[redacted]

[redacted]

April 13, 1970

SECRETARIAT

AEC 604/130

# INFORMATION MEETING ITEM

## BIKINI: PROPOSED SURVEY OF PLUTONIUM IN SOILS AND AIR

### Note by the Secretary

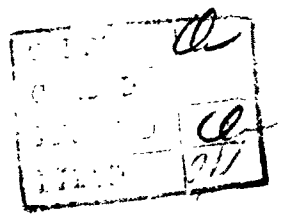
The General Manager has requested that the attached memorandum of April 13, 1970 from the Director of Operational Safety, with the following attachment, be circulated for consideration by the Commission at the Information Meeting scheduled for Monday, April 13, 1970:



W. B. McCool

Secretary





| DISTRIBUTION | NO. OF COPIES | DISTRIBUTION | NO. OF COPIES |
|---|---|---|---|
| Secretary | 7 | Asst. GM for Admin. | 1 |
| Chairman Seaborg | 4 | Asst. GM for MA | 2 |
| Commissioner Ramey | 1 | Asst. GM for Operations | 1 |
| Commissioner Johnson | 1 | Asst. GM for R&D | 1 |
| Commissioner Thompson | 1 | General Counsel | 1 |
| Commissioner Larson | 1 | Biology and Medicine | 1 |
| General Manager | 2 | Congressional Relations | 1 |
| Deputy Gen. Mgr. | 1 | Controller | 1 |
| Asst. Gen. Mgr. | 1 | Inspection | 1 |
| Exec. Asst. to GM | 1 | Operational Safety | 1 |
| Special Asst. to GM | 1 | Public Information | 1 |
| Spec.Asst.for Env.Affairs | 1 | | |

DP 326-86-1/Box 3/
NMB 105



MA-7 Trust Territory

*SNHS 28

2604

[redacted]

[redacted]

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

April 13, 1970

R. E. Hollingsworth, GM

THRU: John A. Erlewine, AGMO

PROPOSED SURVEY OF PLUTONIUM IN SOILS AND IN AIR AT BIKINI ATOLL

Enclosed for your information is a staff paper on the need for additional radiological monitoring at Bikini Atoll. The higher levels of plutonium-239 and plutonium-240 reported for Bikini soil at two locations have been substantiated by additional analyses. However, analyses of samples from four other locations on Bikini show lower levels (from 1.3 to 39 pCi/g).

Comparable field data for Rocky Flats and Palomares and comparison of measured concentrations in air with Concentration Guides indicates no cause for considering plutonium to be of health concern through the inhalation pathway at Bikini Atoll. Staff propose to augment present data by conducting another field trip to Bikini Atoll to collect both additional soil samples and samples of airborne particulates.

The time for planning the survey and for coordinating plans with Trust Territory officials is minimal if the trip is to be conducted before the rainy season which begins about mid June.

Draft reports containing results of the 1969 survey have been submitted to AEC for review and disposition. The staff proposes that the same NV contractors (SWRHL and University of Washington) participate in the 1970 survey and that results obtained from these further studies be incorporated in the draft reports prior to publication. The 1970 survey would provide a more comprehensive picture of radiological health aspects related to plutonium and confirm present determinations that these are negligible.

The proposed 1970 survey could also indicate possible need for examination of plutonium situations at other atolls such as Rongelap and Eniwetok.

With Enclosure

CONFIRMED TO BE UNCLASSIFIED
AUTHORITY: DOE/SA-20
BY R.R. SCHMIDT, DATE:
HRSchmidt 6/9/94
HD 6/15/94

Enclosure:
Staff Report on Bikini Atoll

Martin B. Biles, Director
Division of Operational Safety



[redacted]

NMB 106
2605

4/11/70

STAFF REPORT ON BIKINI ATOLL
ENVIRONMENTAL LEVELS OF PLUTONIUM

1. Background of Bikini Program

Evacuation and Test Operations. Early in 1946 it was determined that Bikini Atoll was a suitable site for nuclear weapons tests. The Bikini population, numbering 166, agreed to leave the atoll. After living some time on Rongerik Atoll and Kwajalein Island, the Bikini people were relocated to Kili Island where they still live today. The Bikinians were promised the return of their atoll when it was no longer needed as a testing site.

The Bikini field operations and test activities occurred periodically from 1946 through 1958. During this time, areas of the islands were cleared for camp sites and there was construction of housing, docks, towers and instrument bunkers. An aircraft runway and parking ramp was built on nearby Eneu and another runway was constructed on a string of islands connected by man-made causeways along the southern rim of the reef.

A total of 23 devices of both fission and thermonuclear types was detonated during 1946, 1954, 1956, and 1958. The islands of Bikini Atoll received fallout from these tests to varying degrees. The largest islands, Bikini and Eneu, located at the Eastern end of the atoll, were generally upwind of the detonation sites and

thus received lesser amounts of fallout debris than some of the other islands. The relative locations of the islands of Bikini Atoll and the test sites are shown in Figure 1 with the number of tests indicated in the circle.

