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INITIALS/ SIG.

August 21, 1979

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Mr. Theodore Mitchell
Executive Director
Micronesian Legal Services
Corporation, Suite 300
1424 Sixteenth Street, N.W.
Washington, D. C. 20036

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Dear Mr. Mitchell:

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The Department of Energy is pleased to respond to your letter of August 3, 1979, in which you requested copies of a number of records pursuant to the Freedom of Information Act. The following responses are numbered to coincide with your numbered requests.

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Item No. 1. The statement is based upon testimony presented by Messrs. DeBrum, Weissgall, Deal, DeYoung and Mrs. Van Cleve, and others at Hearings before Subcommittees of the Committee on Appropriations, House of Representatives, on April 12, May 22, and June 19, 1978. Copies of pertinent portions of that testimony are enclosed (Tab A). Additional relevant information is available in the Hearings testimony conducted by the Subcommittee on July 25, 1978. We do not have a copy of the final transcript of this testimony.

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Reports from Brookhaven National Laboratory indicated that the Cesium-137 levels of Bikini residents increased with time until 1978, and decreased thereafter (post-relocation). These data were based upon whole body counting measurements. A summary of this information is enclosed (Tab B). This increase in body burden coincided with increased availability of locally grown terrestrial foods, particularly coconuts. The Cesium-137 measurements suggest that either the quantity of imported food available to the people or the quantity of available imported food consumed by the people was below that level needed to moderate the increase in Cesium-137 body burdens as locally grown foods became available.

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Item No. 2. The aerial photographs of Bikini Atoll (which I believe have previously been sent to you) show that the Bikini and Eneu Islands are separated by approximately five miles of reef. At low tide it is possible to walk from one island to the other. Considering the facts

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that the island of Bikini is the longed-for home of the Bikini people, that houses already exist on the island, and that tens of thousands of coconut trees are on the island, we feel that it is valid to raise the question of whether or not access to Bikini Island can be controlled if the people reside on Eneu Island. (See also previous comments of Mr. DeBrum.) There are no other records covering the request in Item No. 2.

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Item No. 3(a). The Department of Energy has no records bearing upon this subject. Inquiries of this subject presumably should be directed to the Department of Interior.

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Item No. 3(b). Please refer to the Brookhaven National Laboratory information provided in (1) above. If body burden levels of Cesium-137 were to be equal to or greater than 3 μCi , it would be expected that radiation exposure levels at or above 500 millirem per year would result. This assumption is based upon Publication 2 of the International Commission on Radiological Protection (Report of Committee II on Permissible Dose for Internal Radiation). In that publication it is stated that the maximum permissible body burden of Cesium-137 (assuming that the total body is the organ of critical reference) for occupational exposure is 30 μCi (see Tab C). Since the occupational exposure limit is 5 rem per year, the body burden of Cesium-137 resulting in an exposure level of 1/10 of 5 rem per year (i.e., 500 millirem per year) is 1/10 of the 30 μCi value, or 3 μCi .

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Item No. 4. Lawrence Livermore Laboratory (LLL) currently is in the process of preparing technical articles for publication in the scientific literature addressing these issues. Consequently, the articles as such do not yet exist, and the Department of Energy obviously does not possess them. However, enclosed (Tab D) is a copy of information which the Lawrence Livermore Laboratory sent to the Department of Energy consisting of the food concentrations of radionuclides which LLL used in calculating the dose estimates under discussion.

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Item No. 5. The substance of the request addresses the basis of the decision to employ the Federal radiation guidance. The most relevant basis for this is the Federal Radiation Council guidance as presented in the Federal Register over the signatures of Presidents Eisenhower and Kennedy (see Tab E).

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The text on page 6 and footnote 10 on the same page address the AEC recommendations for planning at Enewetak, the bases for which are in the Environmental Impact Statement.

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Mr. Theodore Mitchell

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Item No. 6. Lawrence Livermore Laboratory (LLL) is in the process of preparing this document. It is not yet available. The dose estimates were provided by LLL, however, and copies of what the Department received are enclosed (Tab F).

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Item No. 7. In response to your FOI request in Item No. 7, the records you requested are at the Lawrence Livermore Laboratory. They are in the process of being assimilated. As soon as they are forwarded here, it will be determined whether they can be released and you will be promptly notified. We anticipate no problems at this time.

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Item No. 8. Risk estimates of somatic or genetic consequences of various radiation exposure levels were not made. Risk estimates for some of the radiation exposure values identified (i.e., 170 millirem per year and 5000 millirem per 30 years) are given in the summary statement of the National Academy of Sciences-National Research Council's Report of the Advisory Committee on the Biological Effects of Ionizing Radiation (Tab G).

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The Atomic Energy Commission Task Group Report published in the Enewetak Environmental Impact Statement, Volume II, Tab B, pages III-11 and 12 provides a somatic risk assessment for a radiation exposure of 250 millirem per year, the recommended radiation protection criteria for the whole body and for bone marrow.

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Item No. 9. No such documents exist.

We trust that this information is responsive to your request.

Sincerely,

Bruce W. Wachholz, Ph.D.
Office of Environment

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7 Enclosures

- bcc: Mrs. Van Cleve, DOI
Mrs. Clusen, ASEV
Mr. Hollister, ADASEV
Mr. Whitnah, OMS
Dr. Weyzen, OHER
Mr. Deal, OESD
Mr. McCraw, OESD
Mr. Brown, OGC
Mr. Gelband, AD-44

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TAB

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Mr. YATES. Were the Bikini people under Federal radiation standards?

Mr. DEAL. They were but the radiation dose from intake of food had begun to rise.

Mr. YATES. Did any go over the top?

Mr. DEAL. None of the people have gone over the top as far as the cesium levels. They are very close to the maximum allowable dose from the maximum of permissible amounts of cesium.

Mr. YATES. Are the people living in the houses along the road?

Mr. DEAL. Yes, and they are getting the radioactivity in their bodies from their diet, from eating the locally grown foods.

In retrospect, this is probably the big mistake made in the beginning of the resettlement program in that we made recommendations which turned out to be impractical in the sense that to have garden-growing but then tell the people not to eat the products.

Mr. YATES. Was he told to grow his garden and eat that food? Was he told that he could do that?

Mr. DEAL. The original recommendations prohibited eating certain of the local foods.

Mr. YATES. This is right. But I think I read here the houses were built on pads of coral and that they were told not to eat the coconut crab. You say you brought in outside foods at the initial stages.

Was this to cut down on the possible intake of radiation residuals? Did you bring in outside food from the start?

Mr. DEAL. Yes, sir.

CURRENT FEEDING PROGRAM ON BIKINI ISLANDS

Mr. YATES. I guess outside food is still being brought in.

Mr. DE YOUNG. It was not until early last year, Mr. Chairman, that the tree crops and some of the other vegetable crops began to become fully productive. So up until 1977 they had been existing primarily on food products that were brought in from the outside. Some of these were surplus agricultural commodity foods plus the local marine food which had been certified to be suitable.

MONITORING OF BIKINI ISLAND

Mr. YATES. When did they get the cesium then?

Mr. DE YOUNG. As Mr. Deal indicated, when this high level of cesium was revealed, a series of analyses were carried out.

Mr. YATES. When was it revealed?

Mr. DE YOUNG. In 1976.

Mr. YATES. Then the Department—were you still the AEC in 1976?

Mr. DEAL. We were ERDA in 1976.

Mr. YATES. So you became a little more alarmed than when you were the Atomic Energy Commission. In '76 you first encountered this kind of a test. Is this an annual test that you had been making of the people?

Mr. DEAL. Yes, sir.

Mr. YATES. What kind of tests, monthly, semiannually, every four months or what?

- April 1975 Preliminary survey of Bikini and Eneu Islands conducted jointly by University of Washington and Brookhaven National Laboratory for ERDA Screening survey of external radiation levels and collection of some soil and vegetation samples in preparation for a major survey later this year. See NVO-266-32 and BNL 50796
- June 1975 A major fine grid survey of Bikini and Eneu Island external radiation levels was conducted by Lawrence Livermore Laboratory for ERDA with participation by scientists from EPA, University of Washington Brookhaven National Laboratory, and ERDA. Also samples of soil, plants, animals, and cistern and ground water were collected. Exposure rates on Bikini Island highly variable Eneu Island dose rates lower than Bikini cistern water on both islands is acceptable for drinking. Some well water acceptable other wells unacceptable for drinking. See (CRL-5197), 51879 Rev. 1, 51913 Pt 1, 52176 51879 Part 2 51879 Part 3, 51879 Pt 5, NVO-266-32 and BNL 50796.
- April 1976 A survey of external radiation levels on Nam Island, the 3d largest island at Bikini Atoll conducted by Brookhaven National Laboratory for ERDA. To be published
- September 1976 Conduct of a joint survey of 5 Atolls including Bikini by University of Washington and Brookhaven National Laboratory for ERDA. Surveyed external radiation levels and collected environmental samples. To be published
- April 1977: Site visits by Brookhaven National Laboratory to plan installation of windmill powered air sampling stations Bikini Atoll one of four sites for long-term air sampling. Work supported by ERDA. Site identified agreement obtained
- October 1977: Brookhaven National Laboratory installed wind-powered long-term air sampling station on Bikini Island. Work supported by DOE. Data not yet available

In vivo Counting and Urine Bioassay Sampling—Bikini Atoll

Year	Sampling/Counting ¹
1970 ²	Pooled urine collected, analyzed for Sr-90, Cs-137, and Pu-239
1971 ²	Pooled urine collected, analyzed for Sr-90, Cs-137, and Pu-239, 240
1972 ²	Pooled urine collected. Cs-137 concentration shows factor of 4 increase over 1970. Sr-90 increase is factor of 2.
1973 ²	Cs-137 in urine higher than 1970 by factor of about 10. Sr-90 increase is factor of 4.
April 1974 ²	First in vivo counting of Cs-137 in Bikini residents. Cs-137 urine values about same as 1973. Sr-90 levels down near 1970 values. Pu-239, 240 higher than 1971 by factor of about 5 ³
April 1975 ²	Pu-239, 240 higher than 1971 by factor of 10 ⁴
Fall 1976 ²	Pu-239, 240 higher than 1971 by factor of 2 ⁴ . Cs-137 urine values.

¹ Results from several surveys published in one report. Sr-90 and Cs-137 are dominant in the terrestrial environment; Cs-60 and Fe-57 in marine environment; and Am-241 and Pu-239, 240 are important in soils. Radioactivity on Bikini Atoll has declined significantly.

² Sampling on different individuals at different times as people come and go at Bikini Atoll.

³ See BNL 50424 Rep. 1975

⁴ These results suspect, samples may have been contaminated either in measurement or in collection.

higher than 1970 by factor of about 20. Sr-90 higher by factor of about 5. Memo Conard to Liverman, May 11, 1977.
 May 1977. Second in vivo counting of Bikini residents. Collection of large volumes urine samples results suspect. The average Cs-137 burden for 22 individuals in 1977 is 10 times the average for 8 individuals in 1974. Two individuals had body burdens of Cs-137 of 36 nCi/kg which is very near the maximum permissible burden of 43 nCi/kg. Memo Conard to Liverman, May 11, 1977.
 October 1977. Large volumes urine samples collected under controlled conditions to avoid cross contamination. Results to be available in May 1978.

Mr. DEAL. We made resurveys of the Bikini environment, including soil and groundwaters in 1969, 1970 and 1972. Annual collection of urine samples for radiation analysis began in 1970, and with those people who were working for the agricultural and housing projects.

Mr. YATES. Are these only Bikinians?

Mr. DEAL. Yes, sir.

Mr. YATES. Did you have non-Bikinians working for them at that time?

Mr. DEAL. I can't answer that, sir.

Mr. DE YOUNG. It is my understanding that there were other Marshallese in the work force who were not from Bikini.

Mr. YATES. You examined them as well. Were they examined through that time?

Mr. DE YOUNG. Yes, as long as they were on the island.

Mr. YATES. Go ahead.

Mr. DEAL. We later included collections from the people who had returned to living in the houses; monitoring the Bikini residents was done by whole body counts in 1974 and 1977.

Mr. YATES. What is a whole body count?

Mr. DEAL. That is a very sophisticated counting system where you essentially sit in a chair and where you have a counter that detects radiation from the cesium that has been taken up in the body. It actually counts the body's burden of cesium.

Mr. YATES. Is that the same strontium?

Mr. DEAL. They travel together in the body. You can see that the strontium is—

Mr. YATES. These are like the heavenly twins.

Mr. DEAL. You can measure the strontium with urine samples, but we have not been able to see much of that in the urine samples available to date. They do the whole body counting sample for cesium.

We had a major resurvey of Bikini and Eneu Islands in 1975.

RESULTS OF THE 1975 RADIATION SURVEY

Mr. YATES. Until '75 you found nothing. What did your tests show?

Mr. DEAL. That is when we began to see the rise in the cesium.

Mr. YATES. Will you place in the record a statement representing the levels you found?

[The information follows:]

5011521

MEAN CESIUM-137 LEVELS OBTAINED BY WHOLE BODY COUNTING - 1974*

	MALES			FEMALES		
	No.	μCi^{**}	nCi/kg body wt.***	No.	μCi	nCi/kg body wt.***
Bikini	8	.128	1.84 (0.43-5.11)	13	.073	1.15 (0.22-3.26)
Utirik	9	.262	4.05 (2.64-6.84)	13	.133	2.13 (0.96-3.85)
Rongelap	22	.475	7.76 (4.37-16.3)	24	.304	5.13 (2.71-13.46)
BNL med. team	4	.003	0.0352 (0.0134-.0791)			

*Reference - BNL50424, "A Twenty-Year Review of Medical Findings in a Marshallese Population Accidentally Exposed to Radioactive Fallout," Conard, September 1975.

