the 1967 value was for unprepared arrowroot which is inedible)

show a significant change. The ^{90}Sr value is higher by a factor of about 14 but the ^{137}Cs value is lower by a factor of 150. These new values should be used in a redetermination of internal exposures from ^{90}Sr and ^{137}Cs.

5. Coconut - The 1969 values for ^{90}Sr and ^{137}Cs in coconut are in good agreement with 1967 values and Gustafson's intake values would still apply.

6. Coconut Crabs - The 1969 levels of both ^{90}Sr and ^{137}Cs in crabs from Bikini Island are higher than the 1967 average value. The edible portion of each crab will contain about 1 pound of muscle and 1 pound of liver. Therefore, the average radionuclide content for crabs will be the average value for muscle and liver. The level of ^{55}Fe in crabs is so low (the average value for muscle and liver) as not to constitute any significant intake of this radionuclide for this item of diet.

7. Clams - The levels of ^{90}Sr, ^{137}Cs, and ^{55}Fe in clams and lobster are so low that intake of these radionuclides through these items of diet may be neglected in dose calculations.

Table III of this report presents revised values of daily radionuclide intake using the Rongelap diet and updated with the 1969 monitoring results.

Table IV presents a comparison of estimated daily dietary intake values that may apply if certain items of the diet are included or excluded. A number of observations may be made:

1. Updating Gustafson's estimates with 1969 monitoring results increases the intake estimate for the total diet by about 50% for ^{90}Sr and 68% for ^{137}Cs. The items contributing most to this increase are Pandanus and Crab.
2. Updating intake estimates with 1969 data and assuming no intake of Pandanus, Arrowroot or Crab (the diet used in Gustafson's dose predictions) shows a minor change when compared with Gustafson's intake estimates.
3. Updated data indicate that including Arrowroot in the diet (no Pandanus or Crabs) increases the ^{90}Sr intake by a factor of about 2 and ^{137}Cs intake remains about the same.
4. Updated data indicate that including Arrowroot and Crab in the diet (no Pandanus) increases the ^{90}Sr intake by a factor of 6 to 7 and increases the ^{137}Cs intake by a factor of about 2.

In the section on "Summary of Radiation Exposure" in Attachment 1 there is the statement that, "It is unlikely that the whole body exposure, or the exposure to specific organs including bone, will exceed 4 rads in 5 years, 15 rads in 30 years or 30 rads in 70 years." The dose estimates

in Table V were obtained by scaling Gustafson's estimates up or down using the updated intake data in Table IV. These estimates indicate that including Arrowroot in the diet increases the dose to bone by about 0.8 rad in 5 years while whole body dose remains the same. Including Arrowroot and Crab in the diet without a dietary supplement of calcium increases dose to bone to almost 8 rads in 5 years or twice the 4 rads in 5 years mentioned above. With a calcium supplement including Arrowroot and Crab in the diet brings dose to bone very near the 4 rads in 5 years value. However, in the interest of placing only those restrictions on intake that are actually needed, it is suggested that Arrowroot and Crab can be left in the diet provided the calcium intake in the diet is brought up to 1 gram per day. There is the additional consideration that intake of Coconut Crab will probably be self limiting in that an intake of 14 grams per day by as many as 100 people would require 600 crabs per year. Large numbers of crabs have not been seen on Bikini Island and some were destroyed during the vegetation clearing operations in 1969.

Unrestricted use of local foods at an intake corresponding to the Rongelap diet could bring whole body dose up to the 4 rads in 5 year level and dose to bone up to about 50 rads in 5 years if an edible variety of Pandanus was available which is not the case. The wisdom of the Ad Hoc Committee's recommendations is that when edible Pandanus does become available on Bikini, exposures such as those above will not occur.

TABLE 1

External Radiation Levels on Bikini and Eneu Islands

μR/hour

	'67 Average	'67 Range	'69 Average	'69 Range
Bikini: Beach	12.7	5-25	< 10	≤ 10
Village	25.1	10-60	35-44*	15-80
Interior	72.7	40-120	86	20-120
Eneu:	4.3	2-10		< 10-20

*The higher value applies if it is considered the village extends 250 feet inland from the lagoon road. The lower value would apply for housing placed near the lagoon road.

