

RADIATION EXPOSURE FROM PACIFIC NUCLEAR TESTS

OVERSIGHT HEARING BEFORE THE SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS OF THE COMMITTEE ON NATURAL RESOURCES HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRD CONGRESS

SECOND SESSION

ON

RADIATION EXPOSURE FROM NUCLEAR TESTS IN THE PACIFIC

**HEARING HELD IN WASHINGTON, DC
FEBRUARY 24, 1994**

Serial No. 103-68

Printed for the use of the Committee on Natural Resources



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RADIATION EXPOSURE FROM NUCLEAR TESTS IN THE PACIFIC

THURSDAY, FEBRUARY 24, 1994

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
COMMITTEE ON NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to call, at 9:23 a.m. in room 1324, Longworth House Office Building, Hon. George Miller (chairman of the subcommittee) presiding.

STATEMENT OF HON. GEORGE MILLER

Mr. MILLER. The Subcommittee on Oversight and Investigations will come to order.

The purpose of this morning's hearing is to conduct oversight hearings on the radiation exposure from nuclear tests in the Pacific.

Forty years ago next week, March 1, 1954, a joint U.S. military/civilian task force detonated a 15-megaton thermonuclear device at Bikini Atoll in the Marshall Islands, 2,000 miles southwest of Hawaii. Code-named BRAVO, the test unleashed the most powerful explosion then known to mankind.

BRAVO's mushroom cloud rose more than 20 miles into the stratosphere. Radioactive fallout from the test blanketed inhabited atolls downwind from ground zero, unalterably changing the lives of the thousands of people who lived in its path. The joint task force called the pattern of radioactive fallout an accident that occurred due to a last-minute shift in the winds and the failure to anticipate the bomb would yield so much power.

The task force evacuated the inhabitants of the islands of Rongelap, Rongerik, and Utirik over the days following the BRAVO accident and issued reports which identified the scope of the fallout from BRAVO as confined to a narrow band of 13 mostly uninhabited atolls east of ground zero. In all, we were told, only 267 people were exposed to the fallout from BRAVO; 28 of those exposed people were U.S. servicemen on Rongerik Atoll. The remainder were islanders from Rongelap and Utirik who became part of the DOE health monitoring program which continues to this day.

This is the picture presented to this committee and to the representatives of the Marshall Islands during the Compact of Free Association negotiations a decade ago. But was it a complete story of the BRAVO test and its aftermath? Information presented to the committee suggests that the true facts of BRAVO have been hidden from this committee, from the American people, and, most seri-

ously, from the affected peoples of the Marshall Islands. That information strongly suggested that the disposition of the BRAVO fallout on the uninhabited atolls was not accidental, that the fallout from BRAVO and other nuclear tests was deposited far more widely than has been disclosed; and many more people may be suffering from their exposure to the BRAVO radiation than are included in the DOE health program.

Just a few months ago, the committee was informed by the Republic of the Marshall Islands about the preliminary results of an alarming thyroid survey. That independent study indicated that the rate of thyroid cancer on Ebeye Island far to the south of the designated fallout zone may be 100 times greater than any other place on Earth. That information appears to corroborate a previous study which found that significant fallout from the U.S. nuclear test most likely extended far beyond the previously identified narrow band of mostly uninhabited atolls.

The Administration, and particularly the Department of Energy, have wisely decided to confront the past of half truths and lies about our nuclear testing and experimentation programs here in the United States. We must also end the secrecy and the deception that have shrouded the aftermath of the BRAVO test in the Pacific.

Long classified and otherwise unavailable information about these tests and their legacy in the Marshall Islands must be opened to the Congress and to public scrutiny. So long as this story is only half told, so long as file drawers full of information remain needlessly restricted, the suspicion and mistrust will continue, particularly in light of the recent disclosures about secret human radiation experiments.

The Administration has indicated its willingness to work toward full disclosure in this matter and its willingness to turn over previously classified documents to this committee. We hope that this hearing will be the first step in a long road to full disclosure to the American public and to the people of the Marshall Islands.

Representative Underwood.

STATEMENT OF HON. ROBERT A. UNDERWOOD

Mr. UNDERWOOD. Thank you, Mr. Chairman, and I commend you very much for holding these hearings.

We have heard a lot lately about the atrocities by the U.S. Government against unknowing citizens. Human radiation testing sounds incongruous for democracy at best and criminal at worst. Today's hearing focuses on a slightly different topic, although the theme is the same, and that is that human beings were needlessly injured by the U.S. Government.

To the people of the central Pacific, this is not a new issue. However, in today's climate of professed openness and disclosures, new opportunities lie on the horizon to get some very old questions answered.

I am concerned, for example, that the Department of Energy's medical checkups on the people of Rongelap and Utirik may be failing to take into account the people who were on islands downwind of the 1954 BRAVO test. The 1978 DOE study lists several islands as exposed to, quote, intermediate-range fallout. These islands are Ailinginae, Ailuk, Bikar, Jemo, Likiep, Mejit, Rongerik, Taka,

Utrik, and Wotho. They may sound like foreign names in Washington, DC, but they are real places with real people, and they certainly are neighbors of mine in Micronesia.

Another concern of mine is that, even after the U.S. Government began offering assistance to the Marshallese, too much emphasis was placed on research and not enough on treatment and prevention. For example, in 1975 about six years after telling the Bikinians that it was safe to return home, U.S. scientists found higher levels of radiation than expected. Even though warning signs were evident, people were not evacuated until 1978.

An error of judgment? We can only speculate, but I am alarmed when I find a DOE report that states, "Bikini may be the only global source of data on humans where intake via ingestion is thought to contribute the major fraction of plutonium body burden."

Mr. Chairman, we owe it to the people of the Marshall Islands to determine if populations were kept in high-risk circumstances unnecessarily.

We are now told that the southern islands of Rongelap may be within "permissible limits" of radioactivity while the northern islands are still unsafe. This begs the question, can we divide the same atoll into categories of safe and unsafe? Do we run the risk of repeating history and resettling people too soon?

Of course, the key question remains, Do we really have enough information? Which leads me to my last point. We must once and for all declassify every last document related to the Marshall Islands testing. We are beginning to see such documents which show higher yield levels than previously acknowledged.

Mr. Chairman, no amount of reparations or trust funds will reverse the crime committed by this country against the people of the Marshall Islands, but the very least we can do is let the truth be known, and I commend you for contributing to that effort.

Mr. MILLER. Thank you very much.

Let me say at the outset of the hearing that we have a rather lengthy witness list today. I would hope that the witnesses, to the extent possible, could summarize their testimony because, much of the testimony which I have been reading over the last week raises a number of questions, and we want to make sure that there is time for those questions to be asked of all panelists.

We obviously will not be able to ask all of the pertinent questions in this morning's hearing, but as I stated at the outset, this hearing is only a beginning. We certainly hope to be able to recontact any of the witnesses that appear this morning for the purposes of helping us with that investigation and with answering additional questions that we simply will not have time to put to individuals today.