**Microcuries

***MPC 43 nanocuries per kilogram

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MEAN CESIUM-137 BODY BURDENS IN ADULT MARSHALLESE - 1977*

	MALES			FEMALES		
	No.	μCi^{**}	nCi/Kg Body Wt ^{***}	No.	μCi	nCi/Kg Body Wt
Rongelap	34	0.296 +0.11**** (0.113-0.680)*****	5.04 +1.97	20	0.182 +0.055 (0.097-0.278)	3.13 +1.1
Utirik	27	0.119 +0.048 (0.050-0.215)	1.79 +0.77	21	0.0781 +0.032 (0.038-0.131)	1.29 +0.58
Bikini	22	1.301 +0.73 (0.568-3.232)	19.1 +10.6	20	0.926 +0.47 (0.534-2.234)	14.8 +6.3
Medical Team	7	.00154 +0.00052 (.00105-.00216)	.0195 +0.006			

*Reference memo Conard, BNL, to Liverman, May 11, 1977
 **Microcuries
 ***Nanocuries per kilogram of body weight
 ****Standard deviation
 *****Range

1176

5011523

MEAN CESIUM-137 BODY BURDENS IN MARSHALLESE CHILDREN - 1977*

	Males			FEMALES		
	No.	μCi^{**}	nCi/Kg Body Wt ^{***}	No.	μCi	nCi/Kg Body Wt
Rongelap	5	0.217 +0.04 ^{****} (0.168-0.266) ^{*****}	7.65 +1.21	5	0.265 +0.092 (0.154-0.396)	5.97 +2.1
Utirik	5	0.0663 +0.018 (0.049-0.091)	2.22 +0.66	5	0.0843 +0.024 (0.051-0.108)	2.84 +1.1
Bikini	3	1.04 +0.26 (0.824-1.331)	32.3 +7.6	3	0.861 +0.29 (0.706-1.196)	22.3 +15.3

*Reference memo Conard, BNL, to Liverman, May 11, 1977
 **Microcuries
 ***Microcuries per kilogram of body weight
 ****Standard deviation
 *****Range

1177

Mr. YATES. Then in '75, all of a sudden now that you are ERDA you find the rise.

Mr. DEAL. In '75 we were asked by the Department of Interior for advice on building additional houses in the interior of Bikini Island.

It was at that time we mounted a rather large survey effort which included a lot of people going out and walking around the island with instruments. We have very large surveys done at that time with 30 or 40 people going out and making measurements of the soil, water samples, vegetation samples, and measuring the external radioactivity.

Mr. YATES. Were these tests being taken prior to 1975 as well?

Mr. DEAL. Yes. But not anywhere near the scale we did this time. We concentrated on Bikini Island. It is precisely for this reason we want to have an aerial survey because we can cover much more territory and much faster and we can see the same levels.

When you have a person walking around, it takes more time.

Mr. DUNCAN. I understood you to say that this rise in the level of measurements of strontium began in '75 and that your preliminary analysis indicates that it is coming from the food source and that that food source began to mature last year.

How can we measure the increase in '75 when you say that it is coming from the food if the food wasn't being produced until '77?

Mr. DEAL. That is a very good question.

Mr. McCraw has done a lot of those surveys.

Mr. McCRAW. When the people first returned, there were few if any terrestrial food items grown in Bikini Island soil, and available for their use. There are some things that grow wild. There were a few coconuts and arrowroot. There was a significant planting of coconut trees during the agricultural rehabilitation effort.

Mr. DUNCAN. Those were the ones that began maturing in '76? Am I not correct? We are in '78, so last year would have been '77. But now he is saying that the planting began to mature and it was '76, so we are narrowing the gap.

Mr. DE YOUNG. It started in '76.

Mr. DUNCAN. It could be coconut or arrowroot that was being consumed prior to '78. You began to notice a rise in the levels of cesium and that those levels have risen more rapidly since the domesticated plants matured and were consumed by the inhabitants.

Mr. McCRAW. We were initially using a predictive capability for a number of items in the diet that are now growing in the atoll. All we could do at first was sample the soil and try to predict the levels in food.

Mr. YATES. Where were they coming from? You said a number of items were not being grown.

Mr. McCRAW. A number of items of the normal diet were not locally available when the people first went back. Those things have subsequently become available and we are seeing an increase in availability, an increase in uptake, and you can't see at what exact point in time things occurred.

Mr. DUNCAN. Is there a level of sophistication to measure this that has been increasing? So we might attribute the greater levels to a greater ability to measure what was there all along?

Mr. DEAL. Yes, and measure it easily. You can always measure if you took samples of soil and vegetation and went through a very costly

laboratory procedure. But now we can do the same thing with instruments that are stationary.

CURRENT METHODS OF MONITORING

Mr. DUNCAN. What about the measurement of the levels of cesium in the body of the Bermudians that increasing in sophistication so that your measures can detect levels that were previously undetectable?

Mr. DEAL. Let me answer that a little differently. Several years ago no one would have thought you could take a whole body counter into the field. Now it is engineered to be taken out into the field.

Mr. DUNCAN. You did early in 1975. But your first whole body count began in—

Mr. McCRAW. '74.

Mr. YATES. Is that when you first detected the increase?

Mr. McCRAW. That is the first measurement of cesium in people. We had predicted what the levels would be.

Mr. DUNCAN. Were your measurements in accordance with the prediction?

Mr. McCRAW. Yes. All of the surveys that we have done have tended to support the earlier findings. We have gotten a better body of data and more confidence in the radiation doses we are predicting, and we are looking at the actual items of the diet and do not have to rely on estimates of radioactivity in the foods that the people are eating.

Mr. DUNCAN. But your whole body counts in '74 were not alarming. It wasn't until you went back in '75 with your major resurvey that you saw the rise begin?

Mr. McCRAW. In 1975 we began to predict higher doses on the basis of samples we had collected. In 1977 when the second whole body count was done the levels were a factor of ten higher than in 1974.

FEDERAL STANDARDS AND CURRENT BIKINI LEVELS

Mr. YATES. Above the Federal standards?

Mr. McCRAW. If I might explain about the standards. There are two numbers. One is for the local population. The other is for an individual where you know the individual's exposure. We have not exceeded that individual number. We have seen levels approaching this lower number for the general population. We feel that we can use the higher number or the standard because we are actually measuring the levels of radioactivity in individuals in the population. We know the distribution. We know the highs and we know the lows.

Mr. YATES. Who is to say that the Federal standards are accurate? How do you know the Federal standards are acceptable?

Mr. DEAL. We don't.

Mr. YATES. Why do you establish standards and say if you come to the standard everything is fine, and if you go above this standard it is not fine. How do you know the Federal standards are not carcinogenic?

Mr. DEAL. I think in the radiation protection field that we are concerned with we have another philosophy which is the lowest practicable solution to a problem and it is believed that the people who work with radiation will not receive—

Mr. DUNCAN. If we gave a whole body count to Mr. Yates right now, would your sophisticated measurements show some level of cesium in him?

Mr. McCRAW. Yes.

Mr. DUNCAN. Do you have any way of knowing that he will not get cancer?

Mr. McCRAW. No.

Mr. DUNCAN. That is all I have. I have to go to another committee. I just wanted to worry you.

Mr. YATES. Wait one half minute for my question.

Getting back to my comment about the Federal standards, my son was treated for a tonsil disease in 1944 by then applicable medical standards. He was given radiation in the treatment of his tonsils. Everyone thought it was great. It was a common medical practice. Thousands of young people were having their tonsils removed or shriveled as a result of this treatment. He, like all the others of that age group, are now threatened with cancer because of having been irradiated 25 years ago. So now these people—I assume the radiation he received may have been comparable to the ingestion of cesium or strontium.

The thought occurs to me, and I talked to the cancer specialists at NCI in connection with some of the herbicides and additions to food, and they say amounts really don't mean very much at any particular time. The question is what will be the effect 25 years from now as a different kind of stimulant or carcinogenic material is brought to bear on the body.

So getting back to the question of Federal standards, five years from now you might decide in the new Department of Energy that the levels you established are much too high and that you should establish lower standards because you have, as Mr. Duncan pointed out, more sophisticated equipment.

Mr. McCRAW. It is not a problem of being able to measure the dose level. It is knowing the effect.

Mr. YATES. You might go now.

Mr. DUNCAN. It is a question of exercising our best judgment. I would suggest that five years from now you might even be able to sustain even lower levels.

Mr. McCRAW. We are looking at 30 year standards, to keep the dose down for a long period of time. We are trying to keep the dose in a year below the annual standards, and all the 30 year doses below the 30 year standard.

SAFETY OF BIKINIANS UNDER PRESENT CONDITIONS

Mr. YATES. That brings us to the question at hand. What are you going to do? You have the level of cesium and strontium in the Bikinians rising over the years. They are still on their island.

Have you told them to get off? For your own good, you ought to move!

Mr. DEAN. Mr. Chairman, I don't know that anyone thinks that this is a life threatening situation at this time.

Mr. YATES. Really?

Mr. DEAN. It is the kind of thing that if you let it continue over a long period of time then it would begin to be of hazard to their health.

Mr. YATES: What happened to Mr. Pinous' article on March 19th where he says—the article is titled, "U.S. Erred on the Safety of Return to Bikini Island."

Nine years ago the U.S. Government told the Bikini Islanders it was safe to return to their atoll, once the site of nuclear weapons tests in the Pacific. Some of the islanders went home. But now the government has found that it was wrong. According to tests last year the groundwater in Bikini is still too radioactive for human consumption. So are the coconuts and fruits and vegetables grown in the still contaminated soil. So the Interior Department has very quietly asked Congress for \$15 million to move the islanders to another location.

Why are you asking for more money if it is safe? Is it safe? Safe is a relative term, isn't it?

Mr. DEAL: Yes, it is. If it was practicable for the people to only eat outside food and maybe have to drink outside water, then we think that goes within the Federal standards, and that is the only guideline we have to go with.

Since that is not a practical solution and we do see a rise in the cesium in the whole body counting, we believe that they should not be allowed to eat the food on the island, and it is probably not a practical situation. Any additional resettlement should be on Enyu Island where they can have their schools and other facilities. That is the direction they should move and not try to do that on Bikini Island.

Mr. YATES: Should they stay there is the question. Who is exercising the judgment on whether they should stay there? Haven't the levels been increasing? Our friend has said they are almost up to the top of the Federal standards. If they stay there, won't they go over the top?

Mr. DEAL: The whole question is, if they were to not eat the locally grown foods on Bikini Island, would the radiation dose from cesium go down?

Mr. YATES: What will you do, bring in box lunches?

Mr. DEAL: That is the impractical part of the solution.

CURRENT FEEDING PROGRAM ON BIKINI

Mr. WINKEL: If I might speak to this part of the discussion, because it brings in the present time period. What is being discussed illustrates, as you have pointed out, one of the difficulties of administration. Decisions must be based on available information. Our decisions have to be based on the information which you have been given, which I also have been given, by representatives of the Department of Energy that local conditions would be safe if ample outside food supplies were provided for the people on the island. In addition, we provided equipment for fishing in the lagoon. The outside food is sent in on a regular basis. These food supplies, while not attractive in all respects from the point of view of the normal diet, because some USDA preserved foods are included, provide a food standard which is in terms of nutrition far above the average as far as diet in the Trust Territory is concerned.

Mr. YATES: What does that mean? You deliver K rations to them? What kind of food are you talking about?

Mr. WINKEL: Dried foods, fresh fruits and vegetables from Ponape, as varied a diet as far as protein, starch, carbohydrates is concerned. It is prepared by nutritionists.

Mr. DEAL. I don't know why they don't count the children. It may be a question of sitting still.

Mr. YATES. Why is that?

Mr. DE YOUNG. I am informed by the medical authorities at Brookhaven, that the children under 5 are too small to be subjected to the whole body counts.

Mr. YATES. Why?

Mr. DE YOUNG. I don't know whether it is the size of the child or whether the measurement itself might have some effect on the child, but the whole body count is not given to children under 5 years.

Mr. YATES. Is there an application of some kind of radiation in the test itself?

Mr. DEAL. No, sir.

Mr. YATES. Then why don't they give it to the children?

Mr. DE YOUNG. Dr. Weyzen from D.O.E. is here.

Mr. DEAL. This is Dr. Weyzen from our medical group.

Dr. WEYZEN. There are two problems. One involves having still for about 20 minutes. I think that is a problem with the children. A more serious problem is the calibration of the instrument. It is not calibrated for small persons. You get an erroneous reading.

Mr. YATES. For all we know, the children may have been contaminated too?

Mr. DEAL. Yes, sir. If they have been drinking the coconut milk.

CAUSES OF RADIATION EFFECTS ON BIKINI ISLAND

Mr. DUNCAN. What accounts for the rather extreme variations, from 0.270 which is within your limits to 1.180?

Mr. DEAL. I am at a loss to answer that, Mr. Duncan, unless the possibility that some of them didn't eat as many coconuts or drink as much coconut milk. There could be some variations of some kind in their metabolism. I really don't know.

Mr. YATES. Does anybody know?

Mr. McCRAW. Yes, I know. Basically two things account for the variation. One is just how much of the rations people get. It varies among individuals are eating. The other is that some of the people have been living on the island longer than others. The longer someone lives, did not return en masse to any of the islands. They come back a few at a time over a period of several years.

Mr. YATES. Starting when?

Mr. McCRAW. About 1972. I believe, the earliest ones came in about 1972, so some people have been there 6 years, some 5 years, some have been there 1 year or less. The body burdens of course to the degree a function of time, so the individuals in the population that have been there the longest and have been eating the largest quantities, basically of coconut, have the highest burdens and are receiving the highest radiation exposure.

Mr. YATES. I have the impression that you told the committee that in 1977 you suggested to the people on the island they ought not to eat the food there, but that you would provide the food from outside sources. If that is true, why did the count nevertheless go up in 1978?

Mr. DEAL. We understand that they have been eating coconuts. I wasn't there so I am telling you what survey team members repeated

to us. They said that the people have been eating some coconuts. They had a drought, and a shortage of fresh water and they were drinking more of the coconut milk than they might ordinarily.

OUTSIDE FEEDING PROGRAM FOR BIKINI RESIDENTS

Mr. YATES. Did they eat the coconuts and did they drink the milk because you weren't providing them with adequate food and water?