TABLE II

COMPARISON OF RADIONUCLIDE CONTENT OF BIKINI DIET

1967 VERSUS 1969

pCi/g WET WEIGHT

	^{90}Sr		^{137}Cs		^{55}Fe	
Diet Item	'67	'69	'67	'69	'67	'69
Fish	.19	.08[1]	.32	.13[1]	100	18[1]
Pandanus Fruit	19	28[3]	52	130	-	-
Birds	.13	-	26.5	28[2]	100	110
Arrowroot	.17	2.4[3]	92	.6[3,4]	-	-
Coconut	.19	.31[3]	114	120[3]	-	-
Crabs: Muscle	19	12[3]	72	181[3]	-	1.2[3]
Liver	-	62[3]	-	170[3]	-	41[3]
Clams or Lobster	.04	-	.02	nd	-	5.9

1. Values for 1969 are eviscerated whole reef fish.

2. Average for four species.

3. Values for Bikini only used for this data point.

4. Value applies to arrowroot flour prepared by grinding, rinsing three times with salt water and once with fresh water (Marshallese method of preparation).

nd - not detectable

TABLE III

ESTIMATED DAILY RADIONUCLIDE INTAKE FOR BIKINI DIET

UPDATED WITH 1969 MONITORING RESULTS

pCi/day

Food Item	Daily Intake (gms)	^{90}Sr	^{137}Cs	^{55}Fe
Fish	554	105	177	55,400
Pandanus	164	4,594	21,320	-
Birds	41	5	1,086	4,510
Arrowroot	41	98	25	-
Coconut	9	2	1,026	-
Crabs	14	518	2,450	-
Clams	45	-	-	-
Imports*	32	-	-	-
	900	5,322	26,084	59,500

*Intake for imports is negligible compared with intake from local products.

TABLE IV

COMPARISON OF RADIONUCLIDE DIETARY LEVELS

1967 VERSUS 1969

pCi/day

Assumption	^{90}Sr	^{137}Cs	^{55}Fe
1964 and 1967 data, all items	3,496	15,570	59,500
1964 and 1967 data, no Pandanus, Arrowroot, or Crabs*	114	2,290	59,500
1964 and 1967 data updated with 1969 results, all items	5,322	26,084	59,500
Updated data, no Pandanus, Arrowroot, or Crabs	112	2,289	59,500
Updated data, no Pandanus or Crabs	210	2,314	59,500
Updated data, no Pandanus	728	4,764	59,500

*These values were used in Gustafson's dose estimated, Table VIII, Attachment 2.

TABLE V

IMPACT OF 1969 MONITORING RESULTS ON EXPOSURE ESTIMATES

(rads)

CHILDREN

	Bone ^{90}Sr	Whole Body (^{137}Cs & ^{55}Fe)[1]	External[2]	Total Whole Body	Total Bone
5 year exposure, Gustafson's estimates for no Pandanus, Arrowroot, or Crab and 0.42 gm/day calcium intake	.98	.28	.75	1.03	2.01
		(Note: the above values also apply to the 1969 data)			
5 year exposure, updated data, no Pandanus or Crab, 0.42 gm/day Calcium intake	1.80	.28	.75	1.03	2.83
5 year exposure, updated data, no Pandanus, 0.42 gm/day calcium intake	6.25	.58	.75	1.33	7.58
5 year exposure, updated data, no Pandanus, 1 gm/day calcium intake	2.63	.58	.75	1.33	3.96
5 year exposure, updated data, no precautions with intake	45.74	3.19	.75	3.94	49.68

1. These dose estimates revised to the extent of assuming 10% instead of 100% ~~retention~~ absorption for ^{55}Fe.
2. Assumes covering village area with 1 to 2 inches of uncontaminated coral gravel. This value does not include the consideration that concrete block houses will provide additional exposure reduction during that time spent indoors.

RADIATION SAFETY CONSIDERATIONS AT BIKINI ATOLL

MAY 1970

In response to an inquiry by the High Commissioner of the Trust Territory of the Pacific, the following general statement is provided regarding radiation safety of Bikini Atoll:

On Tuesday, August 27, 1968, the ship James M. Cook arrived at Kili Island bringing the High Commissioner, then Mr. William Norwood, representatives of the U. S. Department of Interior, Atomic Energy Commission, and Department of Defense, and members of the press. A primary purpose of the visit was to discuss with the Bikini people the recent decision that they be returned to their Atoll and to answer questions regarding conditions in the Atoll. At that meeting there were questions on whether the islands were safe and whether food was safe to eat.