So to the extent to which you can summarize the pertinent points, I think it would be helpful for this initial hearing, but I also want you to testify in the manner in which you are most comfortable. So somewhere in between there is an accommodation to both of our needs. The problem that has occurred is obviously that in a short while the House will be going into session, and we may shortly end up in a series of votes which are going to take Members back and forth to the Floor.

Having said that, let me welcome Jonathan Weisgall, who is the legal counsel for the people of Bikini, to the committee.

Welcome. Your entire statement and whatever supporting documents you think are necessary will be included in the record in their entirety, Mr. Weisgall. Proceed as you are most comfortable.

**STATEMENT OF JONATHAN M. WEISGALL, ESQ., LEGAL
COUNSEL TO THE PEOPLE OF BIKINI**

Mr. WEISGALL. Thank you, Mr. Chairman.

I would like to give the committee a quick historical overview of the U.S. nuclear testing program in the Marshalls, focusing specifically on BRAVO.

Some of my testimony comes from a book I have been working on called *Operation Crossroads: The Atomic Test at Bikini Atoll*, which will be out in about two or three weeks. The rest comes from documents that I have obtained in the last months and, in fact, in some cases in the last five days.

Not only is next Tuesday the fortieth anniversary of BRAVO, but I think today really marks the first time 40 years after BRAVO and 48 years after the first nuclear test at Bikini that any congressional committee has ever asked the questions of: What happened? What went wrong in these tests? So I commend the committee for holding this hearing.

As you know, there were 66 atomic tests held in the Marshall Islands, and what I want to focus on today specifically are two of them.

I would like to set the stage in 1946 with the BAKER shot at Operation Crossroads which was the fifth atomic bomb ever detonated in the world.

These two shots, BAKER and BRAVO, which came eight years later, are linked, in my opinion, by four themes. The first two are the arrogance and the ignorance that permeated the U.S. nuclear testing program. Added to this was a third theme of secrecy that served only to feed that arrogance and excuse the ignorance. Mixed into this recipe was a fourth theme, a weapon of terror called radioactive fallout that was really designed more for genocide than any kind of military purpose.

I think that while Hiroshima and Nagasaki showed that the instant blast from an atomic bomb could kill tens of thousands of people in seconds, the lesson from BAKER and the real lesson from BRAVO was that the killing power of the lingering effects of radioactive fallout far surpasses the sledgehammer effect of the bomb's blast.

BAKER was the world's first underwater shot. It was a near disaster for many of the 40,000 sailors who were exposed to radioactivity from the blast. This was a shot that looked a little bit like Niagara Falls in reverse with a one-mile-wide column of water shooting up into the atmosphere and then about ten seconds later collapsing back into Bikini's lagoon.

Much like BRAVO, there were warnings on the BAKER shot. Los Alamos in December of 1945 warned—and I am quoting—that an underwater test against naval vessels would contain so many hazards that it should be ruled out at this time.

A Los Alamos study, another one, said—and I am quoting—the water near a recent surface explosion will be a witch's brew. There will probably be enough plutonium near the surface to poison the combined armed forces of the United States at their highest war-time strength.

The warnings were there. They were clear, and they all came true, as more than half of the fission products came collapsing back into the lagoon's water and on to the 95 target ships that were at Bikini.

Radiation dangers following that test were serious, and I do not think enough steps were taken there to prevent widespread exposures. This is mostly of American veterans now. This test, much like BAKER or BRAVO eight years later, was also marked by a level of ignorance and indifference displayed by people in charge.

Nevertheless, despite the disaster that was occurring, despite the fact that all of this fallout came back and absolutely inundated the target ships with what a Navy report called a kiss of death. For weeks men routinely boarded these ships, ate on these ships, slept on these ships, and did what they could to get rid of this radioactivity, which of course was something brand new which no one knew about.

While there was no conspiracy, I don't think, to get men exposed to radiation, there was a very clear and deliberate decision by scientific and medical experts to refuse even to consider the possibility that a serviceman's presence at Bikini might later result in any kind of a radiation-related disease.

Let me just read you two quick items, one from the chairman of what was called a medical legal board that was set up at Bikini at the time. The chairman said the purpose of the board was, quote, "to give what assurance was possible that no successful suits could be brought on account of the radiological hazards of Operation Crossroads." Then several months after the tests as experts were studying the radiation levels on these target ships, there is one very interesting meeting in November in which a participant, Leslie Groves, one of his assistants—he, of course, was the head of the Manhattan Project—said that General Groves, quote, "is very much afraid of claims being instituted by men who participated in the Bikini tests."

This is not the 1980s; this is not the 1970s; this was 1946, two months after Operation Crossroads.

The Navy's attitude at the time, much like the U.S. Government's attitude at the time, was kind of casual indifference. Here's a book called *Bombs at Bikini*. It is the official Navy publication on Operation Crossroads. I will just read you one sentence here.

We want ships which are tough even when threatened by atomic bombs. We want to keep the ships afloat, propellers turning, guns firing. We want to protect the crews so that if fighting is necessary, they can fight well today and return home unharmed tomorrow.

Well, the ships at Bikini, virtually every single one was hit with enough fallout that they all had to be scuttled. There might have been a fleet left after the test, but it would have been a little like the *Flying Dutchman*—there would have been no men on these ships.

The ships did survive to a large extent the blast and the heat of an atomic bomb. The Navy, though, had never fought an alpha particle, and the Navy lost that battle.

Now Bikini would not be used again for nuclear testing until 1954. Enewetak, as you know, became the site of several tests in 1948 and 1951, and then after the outbreak of the Korean War, the Government, fearful that the Koreans or the Chinese might actually invade the Marshall Islands, settled on a test site in Nevada.

The return to the Pacific for BRAVO was occasioned by the decision to develop the hydrogen bomb. The AEC could not risk testing this new weapon in the continental United States, so Enewetak in 1952 was prepared for the first test of a hydrogen bomb. That was November 1, 1952. That was not a usable, deliverable weapon. It was two stories tall; it weighed 65 tons. It was not a deliverable hydrogen bomb, meaning one that could be delivered by an airplane.

The Russians, who were behind us in the development of the atomic bomb—of course they didn't test their first one until 1949—in August of 1953, before BRAVO, tested a deliverable hydrogen bomb. So the Soviets had not only caught up with American nuclear technology, they actually had moved ahead. I think that is important, because to me that answers to a certain extent part of this writing about BRAVO and moving forward. There was a need to move forward as quickly as possible.

You summarized the basic results of the BRAVO shot. One of the more interesting documents I came across just a couple of weeks ago was a letter from Lewis Strauss, the chairman of the AEC, inviting President Eisenhower to attend the detonation of the BRAVO shot. Scribbled at the bottom of the letter from Ike, he says, "Thanks. Don't believe I can do it." It would have been interesting to speculate what might have happened if President Eisenhower had been out there.

