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Lawrence Livermore National Laboratory

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THE NORTHERN MARSHALL ISLANDS RADIOLOGICAL SURVEY: TERRESTRIAL FOOD CHAIN AND TOTAL DOSES

ABSTRACT

A radiological survey was conducted from September through November of 1978 to assess the concentrations of persistent manmade radionuclides in the terrestrial and marine environments of 11 atolls and 2 islands in the Northern Marshall Islands.

The survey consisted mainly of an aerial radiological reconnaissance to map the external gamma-ray exposure rates over the islands of each atoll. The logistical support for the entire survey was designed to accommodate this operation. As a secondary phase of the survey, shore parties collected appropriate terrestrial and marine samples to assess the radiological dose from pertinent food chains to those individuals residing on the atolls, who may in the future reside on some of the presently uninhabited atolls, or who collect food from these atolls.

Over 5000 terrestrial and marine samples were collected for radionuclide analysis from 76 different islands. Soils, vegetation, indigenous animals, and cistern water and groundwater were collected from the islands. Reef and pelagic fish, clams, lagoon water, and sediments were obtained from the lagoons.

Here we summarize the concentration data for ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239+240}Pu$, and ^{241}Am in terrestrial food crops, fowl, and animals collected at the atolls or islands. We also provide an assessment of the total dose from the major exposure pathways including external gamma, terrestrial food chain including food products and drinking water, marine food chain, and inhalation. Radiological doses at each atoll or island are calculated from the average radionuclide concentrations in the terrestrial foods, marine foods, etc. assuming the average daily intake for each food item.

The terrestrial food chain is the most significant exposure pathway--it contributes more than 50% of the total dose--and external gamma exposure is the second most significant pathway. Other pathways evaluated are the marine food chain, drinking water, and inhalation.

Cesium-137 produces more than 85% of the predicted dose, ^{90}Sr is the second most significant radionuclide, and the transuranic radionuclides contribute a small portion of the total predicted lung and bone doses.

The major contribution to the terrestrial food chain comes from food such as coconut, breadfruit, Pandanus, etc. Looking specifically at the terrestrial foods, coconut contributes a major share of the dose because of its ^{137}Cs concentration and the high intake of coconut.

The annual dose rates and 30- and 50-y integral doses are calculated for two dietary conditions to indicate the range of doses based on current diet surveys. The doses are calculated assuming that people would be living full time on the listed island, with all of their local foods from that island. This includes islands at atolls that are currently uninhabited. At each inhabited atoll we have included the islands that we were able to determine were being used as a residence or partial residence island or as major agricultural island. At uninhabited atolls we have included the major islands that might possibly be used for residence.

All of the inhabited atolls except Rongelap and many of the uninhabited atolls have annual doses of less than 30 mrem/y, regardless of the assumed diet. The range is from about 3 to 6 mrem/y for the MLSC diet to 20 to 29 mrem/y for the BNL diets. The doses at uninhabited Ailinginae Atoll would range from 13 to 90 mrem/y for the MLSC and BNL diets, respectively. The doses at the southern residence islands at Rongelap Atoll range from 35 to 58 mrem/y for the MLSC diet and from 58 to 135 mrem/y for the BNL diet. If Rongerik were continually inhabited, the respective range of doses would be 42 to 66 mrem/y and 69 to 90 mrem/y. If the northern islands at Rongelap were inhabited continuously, the estimated doses for the various islands would range from 90 to 330 mrem/y for the MLSC diet and from 150 to 580 mrem/y for the BNL diet.

The 30-y integral doses for Likiep, Wotho, Ujelang, Mejit, Ailuk, Taka, Jemo, and Bikar all fall between 0.055 and 0.14 rem for the MLSC diet and between 0.09 and 0.7 rem for the BNL diet. Doses for Utirik range from 0.25 to 0.72 rem for the MLSC diet and the BNL diet, respectively. If Rongerik were inhabited continuously, the estimated doses would range from 0.94 to 1.6 rem for the MLSC diet and 1.5 to 3.8 rem for the BNL diet.

The inhabited southern islands of Rongelap Atoll have 30-y integral, whole-body doses for the MLSC diet ranging from 0.76 to 1.3 rem and for the BNL diet they range from 1.2 to 2.5 rem. If the northern islands of Rongelap were populated continuously, the estimated doses for the MLSC diet would range from 2 to 7.4 rem and for the BNL diet they would range from 3.4 to 14 rem.

INTRODUCTION

A radiological survey was conducted from September through November of 1978 to assess the concentrations of persistent manmade radionuclides in the terrestrial and marine environments of 11 atolls and 2 islands in the Northern Marshall Islands. The atolls and islands are shown in Fig. 1 and include Likiep, Mejit, Ailuk, Utirik, Wotho, Ujelang, Taka, Rongelap, Rongerik, Bikar, Jemo, Ailinginae, and Bikini. There is considerable information on the radiological condition of Enewetak Atoll.[1-4] Concentrations of radionuclides on specific islands of Bikini Atoll have also been well documented.[5-16] However, little radiological information is available for the remainder of the atoll or for other atolls that were considered most likely to have received fallout from nuclear tests conducted at the Pacific Proving Grounds between 1946 and 1958.

This survey was essentially designed as a screening survey, which would be used to determine whether or not further detailed sampling effort might be required at any of the atolls. It consisted mainly of an aerial radiological reconnaissance to map the external gamma-ray exposure rates over the islands of each atoll. The logistical support for the entire survey was designed to accommodate this operation. As a secondary phase of the survey, shore parties collected appropriate terrestrial and marine samples to assess the radiological dose from pertinent food chains to those individuals residing on the atolls, who may in the future reside on some of the presently uninhabited atolls, or who collect food from these atolls.

Over 5000 terrestrial and marine samples were collected for radionuclide analysis from 76 different islands. Soils, vegetation, indigenous animals, and cistern water and groundwater were collected from the islands. Reef and pelagic fish, clams, lagoon water, and sediments were obtained from the lagoons.

A considerable amount of radionuclide concentration data has been generated from the analyses of these samples. Results from different phases of the program appear in separate reports. In the first report of this series we describe the general operation of the survey, the type and quantity of samples collected, locations sampled, and the methods used to process and analyze the samples.[17] The second report summarizes the radionuclide concentrations in cistern water and groundwater sampled at the atolls and the radiological dose assessment from ingestion of water from atoll supplies.[18] The third report summarizes the radionuclide concentrations in fish and the radiological dose assessment for the marine pathway.[19] Another report planned describes our analytical quality-control program coordinated by Dr. C. D. Jennings of the Western Oregon State College. In addition, some results are being summarized for publication in international scientific journals.

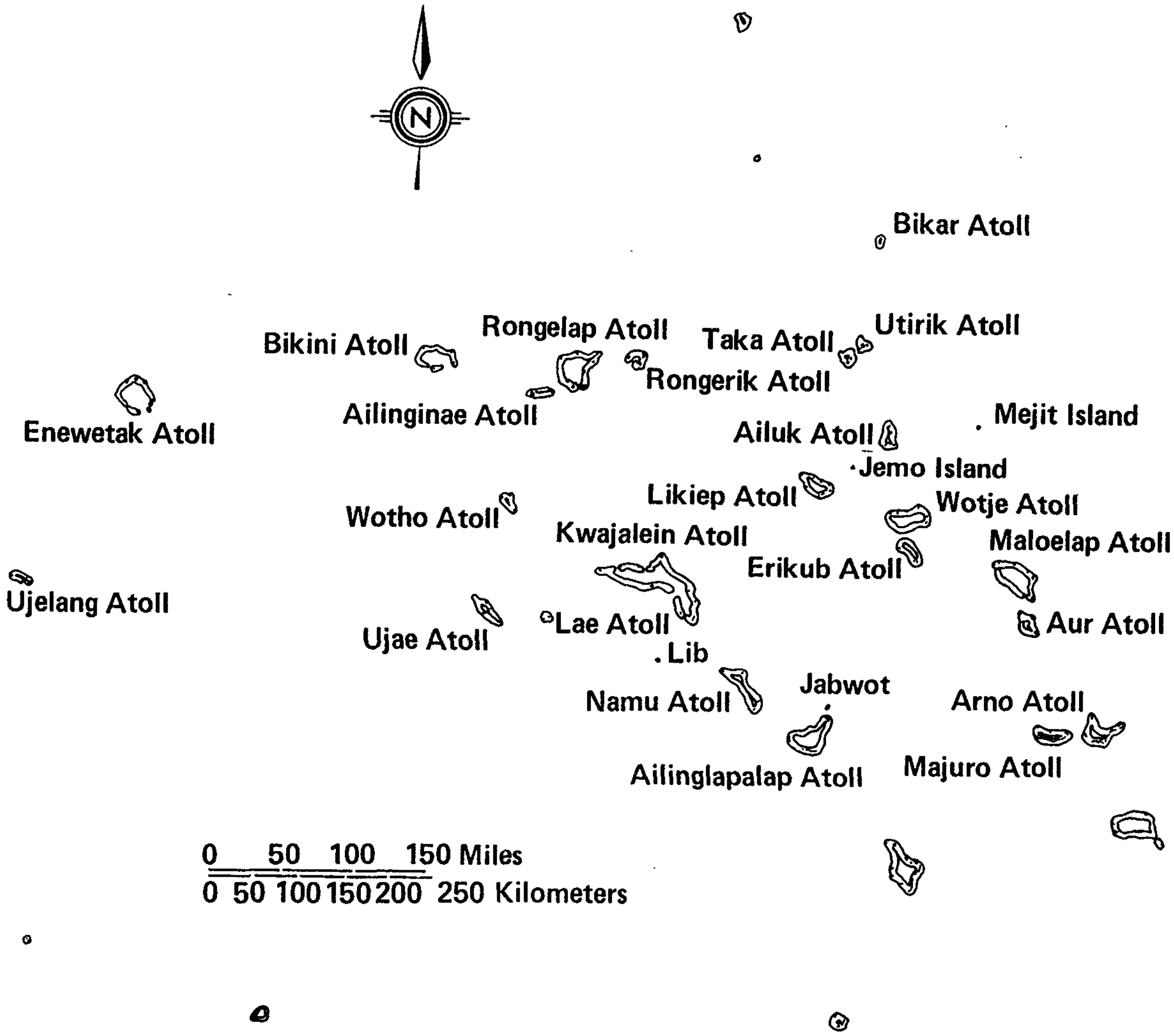

Figure 1. Atolls and islands of the Northern Marshall Islands radiological survey.

Here we summarize the concentration data for ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239+240}Pu$, and ^{241}Am in terrestrial food crops, fowl, and animals collected at the atolls or islands. We also provide an assessment of the total dose from the major exposure pathways including external gamma, terrestrial food chain including food products and drinking water, marine food chain, and inhalation. Radiological doses at each atoll or island are calculated from the average radionuclide concentrations in the terrestrial foods, marine foods, etc. assuming the average daily intake for each food item.

TERRESTRIAL SAMPLE COLLECTION PROCEDURES

The primary purpose of the field collections was first, to take a representative sample of the locally grown food supplies available to the local populations and second, to determine the radionuclide concentrations in animals and plants relative to soils for an entire island and atoll. We will briefly describe the terrestrial sample collections and processing procedures. A more detailed description may be found in Ref. 17.

When sampling an inhabited atoll or one used for agriculture, Department of Energy (DOE) representatives arranged for purchase of local food items to be used as samples. In most cases, local residents were hired to assist Lawrence Livermore National Laboratory (LLNL) field crews in their collection.

Representative samples of available local food supplies consisted of livestock, food grown in gardens, and food plants adjacent to the village. Soil samples were taken in the root zone of all food plant samples. Coconuts are the most common and abundant of the food plants and therefore became our indicator species. To determine relative radionuclide concentrations for the rest of an island or for uninhabited islands, coconuts were collected along transects or on random grid patterns to obtain samples from the total island area. When found by field teams, coconut crabs, Pandanus, breadfruit, and Tacca (arrowroot) were collected along with the coconuts. All vegetation and animal samples were frozen aboard ship and returned to LLNL for processing and analysis.

VEGETATION AND ANIMAL SAMPLING

In nearly all cases, plant samples collected were the edible portions of plants representing different elements of the local diet. Some plants were collected in greater numbers than others because they were present in larger quantities and usually constituted a more significant part of the diet. The majority of the vegetation samples were fruits of coconuts, papaya, Pandanus, breadfruit, banana, Morinda, and squash. Roots of Tacca and taro and leaves from Scaevola, breadfruit, Pisonia, and Messerschmedia trees were also collected.

Coconut palm Cocos nucifera is widespread throughout the Northern Marshall Islands and must be considered the dominant food plant. A coconut sample consisted of five coconuts from one or all three stages of coconut used in the diet--drinking nut, copra nut, and sprouting nut. Drinking coconuts are utilized for both eating and drinking by the Marshallese. Copra nuts are used for food flavoring in many areas of the Pacific as well as for oil that is of commercial value. Customarily the juice is discarded and the meat grated and squeezed. The extract is used to prepare coconut cream to be combined with other foods. The drained copra meat is usually fed to the livestock, which are later consumed by the people. Sprouting coconuts are utilized as food by the Marshallese who eat the spongy, pastry-like cotyledon or embryo food that fills the interior of the seed cavity. This embryo food absorbs moisture and nutrients from the seed cavity (meat and juice) to support the growth of the germinating coconut's leaf sheath and root.

Pandanus was the second most common food plant encountered and both wild and cultivated varieties were collected. Though wild varieties are not utilized as food, they are valuable as indicator plant to estimate the radionuclide concentrations in the edible species. Cultivated Pandanus is highly prized throughout the Marshall Islands for its sweet, spicy-flavored juice that is extracted from its numerous keys or phalanges, which are sections of the fruit. The juice may be used immediately or dried as fruit leather and stored for later consumption. Pandanus samples usually consisted of two large fruits; fully matured fruits were collected when available.

Breadfruit was collected from most of the inhabited islands because it is another important food plant cultivated by the Marshallese. Ripe breadfruit are either baked or fried. It is also dried and preserved in the ground to be cooked later. Yellow to yellowish-green ripe breadfruit were collected whenever possible. A sample usually included five fruits.

Other vegetation collected were papayas, squash, bananas, and Tacca. Tacca is a perennial plant with root tubers that are processed into a starchy material to be cooked or preserved for later use. These food crops are not as common in the diet as coconut, breadfruit, and Pandanus.

Animal samples collected by field teams, with the exception of coconut crabs, were purchased from the Marshallese by the DOE representatives. The purchased animals were always either pigs or chickens, which represent the major source of meat protein outside of imported canned meats.

The pigs were moved to a contamination-free area, and biologists carefully dissected from the animals the major organs: heart, liver, lung, kidneys, sternum, cartilage, spleen, skin, muscle tissue, bone, and reproductive organs. The organs were carefully removed to avoid contact with the animal skin, transferred to plastic bags, labeled, and then frozen. The major organs removed from the chicken were muscle, liver, bones, skin, gizzard, and heart.

Coconut crabs were sometimes discovered by field team members while collecting plant samples. These large land crabs were usually found in areas isolated from local population centers because they are considered a great delicacy and taken for food whenever discovered. Only the muscle and hepatopancreas tissue was removed from the coconut crab.

SOIL SAMPLING

In most cases, soil profile samples were collected in the root zone of sampled plants so that radionuclide concentrations measured in the plant tissue could be compared to concentrations in the soil. While the total soil volume utilized by the plant roots could not possibly be sampled, profiles taken through the root zone are representative of the radionuclide concentration encountered by the plant's roots.

The soil profile increments of 0 to 5, 5 to 10, 10 to 15, 15 to 25, 25 to 40, and 40 to 60 cm are those developed on previous LLNL Marshall Islands surveys, so they can easily be compared with the bulk of data previously collected from Enewetak and Bikini Atolls. We have found that a 40-cm depth encompasses most of the active root zone of the subsistence crops that we have sampled in the Northern Marshall Islands.

Many soil profiles were collected at sites around the islands where no associated plant samples were taken. These profiles were collected in the same manner described above. While the sample profile sites are selected more or less randomly, it is advantageous to choose a relatively undisturbed site with litter and surface soil intact.

PROCESSING PROCEDURES FOR TERRESTRIAL SAMPLES

SOIL SAMPLES

Soil samples were the largest category of all the samples collected. The soil-processing laboratories were carefully surveyed for possible radioactive contamination. Air filter samples and swipe samples were taken around the processing area. This monitoring program continued throughout our entire processing phase.

Each soil profile produced six samples, except in cases where it was impossible to get to the deeper depths because of coral bed rock. There were approximately 516 profiles collected and some 3093 soil samples were processed in the soil preparation laboratory between January and October of 1979.

The 0.5- to 1-kg soil samples were dried to a constant weight and ball milled continuously for 48 h to produce homogeneous samples. After ball milling, fractions of the finely ground soil samples were packed in aluminum cans for analysis by gamma spectrometry. When gamma counting was completed, the sample in the can was sent to a contract laboratory for analysis requiring radiochemical separations. Blind duplicates and standards were included with each group of samples sent for analysis. A complete report on the quality control program using blind duplicates and standards will be a part of this series of reports. The quality control program was conducted independently by Dr. C. D. Jennings of the Western Oregon State College.

VEGETATION SAMPLES

Most vegetation samples were a composite of one or more individual fruits. A coconut sample consisted of five coconuts. They were dissected into meat and juice. A papaya sample consisted of 20 papayas that were dissected into meat, skin, and seeds. A Pandanus sample consisted of two Pandanus fruits; the keys of the Pandanus were extracted and the juice was squeezed from them. The ends of the Pandanus keys were also kept for analysis. A breadfruit sample consisted of 5 breadfruit, a banana sample was 3 bunches of bananas, a squash sample consisted of 1 squash fruit, and there were about 20 Morinda fruit to a sample. The breadfruit, banana, squash, and Morinda fruits were dissected into meat and skin. The Tacca and taro root samples consisted of five tubers. They were also dissected into meat and skin. The leaves of the Messerschmedia, Scaevola, breadfruit, and Pisonia trees were cut into small segments.

To ensure no cross contamination with the soil samples, the fruit processing and canning was conducted in a different laboratory. Between January and October 1979, 961 vegetation samples were processed.

The vegetation samples were received frozen and maintained frozen at LLNL until processed. Before the samples were dissected, the fruits and roots were washed very carefully to remove any adherent soil particles. The plant samples were dissected into different segments (i.e., meat, skin, and seeds) and the wet weights were determined.

The samples were subsequently freeze-dried to remove the water from the vegetation. Each day ice was removed from the condenser and when ice ceased to form on the condenser, the samples were considered dried.

After freeze-drying, the sample dry weights were determined. The dried vegetation material was ground to a homogeneous texture in Waring blenders and pressed into aluminum cans until a uniform density was achieved. Samples insufficient in volume to fill a can were packaged into vials, which had a volume of 42 cm^3. Sample weights were recorded for calculation of specific radionuclide concentrations. The cans were first sent for gamma spectrometry analysis and then to a contract laboratory for analysis requiring radiochemical separations.

Coconut and Pandanus juices were processed by a slightly different procedure. The coconut juice was poured from the coconut; the Pandanus juice was squeezed from the Pandanus keys at 50,000 psi. The juices were measured, transferred to 1-L beakers, and formaldehyde added to prevent bacterial degredation. The beakers were placed in mechanical convection ovens at 40°C and the liquid evaporated to a volume of approximately 200 mL. The juice was then poured into an aluminum can. To ensure that all material was removed from the sides and bottom of the beaker, the beaker was acid rinsed during transfer. Formaldehyde was again added to prevent bacterial action in the can. The can was sealed and weighed.

Blind duplicates and standards were included with each set of samples sent for analysis.

ANIMAL SAMPLES

The animal samples were processed in the same manner as were the vegetation samples, the only difference being that formaldehyde was pipetted into the aluminum can after the sample had been pressed.

The animals were the smallest category of samples collected and processed. There were 153 samples processed between September and December of 1979. Blind duplicates and standards were included with each set of samples sent for analysis.

LIMITATIONS OF THE ASSESSMENT

The purpose of the terrestrial and marine program was to collect sufficient samples to estimate the doses via pathways other than the external gamma exposure. The number of terrestrial and marine samples collected at each atoll was determined by the time on station for the aerial portion of the survey and by the weather conditions. Although the sampling of soil and vegetation for each of the atolls was not as detailed as at Enewetak and Bikini,[4,5] it was sufficient for correlation with those more extensive programs. Further, samples from the survey were adequate to determine if any concentrations were unusual and if further sampling might be required. A reasonable data base of the radionuclide concentrations on both inhabited and uninhabited atolls and islands was developed so that a general picture of the dose magnitude for the terrestrial food chain pathway, marine food chain pathway, inhalation pathway, and groundwater and cistern water pathway could be determined.

A very critical aspect of the dose assessment is the assumed average dietary intake of all foods for a resident or returning population. The estimated doses will correspond directly with the activity ingested from local food products (pCi/d). Thus, once the concentration of radionuclides has been determined for the foods and soils, the assumed diet becomes very important for estimating the activity that will be ingested. In the past, the diet we established was based on limited, early literature reports and limited direct observation. In 1978 we were ready to initiate diet studies of the people living on Bikini Island. However, about this same time the Trust Territory Government began a large-scale program of supplying imported foods to the atoll. Furthermore, the people were relocated from Bikini in August of 1978. As a result, we obtained no data concerning the intake of locally grown foods for the Bikini people living at Bikini Atoll. More recently, however, the Micronesian Legal Services Corporation (MLSC) conducted a medical and dietary survey of the Enewetak people at Ujelang Atoll.[5]

A recent report from the Brookhaven National Laboratory (BNL) gives estimates of the quantity of food prepared per household from observations made at Rongelap, Utirik, and Ailuk Atolls as well as from questionnaires from these and other atolls.[20] In the BNL survey, the average daily amounts of coconut fluid, coconut meat, and Pandanus meat prepared are higher than the average daily amounts consumed in the MLSC survey. The BNL estimates are for atolls visited as part of the Northern Marshall Islands survey and are the highest average for either preparation or consumption amounts that we have found in the literature. The BNL report indicates that these values are upper limits and that "typical average" values are probably less. We are applying the BNL diet data to the appropriate atolls and are using the MLSC survey as a general diet to estimate the doses at Bikini, Enewetak, and Ujelang Atolls. If the true diet for each atoll were known, predicted doses for any atoll could vary some from the values we list here, which are based on average diets obtained from only two surveys.

It is very important to again emphasize how dependent the estimated doses are on the dietary habits that are assumed and the importance of having atoll-specific dietary information.