With Mr. Chutaro acting as interpreter, the AEC representative told the Bikinians that the question of safety of returning to the Atoll and using foods found there had been carefully studied. A Committee of experts meeting in Washington, D. C. had concluded that returning the people to Bikini Atoll would not offer a significant threat to their health and safety but certain simple measures should be taken to further reduce radiation exposure. The recommendations of this Committee of experts were summarized. The people were told that for the present, only the Bikini-Eneu complex is to be rehabilitated. While they may go any-

where in the Atoll for purposes such as fishing and food collection, homes and community facilities are to be built only on Eneu and Bikini. In answer to a question, the Bikinians were told that food from the lagoon would be safe to eat. Certain precautions were to be taken in planting Pandanus, and radioactive scrap metal was to be removed from the islands.

Questions have since been asked as to how one can interpret the conclusions of the experts. As to whether certification can be given that Bikini is radiation free, the answer is that this cannot be done. Such a certification could not be given for any location in any country since there is radioactivity everywhere. Levels of radioactivity vary from place to place. Some occur naturally and some are man made. The levels of man-made radioactivity in Bikini Atoll are higher than in the U. S. due to tests conducted in the Atoll, but these levels are slowly declining. The radiation which comes from this radioactivity can be measured with instruments and the radioactivity in foods can be measured in the laboratory. Such measurements have been made for Bikini Atoll, the levels are known, and additional measurements will be made in the future.

Since the levels of radioactivity in Bikini Atoll are not zero, the question comes as to how much radioactivity or radiation is acceptable from a health viewpoint and do the levels expected for Bikini residents fall within the acceptable range. The answer from the Committee of

experts is that exposures at Bikini Atoll are expected to be acceptable. Predicted exposures are well within the radiation safety standards set by national and international bodies of experts provided certain precautions are taken. The Committee of experts who evaluated the safety of returning to Bikini Atoll recommended measures that should reduce radiation exposures and insure that exposures remain acceptable for all future time.

One recommendation is that periodic resurveys of Bikini Atoll should be conducted that will provide a continual check on the radiation status of the people and the environment and that will help form the basis for decision as to the time of rehabilitation of islands outside of the Bikini-Eneu complex. This continuing monitoring of the environment at Bikini Atoll is no different than the monitoring conducted throughout the United States wherein measurements of radiation and radioactivity in foods are made. It would be unusual not to make such measurements for the Bikini people considering such measurements are made for the people in the U. S.

As to levels of radioactivity in foods in Bikini Atoll, two foods should be mentioned, namely, coconut crab and Pandanus. The Committee of experts did not recommend that eating coconut crab be prohibited. Rather, coconut crab should not be eaten in such quantity that it forms a major part of the diet to the exclusion of other foods which generally

contain lower levels of radioactivity than coconut crab. The Committee's recommendation that the population of coconut crabs be sharply reduced was directed to this end but there was no intent that the crabs be entirely removed from the Atoll. Some reduction occurred during cleanup operations on Bikini Island and coconut crabs are not now seen there in large numbers. Coconut crabs may be included in the diet when the population returns but this recommendation is subject to continuing review.

For Pandanus, the Committee recommended removal of two inches of topsoil over an area covered by the crown of mature trees for plantings on Bikini. If this is not done on Bikini, the fruit produced may not be acceptable. Fruit produced by Pandanus trees planted on Bikini will be analyzed to insure that it is acceptable for food.

The Committee has recommended that no precautions are needed on Eneu and coconut crabs found there may be eaten in any quantity. Pandanus may be planted there without soil removal.

While the Committee's recommendations for achieving lower radiation exposure are all beneficial, there is one very important recommendation requiring the cooperation and participation of the Bikini people. This concerns insuring an adequately nutritious diet for those living in the Atoll. Use of a dietary supplement of powdered milk has been suggested which will relieve the calcium deficiency usually associated with the Marshallese diet.

In addition to the general statement above, there has been a request for answers to specific questions which may be asked. A list of questions and answers is provided below:

1. Q. HOW DID THE COMMITTEE OF EXPERTS DECIDE BIKINI IS SAFE?

   A. They reviewed measurements and data that had been accumulated during past surveys, then met with the 1967 survey team. Predictions were made of the total radiation exposure expected to occur from all possible sources if the natives were returned. In their opinion this exposure does not offer a significant threat to health and safety.

2. Q. DOES THE REPORT OF THE COMMITTEE OF EXPERTS MEAN THAT THERE IS NO RADIATION ON THE ISLANDS?

   A. No. It means that in the opinion of the AEC and the Committee of experts the type and level of radiation do not offer a significant threat to health and safety.