Mr. DEAL. I will have to defer to our friends in Interior on what was provided.

Mr. YATES. Will somebody answer that? Who are his friends in Interior?

Mr. DEAL. I am not sure.

Mr. YATES. Apparently you don't have any friends.

Mr. DEAL. I was a afraid of that.

Mr. YATES. Somebody ought to answer that question.

Were you on duty then, Mr. Winkel? When did you take office?

Mr. WINKEL. I took office in June of 1977.

Mr. YATES. Who did you have in charge of this operation?

Mr. WINKEL. I was in charge of the operation, and under me the District Administrator was in charge of the operation. The feeding program was initiated in October and November of 1977, and ample food supplies to provide a balanced diet were delivered, have been delivered. Nutritionists accompanying these supplies and staying with the people for a period of time to help them and assist them in the utilization of the food and so forth. We have no reason to believe the food was not consumed, inasmuch as there is no evidence of unconsumed quantities in any size at all.

Mr. YATES. What kind of food did you deliver to them? Did you also deliver water to them?

Mr. WINKEL. U.S. Department of Agriculture foods, and fresh foods from Honolulu, and water was delivered. I do not know myself in what quantities.

Perhaps the District Administrator could respond to that, because he has accompanied one of the shipments in the first instance.

Mr. YATES. Let's hear from him.

What we are trying to find out is why they went back to the coconuts and the milk, if they were warned against eating the coconuts and the milk?

Mr. O. DEBRUM. I am the Deputy Administrator of the Marshall Islands.

Coconut is something that the people can see. They will drink the milk. They do that even when we visit the island periodically. They offer us coconuts to drink, so as long as they have coconuts in their hands they will believe that they will drink it.

Mr. YATES. In the face of warnings not to drink it?

Mr. O. DEBRUM. Yes, sir.

Mr. YATES. Then they continue to eat the coconut and drink the milk and eat the food that the government gives them.

Mr. O. DEBRUM. The last time I was there they were still eating the coconuts. They have been told not to eat them. To stop them from eating that, sir, we have to remove the people from the islands or cut down the total number of trees.

Mr. YATES. What is the only way you can do it.

DESIRE OF BIKINIANS TO REMAIN ON BIKINI ATOLL

Mr. YATES. Your letter indicates that the Bikinians want to stay on the atoll. Is that impossible?

Mrs. VAN CLEVE. In our judgment, it would be improper for them to remain because of the medical risks involved, and the Department of Energy agrees with that conclusion.

Accordingly, we mean to persist in our plans to relocate them, this in the interests of their physical safety. We recognize, of course, their preference to remain. That is why we have had this problem for some 30 years and it will continue for some decades hence. We are simply trying to meet it in the most reasonable way we know, recognizing the physical threats that exist if they remain on Bikini Island.

CAUSES OF RADIOACTIVITY ON BIKINI ATOLL

Mr. YATES. Let's look at it a minute before we go to the High Commissioner's statement.

The reason they cannot remain there is because of the radioactivity of the coconuts and water. It was the food, the intake, rather than the external causes that was the problem, is that correct?

Mrs. VAN CLEVE. I believe it is a combination of both.

Mr. YATES. That wasn't Mr. Deal's testimony the last time. As I remember his testimony the last time, it was internal causes rather than external causes; is that right, Mr. Deal?

Mr. DEAL. I think maybe both are right. The external radiation has to be considered. The internal is so high that it overshadows the external.

Mr. YATES. How potent is the external; and suppose you did not have the internal radiation? Would it be feasible for them to remain?

Mr. DEAL. The external radiation is about like Denver, Colo.

Mr. YATES. It would be as dangerous as Denver, Colo., is to those who live in Denver?

Mr. DEAL. Yes, sir.

Mr. YATES. They are not evacuating the city of Denver, are they?

Mr. DEAL. I hope not.

Mr. YATES. So, therefore, the amount of external radiation in the city of Denver is not considered sufficient for that city to be evacuated. I assume, therefore, that if that is the same condition on Bikini, the basic cause for your suggestion or your recommendation that Bikinians be evacuated is the ingestion of the food and the water; correct?

Mr. DEAL. Yes, sir.

Mr. YATES. Now if the Bikinians wanted to stay there, stay on their atoll, if they did not consume the water and the food that was there, I would deduce from what you say that it would be as dangerous for them to live on Kili or Jaluit or any one of the other islands as it would on Bikini, right?

Mr. DEAL. Yes, sir, the other islands are quite—

Mr. YATES. That gets us to the basic question then: Can you feed them and give them water from other sources that would permit them to stay on Bikini so that they would not be taking in the radiated food and water?

Mr. DEAL. If you ask my opinion, Mr. Chairman, I have personally concluded that it is probably impractical to have people living in

an area where they are able to farm it and to take the water from the area. I think that is a practical situation.

CONTAMINATION OF FOOD SOURCES

Mr. YATES. Suppose you were to plant other coconut trees. How long does it take coconut trees to come?

Let's ask the next question. We talk as though coconuts were the only food there. Isn't there other food?

Mrs. VAN CLEVE. There is, indeed.

Mr. YATES. What other foods do they eat?

Mrs. VAN CLEVE. Breadfruit, papaya, sweet potatoes.

Mr. YATES. Are all of these contaminated?

Mrs. VAN CLEVE. All of these have turned out to be contaminated when grown in Bikini.

Mr. YATES. That is because of the soil being contaminated?

Mrs. VAN CLEVE. That is correct.

Mr. YATES. And the contamination in the soil is transferred to the food, and there is no way they can grow food without it being contaminated: is this correct?

Mr. DEAL. That is correct.

Mr. YATES. How much of a chore is it to bring food in from the outside? Suppose it were a barren atoll; they didn't have the opportunity to grow things.

Mrs. VAN CLEVE. I think it is entirely feasible to bring food in from the outside. What we believe, however, also to be true, is that it is not feasible to expect the people to live on an atoll and not eat the things that are growing there and not getting contaminated. It is true. We could feed them entirely from outside sources, but we could not bar them entirely from eating local produce.

CONTAMINATION OF GROUND WATER

Mr. YATES. How do they get their water now? What is the water that is contaminated? Is it from wells?

Mrs. VAN CLEVE. It is a groundwater supply as I understand it, yes.

Mr. DEAL. My understanding is that there are some cisterns too, some runoff water from rain, but I think it is the wells too. They have to use the wells under certain conditions. There isn't enough cistern water.

Mr. YATES. There is not enough cistern water. The cistern water is not contaminated, is it?

Mr. DEAL. Not to any extent to cause them this kind of problem, sir.

And the well water is contaminated?

Mr. DEAL. Yes, sir, it is.

Mr. YATES. Is there any way of decontaminating the well water? Can you boil the contaminants out?

Mr. DEAL. No, sir. It would take a very sophisticated system of resins used in chemical processing to remove the radionuclides.

Mr. YATES. How difficult and how expensive is it?

Mr. DEAL. I really don't know. We have never looked at that problem, that I know of, except back during the fallout days there was a question about decontaminating milk, and there was some looking at

LOCAL FOODS BANNED IN 1974

Mr. YATES. We are now up to 1976. Let's go back to the interrogation on page 1171:

"Mr. YATES. Were you still the AEC in 1976?"

"Mr. DEAL. We were ERDA in 1976."

"Mr. YATES. So you became a little more alarmed than when you were the Atomic Energy Commission. In 1976 you first encountered this kind of a test. Is this an annual test that you had been making of the people?"

Of course, in retrospect now my question is not correct, because you knew about it in 1974. You knew about the water certainly in 1974. In 1976 the coconuts were first becoming ripe. Mr. deBraum, together with the Bikinians, was eating the coconuts. But you were not drinking the water?

Mr. DEBRAUM. Not the well water.

Mr. YATES. Were you eating the pandanus in 1976?

Mr. DEBRAUM. Some people ate them.

Mr. YATES. They ate the pandanus. What else was growing there?

Mr. DEBRAUM. Papaya was growing on the island.

Mr. YATES. Papaya. Anything else?

Mr. DEBRAUM. Pumpkins.

Mr. YATES. Pumpkins?

Mr. DEBRAUM. Yes.

Mr. YATES. And people were eating all of these things, all the vegetables?

Mr. DEBRAUM. We had indication that some of them admitted they ate them, sir.

Mr. YATES. They ate them?

Mr. DEBRAUM. Yes.

Mr. YATES. And were you told you were not to eat them?

Mr. DEBRAUM. They were told that it was questionable, sir, and not to eat them.

INITIATION OF TIPI FEEDING PROGRAM

Mr. YATES. And all during the period starting in 1972, every month a ship came to Bikini with food?

Mr. DEBRAUM. Yes.

Mr. YATES. And water?

Mr. DEBRAUM. No, no water.

Mr. YATES. Just food?

Mr. DEBRAUM. Yes.

Mr. YATES. So they were drinking the cistern water?

Mr. DEBRAUM. Yes.

Mr. YATES. And you were supplying them with food. Were you supplying them with enough food?

Mr. DEBRAUM. At times we tried to supply them with enough. There were times when we could not get there in time, sir.

Mr. YATES. So in the meantime they had to eat coconuts?

Mr. DEBRAUM. Sometimes they were eating coconuts, yes. They indicated that to us.

Mr. YATES. They did?

Mr. DEBRAUM. Yes.

Mr. YATES. Why could you not get there in time?

Mr. DEBRUM. We wanted to get there in time. At times we had serious transportation problems and were down to one ship for trips to the outer islands. Sometimes, the odds were against us, but we tried to do the best we could.

Mr. YATES. What do you mean, the odds were against you?

Mr. DEBRUM. We were down to one ship for all the outer islands at times.

Mr. YATES. And one ship would not service the island or the people?

Mr. DEBRUM. It takes three field trip ships to service, to make a complete circuit of the Marshall Island group, once a month.

Mr. YATES. How many ships do you need for the food for the people who were on Bikini? Was one ship adequate for a month's supply of food?

Mr. DEBRUM. If we have one ship committed only to Bikini, yes, one ship will do it. The ship that is committed to service Bikini also services other islands in the Marshall Islands.

Mr. YATES. You mean provide food for the other islands?

Mr. DEBRUM. It provides services, it brings in copra and takes in trade goods so the people can buy it.

FREQUENCY OF SERVICE TO BIKINI ISLAND

Mr. YATES. Maybe we had better find out about where you work throughout the islands.

How long would your lapses be? Presumably your schedule was one ship a month with food for Bikini.

Mr. DEBRUM. Yes.

Mr. YATES. And how often were there lapses in this?

Mr. DEBRUM. Not very much. There were times, as I recall, when we could not provide a ship until it was a month and a half late, sir.

Mr. YATES. A month and a half late; you mean two weeks after the schedule.

Mr. DEBRUM. Two weeks after.

TYPE OF FOODS PROVIDED

Mr. YATES. After the schedule date. And what kind of food? You said you provided staples? What do you mean by staples?

Mr. DEBRUM. Staples in Marshallese terms is rice, flour, canned meats, milk.

Mr. YATES. No coconuts?

Mr. DEBRUM. No coconuts.

Mr. YATES. I mean from the other islands.

Mr. DEBRUM. We never shipped any coconuts from the other islands.

Mr. YATES. Why would you not? If coconuts were such a delicacy for the Bikinians, why would you not provide coconuts for them, too?

Mr. DEBRUM. It was not a part of our feeding program, sir.

Mr. YATES. If you were a Bikinian you would have liked coconuts, would you not, from other islands?

Mr. DEBRUM. I would be climbing a tree and getting it myself.

Mr. YATES. You would not worry about radiation.

Mr. McKAY. How do you get coconuts in the program? What kind of a bureaucratic round-about do you have to go through to get them on the program?

Mr. DeBRUM. I guess we just include it, make sure we have enough money to go around.

Mr. McKAY. Would you have authority to approve it?

Mr. DeBRUM. No, sir. It would have to be approved by the High Commissioner.

Mr. McKAY. Could he approve it alone or would he have to get approval up here?

Mr. DeBRUM. I think he has authority to approve it, the High Commissioner.

Mrs. VAN CLEVE. Yes.

Mr. YATES. Mr. DeBRUM, you said if coconuts were not supplied to you as a Bikinian, you would be climbing up trees to get them?

Mr. DeBRUM. Yes, if they were available on the island, yes.

Mr. YATES. And they are available on the island are they not?

Mr. DeBRUM. Yes.

Mr. YATES. So if you do not give them the coconuts they are going to climb the trees to get the coconuts, even if they are contaminated?

Mr. DeBRUM. They have been doing that, sir.

NATURE AND THE TYPE OF ANALYSIS BY DOE

Mr. YATES. Let's go back to the interrogation.

"So you became a little more alarmed than when you were the Atomic Energy Commission. In '76 you first encountered this kind of a test. Is this an annual test that you had been making of the people?"

"Mr. DEAL. Yes, sir.

"Mr. YATES. What kind of tests, monthly, semiannually, every four months, or what?"

"Mr. DEAL. I can supply you a statement for the record. I will give you some information."

Then there is placed in the record on pages 1172 and 1173 a pretty good statement of tests that were made and a very bad estimate of the results of the tests. We find in 1961 the findings, "photographed and identified organisms on reefs and islands. No gross anomalies seen in plants and animals due to radioactivity."

1976 shows "exposure levels to the Bikinians varies considerably from island to island on the atoll."

February 1967. "confirmed earlier survey results for external radiation."

That does not tell us anything. "Cs-137 and strontium 90 predominate in terrestrial organisms, Co-60 and Fe-55 in marine organisms."

What does that mean, Dr. Deal?

Mr. DEAL. It means that in the fish that they were catching they found cobalt-60 and Fe-55.

Mr. YATES. In large amounts?

Mr. DEAL. I do not know, sir.

Mr. YATES. This result does not show that then?

Mr. DEAL. No. We did not try to give you a complete copy of the reports. We just tried to give you the highlights of the surveys at the time, and probably, as you say, did a pretty poor job on that.

Mr. YATES. Yes.

Mr. McGRAW. And the value is 3?

Mr. YATES. Okay.