DATA BASES

The exposure pathways for persons living at or resettling an atoll consist of two major categories: external and internal exposure.

The specific pathways in each category are as follows.

(1) External exposure
   (a) Natural background
   (b) Man-made gamma and beta rays
(2) Internal exposure
   (a) Radionuclides inhaled
   (b) Radionuclides in drinking water
   (c) Radionuclides in terrestrial foods
   (d) Radionuclides in marine foods

The natural background at the atolls is 3.5 μR/h (microroentgen per hour) or 22 mrem/y (milliroentgen equivalent man per year) and results primarily from cosmic radiation. The natural background is not included in the doses presented here.

EXTERNAL EXPOSURE--IN SITU MEASUREMENTS

External exposure rates for ^{137}Cs, ^{60}Co, and ^{241}Am were obtained from in situ measurements performed by EG&G as part of the Northern Marshall Islands survey.[11] These measurements were made with 40 12.7-cm-diameter by 5.1-cm-thick sodium iodide scintillation detectors mounted on two pods on a Sikorski SH-3 helicopter. Flight lines were on a 46-m grid at an altitude of 38 m over the islands. For a detailed description of this methodology, see Ref. 11. The average external exposure for Bikini Island is 31 μR/h for ^{137}Cs and 1.9 μR/h for ^{60}Co and for Eneu Island it is 2.3 and 0.2 μR/h, respectively. The external gamma doses presented here are based on the island average external exposure. However, the Marshallese spend considerable time (30 to 50%) in or around the housing area. As a result, the housing provides shielding that reduces the average outside exposure by a factor of 2. Also, coral gravel spread 20 to 40 ft around houses, a common practice in the Marshall Islands, will reduce the external exposure by another factor of 2 (see Ref. 6).

The result is that the external gamma doses presented here are probably upper limits because, depending on how much time one wishes to estimate is spent in and around the housing area, the external exposures will be considerably reduced because of shielding by the house and gravel. In addition, if the housing were located near lagoon roads, the average external gamma exposure will be much less than in the interior of the island, so selection of the housing site can also make a significant difference.[6]

INHALATION

Airborne concentrations of respirable $^{239+240}Pu$ and ^{241}Am are estimated from data developed in resuspension experiments conducted at Bikini Atoll in May 1978. We briefly describe the resuspension methodology here; further details can be found in a paper summarizing the studies at Enewetak and Bikini Atolls.[12]

The study conducted on Bikini Island in May 1978 provided a more complete set of data than our preliminary studies on Enjebi (Janet) Island of Enewetak Atoll in February 1977. (Subsequent studies were conducted on Eneu Island at Bikini Atoll.) The Bikini Island study used extensive soil sampling and in situ gamma spectroscopy to determine isotope concentrations in soil and vegetation, various air-sampling devices to determine particle size distribution and radioactivity, and micrometeorological techniques to determine aerosol fluxes. Four simultaneous experiments were conducted: (1) a characterization of the normal (background) suspended aerosols and the contributions from sea spray off the windward beach leeward across the island, (2) a study of resuspension of radionuclides from a field purposely laid bare by bulldozers as a worst-case condition, (3) a study of resuspension of radioactive particles by vehicular and foot traffic, and (4) a study of personal inhalation exposure using small dosimeters carried by volunteers during daily routines. Less complete studies similar to (1) and (2) had been performed previously on Enjebi (Janet) and background studies similar to (1) were later performed on Eneu.

The normal or background mass loading measured by gravimetric methods for both atolls is approximately 55 $\mu g/m^3$. The Bikini Island experiments show that 34 $\mu g/m^3$ of this total is from sea salt, which is present across the entire island as a result of ocean, reef, and wind action. The mass loading from terrestrial origins is therefore about 21 $\mu g/m^3$. The highest terrestrial mass loading observed was 136 $\mu g/m^3$ immediately after bulldozing.

Concentrations of $^{239+240}Pu$ have been determined for (1) collected aerosols for normal ground cover and conditions, that is, normal conditions in coconut groves; (2) areas being cleared by bulldozers and being tilled, that is, high-activity conditions; and

(3) stabilized bare soil, that is, the cleared areas after a few days of weathering. The plutonium concentration in the collected aerosols changes relative to the plutonium concentration in surface soil for the various situations. We have defined an enhancement factor (EF) as the $^{239+240}Pu$ concentration in the collected aerosol mass divided by the $^{239+240}Pu$ surface soil concentration (0 to 5 cm).

The EF obtained from standard high-volume air samples (hi vols) for normal conditions is less than 1; the EF for worst-case, high-activity conditions is 3.1. Table 1 summarizes the observed EF at Bikini Atoll. The EF of less than 1 for hi vol data for normal, open-air conditions is apparently the result of selective particle resuspension in which the resuspended particles have a different plutonium concentration than is observed in the total 0- to 5-cm soil sample. In other words, the particle size and density and the corresponding radionuclide concentration is different for the normally resuspended material than for the total 0- to 5-cm soil sample. In addition, approximately 10% of the mass observed on the filter is organic matter, which has a much lower plutonium concentration than the soil. Similarly, the EF of 3.1 for high-activity conditions results from the increased resuspension of particle sizes with higher plutonium concentration than observed in the total 0- to 5-cm soil sample.

We have developed additional personal dosimeter enhancement factors (PDEFs) from personal dosimeter data. These data are normalized to the hi vol data for a particular condition and represent enhancement that occurs around an individual because of his daily activities (different from the open-air measurement made with the hi vols). These data are summarized in Table 1. The total enhancement used to estimate the amount of respired plutonium is the combination of the hi vol and personal dosimeter values. The effective enhancement used for normal conditions is 1.54 and for high-activity conditions it is 2.9.

In the scenario adopted for the calculations we assume that a person spends 8 h/d under high-activity conditions and 16 h/d under normal conditions. Finally, a breathing rate of 23 m^3/d (9.6 m^3 under high-activity conditions and 13.4 m^3 under normal conditions)[21] and the surface soil concentration (0 to 5 cm) for each island are used to complete the calculation for plutonium and americium intake via inhalation.

The International Commission on Radiological Protection (ICRP) lung model is used to estimate the lung and bone doses.[22] A pulmonary fractional deposition of 0.3 is used in the inhalation lung model; at this time we feel it is conservative from a dose-assessment point-of-view because preliminary analysis of the particle size distribution for both

Table 1. Pulmonary deposition of plutonium ($^{239+240}Pu$) for worst- and best-case conditions on Bikini Atoll.

Condition	Inhalation rate (m^3/h)	Dust aerosol (g/m^3)	Soil Pu activity (aCi/g)	Enhancement factor	Personal dosimeter factor	Respirable fraction	Pulmonary deposition (aCi/h)
Bare field, during tilling	1.04	136	15.3	3.1	0.92	0.24	1476
Stabilized field, heavy work	1.04	21	15.3	0.83	2.64	0.19	139
In and around houses, light work	0.83	21	15.3	0.83	1.86	0.19	78
Coconut grove, light work	0.83	21	8	0.41	1.1	0.19	12
At roadside, one vehicle/h[a]	0.023	28	4.1	2.5	1[b]	0.24	1.58 + BG[c]

[a] Exposure to one 10-s, median, vehicular dust pulse not including background (BG).
[b] Assumed value.
[c] Radionuclides inhaled via background mass loading.

normal and high-activity conditions at Bikini Atoll indicate that the pulmonary deposition would be less than 0.3 (Table 1). The gut transfer factors used for $^{239+240}Pu$ and ^{241}Am are 10^{-4} and 5×10^{-4} respectively, as recently suggested by the ICRP.[23] Both plutonium and americium are considered to be class-W particles.

The dose contribution from the inhalation pathway is a major source of exposure to the transuranic radionuclides, but both the inhalation pathway and the transuranics will contribute a minor portion of the total doses predicted over the next several decades. The transuranic radionuclides that must be considered in evaluating the inhalation pathway are $^{239+240}Pu$, ^{241}Pu, and ^{241}Am as well as the ^{241}Am that in the future will result from the radiological decay of ^{241}Pu currently present. Because of the low-energy beta radiation (0.021 MeV maximum) and a much shorter half-life (14 y), the doses from ^{241}Pu are less than one tenth those from $^{239+240}Pu$.

The concentrations of ^{241}Am in the soil (pCi/g) at most of the atolls are approximately 70 to 75% of the $^{239+240}Pu$ concentrations. However, more ^{241}Am will result from the decay of ^{241}Pu. The parent-daughter relationship for ^{241}Pu to ^{241}Am is shown in Fig. 2. The maximum ^{241}Am activity that will result from an initial ^{241}Pu

activity is 2.6% of the initial ^{241}Pu activity. Because the present ^{241}Pu activity in the soil is about seven times that of $^{239+240}Pu$, the final ^{241}Am soil activity resulting from the decay of ^{241}Pu will be 0.18 that of $^{239+240}Pu$. The currently observed ^{241}Am soil concentrations are 0.7 that of $^{239+240}Pu$. Thus, the final total soil concentration of ^{241}Am resulting from ^{241}Am now present and that resulting from ^{241}Pu decay will be 0.88 (0.7 + 0.18) that of the existing $^{239+240}Pu$ soil concentrations. For estimates of dose via inhalation, the eventual ^{241}Am soil concentrations can be considered equal to the $^{239+240}Pu$ concentrations. As a result, the doses calculated for $^{239+240}Pu$ can be doubled to account for the ^{241}Am.

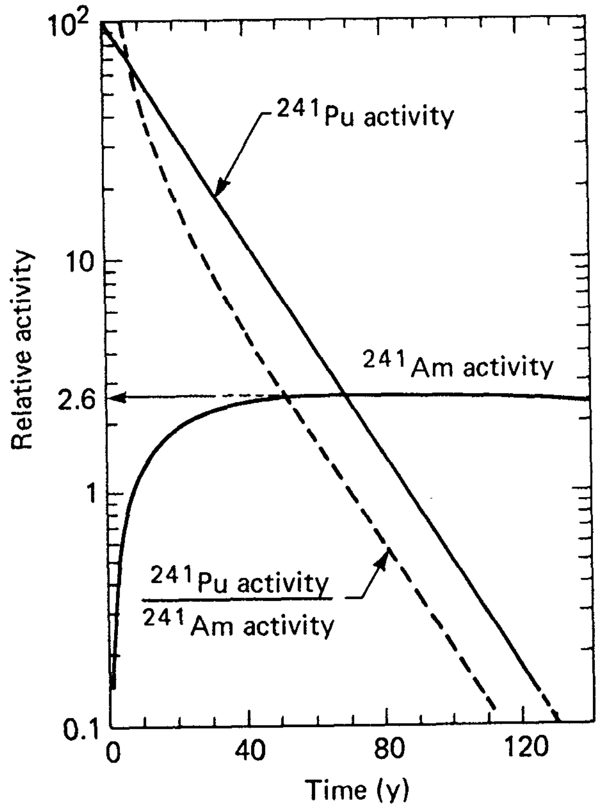

Figure 2. Relationship between parent ^{241}Pu activity and daughter ^{241}Am activity.

DRINKING WATER

The drinking water pathway for the atolls visited in the Northern Marshall Islands survey has been evaluated in a separate publication.[18] This pathway contributes a very small portion of the total dose.[5,10]

The radionuclide concentration data used to evaluate the drinking water pathway are listed in Appendix A. Cistern water is preferred and most often used; however, well water is used when drought conditions exist. When well water is used, the suspended material is allowed to settle out prior to consumption. In addition to drinking water, the Marshallese consume considerable quantities of coffee and Kool-Aid (Malolo), for which they again primarily use cistern water.

TERRESTRIAL FOODS

Food Radionuclide Concentration

The radionuclide concentrations directly measured in local foods for the atolls and islands and used in the dose assessment are listed in Appendix A. Because there were insufficient food products to directly determine the radionuclide concentrations in all locally grown foods at all islands, we have predicted the concentrations in those foods for which we do not have direct data by multiplying the average island soil concentrations for either the 0- to 10-, 0- to 15-, 0- to 25-, or 0- to 40-cm depth for one island by the concentration ratios between food products and soil developed for the same profile at another island. Most of the data in the tables are from direct measurements of the food products. These measured and predicted radionuclide concentrations in foods are then used in conjunction with the assumed average diets and dose models to develop the dose assessment for various living patterns.

Soil Radionuclide Concentration

Radionuclide concentrations for the profiles 0 to 5, 0 to 10, 0 to 15, 0 to 25, 0 to 40, and 0 to 60 cm are calculated using equal weights for each 5-cm increment. The island average for each depth profile (i.e., 0 to 5 cm, 0 to 10 cm, etc.) was calculated by averaging the results for each profile taken on the island. The results are summarized in Appendix B.

Concentration Ratios

As previously indicated, we have developed concentration ratios between food products and soil for each radionuclide (pCi/g wet weight in food per pCi/g dry weight in soil). The mean for the concentration ratios developed from samples collected on the Northern Marshall Islands survey is listed in Table 2 for ^{137}Cs, ^{90}Sr, $^{239+240}Pu$, and ^{241}Am. The concentration ratios are developed from soil profiles taken to a depth of 40 cm through the root zone of the plants being sampled. This depth is used, if data are available, because we observe that it encompasses most of the active root zone of the subsistence plants we have studied on Enewetak and Bikini Atolls. A report on the root activity of large, mature coconut and banana trees in other tropical regions showed most of the activity in the 0- to 40-cm depth, with some activity also in the 40- to 60-cm depth, although root activity did vary with age and species.[24] The report is consistent with our observations of the physical location of the root zone at Enewetak and Bikini Atolls in the 0- to 40-cm depth. Concentration ratios can be developed equally well for 0- to 10-, 0- to 15- or 0- to 25-cm depths, and in those cases where we were unable to obtain soil samples to a depth of 40 cm, we used the 0- to 10-cm concentration ratios as appropriate.

MARINE FOODS, BIRDS, AND COCONUT CRABS

The radionuclide concentrations in marine fish, shellfish, and invertebrates are described in detail in Ref. 25, and the summarized radionuclide concentrations in fish and the doses from the marine pathway at each atoll are presented in Ref. 19. The average radionuclide concentrations in fish and invertebrates for each atoll are listed in Appendix A. Some of the data are limited but the radionuclide concentrations in most of the species, which constitute a very small portion of the diet, are quite low. Thus, they have a minimal impact on the overall dose assessment.

Very few bird samples were collected on the survey. However, studies at other atolls indicate that the radionuclide concentrations in birds is very similar to the fish radionuclide concentrations because most of the birds are marine feeders. The combination of the low radionuclide concentration in birds and the low average daily intake make the dose contribution from this pathway very small. Thus, the radionuclide concentrations in birds is assumed to be the same as in the fish at each atoll.

Table 2. Average concentration ratios for ^{137}Cs, ^{90}Sr, $^{239+240}Pu$, and ^{241}Am for the 0- to 40- and 0- to 10-cm soil depths for all atolls except Bikini.

Sample code number	Food	Concentration ratio (pCi/g wet plant: pCi/g dry soil)					
		^{137}Cs		^{90}Sr		$^{239+240}Pu$[a]	
		0-40 cm	0-10 cm	0-40 cm	0-10 cm	0-40 cm	0-10 cm
91	Pandanus fruit	2.2	0.98	0.33	0.096	6.8e-4[b]	2.1e-4
92	Pandanus nut[c]	2.2	0.98	0.33	0.096	6.8e-4	2.1e-4
100	Breadfruit	2.6	1.3	0.021	0.12	2.7e-4	8.6e-4
111	Drinking coconut juice	0.48	0.22	0.0014	0.0015	8.8e-4	1.4e-3
112	Coconut milk[d]	3.0	1.4	0.013	0.011	2.1e-3	1.4e-3
121	Drinking coconut meat	2.2	1.0	0.013	0.011	2.1e-3	1.4e-3
122	Copra meat	3.0	1.4	0.013	0.011	2.1e-3	1.4e-3
123	Sprouting coconut	2.7	1.3	0.013	0.011	2.1e-3	1.4e-3
124	Marshallese cake[d]	3.0	1.4	0.013	0.011	2.1e-3	1.4e-3
130	Papaya	3.0	1.7	--	0.022	--	--
140	Squash	1.8	0.76	--	--	--	--
160	Banana	0.35	0.16	--	0.0095	--	--

[a] Concentration ratios for ^{241}Am are similar to those for $^{239+240}Pu$.
[b] Value following e notation indicates power of ten. For example, 5.1e-4 is equal to 5.1×10^{-4}.
[c] Assumed to be the same as Pandanus fruit.
[d] Assumed to be the same as copra meat.

We were also unable to collect coconut crabs at all atolls. For atolls other than Rongelap, Utirik, Rongerik, and Ailinginae where coconut crabs were collected at one or several islands, the average radionuclide concentration was used for the entire atoll. When no coconut crabs were found, the radionuclide concentration was determined by using the average value observed at the atolls where coconut crabs were collected because the external gamma measurements and radionuclide concentrations in soil and vegetation were very similar. For Rongelap, Utirik, Rongerik, and Ailinginae, direct measurements or concentration ratios were used.

DIET

The estimated average diet used in the dose assessment is a very critical parameter--doses will correspond directly with the ingested activity, which is directly related to the quantity of locally grown food that is consumed. Therefore, an accurate estimate of the average daily consumption rate of each food item is important.

Because we have been unable to obtain information on the dietary habits of the people at all of the atolls, the diets used in this dose assessment are those recently developed from the MLSC survey conducted of the Enewetak people on Ujelang Atoll and from the BNL surveys at Rongelap, Utirik, and Ailuk. More detailed discussions of the MLSC survey can be found in Refs. 4 and 5 and a discussion of the BNL survey appears in Ref. 20.

Briefly, in the MLSC survey there were 144 persons, approximately 25% of the Ujelang population, who were interviewed. Two females failed to complete the dietary questionnaire. The breakdown by age group was as follows:

36 adult males,

36 adult females,

19 children 12 through 17 y of age,

37 children 4 through 11 y of age, and

16 children 0 through 3 y of age.

Some people were away from the atoll during the interview, so selection was limited to those households where several people were available. The households were selected at random from the available pool.

Data on the dietary preferences of the Enewetak people were provided to LLNL in three parts: (1) household survey results for the Ujelang population, (2) individual medical and diet (IMD) survey results for 144 persons, and (3) a memorandum from Michael Pritchard of the MLSC.[4,5] According to Pritchard, "the household survey met three major needs: it provided in descriptive fashion an account of the eating habits for the entire population of Ujelang; it provided data on certain special diets for certain types of individuals such as pregnant women; and served as a census document for locating individuals for the IMD survey." The completed IMD questionnaires provided, when known, each individual's name, age, sex, height, weight, sickness frequency, prior medical treatment, x-ray history, radiation therapy history, parental data, and preference for various local and imported foods for conditions where imported foods were both available and unavailable. Consumed quantities of each food item preferred were expressed in volume equivalents of a 12-oz beverage can per day, week, and month. Pritchard's memorandum provided insight into such things as the overall survey procedure, the estimated uncertainties in some reported values, the preferences in preparation and consumption of many food items, and the can conversion data for some food items (grams of food per 12-oz can).

Tables 3 through 7 summarize the dietary intake results from the MLSC survey at Ujelang for local foods when imports are available and unavailable for adult males (18 to 80 y); adult females (18 to 78 y); and children in the 0- through 3-, 4- through 11-, and 12- through 17-y age ranges, respectively. Results for imported foods (normal conditions only) are summarized in Tables 8 through 10. The maximum diet (adult female) from the MLSC survey was also used to estimate doses for Enewetak and Bikini Atolls.

In the summary of a survey conducted during July and August of 1967 at Majuro Atoll, the average coconut use was reported to be approximately 0.5 coconut per day per person.[26] This included young drinking coconuts, old nuts used for grated meat and pressed for small volumes of milk, and sprouting nuts used for the sweet, soft core. Recent data from Eneu Island shows that an average drinking coconut contains 325 mL of fluid (standard deviation = 125 mL) so that even if the entire average coconut use of 0.5/d were all drinking nuts, the average intake would be about 160 g/d. This is in agreement with the results from the MLSC survey at Ujelang.

The recent BNL report on dietary information on Rongelap, Utirik, and Ailuk was developed by the authors from personal observations while living with the Marshallese and from answers to questionnaires.[20]

The observations and questionnaires were directed more toward estimating the food prepared for a family rather than the amount of food actually consumed. Because food is shared and some food prepared is fed to pigs or chickens, these two are not necessarily the same. In the draft report the authors state:

> This attempt then to seek estimates from the islanders themselves concerning the actual amounts of local foods in the contemporary diet should be used not as an answer to the question of what constitutes the "typical average" but rather as a feasibility study on the possibility of obtaining the desired information in this way. We feel the averages which we obtained from the interview study are for one reason or another consistently overestimated and should be considered maximum estimates or overestimates until such time as further study proves them accurate or (more likely) provides average factors for food sharing and wasting which can be folded into the study to provide more accurate, reduced estimates* (Ref. 20).

The diet patterns are divided into three categories representing three types of communities.

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* Underlined for emphasis.

Table 3. Intake in grams per day of local dietary items in the MLSC survey at Ujelang for adult males.

	Imports available						Imports unavailable					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Fish	36	41.5	34.7	7.9	195	1	36	89.3	67	12.7	342	1
Shellfish	36	5.8	7.7	0	28.4	0.53	36	27.6	46.1	0	203	0.92
Clams	36	9.3	15	0	60.8	0.5	36	53.1	67.4	0	276	0.97
Crabs	36	3.4	7.3	0	38.9	0.44	36	14.1	31	0	181	0.86
Octopus	36	2.6	5.2	0	26.1	0.56	36	12.1	21.8	0	91	0.86
Turtle	36	3.7	6.9	0	26.4	0.72	36	7.6	13	0	52.8	0.94
Domestic meat	36	18.6	22	0	92.7	0.92	36	32	36.9	1	145	1
Wild birds	36	8.8	12.6	0	41.4	0.42	36	25.4	25.3	0	109	0.83
Eggs	36	7.9	11.9	0	45.3	0.64	36	15.3	14.2	0	58.2	0.92
Pandanus	36	2.7	3.5	0	13.1	0.44	36	27.9	33.5	0	112	0.97
Breadfruit	36	12.8	12.7	0	54.2	0.75	36	57.6	51.4	7.8	217	1
Coconut fluid	36	98.6	82.2	0	368	0.97	36	168	114	51	380	1
Coconut meat	36	32.5	30.1	3.9	147	1	36	125	112	33	610	1
Papaya	36	1.6	5.4	0	27.2	0.14	36	6.8	11.2	0	38	0.36
Pumpkin	23	0.2	0.8	0	3.9	0.04	23	0.7	2	0	8.4	0.13
Banana	36	0	0	0	0	0	36	0	0	0	0	0
Arrowroot	36	2.3	6.9	0	31.5	0.17	36	64.8	75.6	0	220	0.97
Citrus	36	0	0	0	0	0	36	0	0	0	0	0
Aqueous liquids	36	915	570	228	2750	1	36	549	447	0	2130	0.97
TOTAL INDIVIDUAL INTAKE	36	1170	597	334	3190	1	36	1280	553	379	2850	1

Table 4. Intake in grams per day of local dietary items in the MLSC survey at Ujelang for adult females.