3. Q. HOW MUCH RADIATION WILL THE BIKINIANS BE EXPOSED TO?

   A. That will depend on whether or not the recommendations from the Committee of experts are followed. Under the worst conditions, with all of the recommendations ignored that are intended to minimize intake of radioactivity in food, the exposure in the first five years from internal and external radiation sources still would be within acceptable limits set by the Federal

Radiation Council for individuals not engaged in atomic energy work. However, the recommended actions to minimize exposure from radionuclides in food will be needed to insure that the Pandanus may be eaten when it becomes available and that exposures over longer times such as 30 and 70 years remain within acceptable levels. The calculated figures for accumulated whole body doses are:

ADULTS	CHILDREN
5 years - 1 rad	1 rad
30 years - 6 rads	5 rads
70 years - 10 rads	10 rads

The Federal Radiation Council's radiation protection guide for the whole body of the individuals amounts to:

Individuals in a Population

1 year	- 0.5 rad
5 years	- 2.5 rads
30 years	- 15 rads
70 years	- 35 rads

The general philosophy, based on both experience and research, is that 0.5 rad per year provides an acceptable level of whole body exposure for individuals. This value may be used where sufficient monitoring is performed so that radiation exposures are known.

4. Q. WHAT ABOUT THE RATE OF ACCUMULATION OF RADIATION EXPOSURE?

A. The rate for external radiation will be higher in the first few years but will decline steadily with time. Initially the accumulation will be about twice that for the average person in the U. S. Reduction to the U. S. average will occur in about 30 to 50 years. When the Bikini people first return, the doses to whole body from external and from internal radioactivity will be about equal. When more of the locally produced foods such as Pandanus begin to become available, the contribution from internal radioactivity may increase. The recommendations of the Committee of experts are intended to insure that such exposures in the future remain within an acceptable range.

5. Q. WHERE DOES THE RADIATION IN THE ATOLL COME FROM?

A. Primarily from radionuclides in soil. The levels vary considerably from one island to another. It is for this reason that Eneu and Bikini were suggested as village sites since these two islands have lower levels.

6. Q. WHY ARE THE ISLANDS NOW CONSIDERED ACCEPTABLE FOR HABITATION WHEN THEY WEREN'T SOME YEARS AGO?

A. Radioactivity decreases with the passage of time. Some radionuclides disappear faster than others. Altogether it is a combination of the passage of time and the work of nature in diffusing and dispersing the radionuclides. Readings taken in 1964, for instance, were higher than those of 1967.

7. Q. WHY MUST PRECAUTIONS BE TAKEN IN PLANTING PANDANUS TREES ON BIKINI?

A. Pandanus fruit is a native diet staple, supplying certain needed vitamins. While there are no Pandanus of edible variety now on Bikini Island, samples from a nonedible variety have been found to contain a higher level of both strontium-90 and cesium-137 than other plants grown in the same soil. The Committee of experts have made a recommendation for reducing these levels in the fruit of trees to be planted on Bikini Island by removing the top two inches of soil which contains most of the radionuclides. On Eneu there is no need for such precautions since the soil there contains only a very small amount of radionuclides.

8. Q. WHY WAS IT SUGGESTED THAT THE COCONUT CRAB POPULATION SHOULD BE REDUCED IN NUMBER?

A. The coconut crab is a native favorite. However, it is not desirable that this food be a major part of the diet since the levels of radioactivity in the crab are somewhat higher than some other food items. This consideration is the basis for the recommendation on crab population reduction.

9. Q. WHAT ABOUT COCONUTS? ARE THEY RADIOACTIVE?

A. Coconuts have been observed to contain some amounts of radioactivity but much less than Pandanus fruit. Suitable planting and fertilizing procedures are expected to reduce even these amounts. There are

not many mature coconut trees on the atoll now. On some of the islands the tops of the coconut trees were snapped off by the force of the test blasts. On the islands most affected by the tests, the trees were burned or washed away. Many new coconut trees are being planted on the islands of Eneu and Bikini.

10. Q. WILL THE BIKINIANS BE ABLE TO FISH IN THE LAGOON?

A. Yes. The survey team reports the lagoon contains a large quantity of fish. Marine life is low in radioactivity.

11. Q. IS THERE ANY RADIOACTIVITY IN THE BIRDS AND FISH?

A. Some fish and birds contain measurable amounts of radionuclides which they have retained from what they've eaten, but the amount is not large enough to cause concern.

