STAFF REVIEW OF BIKINI ATOLL CLEANUP AND REHABILITATION

In December, 1966, the Secretary of the Interior requested that a determination be made of whether Bikini Atoll could be resettled. Subsequently the AEC, now the Department of Energy, conducted a major radiological survey of Bikini Atoll, developed estimates of radiation exposures for residents of Bikini and Eneu Islands using all available data, and in August of 1968 made the judgment that "exposures that would result from repatriation of the Bikini people do not offer a significant threat to their health and safety".

The statement responding to the resettlement question was accompanied by recommended precautions and restrictions that may be briefly summarized:

1. Restrict rehabilitation to the Bikini-Eneu complex.
2. Establish the first village and food crops on Eneu where no precautions are needed.
3. Any village construction on Bikini Island should involve covering the site with coral rock.
4. Remove radioactive scrap.
5. Reduce the population of land crabs.
6. Remove two inches of topsoil for planting sites for pandanus trees.
7. Initiate followup radiological surveys of residents and their environment.
8. Insure a balanced nutritious diet.

Cleanup and rehabilitation of Bikini Atoll was a cooperative effort. The Department of Defense, DOD, performed cleanup of the Atoll. The Department of the Interior, DOI, and its office of Trust Territories of the Pacific Islands, TTPI, provided housing and agricultural rehabilitation. AEC agreed to conduct followup radiological surveys and to provide advice on radiological matters to DOD and DOI. Cleanup and rehabilitation of the Atoll began in 1969.

The DOD sees their participation in Bikini Atoll rehabilitation as ending when cleanup was completed and the Atoll was turned over to the TTPI. However there are eleven ships in about 200 feet of water in Bikini Lagoon sunk during the ABLE-BAKER tests in 1946. These are under control of the Department of Navy. They are the source of continuing inquiry regarding profitable salvage and contain munitions and quantities of oil. It is believed these ships do not constitute any radiological hazard for the Bikini people.

Considerations basic to the judgement that the Atoll could be resettled, and qualifications applicable thereto are as follows:

1. Radiation protection standards for annual whole body exposures in 1968 were 0.17 Rem/yr for population groups, and 0.5 Rem/yr for individuals.

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[1] The largest island in Bikini Atoll is Bikini Island, the traditional village island for the Bikini people.

The value for bone for individuals was 1.5 Rem/yr. The standards contain the recommendation that whole body exposures of the population be limited to 5 Rem in 30 years exclusive of medical and natural background exposures. Note: these same standards are still in effect today.

2. Since a radiological followup program would be instituted and the exposures of individuals would be known, standards for residents of Bikini Atoll would be those applicable to individuals, namely, 0.5 Rem/yr whole body and 1.5 Rem/yr to bone.

3. Results of the 1967 and earlier surveys indicated there would be two primary routes of exposure of atoll residents, exposure to external radiation and intake of radionuclides in terrestrial food, and two radionuclides, Cesium-137 and Strontium-90, would contribute the major portion of total radiation dose:

a. External radiation dose for Bikini Island residents would be about 3 to 4 Rads/30 yrs to whole body and bone depending upon age distribution of residents and time spent in various island locations, and about 1.3 Rad/30 yrs for Eneu Island. (For these dose estimates units of Rem and Rad are the same.) These external exposures for both islands would be within the annual and 30 year whole body standards. Cesium-137 would contribute about 70% of these external exposures and has a half life of about 30 years. Therefore, external radiation levels on Bikini and Eneu would be reduced by one half every 30 years through radioactive decay.

b. Adding internal dose through the food chain to the external dose to develop the total dose, but leaving three items out of the diet having the highest levels of radioactivity should they be grown on Bikini Island, indicated that doses for Bikini Island residents would be about 1.5 Rads to whole body in 5 years, 6 Rads to whole body and 9 Rads to bone in 30 years, and 10 Rads to whole body and 16 Rads to bone in 70 years. Total doses on Eneu Island would be less than one half of these values. These estimates indicated that total whole body dose for Bikini residents may somewhat exceed the 30 year standard even with certain items left out of the diet. The corresponding dose on Eneu would be well within the 30 year standard. Plutonium-239 was not expected to be a significant contributor to total dose.

4. In forming a judgement, predicted radiation exposures limited by dietary restrictions and exceeding the standards by some small amount, were viewed against the benefits to be derived by the Bikini people in returning to their homeland. The safeguard built into the advice on resettlement was the recommendation for radiological followup and the expectation that if the radiation exposure picture was not as predicted, or recommended precautions were not effective, this would be known and additional recommendations for limiting exposures could be made.

In discussions with TTPI officials on housing locations, representatives of the Bikini people insisted that since all Bikinians had land rights on Bikini Island but not on Eneu Island, housing must be constructed on Bikini. It was pointed out that recommendations on resettlement did not prohibit living on Bikini. Housing was constructed on Bikini Island during the 1971-72 time period.

Resurveys of the Bikini Atoll environment including foods, soil, and ground water were conducted during 1969, 1970 and 1972. Annual collections of urine samples for radioanalysis began in 1970 with those who were working on agricul-

tural and housing projects, and later included collections from the Bikini people who returned to live on Bikini Island. Monitoring of Bikini Island residents was done by a whole body counter in 1974 and 1977 that measured the amount of Cesium-137 in the body. The AEC conducted a major resurvey of Bikini and Eneu Island external radiation levels in 1975 responding to a question of whether or not additional houses could be constructed in the interior of Bikini Island. Windmill powered air samplers were installed in the Atoll in 1977.