But for the BRAVO shot, incidentally, Bikinians might well have been put back at Bikini atoll because in 1952 the AEC said—and I am quoting from an AEC memo—"The health hazard here essentially is negligible. There is no reason why these people should not be returned as far as the hazards from radioactivity may be concerned."

The AEC, though, before even testing MIKE at Enewetak, was very concerned about the explosive force of this hydrogen bomb. Again, I think this is relevant as we look into the facts of March 1. Listen to what the AEC says in 1952 before a hydrogen bomb is tested. "It is possible that the tests planned for Enewetak may result in the destruction of a part of or all of the atoll. A severe shock may cause the crumbling of the entire structure. In such case, there would be no other test site feasible in the entire area other than Bikini."

What happened at BAKER in 1946 was repeated in BRAVO in 1954. The same four themes came back on a grander scale. The ignorance, the arrogance, the secrecy, and, sadly, the radioactive cloud.

To me, Mr. Chairman, the greatest irony of BRAVO concerned the decision whether to evacuate any Marshallese at all. For Operation Crossroads back in 1946, the Navy evacuated all Marshallese

living on the three inhabited atolls closest to Bikini: Rongelap, Wotho, and Enewetak. So here we have Bikini. All the way to the west, Enewetak, south to Wotho and east to Rongelap, the three inhabited atolls were evacuated for a couple of months for the two shots.

In 1953, the Navy suggested extending the danger zone for the BRAVO shot to include Rongelap and Ailinginae.

Mr. MILLER. The information highway is having trouble following you, so slow it down here a bit.

Mr. WEISGALL. Sorry I can't show it for the crowd [indicating map], but basically you have got the Navy suggesting in 1953, with Bikini here, that Rongelap and Ailinginae be evacuated. Ailinginae, while not inhabited, was used quite frequently by the people of Rongelap for fishing. It is not more than 10 or 15 miles from one to the other. In 1946, you had an area this wide evacuated for an atomic bomb. But in 1953 the decision was made not to evacuate Rongelap.

Who made that decision? Interestingly enough, it was the U.S. Interior Department, those great experts on nuclear testing. The trust territory high commissioner, who was the highest ranking U.S. official at the time, wrote to Washington—and I am nine months before BRAVO—he says that the reaction of displacing more Marshallese will be apprehension and fear that future extensions may place any of them in the same homeless position as the Bikinians now occupy. The Bikinians, of course, had been evacuated in 1946. He said, "I urge you"—this is to his superior in Washington, the director of territorial affairs—"I urge you to do everything in your power to limit the boundaries of the proposed danger area to exclude Ailinginae Atoll in its entirety as well as any other atolls or islands in the Marshall Islands other than Bikini or Enewetak."

As a compromise, he said, okay, extend the danger area to Ailinginae but draw that line three miles west of Ailinginae Atoll. I'll quote: "This would at least avoid the necessity of informing the Marshallese of the expanded danger area and so protect them and the Administration from the results of what would be, at the very best, unsettling knowledge for them to have."

So the irony you have got is, in 1946 with an atomic bomb the size of Nagasaki, three atolls are evacuated. In 1954, knowing that the hydrogen bomb was at least 400 times more powerful—and in fact BRAVO turned out to be 1,000 times more powerful than the atomic bomb shots in 1946—no action was taken, no one was evacuated from these atolls.

There were other warnings given. In 1953, the head of the Los Alamos Test Division wrote a memorandum criticizing a technical report on the weather tracking for the tests, and he said, "The whole approach of this report is felt to be based on too few observations by observers with too little experience. The result has been the creation of a theoretical picture and conclusions based on this picture which are not supported by the facts."

Let's move up to March 1, 1954. Let me introduce Senator Henchi Balos, the elected representative of the people of Bikini to the Marshall Islands Legislature.

Mr. MILLER. Welcome, Senator.

Mr. WEISGALL. You know the story. The party line has been that there was an unexpected shift of the winds. I don't want to spend much time on this, but I think it is important to note that the documents at the time, documents written not after the fact, the actual weather briefings on February 28 and March 1, paint an absolutely clear picture of the weather pattern.

Seven a.m., the day before the shot: "No significant fallout for the populated Marshall Islands." Later in the day: "The trend was toward an unfavorable or marginal condition."

Six p.m.—now we are 12 hours before the shot—"Conditions were getting less favorable." Midnight, less than seven hours before the shot: "Less favorable winds at 10,000- to 25,000-foot levels, winds headed for Rongelap to the east," and it was recognized that Bikini and Enmon Islands would be contaminated.

Let me take a quick moment just to show you where the shot was detonated at Bikini. If I hold this here, perhaps some of the audience can see as well, Mr. Chairman.

Here is Bikini Atoll, a circular chain of what was 26 islands. This circle in the northwest corner is a BRAVO crater detonated in the northwest corner of Bikini, and it was recognized at midnight that Bikini and Enmon Islands would be contaminated. Winds were not going north; they were headed due east and southeast.

Now, who took action at the time? Was the shot postponed? No. Were precautions taken for the Marshallese downwind? No. But following the midnight briefing, Task Force 77 ordered several of its ships to move 20 miles farther out to sea and to the south to get out of the way. This, to me, puts the BRAVO shot in a different category from an unexpected wind shift.

Have I seen evidence of U.S. Government officials deliberately planning to expose Marshallese to fallout? No. Have I seen evidence of U.S. officials failing to take immediate action to get Marshallese out of harm's way? Yes. Measures were taken to try to help some of the Americans to take precautionary moves. Nothing was done for the Marshallese. So either way, the result is the same, irradiated Marshallese and U.S. scientists measuring the long-term effects on them.

If this weather forecast created enough risk to move the ships, the Marshallese in danger should have been warned, they should have been moved, or the shot should have been postponed.

One other thing I remembered this morning in my own research on Operation Crossroads. The Bikinians were on Rongerik for Operation Crossroads in 1946. They were 125 miles away from Bikini. The U.S. Navy had a landing craft at Rongerik, and it actually put the Bikinians on that ship the day of the first shot at Bikini, and then when the winds turned out okay, they were put back and there was no fallout in the area. Nothing like this was done eight years later.

The cover-up began immediately. Lewis Strauss, chairman of the AEC, sent out a cable to Kwajalein saying, "No public release will be made in regard to fallout or evacuation in the trust territory unless forced by leak or other circumstances. Washington presently plans no report, no announcements, and urgently requests that you make nothing public on these matters."

The Los Alamos Test Division leader cabled back that he was "very concerned" about Strauss's order saying, quote, "I should regret very much the impression that we are being furtive in our actions with regard to these people." The cover-up started on March 3.

Bikini, Mr. Chairman, would be the site of 20 other nuclear tests over the next four years, and I applaud what this committee is doing today. You are going to hear from other witnesses about the effects today.

This hearing is a start, you are correct, and this hearing, these issues, don't just concern the BRAVO shot. BRAVO alone was one of six shots in March 1954, March and April at Bikini, that had a total megatonnage of about 48 megatons, with BRAVO being about 15.

