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July 24, 1981

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Mr. T. F. McCraw
Division of Health and Environmental Research
U.S. Department of Energy
Washington, DC 20545

Dear Tommy:

This letter is in response to the requests made during our phone conversations of July 10 and 13, 1981. These were:

1. Determine what was told or reported to the Rongelap people concerning use of the northern islands of Rongelap Atoll. Use trip reports, BNL publications, log books and personal communications.
2. Determine what use can be made of the northern islands in the future.

To answer the first issue, discussions were conducted with Bob Conard, Vic Bond, Bill Scott, Allyn Seymour, Tony Greenhouse, and Lauren Donaldson. Many of these persons were mentioned in the first discussion with Bob Conard. Other names were given during discussions with these people. In addition, trip reports, field notebooks, BNL reports, and other documentation were used. The second issue required an analysis of past and current external exposure rate data, followed by internal and external dose equivalent projections. Each issue is addressed in a separate summary.

Summary of Past Use of the Northern Islands of Rongelap Atoll

Over the years since their resettlement in 1957, Bob Conard has participated in numerous discussions with the Rongelap people. He recalls questions asked by the people concerning land use and food items from the northern islands that were restricted. Questions concerning land use were directed to Ed Held from the University of Washington. Ed had been involved in early environmental studies on Rongelap and had been there during several medical team visits. From 1974 on, and until recently, environmental questions were directed to Tony Greenhouse, of the BNL Safety and Environmental Protection Division. Dr. Conard reported that the BNL medical team primarily was responsible for development and declaration of food restrictions. He indicated that the eating of coconut crab (*Birgus Latro*) was forbidden, if the crab was gathered from any island of Rongelap Atoll. During the late 1960's or early 1970's

this restriction was revised so that it applied only to crab gathered from the northern islands of Rongelap Atoll. Dr. Conard indicated Ed Held, John Harley, Ed Hardy, Stan Cohn and Vic Bond may possess additional information on the very early restrictions.

Bill Scott was present during many discussions between the people of Rongelap, Dr. Conard and other principal investigators of the BNL Medical Department. In general he recalls that land use questions were directed to Ed Held or Tony Greenhouse. He suggested that the restriction placed on eating coconut crab may have been stated as "do not gather land crabs from the northern islands". He remembered in particular that Thomas Bella of Rongelap asked Tony Greenhouse about the use of particular islands on the northern part of the atoll. Scott connected Bella's many questions with his ownership of these islands. While Scott's recollection of details of their conversation is sketchy, he thought they centered around use of the islands in question as a total food source (pandanus, coconuts, land crabs, fishing, etc.).

Tony Greenhouse recalls an involved conversation with Bella but does not remember the details. He felt travel by Rongelap people to the northern islands was unlikely because it was an exhausting trip. Therefore, his advice to them was that persons who venture north should refrain from bringing crabs back. However, during an expedition if a person was hungry, then a crab could be eaten occasionally. Tony also said that he told the Rongelap people not to use the northern islands for year-round habitation. Tony indicated his notebooks do not contain any references to such restrictions.

Dr. Bond recalls the promulgation of such a recommendation to restrict land crab consumption. However, he also recalls some indication that this recommendation was widely ignored. He does not recall any other specific suggestions or recommendations.

In discussions with Jan Naidu, Allyn Seymour and Lauren Donaldson indicated that restrictions had been recommended by the environmental team which visited Rongelap Island in the late 1950s. They explained to the people of Rongelap that the northern islands of their atoll were "radioactively hot" and therefore off limits to habitation and to the taking of coconut crab. Seymour recalls that Gordon Dunning, a health physicist, was responsible for making statements concerning diet restrictions and permissible activities at Rongelap. Dr. Charles Dunham had given Dunning this responsibility. Written statements concerning levels of radioactivity in food items might be found in the archives of records for the University of Washington's Laboratory of Radiation Ecology. Efforts to contact other persons mentioned previously have not been successful to date.

Six reports implying the existence of restrictions were located. They are:

1. Report Of The Repatriation Of The Rongelap People, 1957, Holmes and Narver, Inc. pages 1-29 and 1-30.
2. Conard, R.A. et.al., 1959, Medical Survey Of Rongelap People, March 1958, Four Years After Exposure To Fallout, BNL 534 page 8.

3. Conard, R.A., et.al., 1960, Medical Survey Of Rongelap People Five and Six Years After Exposure To Fallout, BNL 609, pages 6 and 14.
4. Conard, R.A., et.al., 1967, Medical Survey Of The People Of Rongelap and Utirik Islands Eleven And Twelve Years After Exposure To Fallout Radiation (March 1965 and March 1966), BNL 50029, pages 63 and 64.
5. Larsen, C. Acting Chairman of the United States Atomic Energy Commission, 1973, Letter to Honorable Olympio T. Borja Chairman, Special Joint Committee Concerning Rongelap and Utirik, Congress of Micronesia, dated August 21, 1973.
6. Conard, R.A., 1975, A Twenty Year Review Of Medical Findings In a Marshallese Population Accidentally Exposed To Radioactive Fallout, BNL 50424, pages 96 and 97.

Copies of the pertinent sections of these references are enclosed for your further examination. Each reference refers specifically to restriction on eating coconut crab. In my search through the reports, I could not locate any other type of written recommendation such as not residing on the northern islands of Rongelap Atoll. One reference, Conard 1975, states that there are no restrictions on "moving into these islands". However, I assume the statement applies to moving onto Rongelap and Utirik Islands, and not specifically to the northern islands of Rongelap Atoll.

Summary of Future Use of the Northern Islands of Rongelap Atoll

Current external exposure rates at each island were estimated on the assumption of a subsiding exposure rate, the reasons for which are as follows. Redistribution of fallout has occurred due to erosion of soil, weathering and vertical movement of fallout through the soil. Weather data and exposure rate history curves indicate that weathering was responsible for an initial rapid decline of exposure rate levels for periods of a few years following deposition of fallout. A similar short term rapid reduction was observed on soils that bordered land and water e.g. intertidal zones. However, the observed vertical movement of fallout through the soils of Rongelap Atoll was not rapid (He 65). Over the past several years, the exponent associated with the observed exposure rate reduction has had a value very close to that solely associated with radioactive decay (-1.0 versus -1.2). This is true for Rongelap Island (Le 80) when the declining exposure rate is referenced to March 1, 1954.