Radiological Surveys. An assessment of the impact of test activities on the environment at Bikini Atoll was begun shortly after the first two detonations were conducted in 1946. Survey teams have revisited the atoll between testing periods and since testing was concluded to obtain samples of marine life, land plants and animals, soil, water and to spot-check the external radiation levels within the atoll. The most recent surveys were conducted in 1964, 1967, and during clean-up operations in 1969.

1964 Survey. The Division of Biology and Medicine, through its contractors, conducted a field survey of the Eniwetok-Bikini Atolls during August of 1964. Ten scientists from the University of Washington, Bowling Green University, and Puerto Rico Nuclear Center, led by Dr. Lauren R. Donaldson of the University of Washington spent two and one half weeks in Eniwetok Atoll, ten days in Bikini Atoll, and two and one-half days at Rongelap Atoll. The purpose of this survey was to assess, in reconnaissance fashion, the conditions with respect to the effects of nuclear tests and related fallout at these islands. This visit to Bikini Atoll produced a sizeable quantity of data on the



NMB 108
2607

radionuclide content of foods (marine and terrestrial) that would be available to a returning population. Measurements of external radiation levels were less extensive. Islands were divided into several measurement areas and readings of gamma and beta-gamma were taken at several locations in each area.

Results of analyses of environmental samples collected in 1964 including analyses for plutonium-239 were published in CONF-670503, Symposium on Radioecology, Proceedings of the Second National Symposium, Ann Arbor, Michigan, May 15-17, 1967, in a report by A. D. Welander entitled "Distribution of Radionuclides in the Environment of Eniwetok and Bikini Atolls, August 1964." The value reported for plutonium-239 in a single soil sample at the 1/2" to 1" depth was 11 pCi/g.

1967 Survey. In December, 1966, the AEC, in responding to a request from the Secretary of the Department of Interior, agreed to make a determination on whether Bikini and its lagoon were safe for continued habitation and whether the Bikinians could have hazard-free use of the resources of the atoll and its adjacent water areas. Subsequently it was determined that the available survey data were not yet complete and that another team visit was needed to conduct a more extensive survey of external radiation levels in Bikini Atoll. Also needed was a determination of the radionuclides that contributed to this radiation field.



NMB 109
2608

[redacted] ONLY

Planning for a major survey effort by the Division of Biology and Medicine began early in 1967. The emphasis was on delineation of the external radiation fields, particularly at locations of past and future habitation, and on obtaining more measurements on all islands, including the smaller islands near test locations. Dr. Edward Held, University of Washington Marine Radiobiologist was appointed survey team leader. Team membership included personnel from AEC (BM, OS, HASL), AEC contractors, U. S. Trust Territory, and the U. S. Naval Radiological Defense Laboratory. Four native workers were added to the team in Kwajalein.

The survey team spent 16 days at the atoll in April-May 1967 conducting an extensive survey of external radiation levels. Except for Adrikon, a very small island in the southwest corner of the atoll, all fourteen islands and the two complexes of islands joined by man-made causeways were surveyed. Seven days were spent with studies on Bikini Island. In addition to monitoring external radiation, samples of food items, vegetation, and soil were collected and analyzed for radionuclide content.

External radiation levels and the radionuclides contributing to those levels were found to vary from island to island. On islands more remote from testing activities such as Eneu and Bikini, the major contributor to the external gamma field is cesium-137. The

[redacted]



NARS 110
2609

levels on Bikini were observed to be highest in the more heavily vegetated interior and lowest along the shore where there has been more weathering. On near test islands, the major contributor to the external gamma field was observed to be cobalt-60. Quantities of scrap metal containing cobalt-60 were found on these islands.

Following the 1967 survey, the next significant step was taken by Dr. Philip F. Gustafson of the Division of Biology and Medicine,* who collected and summarized the data from all past surveys. Included in this material were reports from the Trust Territory District Agriculturist and from the Trust Territory District Anthropologist. Dr. Gustafson prepared estimates of potential exposures, both internal and external, for a returning population having living habits and diet that are expected to apply to the Bikinians. Also prepared were tentative recommendations with regard to the basic question of whether from a radiation exposure viewpoint the Bikinians should be allowed to return.