Other hydrogen bomb shots destroyed other parts of Bikini. The ZUNI shot in 1956 vaporized the western end of one of Bikini's islands. There is more to this story. A lot of it has been made public.

For you English literature majors, I rather enjoyed one document I found which was AEC's efforts to try to return the Rongelap people back to their atoll. It was called "Project Hardy, the Return of the Native." So the AEC did get a chuckle out of all this.

I think the real issue today, though, is, What should this committee do? Let's begin with the Compact of Free Association. Article 9 is entitled "Changed Circumstances," and it says that if injuries or damages in the Marshalls are discovered after the date of this agreement and could not have reasonably been identified at the effective date of the agreement, which was 1985, that the Marshalls Government can ask the Congress to provide for such injuries.

Ironically, having provided this remedy to the Marshallese, most documents have remained classified. So despite requests from myself and others to declassify documents, a lot of documents on the nuclear testing program in the Marshall Islands remain classified. The compact negotiations were largely one-sided. The U.S. had all the information.

I sat at this table ten years ago, and I said to Mr. Seiberling—I'll quote my testimony—"The U.S. Government has sought in the section 177 agreement to put a price tag on its nuclear legacy in the Pacific and close the books on this sorry bit of history. If Congress is to pass judgment on the agreement, it seems only fair that it should have before it all the pertinent facts on the testing program."

That was May 1984. I could say the same thing today. There is a catch-22. "Here's a remedy," said the U.S., "Changed circumstances, but we will set up every obstacle we can to make sure you can't exercise it by keeping documents classified."

I have been filing Freedom of Information requests since the compact became effective. I filed one as recently as about a week ago. There is a lot that remains classified.

I am aware from your opening statement that apparently there has been some movement already in the Administration, but by calling on the Government to declassify these documents this committee can also help determine whether these changed circumstances have occurred.

What you have heard from me today is information I have learned since the compact came into effect. As far as I know, the position of the White House remains that the radiation tests on humans and the U.S. nuclear testing program are separate issues. I don't think that is the case.

I think there is a fine line, at best, between a patient injected with radioactive isotopes that we have been reading about and, on the other hand, a Marshallese and resident of Rongelap sprinkled with fallout or a Navy diver who went back into Bikini's lagoon two hours after the BAKER shot. They all get sick; they are all studied by doctors. In fact, I would argue that there is almost a more compelling case in the case of the BAKER-BRAVO victims where there was not even a hint of informed consent.

Mr. MILLER. I am going to ask you to summarize.

Mr. WEISGALL. I am wrapping up right now.

Step one, I think that there has got to be complete declassification of documents. It is 40 years after BRAVO, 40 years after Operation Crossroads.

Step two, I think the people of Bikini need to be included in the Brookhaven medical program. The Bikinians, as Mr. Underwood said earlier, were back on Bikini in the mid-1970s. Sir, you quoted one sentence from a Lawrence Livermore study. Let me quote the second sentence after that. "Bikini is possibly the best available source of data for evaluating the transfer of plutonium across the gut wall after being incorporated into biological systems."

Now a lot of that is medical-speak, but the fact of the matter is, the Bikinians in the 1970s were the same experimental subjects that the Rongelapese, the Utirikese, and undoubtedly, as you will hear today, other Marshallese were as well.

Mr. Chairman, I would be pleased to answer any questions that you may have.

[Prepared statement of Mr. Weisgall follows:]

STATEMENT OF JONATHAN M. WEISGALL
 LEGAL COUNSEL TO THE PEOPLE OF BIKINI
 BEFORE THE HOUSE NATURAL RESOURCES COMMITTEE
 FEBRUARY 24, 1994

Mr. Chairman and members of the Committee:

My name is Jonathan Weisgall. I have served as legal counsel for the people of Bikini since 1975.

I. Overview

Let me begin with a thumbnail sketch of the history, numbers and statistics: First, consider this statistic. From July 16, 1945 until September 23, 1992, the United States conducted 1,051 nuclear tests. Put another way, from July 16, 1945 until September 23, 1992, the United States conducted one nuclear test every 16.4 days. Sixty-six of these tests were conducted in the Marshall Islands, 23 at Bikini Atoll and 43 at Enewetak. I want to talk to you today about two of these tests: the 1946 Baker shot at Bikini, which was part of Operation Crossroads, and the 1954 Bravo shot, which was part of Operation Castle.

In a little over three weeks in 1945 -- at Alamogordo in the New Mexico desert and at Hiroshima and Nagasaki -- the world entered the atomic age. Seven months later, the U.S. Navy moved the 167 residents of Bikini off their atoll, and in July 1946 it exploded the world's fourth and fifth atomic bombs in Bikini lagoon. Operation Crossroads, as these tests were called, consisted of two shots -- an air-drop code-named Able and an underwater shot -- the world's first -- code-named Baker.

Bikini would not be used for nuclear testing for eight years, until 1954, when it was the site of five of the six hydrogen bomb shots in Operation Castle. Next Tuesday, March 1, will mark the 40th anniversary of the first shot in Operation Castle, the Bravo shot, the largest and most destructive nuclear test in U.S. history.

The stories of Baker and Bravo are linked by four major themes. The first two are the ignorance and arrogance that marked the U.S. nuclear testing program. Added to this was a third theme -- secrecy -- that served only to feed the arrogance and excuse the

ignorance. Mixed into this recipe was the fourth theme -- an insidious new weapon of terror called radioactive fallout -- a weapon of biological extinction, designed more for genocide than the destruction of buildings or military targets. Hiroshima and Nagasaki showed that the instant blast and heat of an atomic bomb can kill tens of thousands of people in a matter of seconds. The story of Baker and Bravo was that the killing power of lingering radioactive fallout far surpasses the instant sledgehammer effect of the bomb's blast.

In light of the Clinton Administration's new policy of openness concerning archival documents related to radiation testing, as exemplified by Energy Secretary O'Leary's bold and courageous stand, the time has come to reexamine the U.S. nuclear testing program in the Marshall Islands, its health impacts on U.S. military personnel and Marshallese citizens, and the relationship between these new facts and the 1985 Compact of Free Association between the United States and the Marshall Islands. I might add that Congressional committees have previously examined the impact of U.S. nuclear testing on both U.S. veterans and the Marshallese, but I believe that today marks the first time ever, 40 years after Bravo and nearly 48 after Baker, that Congress is asking what went wrong in these tests and why.

II. Compact Section 177 Agreement and Declassification of Documents

As I review this history, please keep in mind the Compact of Free Association Act of 1985, P.L. No. 99-239 (Jan. 14, 1986), which contains the Compact Section 177 Agreement. Article IX of that Agreement, entitled "Changed Circumstances," provides that if personal injuries or property damage in the Marshall Islands are later discovered and could not "reasonably have been identified as of the effective date of [the] Agreement," and if those "injuries render the provisions of [the] Agreement manifestly inadequate," the Marshall Islands government can ask the U.S. government to "provide for such injuries by submitting such a request" to Congress.