RADIOACTIVITY IN COPRA

The decision to return the Bikinians to their home Atoll was based in part on the consideration of radiation exposures of those who will reside in homes on the islands of Bikini and Eneu and who will consume locally produced foods. The health of the people was the primary consideration. Several simple measures have been recommended which are expected to insure that exposures of Bikini residents remain within acceptable levels.

In addition to insuring that radiation exposures are at acceptable levels, there are other considerations. People along with some quantities of goods, household possessions, and food will come to the Atoll. At least two important materials will go from the Atoll, e. g., scrap metal and copra. Any radioactivity associated with metal scrap would appear not to be a problem if this scrap is monitored before shipment from the Atoll. Although sale of scrap metal will be an important source of income for the returning population, copra is the money crop and the chief source of income.

The Trust Territory agriculturist estimates that with the replanting now under way, the Bikinians can produce as much copra in a month as they once produced in a whole year. This earlier annual production has been reported to be about 80,000 pounds or 40 tons. Future production

may then be about 480 tons per year. If the copra produced through the agricultural rehabilitation program contains as much ^{137}Cs as in the 1967 and 1969 samples, i.e., 114 to 120 pCi/gm, and considering that in producing copra, coconut meat is reduced in weight by the sun drying process by as much as 50%, the copra may contain up to 240 pCi/gm. The fertilizing of the new plants which is being done in the agricultural rehabilitation program may reduce the ^{137}Cs levels in the copra.

The relationship between ^{137}Cs in coconut meat and in soil where coconut trees are growing is not known. Available soil samples have come from one place and coconuts from another on Bikini. It would be desirable to have samples of coconut and soil from the same place and to fertilize an existing tree to see what change in radioactivity content in the coconut there may be compared to unfertilized trees. Also, it would be desirable to have samples from trees wherein 2 inches of top soil were removed as suggested by the Ad Hoc Committee for Pandanus and from trees where both fertilizer and top soil removal were used.

It would be desirable to sample coconut meat and coconut frond for ^{137}Cs from existing trees on Bikini. If levels in frond and meat are related in some way, then predictions of coconut meat ^{137}Cs could

be made using results of analysis of frond from young trees, years before these trees produce coconuts.

An indication of the significance of radioactivity in coconut meat can be seen by reviewing the production and use of copra. The natives harvest the coconuts which have taken about a year to mature and extract the coconut meat from the shell and husk. The shells are sometimes used by the natives for eating utensils and such shells may find their way into commerce in the form of charcoal. Husks are used in cooking fires and as a mulch in planting crops including coconut trees. Cord and rope are also made from husk fiber. Sleeping mats are made from coconut palm frond along with other items of handicraft such as hats and handbags. The "Kili Bag," which is a handbag manufactured by the Bikinians, is made from palm frond and Pandanus leaf and is widely known in the Pacific.

Pieces of coconut meat are sun dried, bagged, and stored under cover (warehouse) until picked up by a copra boat which may visit an Atoll two or three times a year. Collection of 25 to 50% of a years copra production in a warehouse would accumulate a sizable quantity of ^{137}Cs at the 1969 levels. Fresh coconut meat is about 50% water, 30-40% oil, and 10-20% copra meal by weight.

Copra processing plants which process copra from islands of the western Pacific are in the Philippines and Japan. The copra is washed and run through a press which extracts the coconut oil leaving a residue which is called copra meal. The oil is used in foods and cosmetics. The oil is reported to have a low mineral content and very low levels of radioactivity. Radioactivity such as ^{137}Cs in the processed copra ends up in the copra meal which contains about 20% protein and 5% oil. This meal is a good quality animal feed and is used for dairy cows. On a gram basis the level of ^{137}Cs in copra meal can be expected to be 5 to 10 times the level in fresh coconut meat. In the case of coconuts from Bikini, if the levels of ^{137}Cs in future crops are as high as found in the 1969 samples, the copra meal may contain 600 to 1,200 pCi/g.

Measures recommended by the Ad Hoc Committee for minimizing levels of radioactivity in Pandanus (removing 2 inches of soil at the planting site over an area covered by the crown of mature trees) may also be needed for planting coconut trees on Bikini. Whether this is needed cannot be determined with present information. If needed, the justification would not be so much the protection of the Bikini people but rather to minimize the level of ^{137}Cs in the copra meal that is a byproduct of production of coconut oil.