In Table 1 a summary of exposure rates at the islands of Rongelap Atoll are presented. The estimated July 1981 values are extrapolated from the 23.2 year or 24 year post Bravo measurement and an exposure rate reduction exponent of -1.0. Natural background exposure rate may be taken as 3.7×10^{-6} Roentgens per hour (Gr 77).

Recent data for the islands of Yugui, Gabelle, Labaredj and Gejin are not available at this time. An interpolation estimate was made for the July 1981 exposure rate for these islands.

These July 1981 exposure rate estimates indicate that all of the islands of Rongelap Atoll could be inhabited year-round, if there were no contribution to dose from internal sources. The islands of Gejin, Naen, Kabelle, Aerik and Yugui have estimated exposure rates similar to those of Bikini Island in 1975 (Gr 79). The 10 year net external integrated dose equivalent is estimated to be less than 2.2 rem for any full time inhabitant of these islands. The 10 year net external integrated dose equivalent for all other islands at Rongelap Atoll is estimated to be less than 0.25 rem.

Significant internal dose equivalent could arise from the coconut food product and coconut crab dietary pathways. An adult who ingested an average of 100 grams per week (Du 57) of northern island coconut crab would have incurred a dose equivalent commitment from Cs-137 and Sr-90 of 15 mrem to red marrow and 5 mrem to the total body during the year April 1978 to April 1979 (Le 81). In the future, this dose equivalent commitment from crab intake will decline as the radioactivity content of crab declines with time. At least a three fold decrease in the annual dose equivalent commitment could be expected every 20 years if the crab population were not reduced by harvesting.

Coconut tree products from Rongelap Island were obtained in April 1978 and the results are presented in Table 2. In addition a ratio of exposure rate to coconut activity per unit mass for Cs-137 is shown in Table 2. This ratio leads to calculated 1981 coconut activity per unit mass estimates as listed. Other studies indicate a one to one ratio between the wet activity per unit mass of coconut meat and coconut fluid (NVO-140). The BNL measurements are based on a small sample size (12 fruits) and this could account for the difference. However, a similar ratio is obtained with data from UW 55.

According to Na 80, the adult coconut product intake could be as much as 380 kilograms per year of coconut milk, 390 kilograms per year of coconut meat, and 140 kilograms per year of coconut sap. These quantities are for a person consuming only locally available food.

Based on this product intake, the adult Cs-137 activity intake from the ingestion of coconut products was determined for a 10 year period post July 1981. The total Cs-137 and Sr-90 intake from coconut crab was also determined for this same 10 year period. These estimates take into account the decline in Sr-90 and Cs-137 activity in these food products with time. In order to calculate the intake by an adult, the coconut sap Cs-137 per unit mass was assumed to equal the coconut milk Cs-137 per unit mass value. This is approximately an average of the relationship between sap and milk reported by Ro 81 and by Le 80. For example, the total Cs-137 intake on Naen Island from the ingestion of coconut products and crab over a 10 year period is estimated to be 160 μ Ci. The total Sr-90 at Naen from the ingestion of crab is estimated to be 0.28 μ Ci. A total intake of Cs-137 and Sr-90 was calculated for each island of the atoll.

From the intake data, an estimate of future dose equivalent commitment was determined. The results are shown in Table 3. For each island four assumptions were made: 1) all food eaten is indigenous, 2) the quantity of food eaten is that suggested for a person in a type A community (Na 81), 3) coconut products and coconut crab are the major internal dose pathways, and 4)

the person lives on the island from July 1981 up to July 1991. The first three assumptions are reasonable. The fourth assumption will in most cases overestimate the time spent on the northern islands away from Rongelap the main island of the atoll. According to Na 81, a person typically spends several weeks per year visiting the other islands of Rongelap Atoll. These dose estimates indicate a person should be restricted from year-round subsistence on food from several northern islands, if one follows the recommended dose limits of ICRP 26. Although the significant figures in Table 3 are shown out to two places, these estimates are considered accurate only to one significant figure due to the wide variation of biological and dietary information.

Conclusions and Recommendations

From the data and the literature which have been examined, it can be concluded that restrictions concerning the eating of coconut crab from all islands of Rongelap Atoll have been recommended by various authorities to the Rongelap people from time to time. Additionally, very limited habitation of and subsistence from the northern islands had been recommended by knowledgeable persons who visited the island of Rongelap in the past.

Based on the data available to us, future use of Lomuila, Rongelap, Eniaetak, Gabelle, and Labaredj Islands should be unrestricted. Future gathering and eating of coconut crab from all islands of Rongelap Atoll should be unrestricted.

Dose estimates for Naen, Gejin, Kabelle, Yugui and Aerik indicate the potential for greater than 500 mrem per year for red-marrow or whole-body dose-equivalent commitment over the next 10 year period, thus further analysis is recommended. The analysis should determine the amount of coconut presently available on these islands and the mean exposure rate. It should be possible to determine this from results of the 13 atoll survey. If the analysis indicates a person could subsist on a community A type (Na 81) diet of island grown coconuts and coconut tree products, then a diet primarily made up of imported food should be required for any full time residents of these islands. From our data on Naen, the island with largest residual activity, a person can presently subsist four months a year from locally grown food and still remain below the ICRP 26 dose limit. Cultivation of coconut trees for future copra production on these islands should be possible now, since a seven year delay will occur before the coconut palms begin to bear fruit.

I hope this information is complete enough for your needs. Should you require further details, I will be pleased to attempt to provide them.

Best regards,

Edward T Lessard

Edward T. Lessard
Marshall Islands Radiological
Safety Program Director

ETL/slg:54

Attachment

cc: B. Wachholz

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- Le 81 Lessard, E.T., 1981, Draft Letter to Tommy McCraw, dated February 26, 1981.
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Radiobiological Resurvey of Rongelap and Ailinginae Atolls, Marshall Islands,
October-November 1955, UWFL-43.

TABLE ONE.

Average Rongelap Exposure Rate History (He 65, Gr 77, Mi 78).