Having provided a remedy for the Marshallese to come back to Congress in case of changed circumstances, the U.S. government has continued to keep documents from the testing program classified, thus making it impossible to determine the extent of injuries and damages during the 1940s and 1950s. The Compact negotiations

were largely one-sided. Only the U.S. government knew the full details of the 66 nuclear tests it conducted in the Marshall Islands and the damage and destruction they caused. Despite requests from myself and others, in litigation and negotiations, thousands of documents remained classified and were never produced.

I recently looked back at my testimony in this very hearing room ten years ago on the upcoming Compact of Free Association:

The U.S. government has sought in the Section 177 agreement to put a price tag on its nuclear legacy in the Pacific and close the books on this sorry bit of history. If Congress is to pass judgment on the agreement, it seems only fair that it should have before it all the pertinent facts on the testing program.¹

I could submit that very statement today. The situation is exactly the same today as it was 10 years ago and 40 years ago; the United States still has most of the information. Some documents have been declassified over the last decade, but many remain inaccessible. This is a classic Catch-22. The United States agreed to a remedy called "Changed Circumstances," but it continues to block access to archival documents, thus making it harder to prove that "Changed Circumstances" may have occurred. Here's a remedy, said that United States, but we will set up every obstacle we can to make sure you can't exercise it.

My historical overview today is not intended as an indictment of anyone in this room. These events did not occur during the watch of anyone here; indeed, some of us weren't even born. But that fact is all the more reason why the U.S. government must declassify all documents related to these tests. We must all be dealing with the same set of facts. There is no longer any reason to hide information on the nuclear testing program. Some of this information is nearly 50 years old, and the national security imperatives that necessitated classification in the 1940s and 1950s no longer exist.

¹Compact of Free Association - Part II, Hearings Before the House Interior and Insular Affairs Subcommittee on Public Lands and National Parks 180 (98th Cong., 2d Sess., May 8, 1984).

Following the settlement of the Bikinians' last lawsuit against the United States, I continued to file Freedom of Information Act requests for documents on the testing program and track down new documents as they were declassified and placed in public files. This was for a book I was writing entitled Operation Crossroads: The Atomic Tests at Bikini Atoll, which will be published next week by the Naval Institute Press.

The information I am about to tell you comes from that research -- from documents I have obtained since the 177 Agreement was signed. Nothing of what I am about to tell you comes from material released by the Department of Energy last December or since then. Indeed, the Department -- and the White House's Human Radiation Inter-agency Working Group Task Force formed late last year -- take the position that issues raised by the U.S. nuclear testing program are different from the issues raised by radiation experiments on human subjects.

I submit that this is not the case. There is a fine line, at best, between, on the one hand, a patient injected with radioactive isotopes, and, on the other hand, a Marshallese resident of Rongelap sprinkled with fallout from Bravo or a Navy diver who entered Bikini's water two hours after the Baker shot. All three people end up with radiation-related diseases. All three are studied by doctors, and all three become guinea pigs in one form or another. Indeed, the Baker and Bravo examples may well be more the compelling cases for Secretary O'Leary's offer of compensation. In those cases there was no information given to the military personnel or the Marshallese and there was certainly no informed consent. These people -- the veterans and the Marshallese -- deserve our government's fullest attention.

III. Operation Crossroads

I will begin with Operation Crossroads, first looking at the fate of the tens of thousands of sailors and then the U.S. government's treatment of the Bikinians.

A. Baker

The Baker test, on July 25, 1946, was both a great technical success for the Navy and a near-disaster for many of the 40,000 sailors who were overexposed to radioactivity from the blast. In one

second, an underwater bomb pushed a one-mile-wide dome of water into the sky. It looked like Niagara Falls in reverse. Then, a full 10 seconds later, the water column collapsed back into the lagoon, creating enormous rolling waves of spray, mist and air that crept over the target fleet and swallowed the ships from view. This unexpected radioactive cloud bank, later called a base surge, was not predicted by any of the scientists, and it was about to become America's Chernobyl.²

Billowing outward, the base surge spread more than three miles across and 1,800 feet high, engulfing all the target ships within minutes and leaving what Crossroads's technical director called a "kiss of death" on the ships.³ The base surge "heavily contaminated" all but 9 of the 95 target ships, wrote the Navy, and "its radioactive mist settled on the decks, moistened every bit of exposed metal, wood and canvas."⁴ The blast, which sank the 26,000-ton battleship Arkansas in a matter of seconds, unleashed the greatest waves ever known to humanity, one of which lifted the huge aircraft carrier Saratoga 43 feet.⁵ It also unleashed the greatest amount of radioactivity ever known up to that time.

1. Warnings from Los Alamos and Stafford Warren

At first, an underwater atomic explosion had seemed too reckless. Scientists from Los Alamos National Laboratory warned the Navy in December 1945 that an "underwater test against naval

²William A. Shurcliff, Technical Report of Operation Crossroads (1946), p. 28.3 (XRD-208, NTIS Document No. AD 367496.); Commander, JTF-1, Operational Report on Atomic Bomb Tests Able and Baker (Operation Crossroads) (1946), p. VI-D-45 (XRD-206, NTIS Document No. AD 473986).

³Ralph Sawyer, Report of Technical Director, Operation Crossroads (1946), p. 7. (extracted version prepared by Defense Nuclear Agency as XRD-210).

⁴J. J. Fee, Operation Crossroads: Radiological Decontamination Report of Target and Non-Target Vessels (1946), Vol. I, p. 14 (Technical Report XRD-185-87, NTIS Document No. AD 473 906); William A. Shurcliff, Bombs At Bikini: The Official Report of Operation Crossroads (1947), p. 159.

⁵Director of Ship Material, JTF-1, Bureau of Ships Group, Technical Inspection Report, USS Saratoga, p. 14, Defense Atomic Support Agency Records; Shurcliff, Technical Report, pp. 6.12, 9.14, 21.5, 28.5; Berkhouse, L. et al., Operation Crossroads - 1946 (1984), pp. 101, 107 (DNA Report No. 6032F).

vessels would contain so many hazards that it should be ruled out at this time."⁶ If the muffling effect of the water were to prevent the radioactive material from rising high enough into the atmosphere, there would be trouble. "A rise of only 10,000 feet . . . would present the greatest hazard," one study concluded, "because most of the contamination would fall on the target ships or back into the lagoon," and another report predicted that the water column would rise only 5,000 to 8,000 feet.⁷ "The water near a recent surface explosion will be a witch's brew," warned Los Alamos. "There will probably be enough plutonium near the surface to poison the combined armed forces of the United States at their highest wartime strength."⁸ The warnings could not have been clearer, and they all came true, as nearly half the bomb's fission products fell back into the lagoon's water or onto the target ships.⁹

Stafford Warren, Operation Crossroads's radiological safety (or radsafe) director, warned that Baker would cause severe contamination in the lagoon and that the target ships "may remain dangerous for an indeterminable time thereafter," but these warnings were ignored. Despite drone boat readings of 730 roentgen per day near the center of the target array (more than twice the lethal dose), the first patrol boats entered the lagoon 41 minutes after the shot, followed by a salvage group, radsafe monitors and technicians, who boarded 12 target ships to retrieve data and instruments. By the end of the day 49 support ships returned to Bikini's lagoon with nearly 15,000 men on board.¹⁰

⁶William S. Parsons to Admiral William H. P. Blandy, memorandum, December 3, 1945, Box 4, Entry 1, Folder 8, Record Group 77, Manhattan Engineer District Records, National Archives.