AEC Review. In April 1968, the Division of Biology and Medicine appointed the following Ad Hoc Committee to consider the question of return of the Bikinians:

John C. Bugher, Former Director BM, retired
Robert A. Conard, Brookhaven National Laboratory
Charles L. Dunham, Chairman, Division of Medical Sciences, NRC, NAS
John H. Harley, Director HASL
S. Allan Lough, Assistant Director for Radiological Physics, BM
John B. Storer, Deputy Director BM
Paul C. Tompkins, Executive Director FRC
Shields Warren, Scientific Director, Cancer Research Institute, New England Deaconess Hospital

*Now at Argonne National Laboratory, Argonne, Illinois, USA

The Committee members reviewed the survey data, Dr. Gustafson's reports, and consulted with the team members of the 1967 survey. Based on this review, the Committee prepared a report stating that, on the basis of information provided, the exposures to radiation that would result from the repatriation of Bikini people do not offer a significant threat to their health and safety. Key recommendations for actions to further reduce exposures included restriction of rehabilitation for the present to the Bikini-Eneu complex, removal of radioactive scrap, reduction of land crab population, a dietary supplement of calcium, and periodic resurveys of the atoll. There were other recommendations for agricultural and village construction activities expected to reduce the radionuclide content of pandanus and reduce external radiation levels in village and dwelling sites. These reports and analyses formed the basis for discussions between various governmental groups, including AEC, the Department of Interior and DOD on rehabilitation and resettlement of Bikini Atoll.

On August 12, 1968, the President announced the decision that the Bikinians were to be returned to their atoll. At the same time AEC issued a press release providing background information relative to the decision and including the Ad Hoc Committee's report. The AEC and Department of Defense (DOD) were requested to work with the Department of Interior in planning and carrying out a comprehensive program for returning the Bikinians to their home islands. To begin

[redacted]

the planning, High Commissioner W. R. Norwood of the Trust Territory of the Pacific Islands led a party of Trust Territory officials, nine Bikini natives, AEC and DOD representatives, and members of the press, back to Bikini in late August, 1968.

1969 Operations and Survey. Cleanup operations commenced at Bikini in February 1969. DOD directed the cleanup phase of the rehabilitation project and this phase was completed in October 1969. DOD and AEC shared the cost of cleanup operations with each agency providing $300,000. AEC provided monitoring support during 1969 cleanup operations including guidance for disposal of scrap material. The vegetation removal operations carried out to provide space for replanting coconut groves also provided access to all parts of Bikini and Eneu Islands so that external radiation levels could be mapped in detail (in 1964 and 1967, heavy vegetation placed a limitation on how much area could be surveyed).

During cleanup operations a significant number of additional samples of foods, vegetation, soil and sediment, and well water were collected. Separate draft reports containing the external radiation measurements and results of analyses of radionuclide content of environmental samples have been received from the Southwestern Radiological Health Laboratory (SWRHL) and from the University of Washington. The SWRHL report contains results of analysis for plutonium-238 and plutonium-239 in soil at two locations on Eneman and the University of Washington report contains

[redacted]

such results for one location on Eneman and two locations on Bikini. Except for plutonium levels in soil, the measurements of environmental radioactivity in these reports confirmed the results of the 1967 survey.

The Department of Interior is presently conducting the agricultural recovery phase of the project and it was recently reported that housing construction is to begin about May of 1970. At present there are approximately 20 native workers and a Trust Territory representative at Bikini Atoll engaged in the agricultural program.

2. Levels of Alpha Emitters in Soil and Air

Bikini Atoll. As reported in Information Paper AEC 604/124 dated March 23, 1970, the levels of plutonium-239 (and plutonium-240) in two soil samples for Bikini Island appear to be about a factor of 10 higher than the level reported for a sample collected in 1964. More recent analyses performed by the Southwestern Radiological Health Laboratory (SWRHL) and the University of Washington have confirmed levels for these two samples analyzed in 1969; samples from other locations on Bikini have proven to be somewhat lower. The values for Bikini Island range from 1.3 to 190 pCi/g, and for Eneu Island, from 0.5 to < 3 pCi/g of soil, as shown in Tables 1 and 2. Previous analyses for Eneman Island, a nearby test island not currently planned for rehabilitation, showed plutonium-239 levels ranging from 83 to 410 pCi/g in surface soil.

[redacted]

[redacted]

Rocky Flats. In order to show possible relationships between soil levels and airborne levels of plutonium-239, data for Rocky Flats and Palomares have been examined. Levels of plutonium-239 in surface soil at 1 to more than 5 miles from the Rocky Flats plant range from 0.05 to 3 pCi/g, with an average of 0.5 pCi/g, as shown in Tables 1 and 3. However, the air monitoring network around Rocky Flats showed average gross alpha activity in airborne particulates at various stations ranging from 0.009 to 0.02 $pCi/m^3$ for the last half of CY 1969, as given in Tables 1 and 6. Assuming the gross alpha activitiy to be entirely plutonium-239, the highest average (Marshall) would be 2% of the Concentration Guide value for individuals in the general public, or 6%, for a suitable sample of the public. Air samples specifically analyzed for plutonium include a single sample taken by Dow in December, 1969, at the east security fence with a level of 0.002 $pCi/m^3$, and six samples taken by the State of Colorado following the RF fire and processed by SWRHL. These latter samples averaged 0.005 $pCi/m^3$, with a range of 0.0001 to 0.02 $pCi/m^3$.