Röntgens Per Hour

Island	Date 1 day Post March 1, 1954	5.5 yrs. Post March 1, 1954	23.2 yrs. Post March 1, 1954	24 yrs. Post March 1, 1954	Estimated for July 1, 1981 27.3 yrs. Post March 1, 1954
Naen	-----	0.18	0.000043	-----	0.000037
Lomuilal	35	0.16	-----	0.000007	0.000006
Aerik	-----	0.09	-----	0.000017	0.000015
Gejin	30	0.13	-----	-----	0.00004
Kabelle	19	0.07	0.000022	-----	0.00002
Labaredj	13	0.05	-----	-----	0.000008
Gabelle	-----	0.05	-----	-----	0.000008
Eniaetok	8.5	0.05	0.0000099	-----	0.0000084
Rongelap	3.5	0.02	0.0000073	-----	0.0000062
Yugui	-----	0.10	-----	-----	0.00002

TABLE TWO

Average Coconut Product Cs-137 Activity Per Unit Mass

Island	Estimated* p Ci g ⁻¹ wet JULY 1981		Measured p Ci g ⁻¹ wet (DATE)	
	Coconut Meat	Coconut Milk	Coconut Meat	Coconut Milk
Naen	13	22	-----	-----
Lomuilal	2.1	3.5	-----	-----
Aerik	5.3	8.9	-----	-----
Gejin	14	24	54 (1-55)**	49 (1-55)**
Kabelle	7	10	39 (10-55)**	50 (10-55)**
Labaredj	3	5	28 (10-55)**	50 (10-55)**
Gagelle	3	5	-----	-----
Eniaetok	3	5	5.3 (4-75)***	1.0 (4-75)***
Rongelap	2.2	3.7	2.5 (4-78)	4.2 (4-78)
Yugui	7	10	-----	-----

* Based on 8-12 month old coconut fruit gathered in April 1978 from Rongelap Island:

Coconut Meat - 0.35 p Ci g⁻¹ μ R⁻¹ h
Ratio

Coconut Fluid - 0.59 p Ci g⁻¹ μ R⁻¹ h
Ratio

** UW 55

*** Gr 77

TABLE THREE

Adult Ten-Year Dose-Equivalent Commitment Estimate

Post July 1981 At Various Islands of

Rongelap Atoll

Island	Net Internal*, rem		Net External, rem		Total**, rem	
	Total Body	Bone Marrow	Total Body	Bone Marrow	Total Body	Bone Marrow
Naen	7.9	11	2.0	2.0	9.9	13
Lomuila	1.4	2.3	0.13	0.13	1.5	2.4
Aerik	3.3	5.1	0.67	0.67	4.0	5.8
Gejin	6.0	9.2	2.2	2.2	8.8	11
Kabelle	3.9	6.0	1.0	1.0	4.9	7.0
Labaredj	1.8	2.8	0.25	0.25	2.1	3.1
Gabelle	1.8	2.8	0.25	0.25	2.1	3.1
Eniaetok	1.8	2.8	0.27	0.27	2.1	3.1
Rongelap	1.5	2.4	0.15	0.15	1.7	2.6
Yugui	3.9	5.9	1.0	1.0	4.9	6.9

* Coconut products and coconut crab obtained from the island year round, no imported foods in the diet, type A consumption (Na 81) and 10-year habitation.

** Natural background internal and external dose equivalent not included.

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REPORT

OF

REPATRIATION OF THE RONGELAP PEOPLE

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TOTAL 30

November 1957

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HOMeward BOUND

While construction was still in progress, plans for implementing Phase II - the actual return of the natives - were being firmed. On 22 May 1957 the AEC Branch Chief at ENIWETOK requested the High Commissioner of Trust Territories to furnish the following information:

1. Separate lists of natives who would board the LST at EJIT and EBEYE upon completion of the construction.
2. List of Trust Territory personnel would accompany the natives from above locations and transportation requirements for return of Trust Territory personnel to MAJURO and KWAJALEIN Atolls.
3. Medical facilities required for the natives during the trip.
4. The name of the Trust Territory representatives empowered with authority to accept all facilities and structures for Trust Territories Government in accordance with agreements; these representatives were requested to arrive at RONGELAP approximately four days prior to completion of construction.

On 24 May 1957 the Department of Interior issued a press release with text as follows:

"RONGELAP people to return to their homes in the Trust Territory of the Pacific Islands.

"Plans are being made for the return of the RONGELAP people who

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were exposed to fallout during the nuclear experiments at the U. S. Atomic Energy Commission's ENIWETOK Proving Ground in March, 1954 to their home atoll in the Marshall Islands in about two months, the Department of the Interior announced today.

"The plans are being made as a result of information from the Atomic Energy Commission that the people may be returned to RONGELAP. The Commission has advised the Department that it has carefully evaluated data from several radiological surveys made during the past two and one-half years. The results of the latest survey indicate the presence of residual radioactivity at a level that is acceptable from a health point of view, both as regards the potential external gamma radiation exposure and Strontium-90 in the food supply, with the possible exception of land crabs. The RONGELAP inhabitants will be advised not to eat land crabs pending the results of future radiological surveys. Land crabs are not a major item of their normal diet.

"Eighty-two RONGELAP inhabitants were removed from their home atoll following the fallout that occurred after the March 1, 1954, nuclear test at the ENIWETOK Proving Grounds. They remained on KWAJALEIN until June, 1954, when they were moved to a village constructed for them on EJIT Island in the MAJURO Atoll.

1954 154
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**MEDICAL SURVEY OF RONGELAP PEOPLE MARCH 1954
FOUR YEARS AFTER EXPOSURE TO FALLOUT**

**LENNY A. CONRAD, M.D., JAMES S. ROBERTSON, M.D., Ph.D., LEO M. MYER, M.D.,
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RUSSELL K. CARYER, AND DAVID W. FOSTER**



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data on these counts as well as considerable medical equipment were lost in the Pacific Ocean when the cargo had to be jettisoned from a plane which developed engine trouble. A return trip to Rongelap Island was made two months later (May 1958), and about 100 Rongelap people were again counted in the steel room. Details of the procedures used and the results will be described below.