	Imports available						Imports unavailable					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Fish	34	41.5	28.8	3.6	119	1	34	90.1	81.1	17	410	1
Shellfish	34	5.1	9.3	0	34.8	0.47	34	25.2	42.3	0	232	0.85
Clams	34	8.9	14.1	0	52.8	0.65	34	43.6	48.4	0.5	197	1
Crabs	34	3.1	7.4	0	39	0.32	34	12.5	31.2	0	181	0.77
Octopus	31	4.5	8.3	0	26.1	0.45	31	24.5	50.5	0	273	0.87
Turtle	31	4.3	9.5	0	49.1	0.58	30	8.9	12	0	49.1	0.93
Domestic meat	34	21.2	52.4	0	293	0.74	34	34.5	98.1	1	577	1
Wild birds	34	4.2	8.7	0	38.2	0.29	34	17.8	23.6	0	107	0.88
Eggs	34	10.7	32.2	0	182	0.38	34	55.8	153	0	792	0.91
Pandanus	34	9.2	16.6	0	82.1	0.68	34	32.5	32.3	0	114	0.94
Breadfruit	34	27.2	38.1	0	182	0.82	34	93.1	94	7.2	326	1
Coconut fluid	34	142	122	25.4	521	1	34	217	179	28.4	710	1
Coconut meat	34	63.3	98.8	0	518	0.97	34	187	252	15.6	1320	1
Papaya	34	6.6	32.8	0	190	0.12	34	13.5	65	0	380	0.27
Pumpkin	18	1.2	4	0	16.9	0.28	18	2.7	6.8	0	25	0.39
Banana	34	0.02	0.12	0	0.67	0.03	34	0.3	1.6	0	9.1	0.06
Arrowroot	34	3.9	12	0	63.1	0.18	34	47.4	61.3	0	227	0.77
Citrus	34	0	0	0	0	0	34	0	0	0	0	0
Aqueous liquids	34	830	453	178	2750	1	34	530	399	0	2130	0.97
TOTAL INDIVIDUAL INTAKE	34	1190	518	432	3180	1	34	1430	673	525	2780	1

Table 5. Intake in grams per day of local dietary items in the MLSC survey at Ujelang for children from 0 to 3 y.

	Imports available						Imports unavailable					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Fish	16	20.5	14.7	0	54.4	0.81	16	35.9	42	0	168	0.81
Shellfish	16	1	3.2	0	12.7	0.19	16	3.7	7.2	0	25.4	0.38
Clams	16	3.2	7	0	26.5	0.31	16	8	14.2	0	52.8	0.5
Crabs	16	2	3.8	0	13	0.38	16	3.9	6.5	0	25.9	0.63
Octopus	12	1.7	3	0	10.4	0.58	12	1.7	3	0	10.4	0.58
Turtle	12	0.7	1.7	0	6.1	0.5	12	0.9	1.8	0	6.1	0.58
Domestic meat	16	7	11.6	0	41.3	0.81	16	6.9	8.1	0	28.1	0.81
Wild birds	16	1.6	3.2	0	9.6	0.25	16	10.2	11.6	0	38.2	0.63
Eggs	16	2.4	4.1	0	13.1	0.44	16	6	7.1	0	23.5	0.69
Pandanus	16	10.2	19.1	0	56	0.63	16	22.2	24.8	0	56	0.81
Breadfruit	16	9.9	22.2	0	91.1	0.63	16	45.9	57	0	217	0.88
Coconut fluid	16	70.7	70.3	0	266	0.94	16	88.6	73.3	11.8	266	1
Coconut meat	16	38.4	83.1	0	322	0.81	16	112	177	0	721	0.81
Papaya	14	0	0	0	0	0	14	0	0	0	0	0
Squash	0	--	--	--	--	--	1	0	0	0	0	0
Pumpkin	8	0.04	0.11	0	0.31	0.13	8	0.3	0.7	0	1.9	0.25
Banana	15	0.02	0.09	0	0.34	0.07	15	0.02	0.09	0	0.34	0.07
Arrowroot	16	0.2	0.9	0	3.7	0.13	16	36.4	79.6	0	315	0.5
Citrus	15	0	0	0	0	0	15	0	0	0	0	0
Aqueous liquids	16	502	241	140	1070	1	16	282	125	50.9	533	1
TOTAL INDIVIDUAL INTAKE	16	671	275	140	1220	1	16	664	395	84.5	1580	1

Table 6. Intake in grams per day of local dietary items in the MLSC survey at Ujelang for children from 4 to 11 y.

	Imports available						Imports unavailable					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Fish	37	29.6	19.4	0	102	0.97	37	61.2	35	18.1	168	1
Shellfish	37	4.3	6.8	0	25.4	0.54	37	17	24	0	116	0.89
Clams	37	9.8	17.8	0	92	0.54	37	38.8	49.4	0	190	0.92
Crabs	37	2.2	4.3	0	13	0.49	37	12.3	21.2	0	90.5	0.89
Octopus	33	2.1	4	0	13.1	0.52	34	16.3	48.3	0	273	0.88
Turtle	35	1.5	2.9	0	10.6	0.63	35	3.2	4.3	0	13.2	0.94
Domestic meat	37	13.2	25.9	0	146.4	0.84	37	22.1	48.5	0.2	288	1
Wild birds	37	3.5	8.5	0	41.2	0.32	37	16.3	21.7	0	107	0.89
Eggs	37	5.5	15.9	0	91	0.49	37	18.2	46.1	0	273	0.95
Pandanus	37	5.2	9.8	0	56	0.62	37	23.3	21.5	0	84	1
Breadfruit	37	9.4	9.4	0	54.2	0.81	37	41.6	47.3	7.2	217	1
Coconut fluid	37	76	57.6	12.8	266	1	37	151	149	25.4	710	1
Coconut meat	37	36.9	46.4	0	250	0.97	37	98.3	86.4	32.7	458	1
Papaya	34	5.6	17.4	0	95	0.21	34	8.4	18.5	0	76	0.35
Pumpkin	15	0.04	0.16	0	0.62	0.07	15	1.8	4.6	0	16.6	0.27
Banana	37	0	0	0	0	0	37	0	0	0	0	0
Arrowroot	37	0.1	0.6	0	3.7	0.03	37	25.4	42.4	0	220	0.76
Citrus	37	0	0	0	0	0	37	0	0	0	0	0
Aqueous liquids	37	536	227	183	1330	1	37	349	183	50.9	1070	1
TOTAL INDIVIDUAL INTAKE	37	741	230	360	1540	1	37	901	406	397	2720	1

Table 7. Intake in grams per day of local dietary items in the MLSC survey at Ujelang for children from 12 to 17 y.

	Imports available						Imports unavailable					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Fish	19	36.1	23.1	0	88.6	0.95	19	80.9	111	12.4	515	1
Shellfish	19	2.9	5.7	0	25.4	0.63	19	7.4	11.3	0	50.7	0.9
Clams	19	11.1	13.2	0	52.8	0.79	19	43.6	91.1	0.5	394	1
Crabs	19	3.7	6.5	0	25.9	0.47	19	30.1	62.5	0	272	0.9
Octopus	19	6.2	10.6	0	39.4	0.53	19	24.2	44.9	0	182	0.9
Turtle	18	2.8	6.2	0	26.4	0.56	18	5.4	12.2	0	52.8	0.89
Domestic meat	19	14.2	20.8	0	81.4	0.9	19	25.7	28	0.8	98.4	1
Wild birds	19	9.9	12.4	0	41.2	0.63	19	16.2	18.1	0	67.6	0.79
Eggs	19	10.4	13	0	39.2	0.68	19	27.8	42.8	0	182	0.84
Pandanus	19	6.7	11.7	0	48.2	0.68	19	22	23.3	4	96.3	1
Breadfruit	19	17.8	27.2	0	109	0.74	19	48.5	40.8	0	124	0.95
Coconut fluid	19	106	90.5	0	355	0.95	19	158	165	25.4	710	1
Coconut meat	19	54.2	71.6	1.9	308	1	19	133	110	43.7	471	1
Papaya	19	0	0	0	0	0	19	3.9	8.8	0	27.2	0.32
Pumpkin	11	4.1	8.7	0	25.5	0.27	11	7	12.1	0	33.2	0.45
Banana	19	0	0	0	0	0	19	0	0	0	0	0
Arrowroot	19	0	0	0	0	0	19	32.7	33	0	110	0.95
Citrus	19	0	0	0	0	0	19	0	0	0	0	0
Aqueous liquids	19	596	289	266	1150	1	19	368	144	160	710	1
TOTAL INDIVIDUAL INTAKE	19	880	360	457	1600	1	19	1030	482	439	2130	1

Table 8. Intake in grams per day of imported dietary items in the MLSC survey at Ujelang for adult males and females.

Food	Adult males						Adult females					
	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Baked bread	36	31.8	33.4	1.5	180	1	34	30.3	33.5	3.2	180	1
Fried bread	36	62.8	67.9	6.7	372	1	34	72	55.6	6.7	186	1
Pancakes	36	48	38.9	0	166	0.97	34	59.5	49.9	6	166	1
Cake	36	2.4	6.4	0	30.3	0.56	34	2.6	3.2	0	10.1	0.85
Rice	36	241	124	36.9	515	1	34	234	131	36.9	686	1
Instant potatoes	36	67.7	103	0	355	0.72	32	127	133	0	444	0.94
Sugar	36	73.1	29.2	2.8	146	1	34	65.2	35.2	12.2	170	1
Canned meat and poultry	36	103	81.1	24.5	340	1	34	147	136	13.6	511	1
Canned fish	36	97.1	100	0	510	0.97	34	146	157	2.8	523	1
Carbonated drinks	36	361	224	50.9	1070	1	34	338	206	50.9	1070	1
Canned juices	36	198	264	0	1070	0.83	34	306	287	0	1070	0.91
Milk products	36	210	140	0	621	0.97	34	274	227	0	710	0.97
Onion	1	0	0	0	0	0	2	0	0	0	0	0
Canned vegetables	1	0	0	0	0	0	0	--	--	--	--	--
Cocoa	0	--	--	--	--	--	1	178	0	178	178	1
Ramen noodles	0	--	--	--	--	--	1	6.1	0	6.1	6.1	1
TOTAL INDIVIDUAL INTAKE	36	1500	486	627	2720	1	34	1800	690	458	3140	1

Table 9. Intake in grams per day of imported dietary items in the MLSC survey at Ujelang for children from 0 to 3 y and from 4 to 11 y.

	Child: 0 to 3 y						Child: 4 to 11 y					
Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Baked bread	16	10.5	11.1	0.8	45	1	37	21.1	16.8	2.2	67.5	1
Fried bread	16	26.2	30.7	0	93.3	0.81	37	43.4	29	6.7	93	1
Pancakes	16	25.2	30.9	0	83.3	0.81	37	38.4	27.7	4.8	83	1
Cake	16	1.5	2.9	0	10.1	0.56	37	1.2	2.4	0	10.1	0.51
Rice	16	97	89.8	0	343	0.88	36	154	84.2	24.6	343	1
Instant potatoes	14	49	37.4	0	88.8	0.93	37	80.3	92	0	355	0.87
Sugar	16	44.9	34	2.8	85	1	37	55.7	27.7	5.7	85	1
Canned meat and other poultry	16	49.9	67.7	0	255	0.81	37	95.9	67.8	5.7	255	1
Canned fish	16	43.4	63.6	0	255	0.81	37	99.5	99.9	11.3	510	1
Other meat, fish, and poultry	1	0	0	0	0	0	2	48.7	34.5	24.4	73.1	1
Carbonated drinks	16	171	119	0	355	0.88	37	227	121	50.9	533	1
Canned juices	16	84.5	106	0	355	0.81	37	158	150	0	533	0.92
Milk products	16	123	125	11.8	444	1	37	197	150	12.8	533	1
Onion	0	--	--	--	--	--	1	0.06	0	0.06	0.06	1
Canned vegetables	1	24.4	0	24.4	24.4	1	0	--	--	--	--	--
Baby food	1	68.2	0	68.2	68.2	1	0	--	--	--	--	--
Cocoa	0	--	--	--	--	--	1	0	0	0	0	0
Candy	1	0.5	0	0.5	0.5	1	1	0.5	0	0.5	0.5	1
TOTAL INDIVIDUAL INTAKE	16	726	320	203	1440	1	37	1170	418	374	2550	1

Table 10. Intake in grams per day of imported dietary items in the MLSC survey at Ujelang for children from 12 to 17 y.

Food	Number	Mean	Standard deviation	Low value	High value	Proportion of nonzeros
Baked bread	19	23.5	23.3	3.2	90	1
Fried bread	19	52.8	36.8	13.3	139.5	1
Pancakes	19	43.7	48.9	0	166	0.95
Cake	19	1.7	2.6	0	10.1	0.63
Rice	19	210.8	98.3	61.5	343	1
Instant potatoes	19	134.7	159.3	11.8	710	1
Sugar	19	67.6	27.5	5.7	85	1
Canned meat and poultry	19	123.5	84.8	24.5	364.4	1
Canned fish	19	124.9	114.5	24.4	509.5	1
Carbonated drinks	19	286.3	101.2	25.4	355	1
Canned juices	19	220.2	259	0	1065	0.9
Milk products	19	247.6	166.2	0	532.5	0.9
Onion	1	0	0	0	0	0
Ramen noodles	1	6.1	0	6.1	6.1	1
TOTAL INDIVIDUAL INTAKE	19	1537.6	478.5	1108.6	2720.9	1

Community A

(a) Maximum availability of local foods.

(b) Highly depressed local economy--living within income provided by selling copra.

(c) Low population.

(d) Little or no ability to buy imported food.

Community B

(a) Low availability of local foods except fish, which can constitute as much as 33% of the total diet, because of excellent fishing in the area.

(b) Overpopulated--resulting in low availability of local foods.

(c) Good supply of imported foods (supply boat comes in every 2 to 3 wk) and readily available jobs.

Community C

(a) Low availability of local foods, even fishing is poor.

(b) Large government food program.

(c) Overpopulated.

(d) Good supply of imported foods and availability of cash to buy them.

The BNL data on the daily quantity of food prepared (or consumed) for the three types of communities are listed in Table 11. The community diet pattern applied to each atoll or island of the BNL survey is listed in Table 12. Naidu et al. of BNL feel that Bikini Atoll is representative of a community B diet pattern. However, because of our observations of dietary habits of the people who were living on Bikini Atoll in 1977 and 1978 and the observed similarities in lifestyle between the Bikini and Enewetak people, we have elected to apply the MLSC survey data to Bikini as well as Enewetak and Ujelang Atolls (Table 12).[5]

Considering that the MLSC survey was conducted to ascertain individual consumption and the BNL survey was conducted to ascertain food prepared for a family, the results of the two surveys do, for the most part, reinforce each other--especially when the BNL survey admittedly probably overestimated the actual food consumed. Therefore, for the purposes of this survey the amount of food prepared will be equivalent to the amount consumed.

The largest discrepancy between the two surveys is for coconut fluid. The range in the MLSC survey is 142 to 217 g/d for the average intake when imported foods are available and unavailable, respectively. The range in the BNL survey for the average prepared for a household is 305 g/d for community C to 1025 g/d for community A. The

Table 11. Quantity of food prepared (or consumed) per person per day (g/d) from the BNL diet survey.

Food	Community A	Community B	Community C
Coconut milk	277	125	125
Copra meat	246	68	82
Drinking coconut meat	259	100	133
Drinking coconut fluid	1025	514	305
Sprouting coconut	333	100	79
Jekero	377	0	0
Pandanus	137	96	64
Breadfruit	63	36	53
Arrowroot	5.3	0	0
Fish	439	194	84
Pumpkin	5.5	0	5
Banana	40	19	17
Papaya	33	0	3.6
Sweet potatoes	1	0	0
Local vegetables	20	0	0
Poultry	1.4	3	0
Wild birds	5.6	9	0.6
Pork	2.3	1.4	0.7
Turtle	2.7	0.1	0.3
Lobster	1.4	0.14	0.4
Giant clams	2.1	12	0
Snails	31	12	15
Octopus	2.5	20	3
Coconut crab	12	1	2
Clams (small)	5.9	3	5

Table 12. Diet survey and community diet pattern applied to each atoll or island.

BNL diet survey			
Community A	Community B	Community C	MSLC diet survey
Likiep	Rongelap	Kili	Ujelang
Ailuk	Utirik	Majuro	Enewetak
Wotho	Rongerik		Bikini
Bikar	Ailinginae		
Mejit	(Bikini)[a]		
Jemo	Taka		

[a] Placed in community B according to Ref. 20; however, for purposes of this survey the MLSC survey data is applied to Bikini Atoll.

prepared coconut meat in the BNL survey is 40 to 50% higher than that consumed according to the MLSC survey. The Pandanus fruit prepared is nearly double the MLSC consumption value.

Fish consumption in the MLSC survey is within the range observed by BNL. The intake of squash and papaya is also very similar in the two reports. However, intake of shellfish, clams, coconut crabs, domestic meat, wild birds, breadfruit, and arrowroot is greater in the MLSC survey than in the BNL survey.

In evaluating all available data on dietary habits in the Marshall Islands there are a few general conclusions to be drawn.

(1) The dietary intakes used here are based on the most current diet surveys.

(2) The dietary habits of a people are atoll specific and one should not arbitrarily generalize from one atoll to another.

(3) There is still some uncertainty as to what an average diet really is at any atoll.

(4) Many factors can affect the average diet over any specific year.

(5) Further atoll-specific dietary studies are needed to improve the precision of the dose assessments.

Throughout our discussion of diet and estimated dose, three expressions are used extensively: imports available, imports unavailable, and local foods. Imports-available conditions exist when field ships arrive on schedule and imported and local foods are both available. Imports unavailable indicates a condition where there is an absence of imported foods. Local foods is an LLNL expression for the locally grown foods of the MLSC and BNL surveys. Under normal conditions, imported foods are preferred over local food items. When imports are unavailable, it is assumed that local food consumption increases and that the intake of imported foods would be much more limited. This condition is then projected over a lifetime.

LIVING PATTERNS

Doses have been estimated for the major islands at each atoll assuming a continuous residence on each island and all local food derived from that island. Some of the islands listed are only used part time for residence or for agricultural purposes, but we have estimated the dose assuming continuous occupation to indicate the dose relative to current residence islands.

DOSE CALCULATIONS

BODY AND ORGAN WEIGHTS

Data from BNL have been summarized to determine the body weight of the Marshallese people.[27,28] The average body weights of adult males are listed in Table 13. The average, adult male body weight is 72 kg for Bikini, 71 kg for Enewetak, 61 kg for Rongelap, and 70 kg for Utirik; these are very near the 70-kg value of reference man.[21] As a result, we have used 70 kg as the average body weight in our dose calculations. The average body weight for 113 adult females in the Enewetak population is 61 kg; it is 67 kg for 30 Utirik females and 63 kg for 36 Rongelap females.[27]

DIET

The dietary intake data from the BNL survey and the maximum dietary intake data determined for adult females from the MLSC survey are the values used in our dose calculations. When the daily food intake in grams per day (Tables 4 and 11) are multiplied by the radionuclide concentrations in the food products (Appendix A), we obtain the average daily intake of radionuclides for the various atolls and islands (Table 14).

Table 13. Body weights of Marshallese adult males in kilograms.

Atoll	Number	Mean	Standard deviation	Minimum	Maximum
Utirik[a]	9	69	12.9	59.5	92.7
Bikini[b]	18	71.9	12.4	50	100.5
Rongelap[a]	22	61.2[a]	9.2	46.4	86.8
Enewetak[b]	130	71	14	37	126
TOTAL	179	69.8[c]		37	126

a Reference 28.
b Reference 27.
c Weighted mean.

THE ^{90}SR METHODOLOGY

Bone-marrow doses and dose rates are calculated in two steps. First, the model of Bennett[29-31] is used to correlate the ^{90}Sr concentrations in diet with that in mineral bone. Second, the dosimetric model developed by Spiers[32] is used to calculate the bone-marrow dose rate from the concentration in mineral bone.

Bennett's empirical model is developed from ^{90}Sr concentrations found in foods and autopsy bone samples from New York and San Francisco. The concentrations in the diet are the concentrations expected to result from worldwide fallout. It uses as input the actual dietary ^{90}Sr concentration and the output is the actual ^{90}Sr concentration in mineral bone determined from analysis of autopsy samples. It also includes age-dependent variations that allow us to make dose estimates for children as well as adults. An estimate of the calcium content of the normal Marshallese diet is listed in Table 15; the average intake is 0.8 g/d, which is very similar to the 0.9 g/d estimated for U.S. diets. The model is rather insensitive to calcium intake unless it greatly exceeds 1 g/d or is less than 0.3 g/d.[33] Therefore, the similar intake of calcium of the overall Marshallese and U.S. diets would indicate no major problems in applying the ^{90}Sr model to the Marshallese population.

Table 14. Average daily intake of radionuclides from the consumption of local food products in pCi/d in the Northern Marshall Islands when imported foods are available.