Findings and conclusions drawn from additional survey data were as follows:

1. The body burden data collected for Bikini Island residents in 1974, translated into whole body dose, plus external radiation, indicated a total annual whole body exposure of about 0.2 Rem/yr. This was well within the standard of 0.5 Rem/yr. The diet at that time consisted of fish and imported food since there was little available food growing on the island.

2. Body burden data collected for Bikini Island residents in April, 1977, indicated a 10-fold increase in Cesium-137. This translated into dose, plus external radiation, indicated an annual whole body dose of about 0.4 Rem/yr. The diet still contained fish and some imported food, but more local terrestrial foods were growing on the island and the data clearly indicated use of these foods by the residents.

3. A reassessment of dose estimates based upon all collected radiological data to that time, and upon updated information on diet, was made early in 1977. These predictions indicated that even if use of local foods grown on Bikini Island were restricted to coconut, the whole body doses of residents may still be as high as 16 Rems in 30 years. Of this dose, external radiation accounts for about 3 Rems which leaves little additional dose from internal emitters if the 5 Rem standard is not to be exceeded. Note: these results differ from earlier calculations primarily because much larger amounts of coconut and coconut milk are in the assumed diet pattern for these later estimates. Revision of the dietary pattern was based upon new information. This more recent dose estimate exceeds the 5 Rem/30 yrs and the 0.5 Rem/yr standards, and keeping exposure this low depends critically upon restraint in the use of locally grown foods which body burden data indicate is not being exercised. By comparison, the predicted whole body dose for use of Eneu as a village island with no restrictions on eating foods grown on that island, was 4.2 Rem/30 yrs. This meets the 30 year standard and is far below the annual standard for exposure of the individual.

4. Sampling for plutonium in air on Bikini Island has shown very low levels. Sampling of food and drinking water for plutonium indicates that the pathway giving the greatest intake is marine foods. The collection of urine for plutonium analysis has given results for which there is not a lot of confidence at this time. At the expected plutonium levels, large volume urine samples from individuals are needed which are difficult to collect, and at these low levels, even a trace amount of extraneous dirt can contaminate the sample. Data reported in 1976 indicated Bikini Island residents urine plutonium levels are only about ten times those of New York City residents. The organ likely to receive the highest dose is bone for which the standard is 1.5 Rem/yr. It would not appear the plutonium at Bikini Island is a significant contributor to dose, but efforts to obtain sufficient volumes of shipboard collected "clean" urine samples from individuals to confirm this are continuing.

As results of additional radiological surveys and dose assessments have become available, these have been provided to DOI and briefings on important find-

ings presented to TTPI staff who inform the Bikini people. This advice has been reinforced through discussions with Bikini residents during survey visits to the Atoll. Summarized briefly, this additional advice has:

1. Recommended that a second group of houses not be built on Bikini Island, but on Eneu Island instead.

2. Recommended that if radiation standards are to be met for continued residence on Bikini Island, residents must not eat any local foods grown on that island or use ground water for drinking.

3. Recommended that Eneu Island should be the center of Bikini Atoll rehabilitation.

Two factors largely account for the current situation wherein DOI is seeking to provide housing on Eneu Island. First, the resettlement of the Bikini people on Bikini Island, the island of their choice and at their insistence, has not been successful from a radiological viewpoint due to intake of Cesium-137 and Strontium-90 through use of foods grown on that island. For whatever reasons, and an important and understandable one is that Bikini Island residents greatly prefer a diet containing fresh foods grown on their own land rather than imported foods, recommended restrictions for limiting internal doses at Bikini Island have not been effective. Second, while radiation standards cited previously have not changed from 1967 to 1978, the degree of conservatism in their application has changed markedly. Current applications require not only that radiation standards be met wherever possible, but that exposures be as low as practicable with increased willingness to expend effort and resources to achieve this. While 30-year exposures of an atoll population marginally above the 5 Rem standard, say 6 or 7 Rem in 30 years, are not that different from 5 Rem, exposures three or four times the standard would be very difficult to justify as a satisfactory measure of exposure control. The existance of an alternative to acceptance of exposures above basic radiation protection standards, namely, for the Bikini people to live on Eneu Island instead of Bikini Island, mandates that DOE advise against continuation of a pattern of increasing radiation exposures of Bikini residents wherein recommendation on use of local foods are proving to be impractical and ineffective, and radiation standards are certainly to be exceeded by a significant amount.

The followup radiological monitoring program conducted by DOE has accomplished what it was intended to do at Bikini Atoll. Each survey has tended to confirm earlier findings, and has added substantially to the data base for further evaluation of the environment as an acceptable place of residence. Findings at other atolls such as Enewetak, have been applied at Bikini where this is possible. It is planned that these followup surveys will continue as needed and the recommendation that no restrictions are needed on Eneu Island will be followed closely and from time to time re-evaluated.

SUPPORTING DOCUMENTS PROVIDED

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1. Seaborg press announcement on decision for resettlement of Bikini Atoll, August 12, 1968.

2. Radiological Report on Bikini Atoll, Philip F. Gustafson, DBM, April, 1968.

3. Additions to Radiological Report on Bikini Atoll, Philip F. Gustafson, DBM, May, 1968.

4. External Radiation Levels on Bikini Atoll, HASL-190, Beck, Bennett, and McCraw, December, 1967.

5. Plutonium Concentrations in Dietary and Inhalation Pathways at Bikini and New York, UCRL-52176, Robison and Noshkin, September 27, 1976.

6. Dose Assessment at Bikini Atoll, UCRL-51879 Pt. 5, Robison, Phillips, and Colsher, June 8, 1977.