FINDINGS

Living Conditions

During the past year the Rongelap inhabitants have become well adjusted to life in their new village, which was completely rebuilt, with well constructed houses far superior to the old ones. An interesting sidelight is that some of the people, particularly the older ones, prefer to live beneath their houses, probably because it is cooler and they prefer not to climb the steps.

During the 8 months since the people returned, copra production was being satisfactorily re-established, but it had not reached full capacity. The establishment of an agricultural program was proceeding disappointingly slowly. At this writing it is understood that the Trust Territory is sending a full-time agriculturist to implement this program.

Adequate water is available on Rongelap from the concrete water catchment cisterns from the roofs of nearly all the houses. Flies are quite prevalent. Most of the people still cook outdoors rather than in the screened cook-houses built for them. Scraps of food around the cooking area probably predispose toward flies. The screened-in latrines are a big improvement, and it is hoped that the children will make greater use of them. This point has been emphasized to the people in order that intestinal parasites may be better controlled. The island is heavily infested with rats and some sort of extermination program is indicated.

The diet is extremely limited in variety, although caloric intake appears to be adequate. The chief source of carbohydrate is rice and a small amount of flour. Protein is derived largely from fish with an occasional supplement of canned meat. The fat intake is mostly from coconut meat. Vitamins are obtained mainly from coconuts, pandanus (when available), and fish. In view of the importance of diet in relation to certain puzzling clinical laboratory findings, the following more detailed information is presented.

Fish is the main source of protein. It is eaten fresh, dried, or salted, several times weekly and

frequently daily. A great deal more is eaten fresh than otherwise. The liver is included. Among **canned meats**, corned beef is well liked as well as salmon and sardines. About one can (perhaps two) is eaten weekly per person. **Other meats** include pigs and chickens which run loose on the island and are eaten on rare occasions. **Clams** (particularly the giant clams) are eaten when they can be found; however, they are not plentiful now. Land crabs are considered a delicacy, but eating them is forbidden at this time because of their high Sr⁹⁰ level. (This is the only forbidden dietary item.)

Local plant products. **Coconuts** are an important item of the diet, eaten green or ripe. About three green coconuts per day are consumed per person, both milk and meat. Ripe coconut is eaten with meals either as such or grated onto rice and fish. **Pandanus** is available during the summer and fall. The fruit is eaten raw by sucking the sweet juice from the fibrous segments. The juice is also squeezed out and used to flavor arrow root flour and to make a candy known as "jenkum." This fruit is probably a major source of vitamin A and possibly C. **Arrowroot** is grated to form a starchy flour, which is cooked into a mushy, tapioca-like material. It is available principally in the winter months. **Breadfruit**, a starchy fruit, is not abundant on Rongelap but is eaten when available. **Rice, salt, sugar, flour, tea, and canned meats** are imported. Rice is a mainstay eaten three times a day. Sugar is used to sweeten tea. A little salt is used in cooking rice and bread, but is usually in short supply and is rarely used on prepared food. Bread and pancakes are frequently eaten.

Interval Medical History

The general health of the Rongelapese has been good during this past year. Six children (4 exposed and 2 unexposed) presumably had infectious hepatitis during November and December 1957. No other major epidemics or diseases were reported. Abdominal pain and diarrhea were among the commonest complaints, and were probably associated with the eating of food kept several days without refrigeration. The large number of flies may also play a part in the prevalence of this condition. A complaint of night blindness of several months duration among 10 children and 1 adult was investigated and is reported below. Common colds, fungus infections of the skin, and impetigo

**MEDICAL SURVEY OF LONGER PEOPLE
ONE AND SIX YEARS AFTER EXPOSURE TO FALLOUT**
(With an Addendum by [illegible])

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[illegible text]



September 1964

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15 children who are part of the control series for the growth and development studies. Several Rongelap people of the exposed group and the comparison population group who were living in Majuro were also examined.

The Navy kindly furnished a ship, the LST *USS Duval County*. The team met at Eniwetok where the ship had put in to onload the 21-ton steel room which had been stored there and also the medical equipment and supplies. The medical team was berthed and fed aboard the ship for the expedition. The ship was beached at Rongelap and Utrik for easy accessibility to the villages.

Attitudes of Rongelap People

When the team arrived at Rongelap, the magistrate of the village indicated that there was some confusion and uncertainty in the minds of some of the people as to the necessity and significance of repeated medical examinations. He thought it wise to call a meeting of the village people in the council house so that they could ask questions to help clarify the situation. For the past 5 years during which the annual examinations have been going on there had been no problem in maintaining excellent rapport with the people, and, indeed, the relations of the team members with the Rongelapese were always cordial and friendly. It was recognized that there was slightly increasing resistance to blood sampling procedures. Also there was some discontent that, because of the high Sr^{90} content, they were forbidden to eat coconut crabs, which they consider a delicacy (Figure 4). Since the return of the people to Rongelap, copra production had not increased to the extent that the Trust Territory officials had hoped. Consequently, since copra production is the prime source of income, there was some concern over the slowness with which the people were getting back on their feet economically. It had become necessary to extend food subsistence beyond the time originally planned. Fishing was not being carried on as actively as it should have been.

At the village meeting the main questions centered around the necessity for the continued medical examinations in view of statements on the part of the medical team in the past that the people were generally in good health. It was difficult to explain to them that, though they appeared to be in good health and to have recovered from the acute effects of radiation, very little was known about the possible late effects of radiation, and

continued examinations were essential in order to detect and treat any untoward effects, should they arise. The coconut crab problem was brought up again, and the reasons for prohibiting their consumption carefully explained through the interpreter. To correct a misconception that several cases of fish poisoning during the past year had been due to eating radioactive fish, it was explained that fish poisoning had been going on in these islands for years and was not connected with radioactivity. After much discussion, it seemed that the people were satisfied with answers to the questions, and preparations for the examinations proceeded. Thereafter complete cooperation and the usual friendly relations prevailed throughout the stay on the island.

During the examinations a United Nations team visited Rongelap. A meeting with the people was held in the church (Figure 5), and many aspects of the Rongelap situation were discussed. The report of the UN group was favorable toward the special medical assistance being rendered the people.