Mr. McGRAW. For Bikini 22 people in the sample. The value is 13, quite a bit higher than Rongelap, but still a factor of like a third of the standard that we would evaluate with. This is of course 1977 numbers.

As I recall the 1974 data the value for Bikini was like .1. On the previous page the value for Bikini was .125, so between 1974 and 1977 the values went up by a factor of 10.

DATES OF WARNINGS TO PEOPLE OF BIKINI

Mr. YATES. If all this is true, sir, why four years ago in 1974 were you advising Mr. DeBrum to tell the Bikinians not to drink the well water and why were you then—you were bringing food in four years ago because there is no food on Bikini?

Mr. DEBRUM. That is right, sir.

Mr. YATES. Contaminated or noncontaminated water?

Mr. DEBRUM. That is correct, sir.

Mr. YATES. Then the food came in two years ago, right? When did the coconut trees start maturing?

Mr. DEBRUM. About two years ago.

Mr. YATES. Were you allowing them to eat the food that was growing on Bikini two years ago, Mr. McGraw?

Mr. McGRAW. Were we allowing them two years ago?

Mr. YATES. Yes.

Mr. McGRAW. When was the recommendation made? Did you say four years ago?

Mr. DEBRUM. Yes, approximately about four years ago.

Mr. YATES. You have coconuts growing on Bikini two years ago. You have pandanus and papayas and breadfruit growing two years ago. Four years ago you told them not to drink the water, there was no food. Two years ago had you told them not to eat the food. Were you told not to eat the food two years ago?

Mr. DEBRUM. That was the time, four years ago, Mr. Chairman, that people were told that they were examining their food and they had suspected—

Mr. YATES. And they were told not to eat it?

Mr. DEBRUM. They were discouraged from eating.

Mr. YATES. Were they told not to eat the food all through this period? They were told not to drink from the wells all during this period?

Mr. DEBRUM. Yes.

Mr. YATES. Were they told not to eat the food all during this period too?

Mr. DEBRUM. Further analysis convinced them otherwise.

Mr. YATES. If the analysis never convinced them?

Mr. DEBRUM. Never convinced them.

Mr. YATES. So they were told all during this period not to eat the food?

Mr. DEBRUM. Yes.

ADEQUACY OF FOOD SUPPLIED BY TTPI ADMINISTRATION

Mr. YATES. And in the meantime you were bringing them food?

Mr. DEBRUM. Yes, sir.

Mr. YATES. Every month, except where you lapsed?

Mr. DEBRUM. Yes, sir.

Mr. YATES. And there was adequate food for all of them?

Mr. DEBRUM. Yes.

Mr. YATES. You are sure of that?

Mr. DEBRUM. To the best of my knowledge sir.

Mr. YATES. Is that true, Mr. Weisgall?

Mr. WEISGALL. That is not quite the understanding of the Bikinians.

As Mr. Leviticus has explained to me, the people living on Bikini would eat the food growing on the island even though they had been advised that it was questionable, when their supply was not coming. The boats were not coming on as regular basis as was hoped for, and according to Mr. Leviticus, when a family would run out of food it would eat food growing on Bikini, be it coconuts, pandanus, or breadfruit.

REQUEST FOR MORE MONITORING OF BIKINI

Mr. YATES. Let's go back to Mr. Juda's statement.

Mr. NOTE. The second request we convey to you today, Mr. Chairman, is that your subcommittee closely monitor the upcoming radiological and foodstuff tests to be conducted at Bikini Atoll. The people living on Bikini Island desperately wish to remain on Bikini Atoll, and they are hopeful that tests on Eneu Island will show it to be safe. They understand that the recent test results are preliminary, and they hope that resettlement on Eneu will prove to be possible.

Mr. Chairman, we cannot describe the sorrow felt by our people as they learned, with bitter disappointment, that they must once again leave Bikini. Despite the contradictory statements of the U.S. Government over the last ten years, the people of Bikini have begun to understand the situation they face. They have told us that if the upcoming tests show that our people will not be able to live on Bikini or Eneu for the next 40 or 50 years, the people living in Bikini are prepared to relocate to Kili and Jaluit.

UPGRADING CONDITIONS ON KILI ISLAND

A move to Kili, however, and the establishment of Kili as a permanent home for the next two generations of Bikinians cannot come without help from the U.S. Government to develop Kili as a functional, livable community.

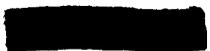
For almost 30 years we have lived on Kili, thinking each year that we will move to Bikini the next year. As we face the possibility of 50 more years on Kili, it is clear that we must think and plan in longer terms.

As you know, Kili is an island with no reef and no lagoon, and access to the island is very difficult for most of the year. Faced with these conditions, our people have not processed copra in large quantities because boats visit this island rarely. Months frequently go by without a visit from passing ships, and our only communication with the rest of the world is by radio.



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BROOKHAVEN NATIONAL LABORATORY

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Upton, New York 11973

Health, Safety & Environmental Protection Division

(616) 348-4207

June 21, 1979

Dr. William L. Robinson
L-452
Lawrence Livermore Laboratory
P. O. Box 808
Livermore, California 94551

Dear Bill:

The enclosed tables present dosimetric and body burden information on former Bikini residents. Net external exposure rates (background subtracted) were obtained from "External Exposure Measurements at Bikini Atoll", N. A. Greenhouse et al., BNL Report (in press). Dosimetric models were outlined in several informal reports and are available upon request. Input data were obtained from "Whole Body Counting Results from 1974 to 1979 for Bikini Island Residents", R. S. Miltenberger et al., BNL Report (in press) and from unpublished bioassay results. New information on the long term removal of ^{137}Cs is being derived from replicate counts of former Bikinians done in January and May 1979. This preliminary information is also included, but we would like to corroborate these results with urine bioassay data which will not be available for several more weeks.

If you have any questions or need additional information, please contact me at FTS 666-4207 or Bob Miltenberger at FTS 666-2503.

Sincerely,



N. A. Greenhouse

NAG/lm

Enclosures

cc: E. Leppard

R. Miltenberger

J. Naidu

T. McCraw (OES) ✓

B. Wacholz (EV)

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Individual Dosimetry Data for Bikinians - Explanation
of Column Headings

<u>Column</u>	Item or Derived Quantity	Measured Quantity	Comments
1	Name	-	Personal Interview
2	ID Number	-	BNL Medical Dept. & S&EF Div. Records
3	Residence Interval	-	Personal Interviews
4	^{90}Sr and ^{90}Y Bone Marrow Dose Equivalent During and Post Residence Interval	Urine Activity Concentration	Three Compartment Model. Constant Continuous Uptake
5	^{137}Cs + ^{137m}Ba Dose Equivalent During and Post Residence Interval	Body Burden Measurements	Two Compartment Model, Monotonically Increasing Uptake
6	Net External Dose Equivalent During Residence Interval	External Exposure Rate Measurements	Assumed Living Patterns
7	Total Bod. Dose Equivalent	-	Sum of Columns 5 and 6
8	Total Bone Marrow Dose Equivalent During and Post Residence Interval	-	Sum of Columns 4, 5 and 6

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INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS

Is Number	Residence Interval Years	90 Sr & 90 Y		137 Cs + 137m Ba		Net External		Total Body		Total Bone Marrow	
		Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During Residence Interval	mRem	Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During and Post Residence Interval	mRem
6001	7.3	130*	480	950	1400	1600					
6127	7.3	39	580	950	1500	1600					
6130	.72	49	200	94	300	300					
6076	3.3	9.9	900	430	1300	1300					
813	4.3	77*	600	560	1200	1200					
6019	5.3	190	420	650	1100	1100					
6111	.80	7.7	130	100	250	250					
6097	4.3	51*	430	520	950	1000					
6115	7.3	97	760	880	1600	1700					
6109	4.3	51*	240	520	760	810					

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INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval	Years	90Sr & 90Y		137Cs + 137mBa		Net External	Total Body	Total Bone Marrow
			Dose Equiv. During & Post Residence Int.	Residence Int.	Dose Equiv. During & Post Residence Int.	Residence Int.			
			mkem	mkem	mkem	mkem	mkem	mkem	mkem
6091		6.3	74*	550	760	1300	1400	1600	1400
6132		2.3	62	1200	300	1500	1600	1600	1600
6046		2.0	27	400	240	600	700	700	700
6061		6.3	65	630	760	1400	1500	1500	1500
6066		3.3	59*	400	400	830	890	890	890
6070		10.3	185*	870	1300	2200			
6118		6.3	42	420	820	1200	1300	1300	1300
6117		6.3	110*	610	820	1400	1500	1500	1500
6128		7.3	130*	810	950	1800	1900	1900	1900
6122		10.3	86	380	1200	1600	1700	1700	1700

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INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	90 Sr & 90 Y		137 Cs + 137m Ba		Net External		Total Body		Total Bone Marrow	
		Dose Equiv. During & Post Residence Int.	mrem	Dose Equiv. During & Post Residence Int.	mrem	Dose Equiv. During Residence Interval	mrem	Dose Equiv. During & Post Residence Int.	mrem	Dose Equiv. During and Post Residence Interval	mrem
6015	1.7	31*	650	220	870	900					
6030	3.3	39*	1200	400	1600	1600					
6129	4.3	51*	330	520	850	900					
6027	3.3	39*	760	400	1200	1200					
6010	7.3	86*	1100	900	2000	2100					
6105	3.3	39*	1100	400	1500	1500					
6033	8.3	150*	900	1100	2000	2100					
6007	.88	15	190	110	300	310					
6008	4.3	77*	850	560	1400	1500					
6071	1.0	18*	220	130	350	370					

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	90 Sr & 90 Y		137 Cs + 137m Ba		Net External		Total Body		Total Bone Marrow	
		Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During Residence Interval	mRem	Dose Equiv. During & Post Residence Int.	mRem	Dose Equiv. During and Post Residence Interval	mRem
863	4.3	120	620	600	1200	1300					
6086	8.3	240	990	1100	2100	2300					
6069	8.3	150*	580	1100	1700	1900					
6073	7.3	130*	490	950	1400	1600					
6072	1.0	18*	330	130	460	480					
6119	7.3	130*	730	950	1700	1800					
864	7.3	130*	960	950	1900	2000					
966	7.3	130*	1400	950	2300	2500					
6059	1.3	15*	240	160	400	410					
6124	.88	10*	180	110	390	400					

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	90 Sr & 90y Bone Marrow Dose Equiv. During & Post Residence Int.		137Cs + 137mBa Dose Equiv. During & Post Residence Int.		Net External Dose Equiv. During Residence Interval		Total Body Dose Equiv. During & Post Residence Int.		Total Bone Marrow Dose Equiv. During and Post Residence Interval	
		mkem	mkem	mkem	mkem	mkem	mkem	mkem	mkem		
6058	5.3	63*	550	600	1200	1300					
6036	.64	7.6*	260	77	340	340					
6110	8.3	98*	450	1000	1400	1500					
6051	5.3	63*	520	600	1200	1200					
6092	6.3	74*	1600	800	2400	2400					
6080	.88	10*	200	110	310	320					
6038	2.3	27*	1100	280	1400	1400					
6103	3.3	39*	1200	400	1600	1600					
6028	5.3	63*	1200	600	1800	1900					
6044	5.3	63*	1600	600	2200	2300					

5011544

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	90 Sr & 90 Y		137 Cs + 137m Ba		Net External		Total Body		Total Bone Marrow	
		Dose Equiv. During & Post Residence Int. mkem	Dose Equiv. During & Post Residence Int. mkem	Dose Equiv. During Residence Interval mkem	Dose Equiv. During & Post Residence Interval mkem	Dose Equiv. During & Post Residence Interval mkem	Dose Equiv. During & Post Residence Interval mkem	Dose Equiv. During and Post Residence Interval mkem			
6002	4.3	51*	540	520	1100	1100	1100				
6034	7.3	86*	880	900	1800	1900					
805	7.3	86*	430	900	1300	1400					
6050	2.3	27*	410	300	710	740					
6009	4.3	77*	1600	600	2200	2300					
6049	2.3	41*	1600	300	1900	1900					
6042	.55	10*	510	72	580	590					
6014	1.6	29*	1300	210	1500	1500					
6012	7.3	130*	1500	950	2400	2600					
6016	7.3	130*	1500	950	2400	2600					

5011545

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	⁹⁰ Sr & ⁹⁰ Y Bone Marrow Dose Equiv. During & Post Residence Int.		¹³⁷ Cs + ^{137m} Ba Dose Equiv. During & Post Residence Int.		Net External Dose Equiv. During Residence Interval		Total Body Dose Equiv. During & Post Residence Int.		Total Bone Marrow Dose Equiv. During and Post Residence Interval	
		mrem	mrem	mrem	mrem	mrem	mrem	mrem	mrem	mrem	
6013	2.3	41*	1300	300	1600	1600					
6094	6.3	74*	1300	800	2100	2200					
6005	1.8	12	470	230	700	710					
6135	1.3	11	330	170	500	510					
6125	9.3	45	890	1200	2100	2100					
6067	7.3	54	780	950	1700	1800					
6002	2.3	7.7	370	300	670	680					
6006	1.0	9.5	260	230	490	500					
6112	1.3	12	260	160	420	430					
6035	6.3	140	600	760	1400	1500					

5011546

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	90 Sr & 90 Y Bone Marrow Dose Equiv. During & Post Residence Int.		137 Cs + 137m Ba Dose Equiv. During & Post Residence Int.		Net External Dose Equiv. During Residence Interval		Total Body Dose Equiv. During & Post Residence Int.		Total Bone Marrow Dose Equiv. During and Post Residence Interval	
		mkem	mkem	mkem	mkem	mkem	mkem	mkem	mkem		
6096	3.3	46	680	430	1100	1100	1100				
80	1.0	18*	200	130	330	350					
6017	8.3	330	1200	1100	2300	2700					
6045	1.0	9.0	150	120	270	280					
6108	4.3	43	210	570	730	770					
6063	4.3	19	620	570	1100	1100					
525	1.0	5.6	350	120	470	470					
934	6.3	120	1300	760	2100	2200					
6068	6.3	60	630	820	1500	1600					
6106	3.3	39*	750	400	1100	1200					
6025	3.3	39*	900	400	1300	1300					

5011547

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	⁹⁰ Sr & ⁹⁰ Y Bone Marrow Dose Equiv. During & Post Residence Int. mRem	¹³⁷ Cs + ^{137m} Ba Dose Equiv. During & Post Residence Int. mRem	Net External Dose Liquid. During Residence Interval mRem	Total Body Dose Equiv. During & Post Residence Int. mRem	Total Bone Marrow Dose Equiv. During and Post Residence Interval mRem
6113	4.3	19	360	520	880	900
6060	2.3	27*	510	280	790	820
6032	3.3	39*	960	400	1400	1400
6123	4.3	50*	480	520	1000	1100
6098	3.3	39*	320	400	720	760
6065	4.3	130	390	20	910	1000
6004	.55	10*	130	72	200	210
6018	6.3	150	1100	520	1900	2100
6126	2.3	45	1100	300	1400	1400
6003	8.3	250	580	1100	1700	1900
6114	1.0	12*	170	120	290	300

INDIVIDUAL DOSIMETRY DATA FOR BIKINIANS (cont'd)

ID Number	Residence Interval Years	⁹⁰ Sr & ⁹⁰ Y Bone Marrow Dose Equiv. During & Post Residence Int. mkem	¹³⁷ Cs + ^{137m} Ba Dose Equiv. During & Post Residence Int. mkem	Net External Dose Equiv. During Residence Interval mkem	Total Body Dose Equiv. During & Post Residence Int. mkem	Total Bone Marrow Dose Equiv. During and Post Residence Interval mkem
6004	7.3	86*	400	900	1300	1400
6023	4.3	77*	990	500	1500	1600
6131	6.3	110*	950	820	1800	1900
6011	6.3	170	550	820	1400	1600
6081	.97	12*	490	120	610	620
6133	7.3	130*	1900	950	2800	3000
6048	.55	6.5*	590	72	600	670

*These values were derived from average male or average female daily activity ingestion rates for Sr-90.