Palomares. Levels of alpha emitters in soil at Palomares following the cleanup operations of surface stripping (area 2-1), plowing, etc., have been reported both by Spanish authorities and by LASL. Background soil levels of gross alpha activity in regions of Spain not affected by the Palomares incident range from 3.9 to 9.5 pCi/g of dry soil and are [redacted]

[redacted]

2614

Wmp 115

pendent on the type of soil, as shown in Table 4. Residual gross alpha activity in surface soil samples taken at Palomares by Spanish authorities in September 1966, approximately 7 months after the incident, ranged from 5.1 to 214 pCi/g. Additional surface samples taken in the same areas and analyzed by LASL for plutonium activitiy had levels ranging from 0.05 to 2,130 pCi/g; areas 2-2 and 3-1 had average plutonium levels of 134 and 156 pCi/g, respectively. These data are presented in Tables 1 and 5. It should be noted that the range of plutonium in surface soil in control areas at Palomares was 0.09-3.6 pCi/g. These areas were selected to be free of plutonium from the incident. This range is comparable to that found at Rocky Flats, viz. 0.05-3.0 pCi/g.

Air samplers to measure gross alpha activity in airborne particulates were set up in the three areas of initial highest deposition, viz. 2-1, 2-2, and 3-2. For these areas, the maximum gross alpha activity for the period 6/66-5/67 ranged from 0.05 to 0.14 pCi/$m^3$, with an average of about 0.003 pCi/$m^3$. These Palomares levels may be compared with background measurements made at Madrid during the same period: a maximum and average gross alpha activity level of 0.16 and 0.004 pCi/$m^3$ in air, respectively. Again, assuming the entire content of the sample to be plutonium, the averages for Palomares and for Madrid would be on the order of 0.2 to 0.4% of the appropriate

Concentration Guide for individuals in the general public, or 0.6 to 1.2%, for a suitable sample of the public.

Thus, the levels of plutonium in the top layer of soil at Rocky Flats and at Palomares have not led to any situations of concern with respect to a possible airborne pathway to man. As discussed in the following section, the situation is expected to be even more favorable with respect to possible airborne plutonium at Bikini.

3. Particle Size in Soil. Determination of the size of individual particles of plutonium oxide or plutonium oxide agglomerated with soil is almost impossible after the particle has reached the earth's surface and become mixed with other particles. It is the opinion of Dr. John Harley, HASL, and Dr. Wright Langham, LASL, that particle size studies of plutonium-bearing soil at Bikini or elsewhere would be unprofitable. Most particle size determinations for studies on plutonium are made on fallout samples collected by cascade impactor or selective filters. A number of particle size determinations were made on samples collected following Project 57 (during Operation PLUMBOB, NTS during 1957) and Operation ROLLER COASTER (Tonopah Test Range, 1963).

A report of particle size determinations on air samples collected by cascade impactors following the Double Tracks event of ROLLER COASTER, indicated particle sizes ranging from 2.5 microns diameter to more than 35 microns diameter. To gain entry into lungs, the plutonium oxide must be in very fine "respirable" particles (i.e., less than 10 microns



02616

in activity median aerodynamic diameter (AMAD) with a density of 1). For a pure plutonium oxide particle of density 11, this would reduce to 2.4 microns diameter, and if the plutonium were adsorbed on other materials so as to give an effective density of 2.5, the relative diameter would be about 5 microns. In a given deposition field these particles are relatively rare, as fine particles are not efficiently deposited from a cloud and tend to be dispersed at large distances with high dilution factors. Once on the ground they tend to become fixed or bound to larger particles by water action. Those remaining on the surface are relatively difficult to resuspend. If plutonium becomes resuspended, the deposition in human lung then becomes a function of the larger size of the carrier soil particles. Approximately 85 percent of all plutonium detected in fallout following ROLLER COASTER experiments was detected on particles above 10 microns in diameter.

Resuspension Factors. Resuspension studies conducted following Project 57, and confirmed by other studies, have shown that once deposited on the ground, the plutonium oxide tends to remain in place and very quickly reaches a vertical distribution in the soil. Daily air concentration measurements for a considerable period of time following an original plutonium deposition indicates that there is an approximately 35 day half-time of reduction for resuspension. Data from Project 57 and from ROLLER COASTER indicate resuspension factors* in the range

*The resuspension factor is the ratio of the air concentration above a contaminated surface (in $\mu g/m^3$) to the surface deposition level (in $\mu g/m^2$).

of $10^{-5}$ to $10^{-7}$. The U. K. made observations on resuspension following the HURRICANE firing (Monte Bello Islands). An average value of $10^{-5}$ was obtained for the resuspension factor at early times after deposition and under conditions when the ground nearby was disturbed mainly by wind and natural turbulence.

The results of trials in the Australian desert indicate the effect of very arid conditions, where a mean value of $10^{-7}$ was measured. A decrease in the resuspension value was observed between 4 and 7 days following the test, suggesting a dilution by mixing of the deposited activity within the top layers of soil. It was estimated that mixing in the top layer of dry Australian desert provided a dilution factor of at least $10^{6}$ per millimeter depth.