Upon completion of the 1959 survey, a meeting was held for the people, and they were advised that they were found to be generally in good health with no serious effects of their radiation exposure apparent, but that continued examinations would be necessary in order to insure continued good health. They were also advised to try to improve their oral hygiene and observe sanitary rules to control the flies on the island.

Before the team left the island, a party was held for the Rongelapese. The Navy kindly furnished a meal, and small gifts were exchanged as tokens of appreciation of mutual cooperation.

Figure 4. Coconut crab (robber crab, *Birgus latro*), considered a delicacy by the Marshallese. (Photo courtesy American Museum of Natural History, New York, N.Y.)



low excretors either heterozygous or homozygous for the dominant allele. Striking differences in the incidence of high excretors in various populations have been demonstrated, and it appears that this genetic polymorphism may be of considerable value in anthropo-genetic investigations.^{21,22}

As a part of the study of the genetic relationships and origins of various Pacific peoples, this report extends observations on BAIB excretion to the Micronesians inhabiting the Marshall Islands. The fact that some of the Micronesians were exposed to considerable radiation in 1954 is of special interest here, since it is known that radiation exposure can, temporarily at least, increase BAIB excretion,²³ and studies on the Marshallese population may elucidate possible long-term effects.

Urine samples from 65 exposed and 119 unexposed people (75.7% of the population of the village) were collected in plastic bottles containing thymol preservative. The sexes were equally represented, and the ages varied from 3 to >70 years. In some cases several members of the same family were included, and some kinships suitable for genetic analysis were available. Eighteen samples collected on Utrik were also studied. Urines were kept at 4°C and shipped in refrigerated containers to Seattle for analysis. These studies were carried out by one of us (B.S. Blumberg) and Dr. S.A. Gartler of the Department of Medicine, School of Medicine, University of Washington. Studies were completed 2 to 3 weeks after collection of the specimens. Determinations of BAIB were carried out by high voltage electrophoresis on paper,²⁴ and creatinine was determined by the alkaline picrate method.

Radionuclide Body Burden Evaluation

The methods used in the radionuclide body burden evaluation are described later in a separate section.

1960 Survey

BACKGROUND MATERIAL

The 1960 survey was reduced in size and scope and limited to a very brief examination of the exposed people only. Several factors brought about this change. The people had recovered to the extent that certain special examinations previously

carried out every year need be done only once every two to three years. In addition, as pointed out before, the Trust Territory officials were concerned about the slowness of economic recovery of the Rongelapese and felt that the numerous visiting scientific teams, particularly those with large ships and crews, were partly responsible for the unrest of the people and therefore requested that the size of the surveys be kept to a minimum. It was decided to defer the gamma spectrographic analysis until 1961. The Trust Territory officials agreed to greater participation of their medical personnel in future surveys and to the use of one of their cargo ships (Figure 9), which routinely made the rounds of the islands for gathering copra, for carrying out the survey at Rongelap. Accordingly, for the 1960 survey the team consisted of only one physician and one technician from Brookhaven National Laboratory, and the remainder of the medical group, arranged by the Trust Territory, included its Director of Public Health, two Marshallese medical officers, and two Micronesian laboratory technicians. The Director of Dental Services and one of his dental officers also accompanied the team to carry out treatment of the people. The District Administrator of the Marshall Islands accompanied the team in order to consult with the people on their agricultural program.*

As in the previous year, several of the exposed people now living at Kwajalein and Majuro atolls were examined at these atolls prior to the Rongelap visit.

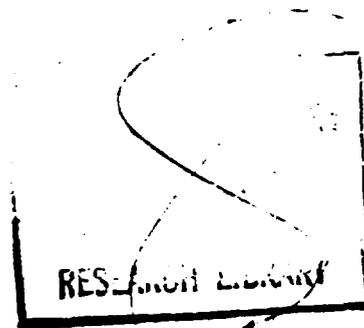
PROCEDURES

As in previous surveys, examinations were carried out in the dispensary and the schoolhouse in Rongelap village. Interval medical histories and complete physical examinations were carried out

*Again in 1960, when the team arrived at Rongelap, the magistrate requested a meeting with the people. The line of questions and discussion was about the same as that reported for the previous year. Resistance toward the examinations was expressed by only one or two of the people. Objections were again raised against the ban on eating coconut crabs, which selectively concentrate Sr⁹⁰ to such an extent that their consumption had to be prohibited (Figure 4). The people were assured that these crabs were being repeatedly examined and that, when it was safe to eat them, immediate notification would be given. Fish poisoning apparently had been less of a problem during the past year since only one case had been noted, and the subject was not brought up again. Following this meeting, cooperation by the people in the examinations was almost complete.

MEDICAL SURVEY OF THE PEOPLE OF RONGELAP AND UTIRIK ISLANDS ELEVEN AND TWELVE YEARS AFTER EXPOSURE TO FALLOUT RADIATION (MARCH 1965 AND MARCH 1966)

ROBERT A. CONARD, M.D., LEO M. MEYER, M.D., WATARU W. SUTOW, M.D.,
JAMES S. ROBERTSON, M.D., PH.D., JOSEPH E. RALL, M.D., PH.D.,
JACOB ROBBINS, M.D., JOHN E. JESSEPH, M.D., JOSEPH B. DEISHER, M.D.,
AROBATI HICKING, PRACTITIONER, ISAAC LANWI, PRACTITIONER,
ERNEST A. GUSMANO, PH.D., AND MAYNARD EICHER



BROOKHAVEN NATIONAL LABORATORY
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from its bremsstrahlung spectrum, but in practice the complications caused by the presence of gamma-ray emitters and by the size of the human body render this method infeasible.)