5011549

Body Burden Data for Medically Registered Children Relocated from Bikini Atoll

ID #	Sex	Age (Yrs)	Height (cm)	Weight (kg)	Yrs On Bikini	Yrs Off Bikini	January		May		1979 Potassium Result Grams	1979 Potassium Result nCi KEq	1979 Potassium Result nCi KEq	1979 Potassium Result Grams	1979 Potassium Result nCi KEq	1979 Potassium Result Grams	1979 Potassium Result nCi KEq	1979 Potassium Result Grams
							137Cs Result nCi KEq	Potassium Result Grams	137Cs Result nCi KEq	Potassium Result Grams								
6031*	M	5	105	20	3	.70	--	--	--	--	2.8	0.10	--	35	--	--	--	35
6029	M	6	112	20	5	.70	--	--	--	--	4.7	0.17	--	25	--	--	--	25
6100*	M	5	99	17	4.3	.70	--	--	--	--	15	0.50	--	24	--	--	--	24
6021*	M	5	103	19	4.3	.71	46	1.7	NC	6.2	0.23	6.2	0.23	51	--	--	--	51
6020	M	6	107	20	2	.71	56	2.1	72	7.4	0.27	7.4	0.27	37	--	--	--	37
6107*	M	5	96	15	4.3	.71	16	0.29	46	2.6	0.096	2.6	0.096	40	--	--	--	40
6074*	M	5	104	20	4.3	.71	9.0	0.33	34	ADL	ADL	ADL	ADL	25	--	--	--	25
6078*	F	5	99	17	--	0.40	3.0	0.11	28	--	--	--	--	--	--	--	--	--
6088*	F	5	95	15	4.3	.70	--	--	--	3.0	0.11	3.0	0.11	33	--	--	--	33
6090	F	6	108	25	5	.70	--	--	--	4.9	0.18	4.9	0.18	31	--	--	--	31
6101	F	6	104	19	5.3	.70	51	1.9	12	6.9	0.26	6.9	0.26	15	--	--	--	15
6056*	F	6	100	17	4.3	.71	46	1.7	NC	7.4	0.27	7.4	0.27	49	--	--	--	49
6057	F	7	107	26	1	.72	--	--	--	5.8	0.22	5.8	0.22	66	--	--	--	66

*Indicates children were 4 yrs or less April, 1978

NC = Not Calculated

131
Leskey's Trans

Transcribed
Consistent

Body Burden Data for Non-Medically Registered Adult Male Residents of Bikini Atoll

ID #	Sex	Age (Yr)	Height (cm)	Height (kg)	Yr on Bikini	Yr off Bikini	Result (kg)	Result (Gms)
6190	M	19	166	57	0.25	2	6.0	0.22
6205	M	42	170	81	4	4.5	HDL	159
6211	M	19	163	55	1	3	HDL	154
6218	M	56	158	72	2	10	HDL	169
6219	M	30	173	60	2	9	HDL	143
6220	M	26	166	66	2	9	HDL	165
6221	M	53	175	82	2	9	4.2	0.16
6223	M	66	152	65	2 day ^a	0.016	99	3.7
6224	M	45	158	55	2 day ^a	0.016	120	4.4
6226	M	18	164	58	2 yr	3	HDL	147

May 1979
 May 14, 15, 1979
 May 14, 15, 1979
 May 14, 15, 1979

5011556

Body Burden Data for Non-Medically Registered Adult Male Prior Residents of Bikini Atoll

ID #	Sex	Age (yr)	Height (cm)	Weight (kg)	Yrs. On Bikini	Yrs. Off Bikini	January			May		
							1979 137Cs Result nCi/kg	1979 Potassium Result Gram	1979 137Cs Result nCi/kg	1979 Potassium Result Gram		
6136	M	48	150	58	4	4	8.5	0.31	144	--	--	--
6138	M	20	163	57	3	3	7.8	0.10	165	--	--	--
6153	M	23	160	65	1	1	1.42	0.21	170	5.4	0.20	146
6168	M	16	150	44	7	7	1.0	0.089	101	HDL	HDL	100
6174	M	52	174	86	6	6	17	0.63	158	--	--	--
6180	M	22	173	67	4	1	34	1.3	141	--	--	--
6182	M	18	161	53	6	6	0.42	1220	45	620	23	131

139Cs
Long Term Removal
Rate Constant
d⁻¹

6.1x10⁻³

Body Burden Data of Non-Medically Registered Adult Female Residents of Bikini Atoll

ID #	Sex	Age (yr)	Height (cm)	Weight (kg)	Yrs. On Bikini	Yrs. Off Bikini	January		May			
							1979 137Cs Result (uCi)	1979 Potassium Result (Gram)	1979 137Cs Result (uCi)	1979 Potassium Result (Gram)		
6137	F	38	161	64	0.33	4	3.8	0.14	113	1.7	0.063	112
6139	F	22	140	38	--	3	2.1	0.078	89	--	--	--
6140	F	16	146	46	0.17	0.42	27	1.0	94	8.6	0.32	94
6144	F	21	150	44	1	0.42	37	1.4	105	13	0.48	89
6152	F	20	157	59	1	1.42	2.4	0.089	123	3.9	0.14	117
6155	F	24	155	66	6	0.42	390	15	120	150	5.6	96
6160	F	65	153	55	6	0.67	360	11	67	140	5.1	87
6165	F	36	142	60	--	1.5	6.6	0.24	76	--	--	--
6175	F	24	155	63	--	--	11	0.41	90	5.2	0.19	92
6181	F	44	151	55	4	1	8.5	0.31	105	4.6	0.17	101
6185	F	21	144	41	3	2.5	2.7	0.10	74	3.4	0.13	79

137Cs Leng
Term Removal
Rate Constant
d⁻¹

8.1 x 10⁻³

4.1 x 10⁻³

8.4 x 10⁻³

8.5 x 10⁻³

1.1 x 10⁻²

1.1 x 10⁻²

Body Burden Data of Non-Medically Referred Adult Female Prior Residents of Bikini Atoll

<u>ID #</u>	<u>Sex</u>	<u>Age (yr)</u>	<u>Height (cm)</u>	<u>Weight (kg)</u>	<u>Yrs</u>		<u>May 1979</u>		<u>May 1979</u>
					<u>on Bikini</u>	<u>off Bikini</u>	<u>Result mCi</u>	<u>Result kBq</u>	<u>Potassium Result Grain</u>
6187	F	21	152	54	0.019	1	1.6	0.059	107
6189	F	21	155	--	2.5	1	1.9	0.070	114
6206	F	32	151	73	3	5.5	HDL	HDL	116
6222	F	39	156	66	2.5	3	HDL	HDL	98

5011559

Body Burden Data for Non-Medically Registered Adolescents and Children Prior Residents of Bikini Atoll

ID #	Sex	Age (yr)	Height (cm)	Weight (kg)	1979		1979		1979		MAY	
					On Bikini	Off Bikini	On Bikini	Off Bikini	On Bikini	Off Bikini		
6156	M	9	130	34	6	1.0	2.0	0.074	53	3.4	0.11	59
6164	M	5	85	15	--	1.5	8.0	0.30	40	--	--	--
6169	M	14	167	46	7	1.0	1.2	0.044	108	MUL	MUL	120
6172	M	10	130	30	7	1.0	2.8	0.10	40	1.9	0.070	74
6178	M	12	157	33	4	1.0	2.0	0.074	46	1.7	0.062	70
6183	M	12	139	35	--	1.67	1.0	0.037	36	MUL	MUL	74
6179	F	8	115	22	4	1	1.2	0.044	MUL	MUL	1.6	59
6177	F	6	103	18	--	6	MUL	MUL	MUL	MUL	MUL	36
6176	F	8	144	24	--	6	MUL	MUL	MUL	MUL	MUL	38
6173	F	13	142	47	3	0.42	4.0	0.15	33	MUL	MUL	48
6171	F	6	96	15	2.67	1.0	4.0	0.15	16	1.1	1.1	47
6170	F	13	140	45	7	1.0	2.8	0.10	58	1.8	0.07	77
6162	F	12	147	50	--	1.5	5.0	0.19	36	--	--	--
6157	F	5	106	20	4	1.0	7.2	0.27	32	MUL	MUL	54
6158	F	6	103	20	4	1.0	3.5	0.13	32	1.2	0.044	46
6150	F	8	120	25	4	0.42	4.0	0.15	42	1.5	0.056	40
6149	F	5	99	19	4.3	0.42	1.6	0.059	37	MUL	MUL	32

5011560

Body Burden Data for Non-Medically Registered Adolescents and Children from Residents of Bikini Atoll

ID #	Sex	Age (Yr)	Height (cm)	Weight (kg)	Yrs on Bikini	Yrs off Bikini	May 1979		
							¹³⁷ Cs Result nCi	Potassium Result Kdly Gram	
6200	M	14	155	43	1	.71	110	4.1	111
6202	M	6	100	19	5.3	.72	1.8	0.067	51
6207	M	12	138	35	4	4.5	HDL	HDL	78
6208	M	10	136	33	4	4.5	HDL	HDL	76
6225	M	11	125	25	5	1.33	HDL	HDL	53
6203	F	5	92	15	-4.3	.72	HDL	HDL	54
6204	F	5	104	21	1	.72	1.1	0.040	57
6212	F	14	151	50	1	3	HDL	HDL	73
6213	F	10	121	25	1	3	HDL	HDL	56
6217	F	10	126	25	2	9	HDL	HDL	44

5011561

Body Burden Data for Non-Medically Registered Adolescents and Children Never on Rixini Island

ID #	Sex	Age (yr)	Height (cm)	Weight (kg)	Result 137Cs mCi Kbq	Result Potassium Gram	Result 137Cs mCi Kbq	Result Potassium Gram	Result 137Cs mCi Kbq	Result Potassium Gram
6141	F	12	138	33	2.7	0.10	63	1.5	0.056	112
6142	F	10	126	26	2.3	0.085	52	1.0	0.037	72
6143	F	6	104	19	1.2	0.044	41			35
6145	M	5	110	21	1.0	0.037	46			--
6186	M	5	104	20	--	--	--			22
6188	F	14	146	49	--	--	--	2.9	0.11	107
6191	F	6	113	23	--	--	--	1.1	0.041	61

January

May

5011562

5011563

1

C

1-AB

C

RADIATION PROTECTION

*Recommendations of
the International Commission on
Radiological Protection*

ICRP PUBLICATION 2

Report of Committee II
on
Permissible Dose for Internal Radiation
(1959)

PUBLISHED FOR
The International Commission on Radiological Protection

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5011564

Table 1. Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and in water for occupational exposure