Limited studies have been made on the possible enhancement of resuspension by mechanical means. The results suggest that vehicular traffic may increase normal resuspension by not more than an order of magnitude, if at all.

Penetration of plutonium oxide in Nevada soil is largely confined to the top 1 1/2 inches. However, in Bikini soil, penetration of plutonium was observed to a depth of 9 inches (the deepest sample analyzed). This latter is undoubtedly due to the type of soil, the constant high humidity in the area, and the many years of soil weathering.



2618 WmB 1/19

It should be noted that particles collected in close-in early fallout from a nuclear detonation, such as those during atmospheric nuclear testing, contain multiple radionuclides including small amounts of plutonium. Fallout particles from near surface detonations tend to be of larger size (10 to > 100 microns) than particles from airbursts (1 to 3 microns). Most of the tests at Bikini were at or near surface bursts.

Fallout particles from different portions of the cloud from a surface detonation contain different ratios of radionuclides due to fractionation. For example, samples collected from a dust column within a few minutes after detonation are depleted with respect to volatile isotopes as well as isotopes having volatile or gaseous precursors. Samples collected from clouds at 70 to 80 kilometers from the detonation are enriched by isotopes having gaseous precursors.

4. Dose to Lung Received From Pu-239 Contaminated Areas. It is difficult but not impossible to predict lung doses resulting from continuous occupancy of plutonium contaminated areas. Plutonium at Bikini is most likely to be in the oxide form and relatively insoluble. If values for resuspension (including reduction with time), air attentuation and particle size obtained from field tests are used along with para-

meters to describe lung deposition, retention, and clearance presented in the ICRP Task Group Report on Lung Dynamics, the average dose to the lung can be calculated for recently deposited nuclides. (Table 7)

Lung doses calculated for adults probably are also valid for children because the relatively long equilibrium time and smaller breathing volume offset the smaller mass of the lungs and possible increase in radiosensitivity.

Plutonium translocates to other tissues such as bone and liver following initial deposition in the lung. The total lifetime accumulated radiation dose to bone or liver is less than that received by the lung.

Ingestion of plutonium is considered to be of much less importance than inhalation mainly because of the small absorption from the gastrointestinal tract (0.003%). Absorption of plutonium through unbroken skin and skin exposure are negligible.

The number of particles comprising the contamination should also be considered. For example, an activity of 1 picocurie of $^{239}Pu$ per gram of soil, in which all the activity is on the surface, represents only about 4 one-micron diameter particles of $^{239}PuO_2$, or about $4 \times 10^4$ particles per square meter. Thus, areas uniformly contaminated with

100 picocuries per $cm^2$ would contain about $4 \times 10^6$ particles per square meter. If all of these particles were on the soil surface and therefore available for resuspension, there would be initially only 4 particles per cubic meter of air for a resuspension factor (RF) value of $10^{-6}$. This air concentration would decrease exponentially with a half-life of around 30-40 days as the particles remaining on the soil surface become less available for resuspension.

The Concentration Guide for continuous inhalation of $^{239}Pu$ is 1 $pCi/m^3$ (averaged over one year for the individual in the population). Thus, initial ground concentrations of 100 picocuries per gram (assuming a gram per $cm^2$ of surface) may be taken to correspond to a deposition of $10^6$ pCi per square meter. For a RF value of $10^{-6}$, the initial air concentration would be 1 pCi per cubic meter. This value would decrease as a function of time because the plutonium becomes less available for resuspension.

Based on the highest reported plutonium level at Bikini Island, 190 pCi/g, and assuming this plutonium to be recently deposited and on the surface, a conservative estimate is that the total lifetime dose to the lung would not exceed 70 millirads.

5. Other Data. A brief verbal report was obtained April 6 from Dr. Robert Conard of Brookhaven National Laboratory who has just returned from conducting another in the series of medical studies for the natives

at Rongelap Atoll. Dr. Conard spent several hours at Eneu Island in Bikini Atoll on this trip. He obtained a pooled urine sample from those on Eneu (about 20 individuals) who had been working there for about two months.

The packaged sample was expected to arrive the week of April 6. Dr. Conard stated that this sample will be forwarded to the Health and Safety Laboratory for analysis to include a determination of plutonium-239 content.

6. Resurvey Plans. The staff considers it prudent to plan another field trip to Bikini Atoll to increase the number of available soil samples and to obtain airborne particulate samples for plutonium analysis. It appears feasible to conduct such a survey prior to the beginning of the rainy season which starts about the middle of June. The beginning of the rainy season poses a time limitation if the field trip is to be conducted before late summer.

The following course of action has been proposed:

a. Planning meeting in NV between staff of NV, HQ, University of Washington, SWRHL, and HASL.

(1) Review available data on plutonium in soil at Bikini Atoll.

(2) Develop plan for field trip to collect addition soil samples, to collect air filter samples, and to monitor scrap metal collected by the natives.

b. HQ and NV staff meeting with Trust Territory staff.

c. Followup meeting at NV.