Atoll and island	^{137}Cs	^{90}Sr	$^{239+240}Pu$	^{241}Am
Likiep				
Agony	944[a] (130)[b]	15.3 (2.3)	0.055 (0.013)	0.029 (0.014)
Kapenor	620 (93)	17.3 (2.4)	0.044 (0.011)	0.022 (0.012)
Likiep	1190 (207)	15 (2)	0.039 (0.0097)	0.022 (0.011)
Rikuraru	749 (109)	10.2 (2)	0.044 (0.01)	0.023 (0.012)
Mejit				
Mejit	1497 (212)	7.09 (1.58)	0.053 (0.013)	0.02 (0.017)
Ailuk				
Enijabro	1001 (130)	6.02 (1.72)	0.053 (0.016)	0.016 (0.0082)
Enejelar	1185 (130)	5.61 (1.75)	0.049 (0.015)	0.095 (0.0064)
Bigen	1399 (227)	6.01 (1.76)	0.054 (0.016)	25.6
Agulue	1171 (164)	6.9 (1.76)	0.048 (0.015)	0.016 (0.0076)
Aliet	1353 (131)	6.74 (1.88)	0.039 (0.013)	0.0066 (0.0058)
Ailuk	1421 (176)	7.78 (1.68)	0.061 (0.017)	0.01 (0.0064)
Bererjao	1719 (149)	6.83 (1.86)	0.053 (0.015)	0.017 (0.008)
Kapen	1082 (160)	4.71 (1.65)	0.053 (0.016)	76.2
Utirik				
Aon	1311 (576)	0.76 (0.15)	0.0095	0.001
Utirik	956 (339)	35.6	0.077	0.001
Wotho				
Medyeron	466 (60)	30 (3)	0.18 (0.028)	0.015 (0.017)
Wotho	380 (69)	10 (1.7)	0.081 (0.013)	0.015 (0.017)
Kabben	326 (60)	8.8 (1.9)	0.081 (0.015)	0.019 (0.017)
Ujelang				
Ujelang	(104)	(2.27)	(0.016)	(0.012)
Taka				
Taka	190 (115)	15.8 (3.9)	0.06 (0.021)	0.012 (0.014)
Eluk	120 (80)	24.4 (4.3)	0.068 (0.027)	0.0089 (0.012)

Table 14. (Continued)

Atoll and island	^{137}Cs	^{90}Sr	$^{239+240}Pu$	^{241}Am
Rongelap				
Kabelle	5451 (2168)	1032 (115)	0.5 (0.13)	0.09 (0.05)
Eniaetak	4667 (1617)	196 (19)	0.26 (0.098)	0.12 (0.043)
Rongelap	4271 (1425)	276 (24.8)	0.27 (0.099)	0.078 (0.04)
Mellu	7997 (1852)	731 (64.4)	0.34 (0.12)	0.057 (0.034)
Arbar	1687 (539)	315 (34)	0.27 (0.092)	0.078 (0.036)
Naen	12070 (2976)	2861 (238)	0.73 (0.21)	0.14 (0.048)
Rongerik				
Eniwetak	2193 (823)	213 (26.5)	0.2 (0.089)	0.039 (0.018)
Rongerik	2183 (1125)	655 (73.2)	0.14 (0.067)	0.026 (0.017)
Bikar				
Jaboerukku	829 (157)	324 (26.9)	4.19 (0.48)	0.02 (0.012)
Bikar	1002 (144)	54.6 (5.55)	0.11 (0.023)	0.02 (0.012)
Jemo				
Jemo	912 (152)	20.6 (2.8)	0.086 (0.018)	0.026 (0.013)
Ailinginae				
Ucchawenen	1717 (545)	46.1 (8.03)	0.041 (0.02)	0.016 (0.014)
Knox	3494 (844)	2.57 (2.68)	0.051 (0.026)	0.016 (0.015)
Mogiri	1688 (585)	158 (17)	0.2 (0.065)	0.17 (0.014)
Sifo	585 (210)	91 (11.8)	0.14 (0.048)	0.015 (0.014)

[a] Values not enclosed by parentheses are based on dietary intake according to the BNL survey (Table 12).
[b] Values in parentheses are based on dietary intake according to the MLSC survey (Table 5).

Using Spiers' model we calculate the dose rate D_o to a small, tissue-filled cavity in bone from the ^{90}Sr concentration in mineral bone. Then from geometrical considerations, the dose rates to the bone marrow D_m and endosteal cells D_s are calculated using conversion factors $D_m/D_o = 0.32$ and $D_s/D_o = 0.43$, respectively. These factors are quoted by the United Nations Scientific Committee on the Effects of Atomic Radiation[34] and are equivalent to a bone-marrow dose rate of 1.4 mrad/y per pCi ^{90}Sr/g calcium and an endosteal cell dose rate of 1.9 mrad/y per pCi ^{90}Sr/g calcium. These dose rates are

Table 15. Average daily calcium intake for the Marshallese based on the MLSC diet when imported foods are available.

Food	Calcium (mg per 100 g)[a]	Intake (g/d)	Calcium (mg/d)
Fish	20	187	37
Turtle	110	4.3	5
Meat	12	168	20
Breadfruit	22	27	5.9
Pandanus	10	9.2	0.92
Banana	7	0.02	0.001
Lobster	45	5.1	2.3
Milk	120	274	328
Coconut meat	10	63	6.3
Coconut fluid	30	142	43
Bread	84[b]	102	86
Rice	10	234	23
Carbonated drink	8[b]	338	27
Canned juices	8[b]	306	25
Clams	100	8.9	8.9
Crabs	45	3.1	1.4
Potatoes	10	127	13
Eggs	55	11	6.1
Pancakes	215	60	129
TOTAL			768[c]

[a] Reference 39.
[b] Reference 40.
[c] The comparable value for the BNL community B dietary pattern is about 1000 mg and for the community A dietary pattern it is about 1140 mg.

determined directly and not by comparison to radium. Therefore rads are equivalent to rems. Because bone marrow is considered a blood-forming organ (annual dose limit equals 500 mrem/y) and endosteal cells are in the other organ category (annual dose limit equals 1500 mrem/y), the bone marrow is the more sensitive organ in bone for ^{90}Sr.[35]

THE ^{137}CS AND ^{60}CO METHODOLOGY

For ^{137}Cs and ^{60}Co, the methods of the ICRP[22,36,37] and the National Council on Radiation Protection and Measurements (NCRP)[38] as developed by Killough and Rohwer in their INDOS code[39] are used for the dose calculations. This code is used as published; however, the output is modified to show the body burdens for each year. For ^{137}Cs, which is of major importance in the Marshall Islands, the model for adults consists of two compartments with removal half-times of 2 and 110 d, with 10% of the intake going to the 2-d compartment and 90% to the 110-d compartment. These data are consistent with preliminary data obtained by BNL on the half-time of the long-term compartment in the Marshallese.[40] The average results for ten Marshallese males showed a mean of 114 d (range: 76 to 178 d) for the long-term compartment. For 21 females the mean value is 83 d (range: 63 to 126 d). The gut transfer coefficient for ^{137}Cs is 1.

The half-time of ^{137}Cs in children is determined in two stages. The equation used to determine the half-time of ^{137}Cs, developed by Snyder at Oak Ridge National Laboratory, is $T_{1/2}$ = 1.63 M, where M is the body mass in kilograms.[41] The M as a function of age is determined using equations given by Spiers.[32] When the Snyder and Spiers equations are combined, the half-time as a function of age can be determined. The average half-time using the above approach for ages 5 through 10 is about 42 d. Data from BNL whole-body counting for 14 Marshallese children in this age bracket is 43 d. For ages 11 to 15, the Snyder-Spiers method gives an average half-time of about 70 d, while the BNL data for nine adolescents in this age bracket is 69 d.[27]

TRANSURANIC RADIONUCLIDES METHODOLOGY

Inhalation

The inhalation model used for the various isotopes of plutonium and for ^{241}Am is that of the ICRP Task Group.[21,42] Parameters for the lung model are also those of the ICRP--the gut-to-blood transfer for plutonium isotopes is 10^{-4} and for ^{241}Am it is 5×10^{-4} (see Ref. 23). Both ^{241}Am and plutonium are assumed to be class-W compounds.

Ingestion

For the ingestion pathway, the gut transfer coefficients are, as stated above, 10^{-4} for plutonium and 5×10^{-4} for ^{241}Am. The critical organs are bone and liver with 100-y biological half-lives for plutonium and ^{214}Am in bone and 40 y in liver. Of the plutonium and ^{241}Am transferred to blood, 45% is assumed to reach the bone and 45% is assumed to reach the liver. The remaining 10% is distributed among other organs.

RESULTS

Here we present the predicted maximum annual dose rates and the 30- and 50-y integral doses for the different living patterns and options starting in September 1978. The doses are calculated using the average dietary intake, radionuclide concentration, radionuclide fraction absorbed into the body from that ingested, biological residence times, and external dose rate. The maximum annual dose rate for the whole body for a case where an atoll or island is yet to be resettled is defined as the dose rate in that year after the Marshallese return when the sum of the ingestion whole-body dose from ^{137}Cs and the external gamma dose is a maximum. For bone marrow, the maximum occurs when the ingestion bone-marrow dose from ^{137}Cs and ^{90}Sr and the external gamma dose is a maximum.

The maximum, annual whole-body and bone-marrow dose rates for the major islands at each atoll are listed in Table 16 for the MLSC diet and for the appropriate BNL diet. This gives the range of doses that might be expected at an atoll depending on the dietary conditions. The estimated doses include the contribution from all of the major exposure pathways excluding the 22 mrem/y of natural background exposure from cosmic radiation.[6] The doses are calculated assuming that people would be living full time on the listed island, with all of their local foods from that island. This includes islands at atolls that are currently uninhabited. At each inhabited atoll we have included the islands that we were able to determine were being used as a residence or partial residence island or as major agricultural island. At uninhabited atolls we have included the major islands that might possibly be used for residence.

All of the inhabited atolls except Rongelap and many of the uninhabited atolls have annual doses of less than 30 mrem/y, regardless of the assumed diet. The range is from about 3 to 6 mrem/y for the MLSC diet to 20 to 29 mrem/y for the BNL diets. The doses at uninhabited Ailinginae Atoll would range from 13 to 90 mrem/y for the MLSC and BNL diets, respectively. The doses at the southern residence islands at Rongelap Atoll range from 35 to 58 mrem/y for the MLSC diet and from 55 to 135 mrem/y for the BNL diet. If Rongerik were continually inhabited, the respective range of doses would be 42 to

Table 16. Maximum, annual whole-body and bone-marrow dose rates in mrem/y for the various diets at the Northern Marshall Islands.

Atoll and island	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Likiep (L)[a]						
Agony (45)[b]	3.7	4	--	--	18	20
Kapenor (55)	3.2	3.4	--	--	13	14
Likiep (37)	5.2	5.4	--	--	23	25
Rikuraru (2)	3.4	3.6	--	--	14	15
Mejit (R)						
Mejit (1)	5.9	6.0	--	--	31	32
Ailuk (A)						
Enijabro (2)	3.9	4.1	--	--	20	21
Enejelar (4)	4.1	4.2	--	--	24	24
Bigen (7)	5.9	6.1	--	--	29	29
Agulue (53)	4.5	4.7	--	--	24	25
Aliet (20)	3.9	4.1	--	--	27	28
Ailuk (51)	4.7	4.9	--	--	29	30
Bererjao (33)	4.1	4.3	--	--	34	35
Kapen (1)	4.7	4.8	--	--	22	23
Utirik (I)						
Aon (8)	15	16	29	31	--	--
Utirik (6)	11	12	22	24	--	--
Wotho (M)						
Medyeron (1)	2.4	2.7	--	--	10	14
Wotho (4)	2.5	2.7	--	--	8.6	9.6
Kabben (17)	2.5	2.7	--	--	7.7	8.7
Ujelang (J)						
Ujelang (18)	3.3	3.5	5.7	6.2	--	--

Table 16. (Continued)

Atoll and island	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Taka (H)						
Taka (4)	4.8	5.3	6.1	7.0	--	--
Eluk (5)	3.6	4	3.8	4.3	--	--
Rongelap (F)						
Kabelle (13)	130	140	200	300	--	--
Eniaetok (33)	95	100	150	220	--	--
Rongelap (42)	56	58	110	135	--	--
Mellu (23)	91	97	200	270	--	--
Arbar (43)	35	39	55	90	--	--
Naen (1)	325	330	490	580	--	--
Rongerik (G)						
Eniwetak (11)	42	45	69	73	--	--
Rongerik (6)	60	66	81	90	--	--
Bikar (D)						
Jaboerukku (1)	6.1	10	--	--	19	69
Bikar (4)	6.0	6.6	--	--	23	30
Jemo (S)						
Jemo (1)	4.2	4.5	--	--	14	16
Ailinginae (C)						
Ucchuwanen (15)	22	24	44	54	--	--
Knox (10)	25	27	76	87	--	--
Mogiri (24)	24	26	44	58	--	--
Sifo (27)	13	14	20	25	--	--

[a] Code letter for atoll.
[b] Code number for island.

66 mrem/y and 69 to 90 mrem/y for the 2 diets. If the northern islands at Rongelap were inhabited continuously, the estimated doses for the various islands would range from 90 to 330 mrem/y for the MLSC diet and from 150 to 580 mrem/y for the BNL diet.

For reference, these doses can be compared with U.S. external background doses of 54 mrem/y weighted for the entire U.S. population; 107 mrem/y for Denver, Colorado; and about 182 mrem/y for Leadville, Colorado.[43] A more detailed discussion of the U.S. external background doses is given in the summary. For further reference, the estimated doses at the atolls, even though they are calculated using average values, can be compared to the U.S. Federal guideline of 500 mrem/y in excess of background for an individual.[44]

The 30- and 50-y integral doses are listed in Tables 17 and 18, respectively, for all atolls. For Likiep, Wotho, Ujelang, Mejit, Ailuk, Taka, Jemo, and Bikar the 30-y integral doses all fall between 0.055 and 0.14 rem for the MLSC diet and between 0.09 and 0.7 rem for the BNL diet. Doses for Utirik range from 0.25 to 0.72 rem for the MLSC diet and the BNL diet, respectively. If Rongerik were inhabited continuously, the estimated doses would range from 0.94 to 1.6 rem for the MLSC diet and 1.5 to 3.8 rem for the BNL diet.

The inhabited southern islands of Rongelap Atoll have 30-y integral, whole-body doses for the MLSC diet ranging from 0.76 to 1.3 rem and for the BNL diet they range from 1.2 to 2.5 rem. If the northern islands of Rongelap were populated continuously, the estimated doses for the MLSC diet would range from 2 to 7.4 rem and for the BNL diet they would range from 3.4 to 14 rem.

These 30-y integral, whole-body doses can be compared with the recommended, maximum population dose of 5 rem above background in 30 y according to the U.S. Federal guidelines.[44] With the exception of the uninhabited northern islands of Rongelap and the uninhabited Rongerik, the estimated doses are for the most part from 5 to 100 times less than this guideline.

Tables 19 and 20 list the 30-y integral doses for Likiep and Rongelap Islands, respectively, with the contributions of the various radionuclides to the total dose. As observed at Enewetak and Bikini, ^{137}Cs is the major contributor to the estimated dose. Second is ^{90}Sr, with the transuranic radionuclides plutonium and americium being relatively minor contributors. Likiep and Rongelap Islands are representative of all of the atolls and islands as far as the relative significance of the various radionuclides.

Table 17. The 30-y integral, whole-body and bone-marrow doses in rem for the various diets at the Northern Marshall Islands.

Atoll and island	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Likiep (L)[a]						
Agony (45)[b]	0.085	0.094	--	--	0.41	0.47
Kapenor (55)	0.072	0.080	--	--	0.28	0.34
Likiep (37)	0.12	0.13	--	--	0.53	0.58
Rikuraru (2)	0.077	0.084	--	--	0.33	0.36
Mejit (R)						
Mejit (1)	0.13	0.14	--	--	0.71	0.73
Ailuk (A)						
Enijabro (2)	0.089	0.094	--	--	0.46	0.48
Enejelar (4)	0.092	0.098	--	--	0.54	0.56
Bigen (7)	0.13	0.14	--	--	0.65	0.67
Agulue (53)	0.10	0.11	--	--	0.54	0.57
Aliet (20)	0.088	0.095	--	--	0.61	0.64
Ailuk (51)	0.11	0.11	--	--	0.65	0.68
Bererjao (33)	0.092	0.099	--	--	0.77	0.80
Kapen (1)	0.11	0.11	--	--	0.50	0.52
Utirik (I)						
Aon (8)	0.35	0.37	0.65	0.72	--	--
Utirik (6)	0.25	0.27	0.49	0.59	--	--
Wotho (M)						
Medyeron (1)	0.055	0.065	--	--	0.24	0.33
Wotho (4)	0.057	0.063	--	--	0.2	0.23
Kabben (17)	0.057	0.065	--	--	0.18	0.21
Ujelang (J)						
Ujelang (18)	0.075	0.082	0.13	0.15	--	--

Table 17. (Continued)

Atoll and island	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Taka (H)						
Taka (4)	0.11	0.13	0.14	0.17	--	--
Eluk (5)	0.082	0.096	0.085	0.11	--	--
Rongelap (F)						
Kabelle (13)	2.9	3.3	4.4	7.7	--	--
Eniaetok (33)	2.1	2.3	3.4	5.5	--	--
Rongelap (42)	1.3	1.4	2.5	3.3	--	--
Mellu (23)	2	2.2	4.4	6.8	--	--
Arbar (43)	0.76	0.92	1.2	2.3	--	--
Naen (1)	7.1	7.4	11	14	--	--
Rongerik (G)						
Eniwetak (11)	0.94	1.0	1.5	1.7	--	--
Rongerik (6)	1.3	1.6	1.8	2.1	--	--
Bikar (D)						
Jaboerukku (1)	0.14	0.26	--	--	0.44	1.8
Bikar (4)	0.14	0.16	--	--	0.52	0.73
Jemo (S)						
Jemo (1)	0.096	0.11	--	--	0.33	0.39
Ailinginae (C)						
Ucchuwanen (15)	0.5	0.58	1	1.3	--	--
Knox (10)	0.56	0.64	1.7	2.1	--	--
Mogiri (24)	0.53	0.61	1	1.4	--	--
Sifo (27)	0.28	0.32	0.45	0.62	--	--

[a] Code letter for atoll.
[b] Code number for island.

Table 18. The 50-y integral, whole-body and bone-marrow doses in rem for the various diets at the Northern Marshall Islands.

	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
Atoll and island	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Likiep (L)[a]						
Agony (45)[b]	0.12	0.13	--	--	0.56	0.66
Kapenor (55)	0.098	0.11	--	--	0.39	0.47
Likiep (37)	0.16	0.17	--	--	0.73	0.80
Rikuraru (2)	0.11	0.12	--	--	0.45	0.50
Mejit (R)						
Mejit (1)	0.18	0.19	--	--	0.97	1.0
Ailuk (A)						
Enijabro (2)	0.12	0.13	--	--	0.64	0.67
Enejelar (4)	0.13	0.14	--	--	0.74	0.77
Bigen (7)	0.19	0.19	--	--	0.89	0.92
Agulue (53)	0.14	0.15	--	--	0.74	0.79
Aliet (20)	0.12	0.13	--	--	0.84	0.89
Ailuk (51)	0.15	0.16	--	--	0.89	0.94
Bererjao (33)	0.13	0.14	--	--	1	1.1
Kapen (1)	0.15	0.15	--	--	0.69	0.72
Utirik (I)						
Aon (8)	0.48	0.51	0.89	1.0	--	--
Utirik (6)	0.34	0.37	0.67	0.82	--	--
Wotho (M)						
Medyeron (1)	0.075	0.091	--	--	0.32	0.47
Wotho (4)	0.078	0.088	--	--	0.27	0.32
Kabben (17)	0.079	0.091	--	--	0.24	0.29
Ujelang (J)						
Ujelang (18)	0.10	0.11	0.18	0.21	--	--

Table 18. (Continued)

Atoll and island	MLSC diet		BNL community B diet pattern		BNL community A diet pattern	
	Whole body	Bone marrow	Whole body	Bone marrow	Whole body	Bone marrow
Taka (H)						
Taka (4)	0.15	0.18	0.19	0.24	--	--
Eluk (5)	0.11	0.13	0.12	0.15	--	--
Rongelap (F)						
Kabelle (13)	4	4.5	6	11	--	--
Eniaetok (33)	2.9	3.2	4.7	7.6	--	--
Rongelap (42)	1.7	1.8	3.4	4.6	--	--
Mellu (23)	2.8	3.1	6.1	9.4	--	--
Arbar (43)	1.0	1.3	1.6	3.2	--	--
Naen (1)	9.7	10	15	19	--	--
Rongerik (G)						
Eniwetak (11)	1.3	1.4	2.1	2.3	--	--
Rongerik (6)	1.8	2.1	2.5	3	--	--
Bikar (D)						
Jaboerukku (1)	0.19	0.38	--	--	0.60	2.7
Bikar (4)	0.19	0.22	--	--	0.71	1.0
Jemo (S)						
Jemo (1)	0.13	0.15	--	--	0.45	0.55
Ailinginae (C)						
Ucchuwanen (15)	0.69	0.8	1.4	1.9	--	--
Knox (10)	0.78	0.89	2.4	2.9	--	--
Mogiri (24)	0.73	0.84	1.4	2.0	--	--
Sifo (27)	0.39	0.45	0.61	0.86	--	--

[a] Code letter for atoll.
[b] Code letter for island.

Table 19. The contribution of each radionuclide to the 30-y integral doses at Likiep Island.

	30-y integral dose (rem)			
	Whole body		Bone marrow	
Pathway and nuclide	MLSC diet (imports available)	BNL diet (community A)	MLSC diet (imports available)	BNL diet (community A)
Ingestion				
^{137}Cs	0.092	0.50	0.092	0.51
^{90}Sr	--	--	0.0064	0.046
$^{239+240}Pu$	--	--	0.000016	0.000097
^{241}Am	--	--	0.00011	0.00033
External gamma[a]				
$^{137}Cs + ^{60}Co$	0.026	0.026	0.026	0.026
Inhalation				
$^{239+240}Pu$	--	--	0.00014	0.00014
^{241}Am	--	--	0.00011	0.00011
TOTAL	0.12	0.53	0.13	0.58

[a] The actual external doses will be less than those listed here because of shielding by houses and other buildings and coral gravel spread around the houses.

Table 21 lists the 30-y integral doses for Likiep and Rongelap Islands by exposure pathway. The contributions from the external gamma pathway for most outer atolls are less than 30% of that from the food ingestion pathways for the MLSC diet when imported foods are available. For atolls more in line with the trajectory of the Bravo cloud, the external gamma pathway contribution is between 40 and 70% of the total dose for the MLSC diet. For the BNL diets and the MLSC diet when imported foods are unavailable, the dose from the ingestion pathway greatly exceeds that from the external gamma pathway. The contribution of the marine, cistern water, and inhalation pathways is very small relative to the terrestrial food chain pathway. Again, the results for Rongelap and Likiep Islands are similar to those for the other atolls and islands.

Table 20. The contribution of each radionuclide to the 30-y integral doses at Rongelap Island.