Radionuclide and type of decay	Organ of reference* (critical organ bold face)	Maximum permissible burden in total body g(μ c)	Maximum permissible concentrations				
			For 40 hr week		For 168 hr week		
			(MPC) _a (μ c/cm ³)	(MPC) _b (μ c/cm ³)	(MPC) _a (μ c/cm ³)	(MPC) _b (μ c/cm ³)	
³ H ³ HTO or H ₂ O β^- [sol.]	Body tissue	10 ³	0.1	5 × 10 ⁻⁶	0.03	2 × 10 ⁻⁶	
	Total body	2 × 10 ³	0.2	8 × 10 ⁻⁶	0.05	3 × 10 ⁻⁶	
(H ₂) ₂ (submersion)	Skin			2 × 10 ⁻³		4 × 10 ⁻⁴	
⁹ Be ⁷ α, γ (sol.)	GI (LLI)		0.05	10 ⁻⁵	0.02	4 × 10 ⁻⁶	
	Total body	600	6	6 × 10 ⁻⁴	2	2 × 10 ⁻⁴	
	Kidney	800	9	8 × 10 ⁻⁶	3	3 × 10 ⁻⁶	
	Liver	800	9	8 × 10 ⁻⁶	3	3 × 10 ⁻⁶	
	Bone	2 × 10 ³	20	2 × 10 ⁻³	7	6 × 10 ⁻⁶	
	Spleen	4 × 10 ³	50	4 × 10 ⁻⁶	20	2 × 10 ⁻⁵	
	(insol.)	Lung			10 ⁻⁴		4 × 10 ⁻⁷
GI (LLI)		0.05	9 × 10 ⁻⁶	0.02	3 × 10 ⁻⁴		
¹⁴ C ¹⁴ /CO ₂ β^- (sol.)	Fat	300	0.02	4 × 10 ⁻⁶	8 × 10 ⁻³	10 ⁻⁴	
	Total body	400	0.03	5 × 10 ⁻⁶	0.01	2 × 10 ⁻⁴	
	Bone	400	0.04	6 × 10 ⁻⁶	0.01	2 × 10 ⁻⁴	
(submersion)				5 × 10 ⁻⁵		10 ⁻⁵	
¹⁸ F ¹⁸ β^- (sol.)	GI (SI)		0.02	5 × 10 ⁻⁴	8 × 10 ⁻³	2 × 10 ⁻⁴	
	Bone and teeth	20	0.2	3 × 10 ⁻⁵	0.06	9 × 10 ⁻⁴	
	Total body	20	0.3	4 × 10 ⁻⁵	0.09	10 ⁻⁵	
	(insol.)	GI (LLI)		0.01	3 × 10 ⁻⁴	5 × 10 ⁻³	9 × 10 ⁻⁷
	Lung			2 × 10 ⁻³		6 × 10 ⁻⁴	
²² Na ²² β^-, γ (sol.)	Total body	10	10 ⁻³	2 × 10 ⁻⁷	4 × 10 ⁻⁴	6 × 10 ⁻⁸	
	GI (LLI)		0.01	2 × 10 ⁻⁴	3 × 10 ⁻³	7 × 10 ⁻⁷	
	(insol.)	I		9 × 10 ⁻³		3 × 10 ⁻³	
				2 × 10 ⁻⁷	3 × 10 ⁻⁴	5 × 10 ⁻⁸	
²⁴ Na ²⁴ β^-, γ (sol.)	GI (SI)		6 × 10 ⁻³	10 ⁻⁶	2 × 10 ⁻³	4 × 10 ⁻⁷	
	Total body	7	0.01	2 × 10 ⁻⁴	4 × 10 ⁻³	6 × 10 ⁻⁷	
(insol.)	GI (LLI)		8 × 10 ⁻⁴	10 ⁻⁷	3 × 10 ⁻⁴	5 × 10 ⁻⁸	
	Lung			8 × 10 ⁻⁷		3 × 10 ⁻⁷	

* The abbreviations GI, SI, I refer to gastrointestinal tract, stomach, small intestine, upper large intestine, and lower large intestine, respectively.

s ck $^{10}C_{10}$ m^2	Radionuclide and type of decay	Organ of reference (critical organ bold face,	Maximum permissible burden in total body g(μ C)	Maximum permissible concentrations			
				For 40 hr week		For 168 hr week	
				(MPC) _w (μ C/cm ³)	(MPC) _a (μ C/cm ³)	(MPC) _w (μ C/cm ³)	(MPC) _a (μ C/cm ³)
10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 10 ⁻⁴ 0 ⁻⁴	¹³⁷ Cs β^- , γ	(sol.) Total body	30	2×10^{-3}	4×10^{-7}	9×10^{-4}	10^{-7}
		Liver	60	5×10^{-3}	7×10^{-7}	2×10^{-3}	2×10^{-7}
		Spleen	80	7×10^{-3}	10^{-4}	2×10^{-3}	4×10^{-7}
		Muscle	90	8×10^{-3}	10^{-4}	3×10^{-3}	4×10^{-7}
		Kidney	100	8×10^{-3}	10^{-4}	3×10^{-3}	4×10^{-7}
		GI (SI)		0.02	5×10^{-4}	8×10^{-3}	2×10^{-6}
		Bone	400	0.03	4×10^{-4}	0.01	2×10^{-4}
		Lung	800	0.06	9×10^{-4}	0.02	3×10^{-4}
		(insol.) Lung			2×10^{-7}	2×10^{-7}	6×10^{-7}
		GI (LLI)		2×10^{-3}	3×10^{-7}	6×10^{-4}	10^{-7}
0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴	¹³⁷ Cs β^- , γ , e^-	(sol.) Total body	30	4×10^{-4}	6×10^{-8}	2×10^{-4}	2×10^{-4}
		Liver	40	5×10^{-4}	8×10^{-8}	2×10^{-4}	3×10^{-8}
		Spleen	50	6×10^{-4}	9×10^{-8}	2×10^{-4}	3×10^{-8}
		Muscle	50	7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}
		Bone	100	10^{-3}	2×10^{-7}	5×10^{-4}	7×10^{-8}
		Kidney	100	10^{-3}	2×10^{-7}	5×10^{-4}	8×10^{-8}
		Lung	300	5×10^{-3}	6×10^{-7}	2×10^{-3}	2×10^{-7}
		GI (SI)		0.02	5×10^{-4}	8×10^{-3}	2×10^{-4}
		(insol.) Lung			10^{-8}	10^{-8}	5×10^{-8}
		GI (LLI)		10^{-3}	2×10^{-7}	4×10^{-4}	8×10^{-8}
0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴	¹⁴¹ Ba e^- , γ	(sol.) GI (LLI)		5×10^{-3}	10^{-4}	2×10^{-3}	4×10^{-7}
		Total body	50	0.1	2×10^{-4}	0.03	7×10^{-7}
		Bone	80	0.1	3×10^{-4}	0.05	10^{-4}
		Liver	1	20	4×10^{-4}	7	10^{-4}
		Muscle	2×10^4	40	7×10^{-4}	10	2×10^{-4}
		Lung	2×10^4	40	7×10^{-4}	10	2×10^{-4}
		Spleen	3×10^4	60	10^{-3}	20	4×10^{-4}
		Kidney	4×10^4	70	10^{-3}	20	5×10^{-4}
		(insol.) Lung			4×10^{-7}		10^{-7}
		GI (LLI)		5×10^{-3}	9×10^{-7}	2×10^{-3}	3×10^{-7}
0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴ 0 ⁻⁴	¹⁴⁰ Ba β^- , γ	(sol.) GI (LLI)		8×10^{-4}	2×10^{-7}	3×10^{-4}	6×10^{-8}
		Bone	4	6×10^{-3}	10^{-7}	2×10^{-3}	4×10^{-8}
		Total body	9	0.01	3×10^{-7}	5×10^{-3}	10^{-7}
		Liver	10^3	2	5×10^{-6}	0.9	2×10^{-6}
		Lung	3×10^3	4	9×10^{-6}	2	3×10^{-6}
			3×10^3	5	10^{-4}	2	4×10^{-6}
			4×10^3	6	10^{-4}	2	4×10^{-6}
		Kidney	4×10^3	8	2×10^{-4}	3	5×10^{-6}
		(insol.) Lung			4×10^{-8}		10^{-8}
		GI (LLI)		7×10^{-4}	10^{-7}	2×10^{-4}	4×10^{-8}

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CONCENTRATION OF ¹³⁷CS IN SUBSISTENCE CROPS AND FISH AT BIRD ISLAND

FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION PCl/G NET WEIGHT	RANGE OF CONCENTRATION PCl/G NET WEIGHT
COCONUT MEAT (GREEN)	6	22.7	3.5-48
COCONUT MEAT (INTER-MEDIATE)	9	16.5	4.8-32
COCONUT MEAT (MATURE)	31	30.9	5.3-117
COCONUT MEAT (SPROUTED, SPRINKY)	8	27	16-52
ALL COCONUT MEAT	54	27	3.5-117
COCONUT FLUID	28	13.5	1.2-44
BREADFRUIT	2	6.5	5.2-7.8
SQUASH	12	8.5	1.6-20
PAPAYA	18	14	1.6-31
BANANA	3	0.92	0.54-1.3
SWEET POTATO	2	3.6	2.3-5
WATERMELON	17	2.6	0.26-7.2
GARDEN FRUITS AND VEGETABLES (AVERAGE OF SQUASH, PAPAYA, BANANA, SWEET POTATO, WATERMELON)		5.9	
FISH (MULLET) ⁺	6	0.026 ⁺	
DOMESTIC MEAT		15*	

+ FROM V. NOSHIKIN

* ESTIMATED FROM BIKINI FIG DATA

CONCENTRATION OF ^{90}Sr IN SUBSISTENCE CROPS AND FISH AT EIEU ISLAND

FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION PCI/G WET WEIGHT	RANGE OF CONCENTRATION PCI/G WET WEIGHT
COCONUT MEAT	9	0.021	0.0033 - 0.052
COCONUT FLUID*	-	0.021*	-
BREADFRUIT	2	1.9	0.47 - 3.4
WATERMELON	8	0.031	0.012 - 0.053
SQUASH	6	0.054	0.024 - 0.15
PAPAYA	5	0.29	0.052 - 0.39
SWEET POTATO	1	0.13	-
GARDEN FRUITS AND VEGETABLES (AVERAGE OF WATERMELON, SQUASH, PAPAYA, SWEET POTATO)		0.13	
FISH (BULLET)		0.076 ⁺	
CLAMS		0.035 ⁺	
DOMESTIC MEAT		0.011 ^{**}	

* ASSUMED TO BE THE SAME AS COCONUT MEAT

+ FROM V. NELSON AND B. SCHELL

** FROM 1975 BIKINI DOSE ASSESSMENT

5011569

CONCENTRATION OF $^{239+240}\text{Pu}$ IN SUBSISTENCE CROPS AND FISH AT ENEU ISLAND

FOOD PRODUCT	NO. OF SAMPLES	AVERAGE CONCENTRATION PCI/G NET WEIGHT	RANGE OF CONCENTRATION PCI/G NET WEIGHT
COCONUT MEAT	9	2.8×10^{-5}	4.1×10^{-6} - 5.3×10^{-5}
COCONUT FLUID	-	2.8×10^{-5} *	-
BREADFRUIT	1	1.7×10^{-5}	-
WATERMELON	8	1.3×10^{-5}	4.4×10^{-6} - 2.0×10^{-5}
SQUASH	6	8×10^{-6}	3.5×10^{-6} - 1.9×10^{-5}
PAPAYA	3	8.3×10^{-6}	6.5×10^{-6} - 1.1×10^{-5}
GARDEN FRUITS AND VEGETABLE (AVERAGE OF WATERMELON, SQUASH, PAPAYA)	..	9.8×10^{-6}	
FISH (MULLET) ⁺	6	1.3×10^{-4} +	

* ASSUMED TO BE THE SAME AS COCONUT MEAT

+ FROM V. KOSHKIN

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5011571

FEDERAL RADIATION COUNCIL

RADIATION PROTECTION GUIDANCE FOR FEDERAL AGENCIES

Memorandum for the President

Pursuant to Executive Order 10631 and Public Law 86-373, the Federal Radiation Council has made a study of the hazards and use of radiation. We herewith transmit our first report to you concerning our findings and our recommendations for the guidance of Federal agencies in the conduct of their radiation protection activities.

It is the statutory responsibility of the Council to advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards and in the establishment and execution of programs of cooperation with States.

Fundamentally, setting basic radiation protection standards involves passing judgment on the extent of the possible health hazard society is willing to accept in order to realize the known benefits of radiation. It involves inevitably a balancing between total health protection, which might require foregoing any activities increasing exposure to radiation, and the vigorous promotion of the use of radiation and atomic energy in order to achieve optimum benefits.

The Federal Radiation Council has reviewed available knowledge on radiation effects and consulted with scientists within and outside the Government. Each member has also examined the guidance recommended in this memorandum in light of his statutory responsibilities. Although the guidance does not cover all phases of radiation protection, such as internal emitters, we find that the guidance which we recommend that you provide for the use of Federal agencies gives appropriate consideration to the requirements of health protection and the beneficial uses of radiation and atomic energy. Our further findings and recommendations follow.

Discussion. The fundamental problem in establishing radiation protection guides is to allow as much of the beneficial uses of ionizing radiation as possible while assuring that man is not exposed to undue hazard. To get a true insight into the scope of the problem and the impact of the decisions involved, a review of the benefits and the hazards is necessary.

It is important in considering both the benefits and hazards of radiation to appreciate that man has existed throughout his history in a bath of natural radiation. This background radiation, which varies over the earth, provides a partial basis for understanding the effects of radiation on man and serves as an indicator of the ranges of radiation exposures within which the human population has developed and increased.

The benefits of ionizing radiation. Radiation properly controlled is a boon to mankind. It has been of inestimable value in the diagnosis and treatment of diseases. It can provide sources of

energy greater than any the world has yet had available. In industry, it is used as a tool to measure thickness, quantity or quality, to discover hidden flaws, to trace liquid flow, and for other purposes. So many research uses for ionizing radiation have been found that scientists in many diverse fields now rank radiation with the microscope in value as a working tool.

The hazards of ionizing radiation. Ionizing radiation involves health hazards just as do many other useful tools. Scientific findings concerning the biological effects of radiation of most immediate interest to the establishment of radiation protection standards are the following:

1. Acute doses of radiation may produce immediate or delayed effects, or both.
2. As acute whole body doses increase above approximately 25 rons (units of radiation dose), immediately observable effects increase in severity with dose, beginning from barely detectable changes, to biological signs clearly indicating damage, to death at levels of a few hundred rems.
3. Delayed effects produced either by acute irradiation or by chronic irradiation are similar in kind, but the ability of the body to repair radiation damage is usually more effective in the case of chronic than acute irradiation.
4. The delayed effects from radiation are in general indistinguishable from familiar pathological conditions usually present in the population.
5. Delayed effects include genetic effects (effects transmitted to succeeding generations), increased incidence of tumors, lifespan shortening, and growth and development changes.
6. The child, the infant, and the unborn infant appear to be more sensitive to radiation than the adult.
7. The various organs of the body differ in their sensitivity to radiation.
8. Although ionizing radiation can induce genetic and somatic effects (effects on the individual during his lifetime other than genetic effects), the evidence at the present time is insufficient to justify precise conclusions on the nature of the dose-effect relationship at low doses and dose rates. Moreover, the evidence is insufficient to prove either the hypothesis of a "damage threshold" (a point below which no damage occurs) or the hypothesis of "no threshold" in man at low doses.