(1) Review Trust Territory response.

(2) Finalize field trip plans.

d. Field trip to Bikini Atoll.

e. Sample analysis and evaluation.

f. Finalize 1969 survey reports.

g. Reevaluate Bikini situation if needed.

7. Meeting with Trust Territory Representatives. It is considered essential to brief Trust Territory officials of the purpose of the presently proposed field trip and to coordinate plans with them. It appears prudent to discuss the 1969 findings and the need for more data on alpha emitters in soil and air to complement the data on beta and gamma emitters. Also, plans for continuing monitoring over the next several years should be discussed.

Dr. Conard reported that the Bikini workers are collecting scrap metal which they intend to sell. He informed the Trust Territory representative on Eneu that he would inquire whether AEC wanted to monitor this material before it is taken from the atoll. The draft SWRHL report entitled "Report of the Radiological Cleanup of Bikini Atoll" states that "All scrap metal or concrete with contact readings greater than 100 micro-R per hour (μR/hr) was treated as radioactive



2623
NMB 124

waste and buried at sea." Even so, scrap may be found buried underground or underwater showing levels this high or higher. It is suggested that provisions be made to monitor the collected scrap during the field trip.

Guidance on contamination and radiation levels developed by AEC staff for "Sale, Abandonment, or Destruction of Personal Property" could be used for approval of sale of scrap. Trust Territory officials should be informed that scrap metals must be monitored before sale to insure that an item containing radioactivity above acceptable levels is not salvaged for reuse. If this approach is acceptable, provisions could be made for monitoring scrap collected in a timely manner in order to allow Bikinians to benefit from sale of this property.

The High Commissioner of the Trust Territory has recently asked whether their earlier question regarding use of the Peter-Oboe-Tare complex in the agricultural rehabilitation program can now be answered. AEC had given an interim reply on July 2, 1969, that if the radiation and radioactivity levels in this area were comparable with those on Eneu and Bikini, it would be in order to review the position of the 1968 Ad Hoc Committee. This question will likely be raised when Trust Territory officials are informed of the team visit. A statement on this question should be developed for use in that meeting if by that time a formal answer has not been given.

The tentative agenda for a meeting with Trust Territory representatives prior to the Bikini field trip includes discussion of:

a. 1969 survey results

b. 1970 field trip

c. Future monitoring programs

d. Scrap metal survey

e. Peter-Oboe-Tare disposition

8. Release of Reports. A report of the results of the 1964 survey was published in CONF-670503 Symposium on Radioecology, Proceedings of the Second National Symposium Ann Arbor, Michigan, May 15-17, 1967, "Distribution of Radionuclides in the Environment of Eniwetok and Bikini Atolls, August 1964," A. D. Welander, College of Fisheries, University of Washington, Seattle. Certain results of the 1967 survey were published in the Health and Safety Laboratory Report HASL-190, "External Radiation Levels on Bikini Atoll - May 1967"

The report of the Ad Hoc Committee appointed in 1968 was part of the Chairman's News Release of August 12, 1968, that discussed AEC's role in President Johnson's decision to return the atoll to the Bikinians. This news release advised the public that additional reports and analyses on the environmental survey of 1967 were available in the AEC H Street Office Public Document Room. The draft reports on radiological aspects



2625
WMB 126

of the 1969 Bikini cleanup operation have been submitted to AEC by SWRHL and the University of Washington for review and disposition. Additional analyses are being performed on soil samples taken during the 1967 and 1969 surveys. It is planned to require that these additional analyses be added to the reports. Reports from the 1970 survey could be added, if the same NV contractors participate, or could be reported separately. Combining 1969 and 1970 survey results in single reports might delay issuance of presently available information by 6 months or longer. Despite the delay, the staff favors combining the data in order to present a more comprehensive picture of radiological conditions at Bikini Atoll.