Pathway and nuclide	30-y integral dose (rem)			
	Whole body		Bone marrow	
	MLSC diet (imports available)	BNL diet (community B)	MLSC diet (imports available)	BNL diet (community B)
Ingestion				
^{137}Cs	0.64	1.8	0.64	1.8
^{90}Sr	--	--	0.080	0.87
$^{239+240}Pu$	--	--	0.00018	0.00051
^{241}Am	--	--	0.00047	0.0012
External gamma[a]				
$^{137}Cs + ^{60}Co$	0.62	0.62	0.62	0.62
Inhalation				
$^{239+240}Pu$	--	--	0.0078	0.0078
^{241}Am	--	--	0.0033	0.0033
TOTAL	1.3	2.4	1.4	3.3

[a] The actual external doses will be less than those listed here because of shielding by houses and other buildings and coral gravel spread around the houses.

Table 21. The contribution of each exposure pathway to the 30-y integral doses for the MLSC diet when imports are available at Likiep and Rongelap Islands.

Pathway	30-y integral dose (rem)			
	Likiep Island		Rongelap Island	
	Whole body	Bone marrow	Whole body	Bone marrow
Marine foods	0.00021	0.00037	0.00047	0.00069
Cistern water[a]	0.000025	0.00025	0.0002	0.001
Terrestrial foods	0.092	0.098	0.64	0.72
Inhalation	--	0.00024	--	0.011
External gamma	0.026	0.026	0.62	0.62
TOTAL	0.12	0.13	1.3	1.4

[a] Based on average daily intake of 1 L.

The major contribution to the terrestrial food chain comes from food such as coconut, breadfruit, Pandanus, etc. Looking specifically at the terrestrial foods, coconut contributes a major share of the dose because of its ^{137}Cs concentration and the high intake of coconut.

DISTRIBUTION OF DOSES AROUND THE ESTIMATED AVERAGE DOSE

The doses presented herein are calculated using the mean value of the data available for each parameter in the dose models. For example, model parameters include body weight, residence time of radionuclides in the body, radionuclide concentrations in either foods or soil, dietary intake (measured in grams per day), and fractional deposition of radionuclides in body organs or compartments. Data for all of these parameters have a log-normal distribution. Thus, the mean value calculated from the data does not represent the midpoint of the distribution but rather falls between the 65th and 70th percentile; that is, for a given parameter approximately 65 to 70% of the data points fall below the mean value. Thus, if the mean values for the parameters are used in the dose models and the data sets are log-normally distributed, the final calculated average doses are also log-normally distributed. For a more detailed discussion of the mathematical evaluation of this problem, see Refs. 4 and 5.

The average doses presented here fall at the 68th percentile on the distribution; that is, 68% of the population would be expected to have doses below this value. A dose equal to twice the average falls at the 88th percentile and a dose three times the average falls at the 95th percentile. Thus, 68% of the population of most atolls would have a 30-y integral dose less than those listed in Table 17. Based on this analysis, there is about a 5% chance for a person to receive a dose that is greater than three times the average dose.

SUMMARY AND CONCLUSIONS

The doses we have presented are calculated from the date of the survey conducted in September of 1978. Because resettlement has not yet occurred at some atolls, the doses for those currently uninhabited atolls will be reduced from those listed in Tables 16 and 17, depending on when resettlement might, if ever, occur.

The diets used to determine the daily intake of radionuclides are the most direct data available on the current dietary habits in the northern Marshall Islands (see Tables 3 to 12). Lacking direct dietary data for many of the Marshallese, we elected to calculate the dose at all atolls using the results from the MLSC diet survey of the Enewetak people on Ujelang Atoll. The dose is also calculated using the BNL diet results by applying the appropriate diet to each atoll as recommended by the BNL authors. We have used the BNL diets even though the authors feel their values probably overestimate the amount of food actually consumed.[20] The diet is, of course, very important in predicting doses to a population because the radionuclide intake, and therefore the dose, will correspond directly with the intake of locally grown foods. We have mentioned in previous assessments the importance of the diet and the uncertainty that was inherent in previously constructed dietary patterns.[4,5,10] The BNL diet survey once again indicates the atoll-specific nature of the dietary intake and supports our concern that specific dietary information is needed for each atoll and each cultural grouping.[20] As an example, if the average coconut intake were assumed to be as high as the values listed for coconut meat and fluid in the BNL report for community B, then the estimated maximum annual dose rates would be about 2.7 times higher than those calculated using the MLSC results when imported foods are available and 1.5 times higher than when imported foods are unavailable. It is clear that more precise diet data are needed for each atoll if we hope to develop more precise dose estimates.

The normal condition referred to in the MLSC diet is the usual and expected living conditions in which the preferred imported foods are available. For the situation where imported foods are unavailable, it is assumed that there is a primary dependence on locally grown crops for a person's lifetime. It is again emphasized that an accurate picture of the diet, especially the consumption rate of locally grown foodstuffs, is extremely important in the dose predictions for current living patterns and resettlement options at an atoll.

The maximum annual dose rates for Likiep, Wotho, Ujelang, Mejit, Ailuk, Taka, Jemo, and Bikar for all exposure pathways excluding cosmic radiation are less than 6 mrem/y if the MLSC diet is used and are less than 30 mrem/y even when the BNL diet is used. The only significant source of natural external background exposure in the Marshall Islands is the 3.5 μR/h or 22 mrem/y from cosmic radiation.[6] For reference, these doses can be compared with the external background doses observed in the U.S. The average dose from cosmic radiation for the entire U.S population is 28 mrem/y and range as high as 50 mrem/y for Denver, Colorado to 125 mrem/y for Leadville, Colorado.[43] Therefore, the additional cosmic radiation doses in the U.S. relative to the Marshall Islands range from 6 to 103 mrem/y depending on whether the U.S. population average or specific subfractions of the population are considered. The external background exposure from terrestrial sources in the U.S., which includes structural shielding, does not exist in the Marshall Islands. It is 26 mrem/y for the U.S. population-weighted dose and about 57 mrem/y for Denver and Leadville, Colorado.[43] Therefore, the total external background dose in the U.S. is 54 mrem/y based on the U.S. population-weighted average; 107 mrem/y for Denver, Colorado, which has a population of about 500,000 (urban population of about 1,500,000); and about 182 mrem/y for Leadville, Colorado, which has a population of about 10,000. Thus, depending on the diet, most of the atolls have estimated doses from all exposure pathways excluding cosmic radiation that range from about 4 to 57% of the U.S. population-weighted background dose; from about 2 to 29% of the Denver, Colorado dose; and from about 1 to 17% of the Leadville, Colorado dose. When the 22 mrem/y of cosmic radiation background dose in the Marshall Islands is added, the total doses at the atolls for all exposure pathways range from 45 to 100% of the U.S. population weighted external background dose; from about 23 to 50% of the Denver, Colorado external background dose; and from 13 to 29% of the Leadville, Colorado external background dose, depending on which diet is employed. The natural internal dose will be similar in the U.S. and the Marshall Islands.

For additional reference, these estimated doses for the various atolls can be compared to the U.S. Federal guideline of 500 mrem/y above background for an individual.[44] The doses at most atolls are from 1 to 5% of the guideline, depending on which diet is assumed to apply. The highest estimated doses for an inhabited atoll are for the southern islands at Rongelap where the doses range from about 10 to 50% of the guideline, depending on the diet.

The 30- and 50-y integral doses provide a similar picture. The 30-y integral doses for Likeip, Wotho, Ujelang, Mejit, Ailuk, Taka, Jemo, and Bikar for the MLSC diet are less than 0.14 rem and for the BNL diet they are less than 0.7 rem. This is less by a factor of 20 to 33 than U.S. Federal guidelines of 5 rem/30 y for a population[44] and less than the integrated 30-y external background dose in the U.S., which ranges from 1.6 to 5.5 rem.[43] The 30-y integral doses for the MLSC diet are less than 0.25 rem for Utirik, less than 0.49 rem for Ailinginae, less than 1.3 rem for the southern islands of Rongelap and for Rongerik, less than 7.4 rem for Naen Island on northern Rongelap, and less than 3.3 rem for the other northern islands of Rongelap if they were to be continuously inhabited. Similarly, for the BNL diet the doses are less than 0.72 rem for Utirik, less than 2.1 rem for Ailinginae, less than 2.5 rem for the southern islands of Rongelap, less than 14 rem for Naen Island at Rongelap, and less than 7.6 rem for the other northern islands at Rongelap for continuous occupation.

Ingestion doses from ^{60}Co are negligible and therefore do not appear in any of the tables. It is observed at low concentrations in soil samples, but incorporation in plants is such that concentrations rarely exceed the detection limit. The ^{60}Co contribution to the external gamma dose is about 5% or less.

Doses from ^{90}Sr, ^{137}Cs, and ^{60}Co via the inhalation pathway are two to four orders of magnitude smaller than doses from the transuranic radionuclides and are therefore not listed in the dose tables.

The global deposition of ^{137}Cs in the 10 to 15° N. latitude of the Pacific region through 1974 was about 30 mCi/km^2 (Ref. 45). Adjusting this to 1978 and comparing it with the concentrations of ^{137}Cs determined here, we see that 30% of the ^{137}Cs soil concentration (and therefore the dose) listed for Likiep, Wotho, Ailuk, Mejit, Ujelang, Bikar, Jemo, and Taka is from worldwide fallout and is not specific to the Marshall Islands. The worldwide fallout of ^{137}Cs accounts for about 7% of the ^{137}Cs at Utirik and about 2% at Rongerik and Rongelap Islands. The other 70, 93, and 98% of the ^{137}Cs concentrations, respectively, is due to intermediate range and global fallout.

The global deposition of ^{137}Cs between 30 and 50° N., which includes the United States, is greater by more than a factor of 3 than that in the 10 to 15° N. latitude. Thus, the deposition of ^{137}Cs from global fallout between 30 to 50° N. is nearly equal to the total ^{137}Cs observed at Likiep, Wotho, Ailuk, Mejit, Ujelang, Bikar, Jemo, and Taka. The deposition of other radionuclides follows a similar pattern.

Another comparison for this latitude and this area of the Pacific is the background concentrations of ^{137}Cs in the soils at Ponape, Truk, Palau, and Guam. The ^{137}Cs soil concentration averaged over 10 cm range from 0.1 to 0.5 pCi/g.[46] The range of ^{137}Cs concentrations in the 0- to 10-cm soil averaged for Likiep, Wotho, Ailuk, Ujelang, Mejit, and Jemo is 0.2 to 0.7 pCi/g, very similar to the background levels at the other areas of Micronesia, although slightly higher.

Uncertainty in the final dose values can result from uncertainty in three sources of input data: (1) radionuclide concentration in food (or soil); (2) dietary intake; and (3) the biological parameters such as radionuclide turnover times in the body, fractional deposition in various organs, and body or organ weight.

First, the distributions of radionuclide concentration data in relatively large vegetation and soil sample populations from Bikini and Eneu Islands at Bikini Atoll is discussed in Ref. 5. The distributions are log-normal; the arithmetic mean $\bar{x}$ includes some 68% of the population, 2 $\bar{x}$ includes 88% of the population, and 3 $\bar{x}$ includes better than 95%. The number of food plants with a concentration three times the mean value is less than 5% of the total. Therefore, the probability of a person finding his entire diet for 1, 5, 10, or 30 y from food crops with a concentration of three times the mean value is very small. Soil concentration data are also log-normally distributed with similar percentages accounted for by $\bar{x}$, 2 $\bar{x}$, and 3 $\bar{x}$; concentrations in plants do, overall, reflect the concentrations in soil.

The observed log-normal distribution of radionuclide concentrations in soils and plants at the atolls is consistent with most elemental distributions in nature. Also, the observation that three times the mean value includes more than 95% of the population distribution is consistent with other observations, several of which have recently been summarized by Cuddihy et al.[47]

The ^{90}Sr concentration distributions in bone have been specifically addressed by Kulp and Schulert.[48] They found that ^{90}Sr from fallout was distributed log normally and that the 98th percentile value was 2.3 times the mean value. Maximum values observed for ^{90}Sr in bone by Bennett were three times the mean; that is, most of the data fell below three times the mean.[27-29] These data also reflect the combined variability of the ^{90}Sr concentration in food products and in dietary intake.

The ^{137}Cs gamma-exposure data, which is listed in Refs. 6 and 11, show that the maximum exposure rate at an isolated point on the island is, for most islands, less than three times the mean value. In many cases, the maximum observed value is only two times the mean value. Because of the movement of people around their residence island, the variation of individual doses around the average dose is probably minimized and would not add much variability to the distribution of doses calculated for the ingestion pathway. In addition, we have not included in the external doses the reduction in external exposure that would occur from spreading crushed coral around the houses and shielding by the houses.

Second, the dietary intake of local foods is a major source of input data that is somewhat uncertain and that could lead to higher average doses than presented here if the average intake were significantly greater than we have assumed. For example, if the current lifestyle for Rongelap, Utirik, and Bikini should change drastically with a total reliance on local foods, then the average doses would be higher than those listed here. This is a very unlikely occurrence because the people have a source of income and imported foods are now considered a staple and a necessity, not a luxury. The people will have access to outside goods and will trade with either the United States or other world governments. Conversely, if the diets of the people at Likiep, Ailuk, Wotho, and Mejit were to include more imported foods, they would be more like the BNL community B or MLSC diets, in which case the doses would be much lower than listed here.

Even if the use of imported and local foods remains as it currently is, there is a possibility that the average intake of local foods could be greater than we have assumed in our model diets--for example, if the entire BNL diet rather than the MLSC results were assumed to apply to Ujelang Atoll. The reasons for our selection of the dietary intakes used here are discussed above in Limitations of the Assessment.

Third, the range of values observed for the retention of ^{137}Cs in humans has been summarized by the ICRP[36,37] and the NCRP.[38] For example, the range of observed values for the retention time for the short-term compartment is 0.5 to 2.1 d with a mean of 1 d; the upper limit that has been observed is greater than the mean by only a factor of 2. For the long-term compartment, the data range from 60 to 165 d with a mean value of 110 d; the maximum value in this case is less than twice the mean value. The fraction of the intake that has been observed to go to the short-term compartment (i.e., 2-d) ranges from 0.02 to 0.22 with a mean of 0.1; for the long-term compartment (i.e., 110-d), the range is 0.78 to 0.97 with a mean value of 0.9. For both cases the maximum value is less than twice the mean.

Previous evaluations indicate that dietary intake in a population is log-normally distributed. Our evaluation of the MLSC survey confirms this log-normal distribution. The distribution of doses is also log normal and the mean dose calculated using the average value for all model parameters falls at about the 68th percentile; that is, 68% of the population would be expected to have a dose at or below the listed mean value. A dose equal to twice the mean value will include 88% of the population. It is important to recognize when we talk about the average doses here that they are not at the midpoint (or 50% point) of the distribution.

There are several reasons why the average doses we present might be lower.

(1) The doses are calculated assuming residence since 1978. For uninhabited atolls, doses would be expected to be about 2.3% lower per year until resettlement occurs based on the radiological decay of cesium and strontium.

(2) We still do not know the environmental residence time of cesium in the atoll ecosystem. If it were 30 y (i.e., equal to the radiological half life), the estimated doses would be half (50%) of those presented in the tables. If the environmental residence time were as long as 50 y, the doses would be 34%

lower and if it should be as short as 20 y, the estimated doses would be 64% lower. We have experiments under way to determine the environmental residence time and when data are available, they will be included and the estimated doses adjusted accordingly.

(3) We have not included shielding from external gamma exposure that occurs from the housing structure and from coral gravel that is commonly spread in a 10- to 15-m area around the houses. The people spend considerable time in and around their houses.[6] Therefore, a significant reduction in the external exposure around the housing area can occur. This reduction from shielding by the house can be a factor of 2 based on a 30 to 40% occupancy. If coral gravel is spread around the house, another factor of 2 reduction can be obtained. Depending on the location of the housing, the use or non-use of coral gravel, and the percentage of time spent in or near the house, the external dose reduction could range from 15 to 80%.

(4) We have used the average values for all of the parameters in the dose models and the resulting doses fall at about the 68% point on the distribution. If we used the median values to estimate the doses for the midpoint of the distribution, the doses would be lower.

(5) If there should be a greater future reliance on imported foods with a concurrent decrease in consumption of local foods, the estimated doses would be lower. Also, the BNL diets applied to most atolls are considered to be upper limits for current lifestyles with a good probability that a typical, average diet would be less than that listed in the BNL report.[20]

The doses to children have been calculated previously and are always less than the estimated adult doses.[4,5] That is, the 30- and 50-y integral doses starting at birth through 30 or 50 y are less than similar doses calculated for an adult. If the dietary intake of ^{137}Cs for children is equal to or less than that for adults, the dose to children will never exceed that to the adult.[41] The data from both the MLSC and BNL diet surveys indicate that the consumption of key local food items for ages 1 to 18 are less than those for adults, and therefore the radionuclide intake would also be less.

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APPENDIX A

RADIONUCLIDE CONCENTRATIONS IN FOOD PRODUCTS AT THE NORTHERN MARSHALL ISLANDS

Table A-1. Radionuclide concentrations in local food products (pCi/g wet weight) for Agony Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.92e-01	7.83e-02	9.11e-06	0.
Coconut fluid	2.13e-01	1.09e-04	1.53e-05	2.07e-05
Coconut milk	5.37e-01	1.00e-03	3.68e-05	3.36e-05
Drinking coconut meat	3.92e-01	1.00e-03	3.68e-05	3.36e-05
Copra meat	5.37e-01	1.00e-03	3.68e-05	3.36e-05
Marshallese cake	5.37e-01	1.00e-03	3.68e-05	3.36e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-2. Radionuclide concentrations in local food products (pCi/g wet weight) for Kapenor Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	5.92e-01	7.35e-02	-7.35e-06	4.71e-06
Coconut fluid	1.13e-01	5.47e-05	1.42e-05	2.27e-05
Coconut milk	3.18e-01	6.69e-04	3.41e-05	3.69e-05
Drinking coconut meat	2.32e-01	6.69e-04	3.41e-05	3.69e-05
Copra meat	3.18e-01	6.69e-04	3.41e-05	3.69e-05
Marshallese cake	3.18e-01	6.69e-04	3.41e-05	3.69e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-3. Radionuclide concentrations in local food products (pCi/g wet weight) for Jeltonet Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.01e-01	0.	0.	0.
Coconut fluid	3.69e-02	0.	0.	0.
Coconut milk	1.06e-01	0.	0.	0.
Drinking coconut meat	7.76e-02	0.	0.	0.
Copra meat	1.06e-01	0.	0.	0.
Marshallese cake	1.06e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-4. Radionuclide concentrations in local food products (pCi/g wet weight) for Likiep Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	1.08e-01	7.24e-04	2.30e-05	3.70e-04
Chicken liver	1.23e-01	-1.87e-03	3.40e-04	4.80e-04
Chicken gizzard	5.62e-02	5.63e-04	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	1.87e+00	1.28e-02	1.50e-04	8.60e-05
Pork liver	9.39e-01	7.46e-04	5.50e-05	-6.80e-06
Pork heart	1.21e+00	2.06e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	1.08e-01	7.24e-04	2.30e-05	3.70e-04
Pandanus fruit	3.76e-01	3.80e-02	5.43e-06	1.50e-05
Breadfruit	5.47e-01	4.26e-03	4.64e-06	8.56e-06
Coconut fluid	1.11e-01	2.73e-04	-2.95e-06	1.44e-05
Coconut milk	1.36e+00	2.50e-03	-7.07e-06	2.34e-05
Drinking coconut meat	9.93e-01	2.50e-03	-7.07e-06	2.34e-05
Copra meat	1.36e+00	2.50e-03	-7.07e-06	2.34e-05
Marshallese cake	1.36e+00	2.50e-03	-7.07e-06	2.34e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-5. Radionuclide concentrations in local food products (pCi/g wet weight) for Rikuraru Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.91e-01	3.80e-02	3.08e-05	1.55e-05
Breadfruit	2.72e-01	1.06e-03	-6.30e-07	0.
Coconut fluid	7.90e-02	1.52e-04	1.48e-05	2.88e-05
Coconut milk	4.78e-01	1.39e-03	3.55e-05	4.68e-05
Drinking coconut meat	3.49e-01	1.39e-03	3.55e-05	4.68e-05
Copra meat	4.78e-01	1.39e-03	3.55e-05	4.68e-05
Marshallese cake	4.78e-01	1.39e-03	3.55e-05	4.68e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-6. Radionuclide concentrations in local food products (pCi/g wet weight) for Etoile Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	4.02e-01	2.34e-02	-1.92e-06	3.09e-06
Coconut fluid	6.40e-02	1.25e-04	1.77e-05	0.
Coconut milk	3.08e-01	1.15e-03	4.24e-05	0.
Drinking coconut meat	2.25e-01	1.15e-03	4.24e-05	0.
Copra meat	3.08e-01	1.15e-03	4.24e-05	0.
Marshallese cake	3.08e-01	1.15e-03	4.24e-05	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-7. Radionuclide concentrations in local food products (pCi/g wet weight) for Jiebaru Island at Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.80e+00	2.90e-04	7.20e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	1.50e-04	8.60e-05
Pork liver	9.58e-01	1.24e-03	5.50e-05	-6.80e-06
Pork heart	7.72e-01	2.94e-03	-3.90e-05	1.40e-04
Bird muscle	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Bird eggs	5.70e-03	4.50e-04	4.60e-05	1.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.28e-01	3.04e-02	0.	3.68e-06
Breadfruit	3.08e-01	1.46e-03	-4.98e-06	0.
Coconut fluid	7.90e-02	3.90e-05	0.	1.22e-05
Coconut milk	5.70e-01	3.58e-04	0.	1.98e-05
Drinking coconut meat	4.16e-01	3.58e-04	0.	1.98e-05
Copra meat	5.70e-01	3.58e-04	0.	1.98e-05
Marshallese cake	5.70e-01	3.58e-04	0.	1.98e-05
Banana	1.12e-01	1.38e-03	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-8. Radionuclide concentrations in local marine products (pCi/g wet weight) for Likiep Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Tuna	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Mahi mahi	9.50e-03	1.00e-03	4.60e-05	1.00e-05
Marine crabs	2.85e-04	2.50e-03	2.07e-04	4.50e-05
Lobster	2.85e-04	2.50e-03	2.07e-04	4.50e-05
Clams	1.80e-03	1.20e-03	1.80e-04	4.00e-05
Trochus	1.80e-03	1.20e-03	1.80e-04	4.00e-05
Tridacna muscle	1.80e-03	1.20e-03	1.80e-04	4.00e-05
Jedrul	1.80e-03	1.20e-03	1.80e-04	4.00e-05
Octopus	5.22e-03	2.50e-03	5.06e-05	1.10e-05
Turtle	1.52e-03	3.80e-04	1.56e-05	3.40e-06
Turtle eggs	1.52e-03	3.80e-04	1.56e-05	3.40e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-9. Radionuclide concentrations in local food products (pCi/g wet weight) for Mejit Island.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	4.75e-01	5.65e-04	2.80e-05	2.60e-05
Chicken liver	2.81e-01	1.46e-02	4.10e-04	1.60e-03
Chicken gizzard	3.17e-01	1.13e-02	1.40e-04	1.60e-03
Pork muscle	1.80e+00	4.00e-04	2.20e-06	2.20e-05
Pork kidney	2.69e+00	8.06e-03	1.50e-04	5.50e-04
Pork liver	1.11e+00	2.11e-03	2.80e-05	-6.60e-06
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	7.00e-03	5.56e-04	2.00e-05	1.72e-05
Bird eggs	4.20e-03	2.50e-04	2.00e-05	1.72e-05
Chicken eggs	4.75e-01	5.65e-04	2.80e-05	2.60e-05
Pandanus fruit	1.22e+00	4.25e-03	-6.79e-07	0.
Breadfruit	9.18e-01	1.12e-03	2.80e-06	7.90e-06
Coconut fluid	1.02e-01	1.20e-04	-3.90e-06	4.50e-06
Coconut milk	1.21e+00	1.08e-03	-9.23e-06	7.36e-06
Drinking coconut meat	8.83e-01	1.08e-03	-9.23e-06	7.36e-06
Copra meat	1.21e+00	1.08e-03	-9.23e-06	7.36e-06
Marshallese cake	1.21e+00	1.08e-03	-9.23e-06	7.36e-06
Papaya	4.67e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-10. Radionuclide concentrations in local marine products (pCi/g wet weight) for Mejit Island.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	7.00e-03	5.56e-04	2.00e-05	1.72e-05
Tuna	7.00e-03	5.56e-04	2.00e-05	1.72e-05
Mahi mahi	7.00e-03	5.56e-04	2.00e-05	1.72e-05
Marine crabs	2.10e-04	1.39e-03	9.00e-05	7.74e-05
Lobster	2.10e-04	1.39e-03	9.00e-05	7.74e-05
Clams	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Trochus	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Tridacna muscle	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Jedrul	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Octopus	3.85e-03	1.39e-03	2.20e-05	1.89e-05
Turtle	1.12e-03	2.11e-04	6.80e-06	5.85e-06
Turtle eggs	1.12e-03	2.11e-04	6.80e-06	5.85e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-11. Radionuclide concentrations in local food products (pCi/g wet weight) for Enijabro Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	3.94e-01	1.27e-02	1.22e-05	-1.49e-05
Coconut fluid	7.86e-02	9.43e-05	4.38e-06	9.89e-06
Coconut milk	7.34e-01	8.65e-04	1.05e-05	1.61e-05
Drinking coconut meat	5.36e-01	8.65e-04	1.05e-05	1.61e-05
Copra meat	7.34e-01	8.65e-04	1.05e-05	1.61e-05
Marshallese cake	7.34e-01	8.65e-04	1.05e-05	1.61e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-12. Radionuclide concentrations in local food products (pCi/g wet weight) for Enejelar Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	7.03e-01	5.04e-03	0.	2.52e-06
Breadfruit	1.55e-01	1.46e-03	0.	2.91e-06
Coconut fluid	6.40e-02	1.47e-04	4.37e-06	7.18e-06
Coconut milk	6.75e-01	1.34e-03	1.05e-05	1.17e-05
Drinking coconut meat	4.93e-01	1.34e-03	1.05e-05	1.17e-05
Copra meat	6.75e-01	1.34e-03	1.05e-05	1.17e-05
Marshallese cake	6.75e-01	1.34e-03	1.05e-05	1.17e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-13. Radionuclide concentrations in local food products (pCi/g wet weight) for Bigen Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	3.61e-01	1.07e-02	2.55e-06	9.33e-06
Coconut fluid	2.54e-01	1.49e-04	6.06e-06	1.11e-05
Coconut milk	1.61e+00	1.36e-03	1.45e-05	1.80e-05
Drinking coconut meat	1.18e+00	1.36e-03	1.45e-05	1.80e-05
Copra meat	1.61e+00	1.36e-03	1.45e-05	1.80e-05
Marshallese cake	1.61e+00	1.36e-03	1.45e-05	1.80e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00 x 10^{-5}.