Comparison of the excretion rates of ^{90}Sr and ^{137}Cs with the body burdens of ^{137}Cs measured by whole-body counting provides a clue to the ^{90}Sr body burden status. A quantitative value cannot be deduced, however, because the factors relating the behavior of the two nuclides are not sufficiently well established. The study by Hardy, Rivera, and Conard⁴⁴ summarized in Appendix 18 is pertinent to this problem. ^{137}Cs and ^{90}Sr retentions were followed for 190 days after ingestion of representative Rongelap food items by one of the investigators. The ^{137}Cs ingested was almost quantitatively absorbed from the gastrointestinal tract, but 50% of the ^{90}Sr was excreted via the feces in the first 10 days and may be regarded as not having been absorbed. By the end of the study almost all of the ^{137}Cs and about 75% of the ^{90}Sr had been excreted in the urine and feces. The exact figure for retention is dependent on the correction used for activities ingested in the normal diet, and these were not measured. In this study the biological half-time for ^{137}Cs was estimated as 74 days. For both ^{137}Cs and ^{90}Sr the urinary excretion rates were markedly elevated during the ingestion period and for a few days afterward. This confirms other results to the effect that the excretion rates found are strongly affected by the recent diet and, when there has been a recent intake of high activity food, the excretion rates do not provide accurate indices of the body burdens.

Comparison of ^{137}Cs Levels in Marshallese and Alaskan Eskimos

It is of interest to compare the ^{137}Cs body burden findings in the Rongelapese with those reported for certain Alaskan Eskimos. The findings in the Eskimo population in August 1965 are shown in Table 29.⁴⁵ It may be noted that the results for adult Eskimos are equal, within statistical limits, to those for the adult male Rongelapese. For the Eskimo population the 1965 data run about 30% lower than the comparable 1964 data, and this trend parallels the findings in the local caribou, one of the principal components of their diet.⁴⁵ The *Federal Radiation Council Radiation Protection Guides*⁴⁶ is cited as recommending a limit of 3000 nCi ^{137}Cs in individual adults for this population,

Table 29

Cesium-137 Body Burdens
for Residents of Anaktuvuk Pass, Alaska⁴⁵

Age, yr	No. persons	Body burden, nCi	nCi per kg body wt.
>21	23	920 ± 58	15.7 ± 1.0
15-20	5	490 ± 42	9.5 ± 1.0
3-14	22	170 ± 17	6.2 ± 0.3
>21*	16	900 ± 60	16.0 ± 1.3

*"Controls" - members of a group who were first counted in 1963 and are re-examined periodically.

and opinions are expressed to the effect that the current body burdens do not constitute a radiological health hazard.⁴⁵ These opinions are consistent with those that have governed the policies applicable to the Rongelapese.

Radiochemical Analysis of Coconut Crabs

A food item that has been of special interest throughout the Rongelap medical surveys is the coconut crab (*Birgus latro*). Because of its high ^{90}Sr content, it has been banned as a food. The following concentrations of ^{90}Sr and ^{137}Cs were found in a crab taken from Rongelap Island in 1965 (radiochemical analysis by the Health and Safety Laboratory): ^{90}Sr , 66,600 pCi/kg original matter; ^{137}Cs , 12,700 pCi/kg original matter; stable Ca, 92.1 g/kg original matter.

Previous analyses of crabs taken from Rongelap Island have been reported in the 7, 8, and 9-10 year reports.⁸⁻¹⁰ For ^{90}Sr the results have run: at 7 years 1140 pCi ^{90}Sr /g Ca; 8 years 1317, 1086, 1113, and 1378 pCi ^{90}Sr /g Ca; and 9-10 years 865, 628, and 780 pCi ^{90}Sr /g Ca, and 39,292, 45,318, and 66,234 pCi ^{137}Cs /kg. The 1965 results for ^{90}Sr are slightly below the average for the previous survey and for ^{137}Cs are reduced to about $\frac{1}{4}$ the previous results. All these results are markedly lower than those that have been obtained with crabs from the more heavily contaminated islets of Eniatok and Kabelle (Figure 71).

The crab data may be compared with the data on Rongelap subject No. 73, who had the highest ^{137}Cs body burden (25,400 pCi/kg) and was excreting activity in concentrations of 78,000 pCi ^{137}Cs /g Ca and 50 pCi ^{90}Sr /g Ca. It seems clear from this that because of its relatively high ^{90}Sr content the

use of crab meat as a food item should continue to be avoided. Other foods, however, are responsible for the ^{137}Cs levels found.

Summary

Medical surveys were carried out on the exposed people of Rongelap Island in March 1965 and March 1966. In 1965 the comparison population was also examined, and in 1966 the exposed population of Utirik Island was examined.

INTERVAL MEDICAL HISTORY

During the past 2 years the Rongelap people have been generally in good health with satisfactory nutritional status. No unusual epidemics of disease occurred. Over the 2-year period 2 deaths had occurred in the Ailingnae group (originally exposed to 69 rads). No autopsy was obtained, but the deaths occurred in older people with no obvious connection with radiation exposure. One death occurred in an older woman of the comparison population. The death rate has been higher in the exposed population than in the unexposed population, which may in part be related to the larger percentage of older people originally in the exposed group. Birth rate has been about equal in the exposed and unexposed groups. No miscarriages or stillbirths were noted in the exposed

women during the past 2 years, but 5 miscarriages occurred in unexposed women. No abnormal babies were born in the exposed group, but two (hydrocephalic and mongoloid) were born to two unexposed women.

The people of Utirik Island appeared to have been in good health and reported few serious medical happenings over the past 3 years. The birth and death rates in this group appeared to be similar to those in the Rongelap group.

PHYSICAL FINDINGS

As noted in previous surveys, the variety and distribution of physical abnormalities (with the exception of thyroid pathology) did not appear to be significantly different in the exposed people as compared with the unexposed population. The trends toward growth retardation in the exposed children, previously noted, have continued. No leukemia or cancer (except one thyroid cancer) was detected.

THYROID FINDINGS

The dosimetric calculation for radiation dose to the thyroid from internal absorption of radioactive iodines from the fallout was reviewed. Early thyroid studies including protein-bound iodine determinations, iodoprotein levels, dietary iodine and urinary excretion of iodine, thyroid uptake of radioiodine, and serum cholesterol levels were reviewed.