⁷Commander, JTF-1, Operation Plan, Annex E (Safety Plan) (1946), App., pp. 1286-89; Berkhouse et al., Operation Crossroads, p. 60.

⁸Henry W. Newson to Norris E. Bradbury, memorandum entitled "Possible Difficulties in Naval Tests," December 17, 1945, p. 4, DOE/CIC (Department of Energy Coordination and Information, Center, Las Vegas) 120851.

⁹Fee, Radiological Decontamination, Vol. 1, p. 14.

¹⁰R. J. Buettner, "Safety Prediction - Test Baker," pp. 14-16, n.d., DOE/CIC 140564; Commander, JTF-1, Operational Report, pp. VII-(C)-53, VI-D-79; Berkhouse et al., Operation Crossroads, pp. 97, 104; Shurcliff, Technical Report, p. 20.12.

Radiation levels on some of the target ships remained dangerously high even a week after the shot, and boarding them was unsafe except for brief visits. To make matters worse, radioactivity in the lagoon's contaminated waters quickly spread to the support ships. Warren's radsafe plan cautioned that no apparatus on the support ships that used saltwater cooling should be operated until the seawater in the lagoon was declared safe. Nevertheless, the day after Baker, the support ships were authorized to operate their evaporators, which distilled seawater for drinking. As a result, every nontarget support vessel became contaminated, just as the planners had feared, and fission products became concentrated on underwater hulls and in condensers, evaporators, and saltwater pipes.¹¹

Despite all the warnings that the highly radioactive column of water would come crashing down on the ships, no one had planned for the disaster that had been predicted with such amazing accuracy. "Since the nature and extent of contamination of the targets was completely unexpected," the Navy later admitted, "no plans had been prepared for organized decontamination measures."¹²

2. Overexposures of Sailors

Few of the 42,000 men at Bikini were even aware of the hazards and the need to take radsafe precautions, and others did not care. One of Stafford Warren's radsafe colleagues wrote about one captain "who insists on a 'hairy-chested' approach to the matter with a disdain for the unseen hazard, an attitude which is contagious to the younger officers and detrimental to the radiological safety program."¹³ Two other monitors wrote of "an attitude of indifference on the part of the ship's officer" of one target vessel, the Prinz Eugen. Despite readings of 50 times the maximum daily tolerance dose, some crew members were ordered to spend the night there, because the ship's officer believed that there was "such a large safety factor

¹¹Herbert Scoville, Jr., to Warren, memorandum, April 27, 1946, Box 1, Folder 13, Warren papers; Bureau of Ships minutes of conference of 3 May 1946 (May 7, 1946), Box 1, Folder 13, Warren papers; Berkhouse et al., Operation Crossroads, p. 105.

¹²Fee, Radiological Decontamination, Vol. 1, p. 4.

¹³George Lyon to Parson, memorandum, May 5, 1947, DOE/CIC 140713.

that it can be ignored."¹⁴ "Radioactive material "was scattered over the decks of the ships," said a Navy speaker at a 1947 conference on defensive atomic warfare. "Men walked through it, tracked it around, and got it on their clothing and hands and faces. There was some tendency on the part of the men to disregard a danger which they could not see, nor touch, nor smell."¹⁵

It is impossible to recreate with any accuracy radiation levels on every part of the target ships over specific periods of time. It is equally impossible to determine who may have ingested or inhaled radioactive materials or received high doses from open cuts or wounds. One sailor sleeping close to saltwater lines may have received much higher doses than another sleeping three feet away. One man may have worn protective boots and gloves during a decontamination shift, while another just a t-shirt. "The erratic location of high and low intensities on the target ships does not permit an accurate estimate of any one individual's exposure," noted Stafford Warren shortly after the tests.¹⁶

Virtually all the available evidence, though, points to the conclusion that radiation dangers following the Baker test were serious and that not enough steps were taken in time to prevent widespread overexposures. A host of factors - the overwhelming amount of contamination from the base surge, lingering radiation on the target and nontarget ships, malfunctioning radsafe equipment, a shortage of monitors, failure to observe radsafe regulations, and the ignorance and indifference displayed toward the radiation hazard by officers and enlisted men alike - caused many men regularly to receive radiation doses in excess of the daily tolerance dose of .1 roentgen. Moreover, this tolerance dose, deemed appropriate in 1946, has now been lowered for the general population by a factor of 365, so that today the current recommended maximum dose for one

¹⁴R. J. Rieckhoff and D. W. Jones to William A. Wulfman, memorandum, August 10, 1946, DOE/CIC 140634.

¹⁵F. T. Winant, Jr., "Command Problems of Atomic Defense Warfare," September 1947, DOE/CIC 48678.

¹⁶Warren to Blandy, memorandum, August 7, 1946, DOE/CIC 140692; GAO, Operation Crossroads: Personnel Radiation Exposure Estimates Should Be Improved (1985) (GAO/RCED-86-15).

year is approximately the same dose that was recommended as the maximum exposure for one day at Operation Crossroads.

The anecdotal documentary evidence of overexposure, even at the 0.1 roentgen level, is simply overwhelming. Warren's radsafe section detected 67 overdoses in one three-day period, with some men exposed to 20 times the daily limit, and one batch of 125 film badges showed 26 overexposures. Work on two target ships was stopped due to the crew's overexposure from working and living on the ships. Ten days after the tests, 35 target ships had average topside readings more than 10 times the daily tolerance dose, and some had readings 70 times greater.¹⁷

3. Actions by Stafford Warren to End Operation Crossroads

In early August, Warren warned Admiral William Blandy, the head of Operation Crossroads, that "some of the most important ships have had many lethal doses [of plutonium] deposited on them and retained in crevices and other places." He warned Blandy that plutonium "is the most poisonous chemical known" that "it is insidiously toxic in very minute quantities," and that his monitors lacked the equipment to measure it.¹⁸ Scientists knew that only a few millionths of a gram of radium lodged within human bones could prove fatal. Plutonium, the main component of the Baker bomb, has the same effects and is even more toxic. The Baker test, though, did not involve millionths of grams of radium, or even hundredths of grams. It created the equivalent of thousands of tons of radium.¹⁹ Nevertheless, for weeks after the test men routinely boarded target ships, swept them, scraped them, ate their meals on board, and even slept aboard them; they were constantly exposed to the danger of inhaling plutonium and fission products from Baker.