Table A-14. Radionuclide concentrations in local food products (pCi/g wet weight) for Agulue Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	1.09e+00	2.01e-02	1.79e-05	1.58e-05
Coconut fluid	9.90e-02	6.69e-05	3.07e-06	1.25e-05
Coconut milk	1.02e+00	6.14e-04	7.36e-06	2.03e-05
Drinking coconut meat	7.43e-01	6.14e-04	7.36e-06	2.03e-05
Copra meat	1.02e+00	6.14e-04	7.36e-06	2.03e-05
Marshallese cake	1.02e+00	6.14e-04	7.36e-06	2.03e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-15. Radionuclide concentrations in local food products (pCi/g wet weight) for Aliet Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	6.59e-01	1.22e-02	8.64e-06	8.02e-06
Coconut fluid	1.18e-01	2.56e-04	-5.92e-06	-4.88e-06
Coconut milk	5.26e-01	2.35e-03	-1.42e-05	-7.94e-06
Drinking coconut meat	3.84e-01	2.35e-03	-1.42e-05	-7.94e-06
Copra meat	5.26e-01	2.35e-03	-1.42e-05	-7.94e-06
Marshallese cake	5.26e-01	2.35e-03	-1.42e-05	-7.94e-06
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-16. Radionuclide concentrations in local food products (pCi/g wet weight) for Ailuk Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.53e-01	1.12e-03	9.80e-06	3.90e-05
Chicken liver	2.90e-01	2.69e-02	8.80e-04	2.60e-04
Chicken gizzard	2.60e-01	-3.80e-04	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	1.14e+00	2.06e-03	5.10e-05	9.90e-05
Pork liver	6.04e-01	1.00e-04	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.53e-01	1.12e-03	9.80e-06	3.90e-05
Pandanus fruit	2.15e+00	2.17e-02	6.20e-06	7.35e-06
Breadfruit	2.72e-01	1.19e-03	5.91e-06	5.88e-06
Coconut fluid	1.13e-01	1.30e-04	1.77e-05	3.96e-06
Coconut milk	1.02e+00	1.19e-03	4.23e-05	6.46e-06
Drinking coconut meat	7.48e-01	1.19e-03	4.23e-05	6.46e-06
Copra meat	1.02e+00	1.19e-03	4.23e-05	6.46e-06
Marshallese cake	1.02e+00	1.19e-03	4.23e-05	6.46e-06
Papaya	3.32e-01	0.	0.	0.
Squash	1.44e-01	0.	0.	0.
Banana	1.72e-01	9.08e-04	-1.33e-06	1.07e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-17. Radionuclide concentrations in local food products (pCi/g wet weight) for Bererjao Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	3.43e+00	1.40e-02	1.31e-05	7.96e-06
Coconut fluid	1.87e-01	2.22e-04	4.13e-06	7.12e-06
Coconut milk	4.06e-01	2.04e-03	9.91e-06	1.16e-05
Drinking coconut meat	2.97e-01	2.04e-03	9.91e-06	1.16e-05
Copra meat	4.06e-01	2.04e-03	9.91e-06	1.16e-05
Marshallese cake	4.06e-01	2.04e-03	9.91e-06	1.16e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-18. Radionuclide concentrations in local food products (pCi/g wet weight) for Kapen Island at Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Chicken liver	2.23e-01	3.82e-02	8.80e-04	2.60e-04
Chicken gizzard	1.88e-01	7.49e-02	1.70e-04	1.10e-04
Pork muscle	7.90e-01	1.90e-04	4.70e-06	1.70e-05
Pork kidney	2.70e+00	6.12e-03	5.10e-05	9.90e-05
Pork liver	9.58e-01	1.24e-03	1.50e-05	1.60e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Bird eggs	6.60e-03	2.48e-04	5.50e-05	5.00e-06
Chicken eggs	2.99e-01	2.07e-03	9.80e-06	3.90e-05
Pandanus fruit	1.75e-01	2.35e-03	8.44e-06	2.16e-06
Coconut fluid	1.50e-01	1.15e-04	4.68e-06	7.68e-06
Coconut milk	1.02e+00	1.06e-03	1.12e-05	7.68e-06
Drinking coconut meat	7.44e-01	1.06e-03	1.12e-05	7.68e-06
Copra meat	1.02e+00	1.06e-03	1.12e-05	7.68e-06
Marshallese cake	1.02e+00	1.06e-03	1.12e-05	7.68e-06
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-19. Radionuclide concentrations in local marine products (pCi/g wet weight) for Ailuk Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Tuna	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Mahi mahi	1.10e-02	5.50e-04	5.50e-05	5.00e-06
Marine crabs	3.30e-04	1.38e-03	2.48e-04	2.25e-05
Lobster	3.30e-04	1.38e-03	2.48e-04	2.25e-05
Clams	1.40e-03	2.60e-03	3.30e-04	1.70e-04
Trochus	1.40e-03	2.60e-03	3.30e-04	1.70e-04
Tridacna muscle	1.40e-03	2.60e-03	3.30e-04	1.70e-04
Jedrul	1.40e-03	2.60e-03	3.30e-04	1.70e-04
Octopus	6.05e-03	1.38e-03	6.05e-05	5.50e-06
Turtle	1.76e-03	2.09e-04	1.87e-05	1.70e-06
Turtle eggs	1.76e-03	2.09e-04	1.87e-05	1.70e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-20. Radionuclide concentrations in local food products (pCi/g wet weight) for Aon Island at Utirik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.70e-03	2.60e-05	5.10e-05
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	2.80e+00	6.90e-04	2.00e-06	7.30e-06
Pork kidney	2.70e+00	6.12e-03	1.80e-04	3.40e-04
Pork liver	9.58e-01	1.24e-03	1.50e-04	8.30e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Bird eggs	8.40e-03	3.60e-04	2.30e-04	1.00e-05
Chicken eggs	2.99e-01	2.70e-03	2.60e-05	5.10e-05
Pandanus fruit	1.08e+00	1.45e-01	2.38e-05	8.81e-05
Breadfruit	9.01e-01	1.71e-02	5.16e-05	0.
Coconut fluid	4.37e-01	7.72e-03	3.60e-05	5.94e-04
Coconut milk	4.08e+00	7.55e-03	8.58e-05	9.69e-04
Drinking coconut meat	2.97e+00	7.55e-03	8.58e-05	9.69e-04
Copra meat	4.08e+00	7.55e-03	8.58e-05	9.69e-04
Marshallese cake	4.08e+00	7.55e-03	8.58e-05	9.69e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-21. Radionuclide concentrations in local food products (pCi/g wet weight) for Pigowak Island at Utirik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.70e-03	2.60e-05	5.10e-05
Chicken liver	2.23e-01	3.82e-02	5.20e-05	3.00e-04
Chicken gizzard	1.88e-01	7.49e-02	3.00e-04	2.70e-04
Pork muscle	2.80e+00	6.90e-04	2.00e-06	7.30e-06
Pork kidney	2.70e+00	6.12e-03	1.80e-04	3.40e-04
Pork liver	9.58e-01	1.24e-03	1.50e-04	8.30e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Bird eggs	8.40e-03	3.60e-04	2.30e-04	1.00e-05
Chicken eggs	2.99e-01	2.70e-03	2.60e-05	5.10e-05
Pandanus fruit	1.63e+00	2.96e-01	2.45e-05	4.74e-05
Coconut fluid	1.47e-01	4.15e-03	3.40e-05	1.12e-04
Coconut milk	1.05e+00	9.95e-02	2.80e-05	1.82e-04
Drinking coconut meat	7.33e-01	9.95e-02	2.80e-05	1.82e-04
Copra meat	1.05e+00	9.95e-02	2.80e-05	1.82e-04
Marshallese cake	1.05e+00	9.95e-02	2.80e-05	1.82e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-22. Radionuclide concentrations in local food products (pCi/g wet weight) for Utirik Island at Utirik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	5.53e-01	7.77e-03	2.60e-05	5.10e-05
Chicken liver	3.15e-01	1.50e-01	5.20e-05	3.00e-04
Chicken gizzard	2.40e-01	2.08e-02	3.00e-04	2.70e-04
Pork muscle	2.80e+00	6.90e-04	2.00e-06	7.30e-06
Pork kidney	5.10e+00	1.61e-03	1.80e-04	3.40e-04
Pork liver	1.89e+00	1.25e-03	1.50e-04	8.30e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Bird eggs	8.40e-03	3.60e-04	2.30e-04	1.00e-05
Chicken eggs	5.53e-01	7.77e-03	2.60e-05	5.10e-05
Pandanus fruit	1.72e+00	1.93e-01	2.05e-05	3.00e-05
Breadfruit	6.53e-01	1.78e-02	1.47e-05	1.96e-05
Coconut fluid	2.19e-01	6.46e-03	5.20e-05	9.69e-05
Coconut milk	1.95e+00	2.95e-03	1.20e-04	1.58e-04
Drinking coconut meat	1.34e+00	2.95e-03	1.20e-04	1.58e-04
Copra meat	1.95e+00	2.95e-03	1.20e-04	1.58e-04
Marshallese cake	1.95e+00	2.95e-03	1.20e-04	1.58e-04
Papaya	3.56e+00	1.31e-02	0.	2.40e-05
Banana	5.57e-01	7.86e-03	1.40e-05	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-23. Radionuclide concentrations in local marine products (pCi/g wet weight) for Utirik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Tuna	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Mahi mahi	1.40e-02	8.00e-04	2.30e-04	1.00e-05
Marine crabs	4.20e-04	2.00e-03	1.03e-03	4.50e-05
Lobster	4.20e-04	2.00e-03	1.03e-03	4.50e-05
Clams	1.90e-03	2.80e-03	4.90e-04	1.10e-04
Trochus	1.90e-03	2.80e-03	4.90e-04	1.10e-04
Tridacna muscle	1.90e-03	2.80e-03	4.90e-04	1.10e-04
Jedrul	1.90e-03	2.80e-03	4.90e-04	1.10e-04
Octopus	7.70e-03	2.00e-03	2.53e-04	1.10e-05
Turtle	2.24e-03	3.04e-04	7.82e-05	3.40e-06
Turtle eggs	2.24e-03	3.04e-04	7.82e-05	3.40e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-24. Radionuclide concentrations in local food products (pCi/g wet weight) for Medyeron Island at Wotho Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.70e-05	1.30e-03
Chicken liver	2.23e-01	3.82e-02	1.30e-04	2.10e-04
Chicken gizzard	1.88e-01	7.49e-02	4.10e-04	3.00e-04
Pork muscle	6.60e-01	7.60e-05	6.70e-06	2.40e-06
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Bird eggs	8.40e-03	9.00e-05	5.50e-05	1.20e-05
Chicken eggs	2.99e-01	2.07e-03	2.70e-05	1.30e-03
Coconut fluid	9.00e-03	4.28e-04	1.46e-05	8.60e-06
Coconut milk	8.08e-02	5.48e-04	3.50e-05	1.40e-05
Drinking coconut meat	5.90e-02	5.48e-04	3.50e-05	1.40e-05
Copra meat	8.08e-02	5.48e-04	3.50e-05	1.40e-05
Marshallese cake	8.08e-02	5.48e-04	3.50e-05	1.40e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-25. Radionuclide concentrations in local food products (pCi/g wet weight) for Wotho Island at Wotho Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	1.06e-01	1.89e-04	2.70e-05	1.30e-03
Chicken liver	1.03e-01	9.53e-04	1.30e-04	2.10e-04
Chicken gizzard	6.74e-02	5.16e-03	4.10e-04	3.00e-04
Pork muscle	6.60e-01	7.60e-05	6.70e-06	2.40e-06
Pork kidney	6.14e-01	2.52e-03	1.70e-05	9.80e-05
Pork liver	3.80e-01	9.00e-04	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Bird eggs	8.40e-03	9.00e-05	5.50e-05	1.20e-05
Chicken eggs	1.06e-01	1.89e-04	2.70e-05	1.30e-03
Pandanus fruit	2.08e-01	3.13e-02	1.43e-05	1.70e-05
Breadfruit	8.70e-02	2.89e-03	5.35e-06	5.70e-06
Coconut fluid	3.80e-02	3.67e-04	1.00e-05	1.50e-05
Coconut milk	3.37e-01	7.50e-04	1.90e-05	2.40e-05
Drinking coconut meat	2.46e-01	7.50e-04	1.90e-05	2.40e-05
Copra meat	3.37e-01	7.50e-04	1.90e-05	2.40e-05
Marshallese cake	3.37e-01	7.50e-04	1.90e-05	2.40e-05
Papaya	5.21e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-26. Radionuclide concentrations in local food products (pCi/g wet weight) for Kabben Island at Wotho Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.70e-05	1.30e-03
Chicken liver	2.23e-01	3.82e-02	1.30e-04	2.10e-04
Chicken gizzard	1.88e-01	7.49e-02	4.10e-04	3.00e-04
Pork muscle	6.60e-01	7.60e-05	6.70e-06	2.40e-06
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Bird eggs	8.40e-03	9.00e-05	5.50e-05	1.20e-05
Chicken eggs	2.99e-01	2.07e-03	2.70e-05	1.30e-03
Coconut fluid	1.06e-01	6.35e-04	1.46e-05	4.50e-05
Coconut milk	1.60e-01	1.30e-03	5.98e-05	7.30e-05
Drinking coconut meat	1.17e-01	1.30e-03	5.98e-05	7.30e-05
Copra meat	1.60e-01	1.30e-03	5.98e-05	7.30e-05
Marshallese cake	1.60e-01	1.30e-03	5.98e-05	7.30e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-27. Radionuclide concentrations in local marine products (pCi/g wet weight) for Wotho Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Tuna	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Mahi mahi	1.40e-02	2.00e-04	5.50e-05	1.20e-05
Marine crabs	4.20e-04	5.00e-04	2.48e-04	5.40e-05
Lobster	4.20e-04	5.00e-04	2.48e-04	5.40e-05
Clams	3.80e-04	1.75e-03	1.50e-04	1.40e-04
Trochus	3.80e-04	1.75e-03	1.50e-04	1.40e-04
Tridacna muscle	3.80e-04	1.75e-03	1.50e-04	1.40e-04
Jedrul	3.80e-04	1.75e-03	1.50e-04	1.40e-04
Octopus	7.70e-03	5.00e-04	6.05e-05	1.32e-05
Turtle	2.24e-03	7.60e-05	1.87e-05	4.08e-06
Turtle eggs	2.24e-03	7.60e-05	1.87e-05	4.08e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-28. Radionuclide concentrations in local food products (pCi/g wet weight) for Ennimenetto Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	6.46e-02	2.37e-02	1.54e-05	1.07e-05
Coconut fluid	4.23e-02	1.60e-04	3.40e-06	3.40e-06
Coconut milk	3.45e-01	1.46e-03	-5.59e-06	4.01e-06
Drinking coconut meat	2.52e-01	1.46e-03	-5.59e-06	4.01e-06
Copra meat	3.45e-01	1.46e-03	-5.59e-06	4.01e-06
Marshallese cake	3.45e-01	1.46e-03	-5.59e-06	4.01e-06
Papaya	3.45e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-29. Radionuclide concentrations in local food products (pCi/g wet weight) for Burle Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	3.48e-01	1.43e-02	-1.16e-05	0.
Banana	4.71e-03	1.74e-03	-9.27e-06	-1.60e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-30. Radionuclide concentrations in local food products (pCi/g wet weight) for Eimnlapp Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	4.01e-01	6.88e-02	-6.38e-06	-1.61e-05
Coconut fluid	6.00e-02	2.29e-04	2.02e-06	5.70e-06
Coconut milk	5.57e-01	2.10e-03	4.85e-06	9.35e-06
Drinking coconut meat	4.07e-01	2.10e-03	4.85e-06	9.35e-06
Copra meat	5.57e-01	2.10e-03	4.85e-06	9.35e-06
Marshallese cake	5.57e-01	2.10e-03	4.85e-06	9.35e-06
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-31. Radionuclide concentrations in local food products (pCi/g wet weight) for Kalo Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.07e-01	1.48e-02	9.21e-06	2.20e-05
Coconut fluid	4.93e-02	2.94e-04	2.39e-05	0.
Coconut milk	1.97e-01	2.70e-03	5.74e-05	5.35e-05
Drinking coconut meat	1.44e-01	2.70e-03	5.74e-05	5.35e-05
Copra meat	1.97e-01	2.70e-03	5.74e-05	5.35e-05
Marshallese cake	1.97e-01	2.70e-03	5.74e-05	5.35e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-32. Radionuclide concentrations in local food products (pCi/g wet weight) for Daisu Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.72e-01	1.74e-02	1.18e-05	1.29e-05
Coconut fluid	1.80e-02	2.89e-04	1.92e-05	2.00e-05
Coconut milk	2.01e-01	2.66e-03	4.60e-05	3.40e-05
Drinking coconut meat	1.47e-01	2.66e-03	4.60e-05	3.40e-05
Copra meat	2.01e-01	2.66e-03	4.60e-05	3.40e-05
Marshallese cake	2.01e-01	2.66e-03	4.60e-05	3.40e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-33. Radionuclide concentrations in local food products (pCi/g wet weight) for Pokon Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.27e-01	9.50e-03	3.02e-06	9.33e-06
Coconut fluid	1.99e-02	0.	0.	0.
Coconut milk	2.29e-01	0.	0.	0.
Drinking coconut meat	1.67e-01	0.	0.	0.
Copra meat	2.29e-01	0.	0.	0.
Marshallese cake	2.29e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00 x 10^{-5}.