Thyroid abnormalities during the past 3 years have increased to 18 cases, 16 with nodules and 2 with hypothyroidism. It is noteworthy that in the higher exposure group thyroid abnormalities occurred in 79% of the children exposed at <10 years of age, as compared with no cases in the children of the Ailingnae, Utirik, or unexposed groups. Only one adult in the Ailingnae group developed a thyroid nodule. Several nodules were noted in the thyroid glands of older Utirik and unexposed adults of Rongelap. Surgery was performed in 11 cases: 9 children and 1 adult were found to have adenomatous goiters, and 1 adult a mixed papillary and follicular carcinoma of the thyroid gland with localized metastasis. The gross and microscopic appearance of these lesions was described and depicted. Correlation of growth retardation in exposed children with thyroid pathology was indicated by the recent finding of definite

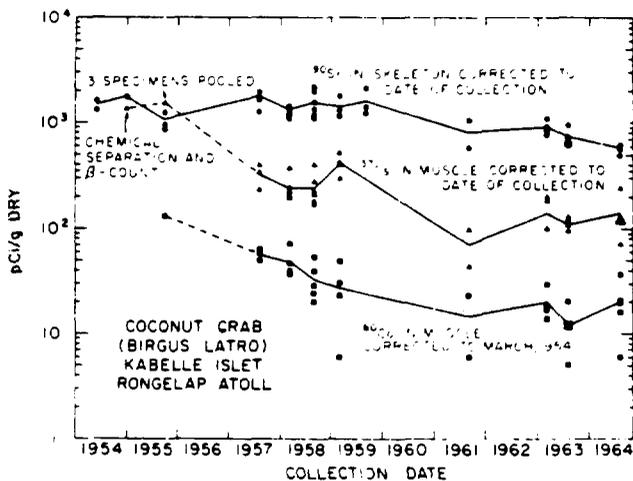
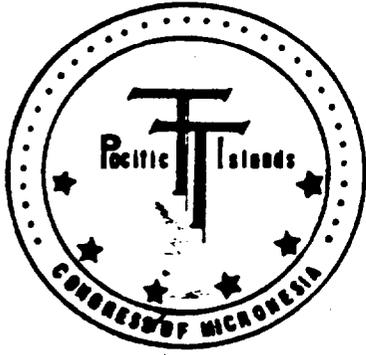


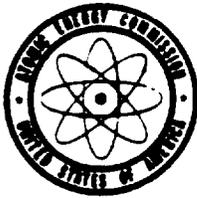
Figure 71. Analyses for ^{90}Sr , ^{137}Cs , and ^{60}Co in coconut crabs of northern Rongelap Atoll since 1954. (Courtesy of E. Held, University of Washington.)



**COMPENSATION
FOR THE
PEOPLE OF RONGELAP AND UTIRIK**

**A Report
by
The Special Joint Committee
Concerning Rongelap and Utirik Atolls
to the
Fifth Congress of Micronesia**

FEBRUARY 28, 1974



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

Honorable Olympio T. Borja
Chairman, Special Joint Committee
Concerning Rongelap and Utirik
Congress of Micronesia
Saipan, Mariana Islands 96950

Dear Senator Borja:

This is in response to your letter of April 23, 1973, with the enclosed copy of your interesting report. Your committee is to be complimented for its hard work in pursuit of its mission. The following addresses the several matters discussed in your letter.

The Atomic Energy Commission has received a request from Mr. Stanley S. Carpenter of the Department of the Interior on behalf of the High Commissioner of the Trust Territory to enter into an executive agreement relative to Micronesian Public Law No. 5-52. In a response to Mr. Carpenter, I have expressed AEC's interest in discussing with the Department of the Interior the funding by AEC of research-related services as they may be provided under that law. The distribution of funding must take into account the authorized responsibilities of the Trust Territory Government to provide routine medical care in the Pacific Islands and of AEC to conduct research-related activities.

It is my understanding that Dr. Knudsen has provided valuable medical service to the people of Rongelap and Utirik. If Dr. Knudsen does not return to the Marshall Islands District, the AEC has approved recruitment of a replacement for him. In contrast to the large medical manpower pool of the U. S. Public Health Service, AEC and its contractors, including laboratories, employ relatively few physicians and, accordingly, have a limited potential for recruitment of a suitable physician. However, if the recruitment becomes necessary, Dr. Conard, with the assistance of the distinguished physician members of his survey teams, should be able to obtain the services of an interested and qualified physician. You may be assured that AEC will assist Dr. Conard in this matter.

Honorable Olympio T. Borja

- 2 -

AUG 21 1973

I have been informed by Dr. Conard that, in view of death, he will have a special team conduct a hematologic survey during the interim period between the annual surveys. In this way it should be possible to detect any disease-related hematologic abnormalities at an early stage.

Relative to the funding of Dr. Conard's work, the level of AEC financial support has enabled his surveys to include an extensive battery of relevant tests. As need arises for additional procedures or projects, Dr. Conard submits his requests to AEC where they are considered for approval by our staff. In fact, AEC is now considering the acquisition of a vessel to be used by Dr. Knudsen and the medical survey teams as well as by other AEC-sponsored biomedical and radiological groups. Such a vessel would make possible more frequent visits to Rongelap and Utirik atolls.

With respect to the concern of the people over eating certain foods, only one food item, the coconut crab, was restricted in the past, and that restriction was liberalized for Rongelap recently. It is unfortunate that the population has been fearful of eating other foods which have been considered safe for consumption. Repeated reassurance is probably the most effective means of combating this fear. Your committee and other respected Micronesian citizens are probably best able to assure the inhabitants of the islands of the safety of those foods. Dr. Conard has informed us that he and members of his scientific team will contribute their scientific expertise in support of this important educational program.

I have brought to the attention of AEC personnel who conduct radiological surveys in the Marshall Islands your suggestion concerning another radiological survey of Rongelap and Utirik and a subsequent report on the survey to be written in the Marshallese language. You undoubtedly are aware that AEC surveyed Bikini Atoll at various times from 1967 to 1972, and recently conducted a survey of Eniwetok Atoll from October 1972 to February 1973. At present, the extensive data accumulated during this latest survey are being analyzed. It is our wish to have the Eniwetok people fully informed of the results of the survey in order that they may participate in a knowledgeable manner in the decisions and planning for their return to the Eniwetok Atoll. We are in fact taking the necessary action to have the essential results of this survey made available in the Marshallese language.