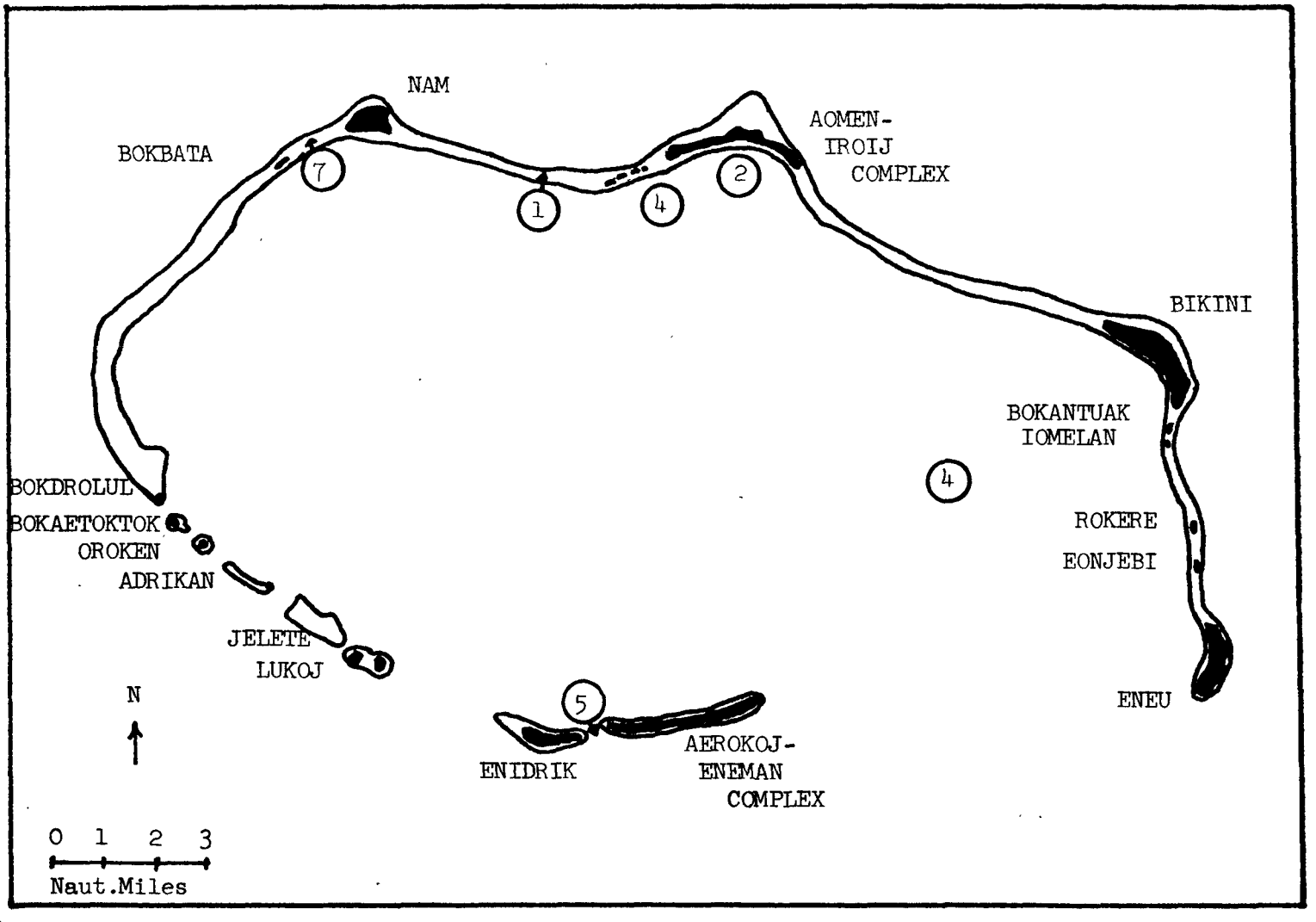



Figure 1. Bikini Atoll

TABLE 1

| Location | Area | $^{239}$Pu in Soil (pCi/g) | Gross $\alpha$ in Soil (pCi/g) | Area: | Average Gross $\alpha$ in Air (pCi/M$^3$) |
|---|---|---|---|---|---|
| Bikini I | Well #1 | 130-190 | | | |
| | Well #2 | 25-30 | | | |
| | Well #3 | 107-150 | | | |
| | Pit #1 | 5.1 | | | |
| | Pit #5 | 1.3 | | | |
| | Pit #6 | 39 | | | |
| | 1964 sample | 11 | | | |
| Eneu I. | Camp Blandy | 0.5 | | | |
| | " " | <3 | | | |
| Rocky Flats | 1 mile Distance | 0.55-1.8 | | Coal Creek | 0.009 |
| | 2 mile Distance | 0.2-3.0 | | Marshall | 0.020 |
| | 5 " " | 0.2-1.5 | | Boulder | 0.009 |
| | > 5 " " | 0.05-0.3 | | Lafayette | 0.009 |
| | | | | Broomfield | 0.012 |
| | | | | Wagner Sta. | 0.008 |
| | | | | Golden | 0.010 |
| | | | | Denver | 0.010 |
| | | | | Westminster | 0.012 |
| Palomares | 2-1* | 0.09-16.8 | 5.1 | 2-1 | 0.002 |
| | 2-2 | 2.7-450 | 214 | 2-2 | 0.004 |
| | 2-3B (control) | 1.4-3.6 | 11.4 | | |
| | 3-1 | 0.3-2.130 | 11.2 | | |
| | 3-2 | 0.5-253 | 97.8 | 3-2 | 0.002 |
| | 5-1 | 0.4-4.5 | 22.1 | | |
| | 5-2 | 0.05-4.1 | 6.2 | | |
| | 5-3B (control) | 0.09-1.8 | 9.1 | | |