¹⁷Scoville, "Nuclear Radiation Effects," pp. J.11, J.46, Los Alamos National Laboratory; Warren to Blandy, message, August 15, 1946, p. 2, Box 4, Folder 5, Warren papers; list of overdoses evaluated on 9 August 1946, 8 August 1946 and 6/7 August 1946, Box 4, Folder 1, Warren papers; Wulfman to Warren, memorandum, August 9, 1946, DOE/CIC 64034.

¹⁸Warren to Blandy, memorandum, August 7, 1946, p. 2, DOE/CIC 140692.

¹⁹Sawyer, Report of the Technical Director, p. 25; Scoville, "Nuclear Radiation Effects in Tests A and B - Preliminary Report of" (September 25, 1946), Enclosure J to Sawyer, Report of the Technical Director, p. J.7.

On August 3, nine days after Baker, Warren was convinced he had a disaster on his hands. He told Blandy that decontamination efforts were largely useless and that the target ships "should be declared hopelessly contaminated." He warned that there was "increasing evidence" of overexposures, and he called for an immediate end to Operation Crossroads.²⁰

Blandy rejected this recommendation at a staff meeting on August 6, but Warren did not let matters rest there. "Control of the safety of the target ships' crew is rapidly getting out of hand," he asserted bluntly the next day. "The target vessels are in the main extensively contaminated with dangerous amounts of radioactivity. Quick decontamination without exposing personnel seriously to radiation is not possible under the present circumstances and with present knowledge." Worried about the breakdown of much of his monitoring equipment, he also sent an urgent cable to Los Alamos requesting 300 new Geiger counters and 50,000 film badges. "Strongly urge that . . . this [be] treated as an actual emergency involving safety to life," he teletyped.²¹

Blandy changed his mind on August 10, when faced with Warren's clear evidence, now buttressed by analyses flown in from Los Alamos. All decontamination work was halted, and most of the target vessels were towed to Kwajalein Atoll, 250 miles away. Operation Crossroads "was conducted as an emergency and a lot of compromises were made to meet this emergency," Warren wrote to a radsafe monitor later that year. "I never want to go through the experience of the last three weeks of August again."²²

While the documentary records of Operation Crossroads do not suggest a conspiracy to cover up the test results, they do show a deliberate decision by the scientific and medical experts to refuse

²⁰Warren to Blandy, memorandum, August 3, 1946, DOE/CIC 140630.

²¹Warren to Blandy, memorandum, August 7, 1946, DOE/CIC 140692; handwritten teletype message from the USS Haven, Box 4, Folder 5, Warren papers, UCLA; D. R. Bergh, Flag Secretary, memorandum prepared on August 6, 1946, Conference on CJTF-1, Los Alamos National Laboratory.

²²Warren to Viola Warren, letter, August 11, 1946, DOE/CIC 140498; Warren to Admiral Fahrion, memorandum, August 13, 1946, DOE/CIC 140666; Warren to William Myers, letter, December 31, 1946, DOE/CIC 140703.

even to consider the possibility that a serviceman's presence at Bikini might later result in a radiation-related disease. In fact, one of the main purposes of a Medico-Legal Board established at Bikini by Stafford Warren was to provide a paper trail designed to lay the groundwork for future denial of legal claims that might be brought against the U.S. government arising from Operation Crossroads. Robert R. Newell, chairman of the Board, readily admitted just weeks after the tests that the board "initially . . . served to reassure Col. Warren that the safety measures adopted by RadSafe were such as to attract no justifiable criticism, and to give what assurance was possible that no successful suits could be brought on account of the radiological hazards of Operation Crossroads."²³

Nevertheless, lawsuits were on the minds of top Crossroads officials at an October 1946 meeting to discuss decontamination issues. "Having in mind both medical and legal protection," the participants, led by Admiral Blandy, agreed that documents relating to decontamination efforts should be classified "and that the public relations angle should be considered carefully to remove confusion and the impression that the Navy is 'covering up.'" And at a meeting in late November to discuss possible litigation from the sale of target ships as scrap, one participant noted that Leslie Groves, the head of the Manhattan Project that developed the atomic bomb, "is very much afraid of claims being instituted by men who participated in the Bikini tests."²⁴

Although the instantaneous bursts from Able and Baker sank only 14 ships, radiological contamination eventually sank almost the entire target fleet. Most of the ships still showed high levels of radioactivity one year after the tests. In the end, all but six vessels were sunk by the bombs or deliberately scuttled or sunk because of lingering radioactivity.

"We want ships which are tough, even when threatened by atomic bombs," wrote the official Navy historian of Operation Crossroads in 1947. "We want to keep the ships afloat, propellers turning, guns firing; we want to protect the crews so that, if fighting is necessary, they can fight well today and return home unharmed

²³Report of Medico-Legal Board, August 19, 1946, DOE/CIC 140683.

²⁴Fee, Radiological Decontamination, Vol. III, pp. 78, 112.

tomorrow."²⁵ His comment captured the Navy's attitude toward the bomb after the war. No one yet recognized that the greatest danger of atomic warfare -- or of weapons testing -- lay not in the immediate blast and heat from the atomic bomb but from the deadly lingering radioactivity. The ghost fleet would not sail back under the Golden Gate Bridge, triumphant and invincible. The ships survived the familiar enemies of heat and blast, but the Navy had never fought an alpha particle.

B. Removal of the Bikinians.

And what of the Bikinians, who were moved off their atoll by the Navy? The working assumption for the past 48 years has been that the Bikinians agreed to leave their atoll forever, or at least indefinitely. Navy Commodore Ben Wyatt wrote that when he visited Bikini on February 6, 1946, to ask the Bikinians if they would leave, their leader, "King" Juda (as he was later dubbed by the media), immediately stood up and said, "If the United States government and the scientists of the world want to use our island and atoll for furthering development, which with God's blessing will result in kindness and benefit to all mankind, my people will be pleased to go elsewhere."²⁶

In a matter of minutes, or hours at most, the Bikinians had readily acquiesced in Wyatt's request, without even knowing where they would go. Why? Several factors may have contributed to their decision: America's power, the destructive force of the bomb, the islanders' fear. Another possibility remains, though, and that is that Wyatt only asked the Bikinians to leave temporarily.

The evidence is there. There were no plans to use Bikini after Operation Crossroads, which originally was planned for three shots. When asked by a reporter if the Bikinians would be moved permanently, Admiral Blandy responded, "I don't think that it should necessarily be permanently." At a later press conference he said that

²⁵Shurcliff, Bombs at Bikini, p. 2.

²⁶Dorothy Richard, United States Naval Administration of the Trust Territory of the Pacific Islands (1957), Vol. III, pp. 509-10; Honolulu Star-Bulletin, February 23, 1946, p. 11.