Table A-34. Radionuclide concentrations in local food products (pCi/g wet weight) for Ujelang Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	2.51e-01	1.96e-03	1.50e-04	1.80e-05
Pork heart	3.34e-01	3.82e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.60e-01	2.12e-02	9.17e-06	6.36e-06
Breadfruit	5.60e-01	5.21e-03	9.14e-06	1.30e-05
Coconut fluid	1.03e-01	3.16e-04	1.14e-05	2.00e-05
Coconut milk	5.40e-01	2.90e-03	2.72e-05	3.40e-05
Drinking coconut meat	3.94e-01	2.90e-03	2.72e-05	3.40e-05
Copra meat	5.40e-01	2.90e-03	2.72e-05	3.40e-05
Marshallese cake	5.40e-01	2.90e-03	2.72e-05	3.40e-05
Papaya	2.05e-01	0.	0.	0.
Squash	4.43e-01	0.	0.	0.
Banana	3.20e-02	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-35. Radionuclide concentrations in local food products (pCi/g wet weight) for J-13 Island at Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	1.60e-04	4.70e-04
Pork muscle	4.40e-01	5.50e-04	1.80e-05	1.10e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	1.50e-04	1.80e-05
Pork heart	7.72e-01	2.94e-03	1.00e-06	1.70e-04
Bird muscle	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Bird eggs	6.60e-03	9.00e-05	2.00e-05	8.00e-06
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.56e-01	6.98e-02	-1.75e-05	1.28e-05
Coconut fluid	1.40e-02	3.48e-04	0.	7.90e-06
Coconut milk	1.36e-01	3.20e-03	0.	1.29e-05
Drinking coconut meat	9.90e-02	3.20e-03	0.	1.29e-05
Copra meat	1.36e-01	3.20e-03	0.	1.29e-05
Marshallese cake	1.36e-01	3.20e-03	0.	1.29e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-36. Radionuclide concentrations in local marine products (pCi/g wet weight) for Ujelang Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Tuna	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Mahi mahi	1.10e-02	2.00e-04	2.00e-05	8.00e-06
Marine crabs	3.30e-04	5.00e-04	9.00e-05	3.60e-05
Lobster	3.30e-04	5.00e-04	9.00e-05	3.60e-05
Clams	9.60e-04	2.80e-03	4.70e-04	2.50e-04
Trochus	9.60e-04	2.80e-03	4.70e-04	2.50e-04
Tridacna muscle	9.60e-04	2.80e-03	4.70e-04	2.50e-04
Jedrul	9.60e-04	2.80e-03	4.70e-04	2.50e-04
Octopus	6.05e-03	5.00e-04	2.20e-05	8.80e-06
Turtle	1.76e-03	7.60e-05	6.80e-06	2.72e-06
Turtle eggs	1.76e-03	7.60e-05	6.80e-06	2.72e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-37. Radionuclide concentrations in local food products (pCi/g wet weight) for Taka Island at Taka Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	4.00e-04	1.50e-04	2.00e-05
Bird eggs	9.00e-03	1.80e-04	1.50e-04	2.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.41e-01	2.41e-02	2.66e-06	6.06e-06
Pandanus nuts	1.41e-01	2.41e-02	2.66e-06	6.06e-06
Coconut fluid	4.50e-02	5.45e-04	3.00e-06	2.60e-05
Coconut milk	4.08e-01	5.00e-03	-7.10e-06	4.22e-05
Drinking coconut meat	2.98e-01	5.00e-03	-7.10e-06	4.22e-05
Copra meat	4.08e-01	5.00e-03	-7.10e-06	4.22e-05
Marshallese cake	4.08e-01	5.00e-03	-7.10e-06	4.22e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-38. Radionuclide concentrations in local food products (pCi/g wet weight) for Eluk Island at Taka Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	4.00e-04	1.50e-04	2.00e-05
Bird eggs	9.00e-03	1.80e-04	1.50e-04	2.00e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	1.83e-02	0.	0.	0.
Drinking coconut meat	1.05e-01	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-39. Radionuclide concentrations in local marine products (pCi/g wet weight) for Taka Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.50e-02	4.00e-04	1.50e-04	2.00e-05
Tuna	1.50e-02	4.00e-04	1.50e-04	2.00e-05
Mahi mahi	1.50e-02	4.00e-04	1.50e-04	2.00e-05
Marine crabs	4.50e-04	1.00e-03	6.75e-04	9.00e-05
Lobster	4.50e-04	1.00e-03	6.75e-04	9.00e-05
Clams	1.60e-03	3.30e-03	1.90e-04	2.00e-04
Trochus	1.60e-03	3.30e-03	1.90e-04	2.00e-04
Tridacna muscle	1.60e-03	3.30e-03	1.90e-04	2.00e-04
Jedrul	1.60e-03	3.30e-03	1.90e-04	2.00e-04
Octopus	8.25e-03	1.00e-03	1.65e-04	2.20e-05
Turtle	2.40e-03	1.52e-04	5.10e-05	6.80e-06
Turtle eggs	2.40e-03	1.52e-04	5.10e-05	6.80e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-40. Radionuclide concentrations in local food products (pCi/g wet weight) for Borukka Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	3.36e+00	3.50e+00	9.77e-05	3.70e-05
Coconut fluid	5.10e-01	1.81e-02	3.82e-05	1.87e-05
Coconut milk	4.05e+00	1.70e-01	9.17e-05	3.00e-05
Drinking coconut meat	2.96e+00	1.70e-01	9.17e-05	3.00e-05
Copra meat	4.05e+00	1.70e-01	9.17e-05	3.00e-05
Marshallese cake	4.05e+00	1.70e-01	9.17e-05	3.00e-05
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00 x 10^{-5}.

Table A-41. Radionuclide concentrations in local food products (pCi/g wet weight) for Kabelle Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Coconut fluid	1.41e+00	1.09e-02	1.25e-04	4.88e-06
Coconut milk	1.35e+01	3.84e-01	1.08e-04	1.63e-04
Drinking coconut meat	9.86e+00	3.84e-01	1.08e-04	1.63e-04
Copra meat	1.35e+01	3.84e-01	1.08e-04	1.63e-04
Sprouting coconut	6.40e+00	3.84e-01	1.08e-04	1.63e-04
Marshallese cake	1.35e+01	3.84e-01	1.08e-04	1.63e-04
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-42. Radionuclide concentrations in local food products (pCi/g wet weight) for Eniaetok Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	1.56e+01	6.14e+00	6.55e-05	2.50e-05
Coconut fluid	1.03e+00	6.03e-03	9.96e-05	2.40e-04
Coconut milk	1.00e+01	5.55e-02	2.39e-04	3.90e-04
Drinking coconut meat	7.32e+00	5.55e-02	2.39e-04	3.90e-04
Copra meat	1.00e+01	5.55e-02	2.39e-04	3.90e-04
Marshallese cake	1.00e+01	5.55e-02	2.39e-04	3.90e-04
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-43. Radionuclide concentrations in local food products (pCi/g wet weight) for Lomuilal Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	1.81e+01	6.11e+00	4.90e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Coconut fluid	2.81e+00	1.19e-02	1.17e-04	7.37e-05
Coconut milk	2.89e+01	3.12e-01	2.89e-04	1.78e-04
Drinking coconut meat	2.11e+01	3.12e-01	2.89e-04	1.78e-04
Copra meat	2.89e+01	3.12e-01	2.89e-04	1.78e-04
Marshallese cake	2.89e+01	3.12e-01	2.89e-04	1.78e-04
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-44. Radionuclide concentrations in local food products (pCi/g wet weight) for Yugui Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	1.51e+01	9.66e+00	2.35e-03	6.02e-04
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-45. Radionuclide concentrations in local food products (pCi/g wet weight) for Rongelap Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	1.11e+01	1.92e+00	2.29e-05	1.29e-05
Breadfruit	2.67e+00	9.58e-02	0.	0.
Coconut fluid	1.35e+00	3.52e-03	7.13e-05	5.76e-05
Coconut milk	7.55e+00	2.25e-02	5.55e-05	5.92e-05
Drinking coconut meat	5.51e+00	2.25e-02	5.55e-05	7.20e-05
Copra meat	7.55e+00	2.25e-02	5.55e-05	5.92e-05
Marshallese cake	7.55e+00	2.25e-02	5.55e-05	5.92e-05
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-46. Radionuclide concentrations in local food products (pCi/g wet weight) for Mellu Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	7.80e+00	2.70e+00	3.15e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	8.82e+00	3.43e+00	3.69e-05	2.02e-05
Coconut fluid	3.65e-01	6.20e-03	4.72e-05	-1.94e-05
Coconut milk	4.64e+00	8.98e-02	1.13e-04	3.79e-05
Drinking coconut meat	3.39e+00	8.98e-02	1.13e-04	3.79e-05
Copra meat	4.64e+00	8.98e-02	1.13e-04	3.79e-05
Marshallese cake	4.64e+00	8.98e-02	1.13e-04	3.79e-05
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-47. Radionuclide concentrations in local food products (pCi/g wet weight) for Arbar Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.52e+00	1.54e+00	1.94e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	1.71e+00	3.24e+00	1.57e-05	7.01e-06
Coconut fluid	7.07e-02	2.01e-03	4.90e-05	3.61e-05
Coconut milk	9.53e-01	1.66e-01	1.18e-04	5.90e-05
Drinking coconut meat	6.96e-01	1.66e-01	1.18e-04	5.90e-05
Copra meat	9.53e-01	1.66e-01	1.18e-04	5.90e-05
Marshallese cake	9.53e-01	1.66e-01	1.18e-04	5.90e-05
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-48. Radionuclide concentrations in local food products (pCi/g wet weight) for Naen Island at Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Chicken liver	2.44e+00	1.14e-02	3.40e-04	4.80e-04
Chicken gizzard	2.11e+00	1.28e-02	1.60e-04	4.70e-04
Pork muscle	8.50e+00	3.60e-03	3.60e-05	2.50e-05
Pork kidney	1.81e+01	5.93e-03	1.70e-05	9.80e-05
Pork liver	5.15e+00	5.93e-03	7.90e-05	2.10e-05
Pork heart	8.50e+00	3.60e-03	1.90e-05	1.60e-04
Bird muscle	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Bird eggs	1.50e-02	3.82e-04	2.40e-04	4.30e-05
Chicken eggs	2.59e+00	5.33e-03	2.30e-05	3.70e-04
Pandanus fruit	1.42e+01	1.14e-01	9.83e-05	1.80e-04
Coconut fluid	2.58e+00	8.27e-02	5.73e-05	1.78e-04
Coconut milk	1.09e+01	2.35e-01	1.38e-04	2.90e-04
Drinking coconut meat	7.96e+00	2.35e-01	1.38e-04	2.90e-04
Copra meat	1.09e+01	2.35e-01	1.38e-04	2.90e-04
Marshallese cake	1.09e+01	2.35e-01	1.38e-04	2.90e-04
Rainwater	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Wellwater	2.40e-03	1.00e-03	1.30e-05	4.00e-07
Malolo	2.50e-04	6.70e-04	2.40e-06	4.00e-07
Coffee/tea	2.50e-04	6.70e-04	2.40e-06	4.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-49. Radionuclide concentrations in local marine products (pCi/g wet weight) for Rongelap Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Tuna	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Mahi mahi	2.50e-02	8.50e-04	2.40e-04	4.30e-05
Marine crabs	7.50e-04	2.13e-03	1.08e-03	1.93e-04
Lobster	7.50e-04	2.13e-03	1.08e-03	1.93e-04
Clams	1.60e-04	5.30e-03	1.00e-02	3.20e-03
Trochus	1.60e-04	5.30e-03	1.00e-02	3.20e-03
Tridacna muscle	1.60e-04	5.30e-03	1.00e-02	3.20e-03
Jedrul	1.60e-04	5.30e-03	1.00e-02	3.20e-03
Octopus	1.38e-02	2.13e-03	2.64e-04	4.73e-05
Turtle	4.00e-03	3.23e-04	8.16e-05	1.46e-05
Turtle eggs	4.00e-03	3.23e-04	8.16e-05	1.46e-05

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-50. Radionuclide concentrations in local food products (pCi/g wet weight) for Eniwetak Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	3.89e+00	5.55e-02	1.76e-04	1.00e-04
Coconut fluid	1.27e+00	4.46e-03	1.02e-04	1.10e-04
Coconut milk	4.20e+00	2.19e-02	4.31e-05	3.50e-05
Drinking coconut meat	3.07e+00	2.19e-02	4.31e-05	3.50e-05
Copra meat	4.20e+00	2.19e-02	4.31e-05	3.50e-05
Sprouting coconut	2.72e+00	2.19e-02	4.31e-05	3.50e-05
Marshallese cake	4.20e+00	2.19e-02	4.31e-05	3.50e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-51. Radionuclide concentrations in local food products (pCi/g wet weight) for Bigonattam Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	2.70e+00	3.12e-03	2.75e-05	3.78e-05
Coconut milk	4.24e+00	9.01e-03	8.73e-05	6.20e-05
Drinking coconut meat	3.09e+00	9.01e-03	8.73e-05	6.20e-05
Copra meat	4.24e+00	9.01e-03	8.73e-05	6.20e-05
Marshallese cake	4.24e+00	9.01e-03	8.73e-05	6.20e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-52. Radionuclide concentrations in local food products (pCi/g wet weight) for Jedibberdib Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	3.58e-01	0.	0.	0.
Coconut milk	3.28e+00	0.	0.	0.
Drinking coconut meat	2.40e+00	0.	0.	0.
Copra meat	3.28e+00	0.	0.	0.
Marshallese cake	3.28e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-53. Radionuclide concentrations in local food products (pCi/g wet weight) for Latoback Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	4.17e+00	4.62e-01	3.52e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	8.73e-01	4.57e-02	1.68e-04	1.60e-04
Coconut fluid	8.58e-01	0.	0.	0.
Coconut milk	3.94e+00	0.	0.	0.
Drinking coconut meat	2.87e+00	0.	0.	0.
Copra meat	3.94e+00	0.	0.	0.
Marshallese cake	3.94e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-54. Radionuclide concentrations in local food products (pCi/g wet weight) for Bock Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	1.05e+00	6.99e-03	6.32e-05	4.50e-05
Coconut milk	2.74e+00	3.42e-02	4.75e-05	1.50e-04
Drinking coconut meat	2.00e+00	3.42e-02	4.75e-05	1.50e-04
Copra meat	2.74e+00	3.42e-02	4.75e-05	1.50e-04
Marshallese cake	2.74e+00	3.42e-02	4.75e-05	1.50e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-55. Radionuclide concentrations in local food products (pCi/g wet weight) for Rongerik Island at Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Bird eggs	9.00e-03	2.25e-04	6.50e-05	1.30e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	2.40e+00	4.57e-02	3.16e-05	2.00e-04
Coconut fluid	1.03e+00	4.63e-03	3.57e-05	4.40e-05
Coconut milk	3.17e+00	1.23e-02	1.64e-05	2.46e-05
Drinking coconut meat	2.31e+00	1.23e-02	1.64e-05	2.46e-05
Copra meat	3.17e+00	1.23e-02	1.64e-05	2.46e-05
Sprouting coconut	6.53e-01	1.23e-02	1.64e-05	2.46e-05
Marshallese cake	3.17e+00	1.23e-02	1.64e-05	2.46e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-56. Radionuclide concentrations in local marine products (pCi/g wet weight) for Rongerik Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Tuna	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Mahi mahi	1.50e-02	5.00e-04	6.50e-05	1.30e-05
Marine crabs	4.50e-04	1.25e-03	2.92e-04	5.85e-05
Lobster	4.50e-04	1.25e-03	2.92e-04	5.85e-05
Clams	2.00e-03	2.00e-03	3.20e-04	1.30e-04
Trochus	2.00e-03	2.00e-03	3.20e-04	1.30e-04
Tridacna muscle	2.00e-03	2.00e-03	3.20e-04	1.30e-04
Jedrul	2.00e-03	2.00e-03	3.20e-04	1.30e-04
Octopus	8.25e-03	1.25e-03	7.15e-05	1.43e-05
Turtle	2.40e-03	1.90e-04	2.21e-05	4.42e-06
Turtle eggs	2.40e-03	1.90e-04	2.21e-05	4.42e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-57. Radionuclide concentrations in local food products (pCi/g wet weight) for Jaboerukku Island at Bikar Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Bird eggs	1.20e-02	2.16e-04	1.90e-05	2.50e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	1.03e-01	0.	0.	0.
Coconut milk	1.02e+00	0.	0.	0.
Drinking coconut meat	7.47e-01	0.	0.	0.
Copra meat	1.02e+00	0.	0.	0.
Marshallese cake	1.02e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-58. Radionuclide concentrations in local food products (pCi/g wet weight) for Arumenii Island at Bikar Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Bird eggs	1.20e-02	2.16e-04	1.90e-05	2.50e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-59. Radionuclide concentrations in local food products (pCi/g wet weight) for Bikar Island at Bikar Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Bird eggs	1.20e-02	2.16e-04	1.90e-05	2.50e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-60. Radionuclide concentrations in local marine products (pCi/g wet weight) for Bikar Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Tuna	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Mahi mahi	2.00e-02	4.80e-04	1.90e-05	2.50e-05
Marine crabs	6.00e-04	1.20e-03	8.55e-05	1.12e-04
Lobster	6.00e-04	1.20e-03	8.55e-05	1.12e-04
Clams	9.40e-04	3.60e-03	9.80e-04	2.30e-04
Trochus	9.40e-04	3.60e-03	9.80e-04	2.30e-04
Tridacna muscle	9.40e-04	3.60e-03	9.80e-04	2.30e-04
Jedrul	9.40e-04	3.60e-03	9.80e-04	2.30e-04
Octopus	1.10e-02	1.20e-03	2.09e-05	2.75e-05
Turtle	3.20e-03	1.82e-04	6.46e-06	8.50e-06
Turtle eggs	3.20e-03	1.82e-04	6.46e-06	8.50e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-61. Radionuclide concentrations in local food products (pCi/g wet weight) for Jemo Island.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.70e-02	1.00e-03	4.60e-05	4.10e-05
Bird eggs	1.02e-02	4.50e-04	4.60e-05	4.10e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	0.	0.	0.	0.
Breadfruit	0.	0.	0.	0.
Coconut fluid	1.14e-02	0.	0.	0.
Coconut milk	1.16e+00	0.	0.	0.
Drinking coconut meat	8.47e-02	0.	0.	0.
Copra meat	1.16e+00	0.	0.	0.
Marshallese cake	1.16e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-62. Radionuclide concentrations in local marine products (pCi/g wet weight) for Jemo Island.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.70e-02	1.00e-03	4.60e-05	4.10e-05
Tuna	1.70e-02	1.00e-03	4.60e-05	4.10e-05
Mahi mahi	1.70e-02	1.00e-03	4.60e-05	4.10e-05
Marine crabs	5.10e-04	2.50e-03	2.07e-04	1.85e-04
Lobster	5.10e-04	2.50e-03	2.07e-04	1.85e-04
Clams	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Trochus	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Tridacna muscle	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Jedrul	1.28e-03	2.31e-03	5.23e-04	1.97e-04
Octopus	9.35e-03	2.50e-03	5.06e-05	4.51e-05
Turtle	2.72e-03	3.80e-04	1.56e-05	1.39e-05
Turtle eggs	2.72e-03	3.80e-04	1.56e-05	1.39e-05

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-63. Radionuclide concentrations in local food products (pCi/g wet weight) for Ucchuwanen Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.78e+00	4.26e-01	0.	9.76e-06
Coconut fluid	4.30e-01	2.88e-03	-6.50e-06	0.
Coconut milk	1.80e+00	2.64e-02	-1.54e-05	0.
Drinking coconut meat	1.32e+00	2.64e-02	-1.54e-05	0.
Copra meat	1.80e+00	2.64e-02	-1.54e-05	0.
Marshallese cake	1.80e+00	2.64e-02	-1.54e-05	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-64. Radionuclide concentrations in local food products (pCi/g wet weight) for Knox Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	1.67e+00	1.19e-03	2.70e-05	5.71e-06
Coconut milk	1.62e+00	1.09e-02	6.45e-05	9.29e-06
Drinking coconut meat	1.18e+00	1.09e-02	6.45e-05	9.29e-06
Copra meat	1.62e+00	1.09e-02	6.45e-05	9.29e-06
Marshallese cake	1.62e+00	1.09e-02	6.45e-05	9.29e-06
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-65. Radionuclide concentrations in local food products (pCi/g wet weight) for Mogiri Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	1.67e+00	2.70e-01	3.35e-04	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	6.42e-01	8.88e-01	9.86e-06	2.13e-05
Coconut fluid	6.40e-01	2.50e-04	1.70e-05	0.
Coconut milk	2.46e+00	2.29e-03	4.08e-05	0.
Drinking coconut meat	1.79e+00	2.29e-03	4.08e-05	0.
Copra meat	2.46e+00	2.29e-03	4.08e-05	0.
Marshallese cake	2.46e+00	2.29e-03	4.08e-05	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-66. Radionuclide concentrations in local food products (pCi/g wet weight) for Sifo Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	1.66e+00	8.86e-02	6.74e-04	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.32e+00	0.	0.	0.
Coconut fluid	1.55e-01	2.70e-03	6.30e-06	3.96e-06
Coconut milk	9.57e-01	2.48e-02	1.50e-05	6.45e-06
Drinking coconut meat	6.99e-01	2.48e-02	1.50e-05	6.45e-06
Copra meat	9.57e-01	2.48e-02	1.50e-05	6.45e-06
Marshallese cake	9.57e-01	2.48e-02	1.50e-05	6.45e-06
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-67. Radionuclide concentrations in local food products (pCi/g wet weight) for Ribinouri Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	1.67e+00	0.	0.	0.
Coconut milk	1.43e+00	0.	0.	0.
Drinking coconut meat	1.05e+00	0.	0.	0.
Copra meat	1.43e+00	0.	0.	0.
Marshallese cake	1.43e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-68. Radionuclide concentrations in local food products (pCi/g wet weight) for Enibuk Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Pandanus fruit	1.99e+00	5.07e-01	2.05e-05	7.12e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	2.92e-01	1.31e-03	1.60e-05	1.23e-05
Coconut milk	2.14e+00	1.20e-02	3.76e-05	2.00e-05
Drinking coconut meat	1.57e+00	1.20e-02	3.76e-05	2.00e-05
Copra meat	2.14e+00	1.20e-02	3.76e-05	2.00e-05
Marshallese cake	2.14e+00	1.20e-02	3.76e-05	2.00e-05
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-69. Radionuclide concentrations in local food products (pCi/g wet weight) for Manchinikson Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Pandanus fruit	1.41e+00	3.50e-01	7.03e-06	6.70e-06
Coconut fluid	3.49e-01	2.07e-03	7.20e-06	0.
Coconut milk	1.46e+00	1.90e-02	1.73e-05	0.
Drinking coconut meat	1.06e+00	1.90e-02	1.73e-05	0.
Copra meat	1.46e+00	1.90e-02	1.73e-05	0.
Marshallese cake	1.46e+00	1.90e-02	1.73e-05	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-70. Radionuclide concentrations in local food products (pCi/g wet weight) for Kuobuen Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Coconut fluid	2.24e-01	0.	0.	0.
Coconut milk	2.05e+00	0.	0.	0.
Drinking coconut meat	1.50e+00	0.	0.	0.
Copra meat	2.05e+00	0.	0.	0.
Marshallese cake	2.05e+00	0.	0.	0.
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-71. Radionuclide concentrations in local food products (pCi/g wet weight) for Majokoryaan Island at Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Coconut crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Land crabs	2.50e+00	2.73e-01	1.51e-03	4.80e-04
Chicken muscle	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Chicken liver	2.23e-01	3.82e-02	3.40e-04	4.80e-04
Chicken gizzard	1.88e-01	7.49e-02	2.60e-04	5.70e-04
Pork muscle	1.40e+00	3.70e-04	6.70e-06	1.30e-05
Pork kidney	2.70e+00	6.12e-03	1.70e-05	9.80e-05
Pork liver	9.58e-01	1.24e-03	7.90e-05	2.10e-05
Pork heart	7.72e-01	2.94e-03	1.90e-05	1.60e-04
Bird muscle	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Bird eggs	9.60e-03	1.93e-04	8.50e-05	2.80e-05
Chicken eggs	2.99e-01	2.07e-03	2.30e-05	3.70e-04
Rainwater	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Wellwater	1.80e-04	1.00e-03	7.00e-07	2.50e-07
Malolo	7.00e-05	8.90e-05	4.00e-07	3.00e-07
Coffee/tea	7.00e-05	8.90e-05	4.00e-07	3.00e-07

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

Table A-72. Radionuclide concentrations in local marine products (pCi/g wet weight) for Ailinginae Atoll.