AUG 21 1973

Your information as to the relationship of Dr. Conard and the Brookhaven team to AEC is correct. Dr. Conard is neither an employee nor an official representative of AEC. In view of the desire of the inhabitants of the Islands to communicate with an AEC representative, I will suggest that either Mr. Streenan or another representative accompany Dr. Conard's team during the next medical survey.

With regard to your request for information or advice, please let me reassure you that AEC staff will cooperate with your Special Committee to the extent of their capabilities.

I regret the delay in this reply and trust that I have clarified our position on these matters of mutual interest.

Sincerely,



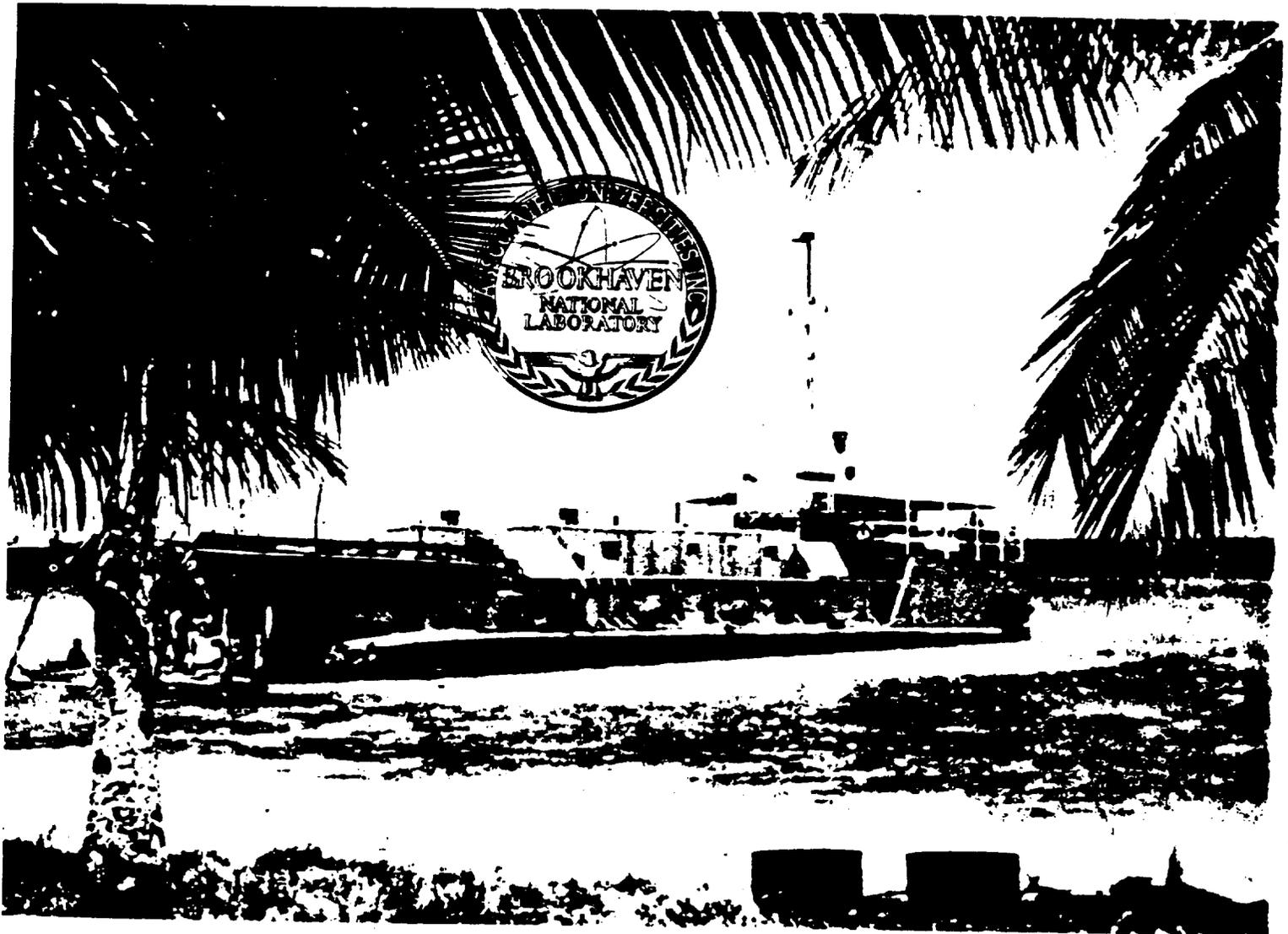
Clarence E. Larson
Acting Chairman

cc: Mr. S. S. Carpenter, Dept. of Interior
Hon. E. E. Johnston, High Commissioner,
Trust Territory of the Pacific Islands



A TWENTY-YEAR REVIEW OF MEDICAL FINDINGS IN A MARSHALLESE POPULATION ACCIDENTALLY EXPOSED TO RADIOACTIVE FALLOUT

ROBERT A. CONARD, M.D., ET AL.



**BROOKHAVEN NATIONAL LABORATORY
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UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Is there still radiation in the ground? How long will it last?

Yes, there is a little radiation left in the ground but it gets weaker and weaker as time goes by.



Woman washing clothes

It is like dirty clothes. If you wash them and lay them in the sun the dirt and poison will come away. The ground is too big to wash like clothes so the rain does it for you.

If the radiation is still in the soil of these islands, why is there no restriction of people moving into these islands?

The radiation in the ground is so weak that it is safe to live on the islands and eat the foods. There is no place in the world that does not have some radiation in the soil.



Feast on Rongelap

Why can't we eat coconut crab and arrowroot?

You can eat the coconut crabs from the southern islands of Rongelap if you do not eat more than three crabs per week. There is still some radiation in the crabs because they eat their old shells when they grow new ones. The people on Utirik may eat all the crabs they want. Arrowroot may be eaten on Rongelap and Utirik.

Is there anything else that we are not supposed to eat?

No, you may eat anything else that is good for you.



*Person eating pandanus
You may eat anything else like pandanus.*

If the U.S. can reach the moon, how come they did not know that the wind was going to be shifted over to the islands?

There were some mistakes made. The U.S. can reach the moon because the equipment used to get man to the moon is under his control. The direction of the wind is more difficult to predict because the wind is not controlled by man.