9. If one assumes a direct linear relation between biological effect and amount of dose, it then becomes possible to relate very low dose to an assumed biological effect even though it is not detectable. It is generally agreed that the effect that may actually occur will not exceed the amount predicted by this assumption.

Basic biological assumptions. There are insufficient data to provide a firm basis for evaluating radiation effects at all types and levels of irradiation. There is particular uncertainty with respect to the biological effects at very low doses and low-dose rates. It is not prudent therefore to assume that there is a linear relation of radiation exposure below which there is absolute certainty that no effect will occur. This consideration, in addition to the adoption of the conservative hypothesis of a linear relation between biological effect and the amount of dose, determines our basic approach to the formulation of radiation protection guides.

The lack of adequate scientific information makes it urgent that additional research be undertaken and not only developed to provide a firmer basis for evaluating biological risk. Appropriate member agencies of the Federal Radiation Council are sponsoring and encouraging research in these areas.

Recommendations. In view of the findings summarized above the following recommendations are made:

It is recommended that:

1. There should not be any man-made radiation exposure without the expectation of benefit resulting from such exposure. Activities resulting in man-made radiation exposure should be authorized for useful applications provided in the recommendations set forth herein and followed.

It is recommended that:

2. The term "Radiation Protection Guide" be adopted for Federal use. The term is defined as the radiation dose which should not be exceeded without careful consideration of the reasons for doing so; every effort should be made to encourage the maintenance of radiation doses as far below this guide as is practicable.

It is recommended that:

3. The following Radiation Protection Guides be adopted for normal peacetime operations:

Type of exposure	Condition	Dose (rem)
Radiation worker:		
(a) Whole body, head and trunk, active blood forming organs, gonads, or lens of eye.	Accumulated dose.....	5 (times the number of years since age 18).
	13 weeks.....	3
	Year.....	30.
(b) Skin of whole body and thyroid.	13 weeks.....	10.
	Year.....	75.
(c) Hands and forearms, feet and ankles.	13 weeks.....	25.
(d) Bone	Body burden.....	0.1 microcurie of radium-226 or biological equivalent.
(e) Other organs.	Year.....	15.
	13 weeks.....	5.
Population:		
(a) Individual.	Year.....	0.5 (whole body).
(b) Average.	30 year.....	6 (gonads).

The following points are made in relation to the Radiation Protection Guides herein provided:

- (1) For the individual in the population, the basic Guide for annual whole body dose is 0.5 rem. This Guide is

plies when the individual whole body doses are known. As an operational technique, where the individual whole body doses are not known, a suitable sample of the exposed population should be developed whose protection guide for annual whole body dose will be 0.17 rem per capita per year. It is emphasized that this is an operational technique which should be modified to meet special situations.

(2) Considerations of population genetics impose a per capita dose limitation for the gonads of 5 rems in 30 years. The operational mechanism described above for the annual individual whole body dose of 0.5 rem is likely in the immediate future to assure that the gonadal exposure Guide (5 rem in 30 years) is not exceeded.

(3) These Guides do not differ substantially from certain other recommendations such as those made by the National Committee on Radiation Protection and Measurements, the National Academy of Sciences, and the International Commission on Radiological Protection.

(4) The term "maximum permissible dose" is used by the National Committee on Radiation Protection (NCRP) and the International Commission on Radiological Protection (ICRP). However, this term is often misunderstood. The words "maximum" and "permissible" both have unfortunate connotations not intended by either the NCRP or the ICRP.

(5) There can be no single permissible or acceptable level of exposure without regard to the reason for permitting the exposure. It should be general practice to reduce exposure to radiation, and positive effort should be carried out to fulfill the sense of these recommendations. It is basic that exposure to radiation should result from a real determination of its necessity.

(6) There can be different Radiation Protection Guides with different numerical values, depending upon the circumstances. The Guides herein recommended are appropriate for normal peacetime operations.

(7) These Guides are not intended to apply to radiation exposure resulting from natural background or the purposeful exposure of patients by practitioners of the healing arts.

(8) It is recognized that our present scientific knowledge does not provide a firm foundation within a factor of two or three for selection of any particular numerical value in preference to another value. It should be recognized that the Radiation Protection Guides recommended in this paper are well below the level where biological damage has been observed in humans.

It is recommended that:

4. Current protection guides used by the agencies be continued on an interim basis for organ doses to the population.

Recommendations are not made concerning the Radiation Protection Guides for individual organ doses to the population, other than the gonads. Unfortunately, the complexities of establishing guides applicable to radiation exposure of all body organs preclude the Council from making recommendations concern-

ing them at this time. However, current protection guides used by the agencies appear appropriate on an interim basis.

It is recommended that:

5. The term "Radioactivity Concentration Guide" be adopted for Federal use. This term is defined as the concentration of radioactivity in the environment which is determined to result in whole body or organ doses equal to the Radiation Protection Guide.

Within this definition, Radioactivity Concentration Guides can be determined after the Radiation Protection Guides are decided upon. Any given Radioactivity Concentration Guide is applicable only for the circumstances under which the use of its corresponding Radiation Protection Guide is appropriate.

It is recommended that:

6. The Federal agencies, as an interim measure, use radioactivity concentration guides which are consistent with the recommended Radiation Protection Guides. Where no Radiation Protection Guides are provided, Federal agencies continue present practices.

No specific numerical recommendations for Radioactivity Concentration Guides are provided at this time. However, concentration guides now used by the agencies appear appropriate on an interim basis. Where appropriate radioactivity concentration guides are not available, and where Radiation Protection Guides for specific organs are provided herein, the latter Guides can be used by the Federal agencies as a starting point for the derivation of radioactivity concentration guides applicable to their particular problems. The Federal Radiation Council has also initiated action directed towards the development of additional Guides for radiation protection.

It is recommended that:

7. The Federal agencies apply these Radiation Protection Guides with judgment and discretion, to assure that reasonable probability is achieved in the attainment of the desired goal of protecting man from the undesirable effects of radiation. The Guides may be exceeded only after the Federal agency having jurisdiction over the matter has carefully considered the reason for doing so in light of the recommendations in this paper.

The Radiation Protection Guides provide a general framework for the radiation protection requirements. It is expected that each Federal agency, by virtue of its immediate knowledge of its operating problems, will use these Guides as a basis upon which to develop detailed standards tailored to meet its particular requirements. The Council will follow the activities of the Federal agencies in this area and will promote the necessary coordination to achieve an effective Federal program.

If the foregoing recommendations are approved by you for the guidance of Federal agencies in the conduct of their radiation protection activities, it is further recommended that this memorandum be published in the FEDERAL REGISTER.

ARTHUR S. FLEMMING,
Chairman,
Federal Radiation Council.

The recommendations numbered 1 through 7 contained in the memorandum are approved for the guidance of Federal agencies, and the memorandum shall be published in the FEDERAL REGISTER.

DWIGHT D. EISENHOWER

MAY 13, 1960.

[F.R. Doc. 60-4539; Filed, May 17, 1960; 8:51 a.m.]

FEDERAL RADIATION COUNCIL
RADIATION PROTECTION GUIDANCE
FOR FEDERAL AGENCIES
Memorandum for the President

SEPTEMBER 13, 1961.

Pursuant to Executive Order 10831 and Public Law 86-373, the Federal Radiation Council herewith transmits its second report to you concerning findings and recommendations for guidance for Federal agencies in the conduct of their radiation protection activities.

Background. On May 13, 1960, the first recommendations of the Council were approved by the President and the memorandum containing these recommendations was published in the FEDERAL REGISTER on May 16, 1960. There was also released at the same time, Staff Report No. 1 of the Federal Radiation Council, entitled, "Background Material for the Development of Radiation Protection Standards," dated May 13, 1960.

The first report of the Council provided a general philosophy of radiation protection to be used by Federal agencies in the conduct of their specific programs and responsibilities. It introduced and defined the term "Radiation Protection Guide" (RPG). It provided numerical values for Radiation Protection Guides for the whole body and certain organs of radiation workers and for the whole body of individuals in the general population, as well as an average population gonadal dose. It introduced as an operational technique, where individual whole body doses are not known, the use of a "suitable sample" of the exposed population in which the guide for the average exposure of the sample should be one-third the RPG for the individual members of the group. It emphasized that this operational technique should be modified to meet special situations. In selecting a suitable sample particular care should be taken to assure that a disproportionate fraction of the average dose is not received by the most sensitive population elements. The observations, assumptions, and comments set out in the memorandum published in the FEDERAL REGISTER, May 16, 1960, are equally applicable to this memorandum.

This memorandum contains recommendations for the guidance of Federal agencies in activities designed to limit exposure of members of population groups to radiation from radioactive materials deposited in the body as a result of their occurrence in the environment. These recommendations include: (1) Radiation Protection Guides for certain organs of individuals in the general population, as well as averages over suitable samples of exposed groups; (2) guidance on general principles of control applicable to all radionuclides occurring in the environment; and (3) specific guidance in connection with exposure

of population groups to radium-226, iodine-131, strontium-90, and strontium-89. It is the intention of the Council to release the background material leading to these recommendations as Staff Report No. 2 when the recommendations contained herein are approved.

Specific attention was directed to problems associated with radium-226, iodine-131, strontium-90, and strontium-89. Radium-226 is an important naturally occurring radioactive material. The other three were present in fallout from nuclear weapons testing. They could, under certain circumstances, also be major constituents of radioactive materials released to the environment from large scale atomic energy installations used for peaceful purposes. Available data suggest that effective control of these nuclides, in cases of mixed fission product contamination of the environment, would provide reasonable assurance of at least comparable limitation of hazard from other fission products in the body.

Establishment of the Federal Radiation Council followed a period of public concern incident to discussions of fallout. While strontium-90 received the greatest popular attention, exposures to cesium-137, iodine-131, strontium-89 and in still lesser degrees to other radionuclides, are involved in the evaluation of over-all effects. The characteristics of cesium-137 lead to direct comparison with whole body exposures for which recommendations by the Council have already been made.

Studies by the staff of the Council indicate that observed concentrations of radioactive strontium in food and water do not result in concentrations in the skeleton (and consequently in radiation doses) as large as have been assumed in the past. However, concentrations of iodine-131 in the diets of small children, particularly in milk, equal to those permitted under current standards would lead to radiation doses to the child's thyroid which, in comparison with the general structure of current radiation protection standards, would be too high. This is because current concentration guides for exposure of population groups to radioactive materials in air, food, and water have been derived by application of a single fraction to corresponding occupational guides. In the case of iodine-131 in milk, consumption of milk and retention of iodine by the child may be at least as great as by the adult, while the relatively small size of the thyroid makes the radiation dose to the thyroid much larger than in the case of the adult. In addition, there is evidence that irradiation of the thyroid involves greater risk to children than to adults.

Recommendations as to Radiation Protection Guides. The Federal Radiation Council has previously emphasized that establishment of radiation protection standards involves a balancing of the benefits to be derived from the controlled use of radiation and atomic energy against the risk of radiation exposure.

In the development of the Radiation Protection Guides contained herein, the Council has considered both sides of this balance. The Council has reviewed available knowledge, consulted with scientists within and outside the Government, and solicited views of interested individuals and groups from the general public. In particular, the Council has not only drawn heavily upon reports published by the International Commission on Radiological Protection (ICRP), the National Committee on Radiation Protection and Measurements (NCRP), and the National Academy of Sciences (NAS), but has had during the development of the report the benefit of consultation with, and comments and suggestions by, individuals from NCRP and NAS and of their subcommittees. The Radiation Protection Guides recommended below are considered by the Council to represent an appropriate balance between the requirements of health protection and of the beneficial uses of radiation and atomic energy.

It is recommended that:

1. The following Radiation Protection Guides be adopted for normal peacetime operations.

TABLE I—RADIATION PROTECTION GUIDES FOR CERTAIN BODY ORGANS IN RELATION TO EXPOSURE OF POPULATION GROUPS

Organ	RPG for Individuals	RPG for average of suitable sample of exposed population group
Thyroid.....	1.5 rem per year...	0.5 rem per year.
Bone marrow.....	0.5 rem per year....	0.17 rem per year.
Bone.....	1.5 rem per year....	0.5 rem per year.
Bone (alternate guide).	0.005 micrograms of Ra-226 in the adult skeleton or the biological equivalent of this amount of Ra-226.	0.0017 micrograms of Ra-226 in the adult skeleton or the biological equivalent of this amount of Ra-226.

It will be noted that the preceding table provides Radiation Protection Guides to be applied to the average of a suitable sample of an exposed population group which are one-third of those applying to individuals. This is in accordance with the recommendations in the first report of the Council concerning operational techniques for controlling population exposure. Since in the case of exposure of a population group to radionuclides the radiation doses to individuals are not usually known, the organ dose to be used as a guide for the average of suitable samples of an exposed population group is also given as an RPG.

Recommendations as to general principles. Control of population exposure from radionuclides occurring in the environment is accomplished in general either by restriction on the entry of such materials into the environment or through measures designed to limit the intake by members of the population of radionuclides already in the environment. Both approaches involve the consideration of actual or potential concentrations of radioactive material in air, water, or food. Controls should be based upon an evaluation of population

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[Reprinted from the Federal Register of September 26, 1961, as corrected]

exposure with respect to the RPG. For this purpose, the total daily intake of such materials, averaged over periods of the order of a year, constitutes an appropriate criterion.

The control of the intake by members of the general population of radioactive materials from the environment can appropriately involve many different kinds of actions. The character and import of these actions may vary widely, from those which entail little interference with usual activities, such as monitoring and surveillance, to those which involve a major disruption, such as condemnation of food supplies. Some control actions may require prolonged lead times before becoming effective, e.g., major changes in processing facilities or water supplies. The magnitude of control measures should be related to the degree of likelihood that the RPG may be exceeded. The use of a single numerical intake value, which in part has been the practice until now, does not in many instances provide adequate guidance for taking actions appropriate to the risk involved. For planning purposes, it is desirable that insofar as possible control actions to meet contingencies be known in advance.