* 2" of soil removed during cleanup

TABLE 2

$^{239}$Pu Levels in Soil (Top Layer) - Single Samples

| Location | | Date Sample Taken: | Date of Analysis: | Depth of Sample: | 239 Pu Level: (pCi/g dry) | Analysis Laboratory |
|---|---|---|---|---|---|---|
| Bikini Island | Well #1 | 1969 | 1970 | 0-1" | 190 | SWRHL |
| | | | 1969 | 0-1" | 130/130* | U. of Wash. |
| | Well #2 | 1969 | 1970 | 0-1" | 30 | SWRHL |
| | " | | 1970 | 0-1" | 25 (prelim) | U. of Wash. |
| | Well #3 | 1969 | 1970 | 0-1" | 150 | SWRHL |
| | " | | 1969 | 0-1" | 115/107* | U. of Wash. |
| | Pit #1 | 1967 | 1970 | 0-1" | 5.1 | SWRHL |
| | Pit #5 | 1967 | 1970 | 0-1" | 1.3 | SWRHL |
| | Pit #6 | 1967 | 1970 | 0-1" | 39 | SWRHL |
| | - | 1964 | 1964 | 1/2"-1" | 11 | U. of Wash. |
| Eneu Island | Camp Blandy Area | 1969 | 1970 | 0-1" | 0.5 | SWRHL |
| | | 1969 | 1970 | 0-1" | < 3 | U. of Wash |

*duplicate analyses

TABLE 3

Rocky Flats - $^{239}Pu$ Levels in Soil (Surface)

| Distance from plant (miles): | Date Samples Taken: | No. of Samples | $^{239}Pu$ Level (pCi/g dry) Range: | Average: |
|---|---|---|---|---|
| 1 | 1969 | 11 | 0.55-1.8 | 0.9 |
| 2 | " | 21 | 0.2-3.0 | 0.6 |
| 5 | " | 16 | 0.2-1.5 | 0.5 |
| > 5 | " | 14 | 0.05-0.3 | 0.09 |

TABLE 4

Gross Alpha Activity of Several Types of Soil in Spain

| Province | Type of Soil | Gross Alpha Activity (pCi/g/dry) |
|---|---|---|
| Palomares (Almeria) | 2-3B Gypsum Burlap | 9.5 |
| | 5-3B Gypsum Burlap | 8.9 |
| Oviedo | Calcarenite | 5.0 |
| Madrid | Akroses | 5.7 |
| Murcia | Marl | 4.9 |
| Badajoz | Sandstone | 3.9 |
| Coruna | Granites | 7.8 |
| Tenerife | Volcanic rock | 8.4 |



2630
NMB/31

TABLE 5

Residual Gross Alpha Activity - Palomares - 1966 Samples

Post Cleanup - Surface layer of Soil (0-2")

| Area | Gross Alpha* Activity (pCi/g dry) | Plutonium Activity** (pCi/g dry) Range: | Average: | Comment |
|---|---|---|---|---|
| 2-1 | 5.1 | 0.09-16.8 | 2.5 | 2" of Soil removed during cleanup |
| 2-2 | 214 | 2.7-450 | 134 | |
| 2-3B | 11.1 | 1.4-3.6 | 1.3 | Control area believed to be Pu free |
| 3-1 | 11.2 | 0.3-2 130 | 156 | |
| 3-2 | 97.8 | 0.5-253 | 34.1 | |
| 5-1 | 22.1 | 0.4-4.5 | 1.4 | |
| 5-2 | 6.2 | 0.05-4.1 | 0.9 | |
| 5-3B | 9.1 | 0.09-1.8 | 0.9 | Control area believed to be Pu free |

*Samples taken by Junta de Energia Nuclear, Madrid

**Samples taken by LASL for chemical analysis



2631

NMB 132

TABLE 6

Gross Alpha Activity in Airborne Particulates

| Location | Area | Inclusive Dates: | Gross Alpha ($pCi/M^3$) Max. | Average |
|---|---|---|---|---|
| Palomares | 2-1 | 6/66-5/67 | 0.05 | 0.002 |
| | 2-2 | " | 0.14 | 0.004 |
| | 3-2 | " | 0.07 | 0.002 |
| Madrid | | " | 0.16 | 0.004 |
| Rocky Flats | Coal Creek | 7/69-12/69 | | 0.009 |
| | Marshall | " | | 0.020 |
| | Boulder | " | | 0.009 |
| | Lafayette | " | | 0.009 |
| | Broomfield | " | | 0.012 |
| | Wagner Station | " | | 0.008 |
| | Golden | " | | 0.010 |
| | Denver | " | | 0.010 |
| | Westminster | " | | 0.012 |



2632

NwB 133

TABLE 7

Total Lung Dose From Lifetime Occupancy of $^{239}PuO_2$ Contaminated Areas

| Initial Surface Contamination (micrograms/$m^2$) | Initial Surface Contamination ($pCi/cm^2$) | Total Lifetime Lung Dose (rads) |
|---|---|---|
| 1 | 6.2 | .0023 |
| 10 | 62 | .023 |
| 100 | 620 | .23 |
| 1,000 | 6,200 | 2.3 |
| 10,000 | 62,000 | 23 |

[redacted]

2633
WMS 134