Food	137Cs	90Sr	239+240Pu	241Am
Reef fish	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Tuna	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Mahi mahi	1.60e-02	4.30e-04	8.50e-05	2.80e-05
Marine crabs	4.80e-04	1.08e-03	3.82e-04	1.26e-04
Lobster	4.80e-04	1.08e-03	3.82e-04	1.26e-04
Clams	5.60e-04	7.00e-04	1.60e-03	5.00e-04
Trochus	5.60e-04	7.00e-04	1.60e-03	5.00e-04
Tridacna muscle	5.60e-04	7.00e-04	1.60e-03	5.00e-04
Jedrul	5.60e-04	7.00e-04	1.60e-03	5.00e-04
Octopus	8.80e-03	1.08e-03	9.35e-05	3.08e-05
Turtle	2.56e-03	1.63e-04	2.89e-05	9.52e-06
Turtle eggs	2.56e-03	1.63e-04	2.89e-05	9.52e-06

NOTE: Value following e notation indicates power of ten. For example, 1.00e-05 is equal to 1.00×10^{-5}.

APPENDIX B

RADIONUCLIDE CONCENTRATIONS IN SOIL AT THE NORTHERN MARSHALL ISLANDS

Analytical data from one of the four laboratories (Laboratory D) that analyzed samples from the Northern Marshall Islands Radiological Survey did not, for the most part, meet the quality control criteria established for the analysis of samples. These data, which represent about 18% of the total wet chemistry analyses performed by all four laboratories and 55% of the work performed by Laboratory D, were not accepted by LLNL. Thus, there are some islands in the following tables where ^{90}Sr, $^{239+240}Pu$, or ^{241}Am concentrations are unavailable. These missing data are identified by dashes. Data for these three radionuclides are available, however, for the residence islands at each atoll. The 80% of the wet chemistry data from all laboratories that did meet our quality control criteria is sufficient to give an evaluation of the ^{90}Sr, $^{239+240}Pu$, and ^{241}Am concentrations at most islands and at all atolls.

The ^{137}Cs concentration data for all samples is complete. This radionuclide accounts for more than 90% of the estimated doses in the Marshall Islands.

Table B-1. Average ^{137}Cs soil concentrations from the Northern Marshall Islands survey.

Atoll and island	Number of samples	^{137}Cs (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Likiep (L)[a]						
Agony (45)[b]	3	1	0.79	0.6	0.39	0.26
Kapenor (55)	6	0.65	0.43	0.32	0.21	0.15
Jeltonet (13)	3	0.34	0.24	0.18	0.12	0.088
Likiep (37)	12	0.65	0.45	0.35	0.24	0.17
Rikuraru (2)	12	1	0.68	0.5	0.34	0.24
Etoile (47)	4	0.43	0.39	0.33	0.26	0.19
Mejit (R)						
Mejit (1)	8	0.56	0.41	0.33	0.22	0.15
Ailuk (A)						
Enijabro (2)	4	0.64	0.46	0.37	0.25	0.18
Enejelar (4)	5	0.98	0.76	0.57	0.38	0.26
Bigen (7)	4	0.48	0.33	0.26	0.17	0.11
Agulue (53)	7	0.63	0.44	0.34	0.22	0.15
Aliet (20)	4	1.3	0.97	0.75	0.48	0.31
Ailuk (51)	13	0.6	0.44	0.35	0.25	0.18
Bererjao (33)	4	0.7	0.78	0.32	0.21	0.14
Kapen (1)	4	0.7	0.45	0.32	0.21	0.14
Utirik (I)						
Aon (8)	10	2.6	1.9	1.5	0.99	0.65
Pigowak (3)	8	4.4	3.3	2.7	1.8	1.1
Utirik (6)	28	2.4	1.8	1.4	0.96	0.66
Wotho (M)						
Medyeron (1)	8	1.4	0.86	0.62	0.4	0.29
Wotho (4)	15	0.37	0.29	0.25	0.17	0.12
Kabben (17)	6	0.16	0.16	0.14	0.11	0.079
Ujelang (J)						
Ennimenetto (23)	5	0.44	0.44	0.43	0.39	0.42
Burle (20)	3	0.8	0.67	0.51	0.37	0.30
Eimnlapp (22)	4	0.9	0.73	0.58	0.42	0.29

Table B-1. (Continued)

Atoll and island	Number of samples	^{137}Cs (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Ujelang (J) (continued)						
Kalo (25)	5	0.19	0.21	0.21	0.17	0.14
Daisu (17)	6	0.28	0.22	0.16	0.11	0.084
Pokon (5)	3	0.14	0.11	0.078	0.06	0.069
Ujelang (18)	24	0.51	0.43	0.35	0.26	0.2
Taka (H)						
Taka (4)	8	1.1	0.95	0.76	0.56	0.39
Eluk (5)	1	0.53	0.33	0.24	<0.15	<0.10
Rongelap (F)						
Borukka (49)	3	36	25	18	12	7.3
Kabelle (13)	5	40	26	20	16	11
Eniaetok (33)	6	7	9.9	9.4	6.4	4.3
Lomuilal (7)	4	36	46	42	32	22
Yugui (5)	1	170	100	73	46	30
Rongelap (42)	27	15	12	9.8	6.9	5
Mellu (23)	4	71	55	43	30	24
Arbar (43)	6	12	13	9.3	6.3	5
Naen (1)	7	95	80	68	45	29
Rongerik (G)						
Eniwetak (11)	11	6.5	5.2	4.2	3	2.2
Bigonattam (5)	2	8.6	6.6	5.1	3.4	2.2
Jedibberdib (1)	1	7	6.9	5.6	3.9	2.5
Latoback (2)	4	16	13	9.8	6.4	4.3
Bock (12)	2	1.8	2.1	2.2	1.9	1.3
Rongerik (6)	7	33	23	17	11	7.2
Bikar (D)						
Jaboerukku (1)	4	0.35	0.22	0.19	0.16	0.11
Arumenii (2)	1	0.23	0.23	0.17	<0.10	<0.083
Bikar (4)	2	0.43	0.44	0.43	0.44	0.33

Table B-1. (Continued)

Atoll and island	Number of samples	^{137}Cs (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Jemo (S)						
Jemo (1)	3	0.33	0.31	<0.27	<0.18	<0.11
Ailinginae (C)						
Ucchuwanen (15)	2	11	7	5.4	3.6	2.6
Knox (10)	3	17	12	9	5.8	3.8
Mogiri (24)	6	6.1	5.4	4.4	3.2	2.3
Sifo (27)	6	1.4	1.4	1.2	0.82	0.56
Ribinouri (19)	4	5.4	4.3	3.8	2.6	1.8
Enibuk (17)	9	4.4	3.5	2.9	2.2	1.7
Manchinikson (25)	3	6.1	7.7	7	5.3	3.5
Kuobuen (18)	3	6	4.5	3.9	2.7	1.8
Majokoryaan (8)	2	3.4	2	1.7	1.3	0.94

[a] Code letter for atoll.
[b] Code number for island.

Table B-2. Average ^{90}Sr soil concentrations from the Northern Marshall Islands survey.

Atoll and island	Number of samples	^{90}Sr (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Likiep (L)[a]						
Agony (45)[b]	3	0.2	0.22	0.21	0.21	0.14
Kapenor (55)	6	0.22	0.16	0.14	0.010	0.085
Jeltonet (13)	3	0.16	0.12	--	--	--
Likiep (37)	12	0.26	0.22	0.19	0.15	0.11
Rikuraru (2)	--	--	--	--	--	--
Etoile (47)	3	0.18	0.17	0.16	0.15	0.11
Mejit (R)						
Mejit (1)	8	0.31	0.28	0.27	0.24	0.18
Ailuk (A)						
Enijabro (2)	--	--	--	--	--	--
Enejelar (4)	--	--	--	--	--	--
Bigen (7)	--	--	--	--	--	--
Agulue (53)	7	0.26	0.23	0.20	0.17	0.13
Aliet (20)	4	0.43	0.39	0.36	0.28	0.20
Ailuk (51)	13	0.26	0.30	0.29	0.24	0.18
Bererjao (33)	4	0.37	0.32	0.26	0.2	0.15
Kapen (1)	--	--	--	--	--	--
Utirik (I)						
Aon (8)	--	--	--	--	--	--
Pigowak (3)	--	--	--	--	--	--
Utirik (6)	18	1.4	1.2	1.1	0.82	0.59
Wotho (M)						
Medyeron (1)	5	0.37	0.34	0.36	0.33	0.35
Wotho (4)	3	0.14	0.11	0.097	0.077	0.057
Kabben (17)	5	0.09	0.093	0.09	0.08	0.06
Ujelang (J)						
Ennimenetto (23)	5	0.24	0.28	--	--	--
Burle (20)	3	0.2	0.2	--	--	--
Eimnlapp (22)	4	0.44	0.37	--	--	--

Table B-2. (Continued)

Atoll and island	Number of samples	^{90}Sr (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Ujelang (J) (continued)						
Kalo (25)	5	0.12	0.13	0.14	0.12	0.096
Daisu (17)	6	0.12	--	--	--	--
Pokon (5)	3	0.12	--	--	--	--
Ujelang (18)	23	0.2	0.19	0.16	0.14	0.11
Taka (H)						
Taka (4)	8	1.19	1.0	0.85	0.58	0.43
Eluk (5)	1	0.21	0.74	--	--	--
Rongelap (F)						
Borukka (49)	3	17	14	12	--	--
Kabelle (13)	5	46	32	29	24	17
Eniaetok (33)	6	9.5	11	10	8.2	8.3
Lomuilal (7)	4	95	81	66	49	35
Yugui (5)	1	46	38	30	20	14
Rongelap (42)	20	6.9	7.3	7.1	6.1	4.6
Mellu (23)	4	45	39	36	27	21
Arbar (43)	--	--	--	--	--	--
Naen (1)	7	150	134	110	77	53
Rongerik (G)						
Eniwetak (11)	8	5.8	6.5	5.2	3.8	--
Bigonattam (5)	--	--	--	--	--	--
Jedibberdib (1)	--	--	--	--	--	--
Latoback (2)	--	--	--	--	--	--
Bock (12)	1	4.6	4.3	4.7	4.2	3.3
Rongerik (6)	2	30	20	17	12	8.5
Bikar (D)						
Jaboerukku (1)	4	6.8	5.3	--	--	--
Arumenii (2)	1	2.2	3.1	--	--	--
Bikar (4)	2	0.87	0.84	--	--	--

Table B-2. (Continued)

Atoll and island	Number of samples	^{90}Sr (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Jemo (S)						
Jemo (1)	--	--	--	--	--	--
Ailinginae (C)						
Ucchuwanen (15)	2	5.9	4.6	--	--	--
Knox (10)	3	5.9	4.6	--	--	--
Mogiri (24)	6	4.9	4.6	3.6	2.4	1.7
Sifo (27)	6	1.5	1.8	--	--	--
Ribinouri (19)	4	3.2	2.6	2.7	1.9	1.3
Enibuk (23)	9	4.6	3.3	--	--	--
Manchinikson (25)	3	2.8	2.8	--	--	--
Kuobuen (18)	3	6.9	4.1	2.9	1.9	1.3
Majokoryaan (8)	2	7.7	4.8	--	--	--

[a] Code letter for atoll.
[b] Code number for island.

Table B-3. Average $^{239+240}Pu$ soil concentrations from the Northern Marshall Islands survey.

Atoll and island	Number of samples	$^{239+240}Pu$ (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Likiep (L)						
Agony (45)	3	0.041	0.036	0.029	0.019	0.012
Kapenor (55)	--	--	--	--	--	--
Jeltonet (13)	--	--	--	--	--	--
Likiep (37)	5	0.054	0.043	0.033	0.022	0.014
Rikuraru (2)	--	--	--	--	--	--
Etoile (47)	3	0.034	0.034	0.029	0.022	0.015
Mejit (R)						
Mejit (1)	8	0.059	0.043	0.035	0.025	0.017
Ailuk (A)						
Enijabro (2)	1	--	--	--	--	--
Enejelar (4)	5	--	--	--	--	--
Bigen (7)	3	--	--	--	--	--
Agulue (53)	7	0.069	0.048	0.036	0.023	0.014
Aliet (20)	1	0.17	0.11	0.074	0.045	0.029
Ailuk (51)	13	0.098	0.081	0.059	0.038	0.024
Bererjao (33)	4	0.12	0.095	0.067	0.041	0.027
Kapen (1)	--	--	--	--	--	--
Utirik (I)						
Aon (8)	--	--	--	--	--	--
Pigowak (3)	--	--	--	--	--	--
Utirik (6)	16	0.51	0.39	0.3	0.18	0.12
Wotho (M)						
Medyeron (1)	8	0.072	0.049	0.035	0.023	0.015
Wotho (4)	9	0.031	0.022	0.016	0.010	0.0066
Kabben (17)	5	0.011	0.011	0.010	0.0073	0.0050
Ujelang (J)						
Ennimenetto (23)	--	--	--	--	--	--
Burle (20)	--	--	--	--	--	--
Eimnlapp (22)	--	--	--	--	--	--

Table B-3. (Continued)

Atoll and island	Number of samples	$^{239+240}Pu$ (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Ujelang (J) (continued)						
Kalo (25)	5	0.032	0.029	0.035	0.027	0.019
Daisu (17)	--	--	--	--	--	--
Pokon (5)	--	--	--	--	--	--
Ujelang (18)	14	0.04	0.033	0.028	0.019	0.013
Taka (H)						
Taka (4)	8	0.12	0.078	0.067	0.044	0.029
Eluk (5)	1	0.098	0.074	--	--	--
Rongelap (F)						
Borukka (49)	3	7.2	4.0	2.8	--	--
Kabelle (13)	5	14	8.6	6.95	5.31	3.59
Eniaetok (33)	6	2	2.6	2.6	2.3	1.4
Lomuilal (7)	4	19	16	13	8.6	5.5
Yugui (5)	1	15	8.6	5.9	3.7	2.3
Rongelap (42)	18	3.2	2.6	2.1	1.4	0.89
Mellu (23)	4	14	9.9	7.0	4.4	3.5
Arbar (43)	43	--	--	--	--	--
Naen (1)	7	29	25	20	13	8.4
Rongerik (G)						
Eniwetak (11)	8	2.5	1.9	1.4	0.87	--
Bigonattam (5)	--	--	--	--	--	--
Jedibberdib (1)	--	--	--	--	--	--
Latoback (2)	--	--	--	--	--	--
Bock (12)	1	0.49	0.54	0.66	0.66	0.44
Rongerik (6)	2	2.3	1.4	1.2	0.8	0.51
Bikar (D)						
Jaboerukku (1)	4	5.1	3.1	--	--	--
Arumenii (2)	1	2.1	2.6	--	--	--
Bikar (4)	2	0.045	0.054	--	--	--

Table B-3. (Continued)

Atoll and island	Number of samples	$^{239+240}Pu$ (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Jemo (S)						
Jemo (1)	--	--	--	--	--	--
Ailinginae (C)						
Ucchuwanen (15)	2	4.5	2.5	--	--	--
Knox (10)	3	2.7	1.7	--	--	--
Mogiri (24)	6	0.98	0.75	0.55	0.35	0.23
Sifo (27)	6	0.39	0.36	--	--	--
Ribinouri (19)	4	0.79	0.66	0.82	0.54	0.35
Enibuk (23)	9	2.4	1.4	--	--	--
Manchinikson (25)	3	1.1	1.0	--	--	--
Kuobuen (18)	3	1.3	0.70	--	--	--
Majokoryaan (8)	2	3.7	2.0	--	--	--

[a] Code letter for atoll.
[b] Code number for island.

Table B-4. Average ^{241}Am soil concentrations from the Northern Marshall Islands survey.

Atoll and island	Number of samples	^{241}Am (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Likiep (L)[a]						
Agony (45)[b]	3	0.019	0.017	0.013	0.0088	0.0056
Kapenor (55)	1	0.017	0.012	0.0081	0.0052	0.0034
Jeltonet (13)	3	--	--	--	--	--
Likiep (37)	5	0.031	0.025	0.019	0.013	0.0084
Rikuraru (2)	3	<0.021	<0.037	<0.040	<0.037	<0.037
Etoile (47)	3	0.016	0.014	0.011	0.0075	0.0047
Mejit (R)						
Mejit (1)	6	0.036	0.026	0.021	0.014	0.0095
Ailuk (A)						
Enijabro (2)	1	<0.021	<0.019	0.010	0.0059	0.0023
Enejelar (4)	5	0.039	0.026	0.032	0.021	0.014
Bigen (7)	4	<0.023	<0.025	<0.020	<0.014	<0.014
Agulue (53)	7	0.033	0.024	0.018	0.012	0.0074
Aliet (20)	2	<0.014	0.014	0.012	0.0078	0.005
Ailuk (51)	12	0.060	0.036	0.028	0.018	0.012
Bererjao (33)	2	0.068	0.058	0.042	0.026	0.016
Kapen (1)	4	0.063	0.032	0.023	0.014	0.0090
Utirik (I)						
Aon (8)	1	0.25	0.17	<0.12	<0.17	<0.14
Pigowak (3)	1	0.12	0.17	0.086	0.06	--
Utirik (6)	26	0.24	0.18	0.13	0.083	0.059
Wotho (M)						
Medyeron (1)	4	0.061	0.038	0.039	0.034	0.022
Wotho (4)	10	0.037	0.028	0.034	0.044	0.042
Kabben (17)	5	0.0067	0.0080	0.007	0.0053	0.0036
Ujelang (J)						
Ennimenetto (23)	4	0.047	0.030	<0.04	<0.042	<0.036
Burle (20)	2	0.019	0.015	<0.033	<0.071	<0.058
Eimnlapp (22)	3	0.069	0.043	<0.048	<0.043	<0.043

Table B-4. (Continued)

Atoll and island	Number of samples	^{241}Am (pCi/g dry weight of soil) 0 to 5 cm	0 to 10 cm	0 to 15 cm	0 to 25 cm	0 to 40 cm
Ujelang (J) (continued)						
Kalo (25)	5	0.011	0.010	0.0091	0.0080	--
Daisu (17)	6	0.031	0.0099	0.045	0.052	0.055
Pokon (5)	2	0.0087	0.039	<0.041	<0.053	<0.078
Ujelang (18)	18	0.013	0.012	0.0095	0.028	0.018
Taka (H)						
Taka (4)	8	0.12	0.096	0.071	0.044	0.029
Eluk (5)	1	0.15	0.09	--	--	--
Rongelap (F)						
Borukka (49)	3	2.6	1.5	1.1	--	--
Kabelle (13)	2	6.7	5.7	2.5	1.7	1.2
Eniaetok (33)	5	0.71	1.2	1.1	0.74	0.47
Lomuilal (7)	2	5	7	6.6	4.8	3.1
Yugui (5)	1	6.5	4.0	2.8	1.7	1.1
Rongelap (42)	17	1	0.89	0.73	0.51	0.35
Mellu (23)	2	5.8	4.2	3.1	2	1.4
Arbar (43)	1	3.8	--	--	--	--
Naen (1)	6	13	11	8.7	5.6	3.7
Rongerik (G)						
Eniwetak (11)	4	1.2	1.3	--	--	--
Bigonattam (5)	--	--	--	--	--	--
Jedibberdib (1)	1	1.9	--	--	--	--
Latoback (2)	2	1.5	1.1	0.74	0.48	--
Bock (12)	1	0.44	0.40	--	--	--
Rongerik (6)	2	4.9	2.8	2	1.2	0.77
Bikar (D)						
Jaboerukku (1)	4	0.78	0.47	0.32	--	--
Arumenii (2)	1	0.34	0.44	<0.30	<0.19	<0.13
Bikar (4)	2	0.094	0.067	0.069	0.082	<0.061

The following shows the spelling of atolls and islands of the Northern Marshall Islands as established during the radiological survey of 1978 and that commonly used by the Marshallese.

Spelling established during radiological survey	Spelling used by Marshallese
Likiep	Likiep
Rikuraru	Liklal
Likiep	Likiep
Agony	Aikne
Kapenor	Kabinwōd
Taka	Taka
Taka	Taka
Eiluk	Eluk
Jemo	Jemo
Bikar	Bikar
Jaboerukku	Jenliklik
Bikar	Bikar
Rongerik	Rongrik
Rongerik	Rongrik
Eniwetak	Enewetak
Mejit	Mejit
Rongelap	Rongelap
Naen	Naen
Kabelle	Namen
Mellu	Melu
Eniaetok	Eneaetok
Rongelap	Rongelap
Arbar	Arbar
Utirik	Utrik
Utirik	Utrik
Aon	Aon
Ujelang	Ujelang
Ujelang	Ujelang
Wotho	Wotho
Medyeron	Mejirwōn
Wotho	Wotho
Kabben	Kaben
Ailinginae	Ailinginae
Knox	Jerea
Nechuwanen	Wujjuōnen
Mogiri	Makil
Sifo	Karwe
Ailuk	Ailuk
Kapen	Kapen
Enijabro	Enejabrok
Enejelar	Enejelar
Bigen	Biken
Aliet	Aliej
Berejao	Barōrkan
Ailuk	Ailuk
Agulne	Akulle

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