It is recommended that:

2. The radiological health activities of Federal agencies in connection with environmental contamination with radioactive materials be based, within the limits of the agency's statutory responsibilities, on a graded series of appropriate actions related to ranges of intake of radioactive materials by exposed population groups.

In order to provide guidance to the agencies in adapting the graded approach to their own programs, the recommendations pertaining to the specific radionuclides in this memorandum consider three transient daily rates of intake by suitable samples of exposed population groups. For the other radionuclides, the agencies can use the same general approach, the details of which are considered in Staff Report No. 2. The general types of action appropriate when these transient rates of intake fall into the different ranges are also discussed in Staff Report No. 2. The purpose of these actions is to provide reasonable assurance that average rates of intake by a suitable sample of an exposed population group, averaged over a period of the order of one year, do not exceed the upper value of Range II. The general character of these actions is suggested in the following table.

TABLE II—GRADED SCALES OF ACTION

Ranges of transient rates of daily intake	Graded scale of action
Range I.....	Periodic confirmatory surveillance as necessary.
Range II.....	Quantitative surveillance and routine control.
Range III.....	Evaluation and application of additional control measures as necessary.

Recommendations on Ra-226, I-131, Sr-90, and Sr-89. The Council has given specific consideration to the effects on man of rates of intake of radium-226, iodine-131, strontium-90 and strontium-89 resulting in radiation doses equal to those specified in the appropriate RPG's. The Council has also reviewed past and current activities resulting in the release of these radionuclides to the environment and has given consideration to future developments. For each of the nuclides three ranges of transient daily intake are given which correspond to the guidance contained in Recommendation 2, above. Routine control of useful applications of radiation and atomic energy should be such that expected average exposures of suitable samples of an exposed population group will not exceed the upper value of Range II. For iodine-131 and radium-226, this value corresponds to the RPG for the average of a suitable sample of an exposed population group. In the cases of strontium-90 and strontium-89, the Council's study indicated that there is currently no known operational requirement for an intake value as high as the one corresponding to the RPG. Hence, a value estimated to correspond to doses to the critical organ not greater than one-third of the RPG has been used.

The guidance recommended below is given in terms of transient rates of (radioactivity) intake in micromicrocuries per day. The upper limit of Range II is based on an annual RPG (or lower, in case of radioactive strontium) considered as an acceptable risk for a lifetime. However, it is necessary to use averages over periods much shorter than a lifetime for both radiation dose rates and rates of intake for administrative and regulatory purposes. It is recommended that such periods should be of the order of one year. It is to be noted that values listed in the tables are much smaller than any single intake from which an individual might be expected to sustain injury.

It is recommended that:

3. (a) The following guidance on daily intake be adopted for normal peacetime operations to be applied to the average of suitable samples of an exposed population group:

TABLE III—RANGES OF TRANSIENT RATES OF INTAKE (MICROMICROCURIES PER DAY) FOR USE IN GRADED SCALE OF ACTIONS SUMMARIZED IN TABLE II.

Radionuclides	Range I	Range II	Range III
Radium-226.....	0-2	2-20	20-200
Iodine-131.....	0-10	10-100	100-1,000
Strontium-90.....	0-20	20-200	200-2,000
Strontium-89.....	0-200	200-2,000	2,000-20,000

¹ In the case of iodine-131, the suitable sample would include only small children. For adults the RPG for the thyroid would not be exceeded by rates of intake higher by a factor of 10 than those applicable to small children.

(b) Federal agencies determine concentrations of these radionuclides in air, water, or items of food applicable to their particular programs which are consistent with the guidance contained herein on average daily intake for the radionuclides radium-226, iodine-131, strontium-90, and strontium-89. Some of the general considerations involved in the derivation of concentration values from intake values are given in Staff Report No. 2.

It is recommended that:

4. For radionuclides not considered in this report, agencies use concentration values in air, water, or items of food which are consistent with recommended Radiation Protection Guides and the general guidance on intake.

In the future, the Council will direct attention to the development of appropriate radiation protection guidance for those radionuclides for which such consideration appears appropriate or necessary. In particular, the Council will study any radionuclides for which useful applications of radiation or atomic energy require release to the environment of significant amounts of these nuclides. Federal agencies are urged to inform the Council of such situations.

ABRAHAM RUBINOFF,

Chairman,

Federal Radiation Council.

The recommendations numbered "1" through "4" contained in the above memorandum are approved for the guidance of Federal agencies, and the memorandum shall be published in the FEDERAL REGISTER.

JOHN F. KENNEDY.

SEPTEMBER 20, 1961.

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Table 9. Maximum Annual Dose Rate in mrem/y for a Living Pattern Consisting of 100% Time on Eneu Island

Case When Imported Foods are Readily Available in the Diet

	$^{137}\text{Cs} + ^{90}\text{Sr}^{\dagger}$		
	Ingestion	External Gamma*	Total
Bone Marrow	121	20	141
Wholebody	100	20	120

Case When Local Subsistence Crops are in Full Use

	$^{137}\text{Cs} + ^{90}\text{Sr}^{\dagger}$		
	Ingestion	External Gamma*	Total
Bone Marrow	233	20	253
Wholebody	189	20	209

[†]All food crops are from Eneu Island

*Natural background subtracted

Table 10. Maximum Annual Dose Rate in mrem/y for a Living Pattern Consisting of 80% time on Eneu Island and 20% time on Bikini Island

Case When Imported Foods are Readily Available in the Diet

	$^{137}\text{Cs} + ^{90}\text{Sr}^+$		External Gamma*		Total	10%	5%
	Ingestion						
Bone Marrow	121	67	$\frac{10\%}{44}$	$\frac{5\%}{32}$	188	165	152
Wholebody	100	67	44	32	167	144	132

Case When Local Subsistence Crops are in Full Use

	$^{137}\text{Cs} + ^{90}\text{Sr}^+$		External Gamma*		Total	10%	5%
	Ingestion						
Bone Marrow	233	67	44	32	300	277	265
Wholebody	189	67	44	32	256	233	221

Table 11. Maximum Annual Dose Rate in mrem/y for a Living Pattern Consisting of 100% time on Bikini Island

Case When Imported Foods are Readily Available in the Diet

	$^{137}\text{Cs} + ^{90}\text{Sr}$		Total
	Ingestion	External Gamma*	
Bone Marrow	941	256	1,197 \approx 1.2 rem/y
Wholebody	877	256	1,133 \approx 1.1 rem/y

Case When Local Subsistence Crops are in Full Use

	$^{137}\text{Cs} + ^{90}\text{Sr}$		Total
	Ingestion	External Gamma*	
Bone Marrow	2013	256	2,269 \approx 2.3 rem/y
Wholebody	1849	256	2,105 \approx 2.1 rem/y

*Local Background Subtracted

Table 12. 30-Year Integral Dose in Rem for a Living Pattern Consisting of 100% time on Eneu Island and Imported Foods Being Readily Available

Ingestion	Wholebody	Bone Marrow and Bone
^{137}Cs	2.25	2.25
^{90}Sr	--	0.70
$^{239+240}\text{Pu}$	--	.00045
^{241}Am	--	.0012
$^{241}\text{Pu}/^{241}\text{Am}$	--	0.00058
External Gamma	0.433*	0.433*
Total	2.7	3.4

*Based on an initial dose rate for Eneu Island of 20 mrem/y and assuming the entire dose is from ^{137}Cs .

Table 13. 30 YEAR INTEGRAL DOSE IN Rem FOR A LIVING PATTERN CONSISTING OF 100% TIME ON ENEU ISLAND AND FOR FULL USE OF LOCAL SUBSISTENCE CROPS.

INGESTION	WHOLEBODY	BONE MARROW AND BONE
^{137}Cs	4.25	4.25
^{90}Sr	-	1.5
$^{239+240}\text{Pu}$	-	.0008
^{241}Am	-	.0021
$^{241}\text{Pu}/^{241}\text{Am}$	-	0.0019
External Gamma	<u>0.433*</u>	0.433*
TOTAL	4.7	6.2

* Based on an initial dose rate for Eneu Island of 20 mrem/y and assuming the entire dose is from ^{137}Cs .

Table 14. 30 YEAR INTEGRAL DOSE IN Rem FOR A LIVING PATTERN CONSISTING OF 100 % TIME ON BIKINI ISLAND AND IMPORTED FOODS BEING READILY AVAILABLE.

INGESTION	WHOLEBODY	BOLE MARROW AND BONE
^{137}Cs	19.8	19.8
^{90}Sr	-	2.2
$^{239+240}\text{Pu}$	-	.00051
^{241}Am	-	.0013
$^{241}\text{Pu}/^{241}\text{Am}$	-	-
External Gamma	<u>5.54*</u>	<u>5.54*</u>
TOTAL	25.3	27.5

* Based on an initial dose rate of 256 mrem/y and assuming that the entire dose is from ^{137}Cs .

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Table 15. 30 YEAR INTEGRAL DOSE IN Rem FOR A LIVING PATTERN CONSISTING OF 100 % TIME ON BIKINI ISLAND AND FULL USE OF LOCALLY GROWN SUBSISTENCE CROPS.

INGESTION	WHOLEBODY	BONE MARROW AND BONE
¹³⁷ Cs	41.6	41.7
⁹⁰ Sr	-	5.6
²³⁹⁺²⁴⁰ Pu	-	.00094
²⁴¹ Am	-	.0024
²⁴¹ Pu/ ²⁴¹ Am	-	-
External Gamma	<u>5.54*</u>	<u>5.54*</u>
TOTAL	47.1	52.8

* Based on an initial dose rate of 256 mrem per year and assuming that the entire dose is from ¹³⁷Cs.

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FREEDOM OF INFORMATION ACT REQUEST

PLEASE REPLY TO Washington Office

August 3, 1979

Mr. Milton Jordan
 Director
 Division of FOI and Privacy
 Acts Activities
 Department of Energy
 GB-145 Forrestal Building
 1000 Independence Avenue, S.W.
 Washington, D.C. 20585

Dear Mr. Jordan:

This request is made pursuant to the Freedom of Information Act.

Under date of May 15, 1979, the Assistant Secretary of Environment sent a letter to the Honorable James A. Joseph, Under Secretary of the Interior, having to do with Bikini atoll, Marshall Islands. Attached to the letter is a document entitled "Radiological Implication for Resettlement of Eneu Island." This request relates to that letter and its attachment.

Hereby requested are all documents, records and materials related to the following:



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August 3, 1979
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1. On page 1 of the attachment, the following statement appears:

"Based upon previous experience and past practices, however, it is doubtful whether imported food will be a significant part of the daily diet."

Please provide any and all records, materials and documentation for this assertion.

2. On the same page the following statement is made:

"It can also be questioned whether or not access to Bikini Island can be controlled."

Please provide any and all records, documents, reports and materials which form the basis of this assertion.

3. On page 2 the assertion is made that in August, 1978, the Bikinians "left their Atoll because measurements of radiocesium made in April 1978 showed accumulations in the bodies of 13 out of 101 people such that if this level were maintained for one year, it would result in an annual radiation dose equal to or greater than the 500 mrem/yr federal radiation protection criteria for exposure of individuals." Please provide any and all records, reports, documents or other materials which form the basis of the factual assertions contained in that statement concerning (a) the degree of volition in the departure of the people of Bikini from their atoll, and (b) the measurements of radiocesium in the Bikinians.

4. On page 2 of the attachment appears the following statement:

"In early 1979, new information was obtained so that dose predictions for residence on Eneu Island could, for the first time, be based upon data from analysis of actual food items of the

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diet grown on the island rather than on theoretical predictions derived from soil concentrations."

Please provide a copy of all records, reports, or studies or other documents or materials which form the factual basis for this assertion.

5. Regarding the text on page 6 of the attachment which appears at footnote 10, please provide a copy of any study, report or other document which forms the basis of the decision to employ the federal radiation guidance which is taken from the Enewetak Clean-up Environmental Impact Statement of April, 1975. There is no need to provide any materials which are contained in the Environmental Impact Statement. This request is for any additional or other materials.
6. Please provide a copy of the publication relied upon for the calculated dose estimates which is cited at footnote 14 of the attachment, "An Updated Radiological Dose Assessment of Eneu Island at Bikini Atoll," Robison, W.L. and Phillips, W.A., UCRL-52775, 1979.
7. Beginning at the foot of page 7, the following statement is found:

"The diets are based on the recent experience and observations of the scientific teams who have been working on Bikini Atoll."

No support is provided in the text or in the footnote for this statement. Please provide any and all records, reports, studies or other documents or materials which describe the "recent experience and observations" and which provide the names of the members of the "scientific teams" referred to in the quoted statement.
8. With respect to the predicted doses presented on page 8 of the attachment, please provide a copy of any and all studies, reports or other documents

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or materials which show the number of fatal cancer cases and the number of genetic malformations to be expected from a dose of 170 millirem per year, and the expected increase in the frequency of such cancer cases and genetic malformations, to be expected for the predicted dose rates presented on page 8 of the attachment. In other words, what is the expected frequency of fatal cancer cases at an average dose rate for the population of 170 millirem per year, compared with, for the whole body, a dose rate of 210 millirem per year, 240 millirem per year, and 260 millirem per year? For another example, what is the expected increase in leukemia cases at 170 millirem per year compared with 190 millirem per year, 260 millirem per year, 280 millirem per year, and 300 millirem per year?

What is the expected frequency of genetic anomalies at an average whole body dose rate of 5000 millirem per 30 years compared with 2700 millirem, 3200 millirem, 4700 millirem, 5200 millirem and 5700 millirem?

9. Please provide any records, documents and materials which would explain why the attachment and the letter of May 15 did not contain any discussion of the biological risks associated with the predicted doses. If no such documents exist, please so state, and explain why such a discussion was not included in the advice provided to the Department of Interior.

Thank you in advance for your prompt attention to this request.

Sincerely,



Theodore R. Mitchell

xc: Ruth C. Clusen
Bruce Wachholz

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