Bikini would be a restricted security area "for some time after the tests," and in numerous statements he said the Bikinians' return to their homeland was being measured in terms of months.²⁷

Blandy's statement was not an isolated incident. Wyatt said in November 1946, "They can't go home now," and Infantry Journal's April 1946 issue reported that "unless the resulting radioactivity is permanent, and experts are confident that it will not be, the inhabitants will be permitted to return to their homes when the operation is completed."²⁸

The Bikinians clearly believed that they would be able to return home shortly. On the day they were moved, they told a Life magazine reporter that they would return to Bikini one day, and an anthropologist who visited them in 1948 wrote in the early 1950s that "these people understood that their enforced absence from the atoll was to be only short-lived."²⁹

As a precaution against future lawsuits, Navy surveyors photographed each dwelling on Bikini and counted each family's coconut and pandanus trees. Their homes and all buildings on Bikini, though, except for the church and meeting hall, were destroyed, and the Navy transplanted 2,500 palm trees from Bikini and Rongerik "for the purpose of improving the appearance" of Kwajalein, as Wyatt wrote in a confidential memorandum.³⁰

²⁷Blandy press conference, January 24, 1946, p. 5, File No. 39-1-37, Record Group 80, General Records of the Department of the Navy; Honolulu Star-Bulletin, September 5, 1946, p. 13; Blandy, lecture at Constitution Hall, Washington, D.C., November 22, 1946, p. 2, DOE/CIC 100955.

²⁸Time, November 11, 1946, p. 31; "The Atomic Bomb Test," Infantry Journal (April 1946).

²⁹Life, March 25, 1946, p. 105; Mason, Leonard, "Relocation of the Bikini Marshallese: A Study in Group Migration," p. 109 (Ph.D. dissertation, Yale University, 1954).

³⁰Commodore Ben Wyatt to ComMarianas, memorandum entitled "War Diary - Submission of," April 13, 1946, Record Group 313, Records of the Naval Operating Forces, National Archives; CINCPAC to Navy Department, cable, February 14, 1946, Box 225, Record Group 374, Defense Atomic Support Agency.

IV. Bravo

Bikini would not be used again for nuclear testing until 1954. Enewetak Atoll was the site of atomic bomb tests in 1948 and 1951, but after the outbreak of the Korean War the National Security Council, concerned that the Russians or Chinese might invade the Marshall Islands, recommended a site in Nevada for further atomic tests.

The return to the Pacific was occasioned by America's decision to develop the hydrogen bomb, a weapon triggered by an atomic bomb. With a force much greater than the atomic bomb, the AEC could not risk testing the new weapon in the continental United States, so Enewetak was prepared for a new round of tests. The world's first hydrogen bomb, code-named Mike, was tested at Enewetak on November 1, 1952, but it was not a usable weapon. It was larger than a two-story building and weighed 65 tons. A better bomb was needed.

The Russians had tested their first atomic bomb in 1949. Then, in August 1953, they tested a deliverable hydrogen bomb. The Soviets had not only caught up with American nuclear technology; they had actually moved ahead, and America had to develop and test a hydrogen bomb capable of delivery by aircraft.

The result was the Bravo shot, detonated at Bikini on March 1, 1954. Bravo, with an explosive force equal to nearly 1,000 Hiroshima-type atomic bombs, vaporized the test island and parts of two others, sucked them more than 20 miles into the atmosphere, and left a gaping mile-wide crater in the lagoon floor. The force of the explosion shook buildings at Kwajalein, 250 miles away. Incidentally, President Eisenhower at one point considered attending the test, but five weeks before the shot he turned down the AEC's invitation: "Thanks," he wrote by hand to AEC chairman Lewis L. Strauss. "Don't believe I can do it."³¹

³¹January 26 letter from Lewis L. Strauss to President Eisenhower, DOE/CIC 33075.

The 1946 Baker shot at Bikini was a harbinger of the Bravo shot. The four themes I mentioned earlier - arrogance, ignorance, secrecy and devastating effects of fallout were all repeated -- on a grander scale. Bravo's history is better known than Baker's, but what I want to discuss today are some of the facts about Bravo that were not known eleven years ago, when the Compact and the Section 177 Agreement were signed:

A. Possible resettlement of Bikini

But for the 1954 Bravo shot, it is likely that the Bikinians would have returned to their homeland. Scientific teams returning to the atoll in the late 1940s and early 1950s detected such low levels of radioactivity that the AEC saw no reason not to return the islanders. These are the words of Dr. John C. Bugher, the head of the AEC's Division of Biology and Medicine at a 1952 meeting: "The health hazard here is essentially negligible. There is no reason why these people should not be returned as far as the hazards from persistent radioactivity may be concerned."³²

B. Withholding information on Bikini's condition

An April 1952 memorandum for Gordon Dean, the AEC chairman, confirmed Bugher's conclusions, but suggested that the AEC provide no information on the fish in the lagoon. The following are excerpts from that memorandum:

From a health standpoint, Bugher advised that radioactivity on Bikini Island itself is very, very low. . . . Some of the fish around the island have appreciable amounts of radioactivity in their bones, but would be of no possible harm to the natives if they returned. It would be undesirable to volunteer any information on this latter point if it can be conveniently avoided, as there is some doubt as to the basis on which we would prevent the natives from returning.³³

³²Bugher, memorandum to files entitled "Return of Natives to Bikini," April 10, 1952, AEC Division of Biology and Medicine, Box 326-78-3, Box 1, MRA Bikini and Eniwetok, Doc. No. 9458, U.S. Department of Energy.

³³April 9, 1952 memorandum for Gordon Dean, prepared by M. W. Boyer, AEC General Manager, DOE/CIC 138945.

C. Possible destruction of Enewetak

As the AEC prepared for hydrogen bomb tests in the Pacific, it wanted to keep Bikini in reserve as a test site because it was concerned that the Mike shot would completely wipe out Enewetak. Here is an excerpt from an April 1952 memorandum to AEC chairman Gordon Dean:

Bikini may be necessary in connection with future weapons tests, either because the 1952 test at Eniwetok may result in its elimination, or the fall-out may be so bad that we could not go back for so long that we would have to find another test site.³⁴

Another internal AEC memorandum made the same point:

It is possible that the tests planned for Eniwetok may result in the destruction of a part or all of the atoll. A severe shock may . . . cause the crumbling of the entire structure. In such case there would be no other test site feasible in the entire area other than Bikini.³⁵

A third memorandum made the point in less bureaucratic style: "AEC may need Bikini if Eniwetok goes up with M[ike]."³⁶ Eventually, five of the six shots in Operation Castle, including the Bravo test, were held at Bikini, not Enewetak, resulting in the destruction of parts of Bikini, not Enewetak.

D. Danger zone

The greatest irony of Bravo concerned the decision whether to evacuate any Marshallese for the shot. For Operation Crossroads, back in 1946, the Navy, at the recommendation of Stafford Warren, had evacuated the Marshallese living on the three inhabited atolls closest to Bikini -- Rongelap, Wotho, and Enewetak -- but no damage

³⁴Id.

³⁵Bugher, memorandum, supra, note 32.

³⁶April 7, 1952 memorandum entitled "Possible Return of Bikini Natives," DOE/CIC 103587.

was caused to these atolls.³⁷ Thus, in 1953, when the Navy suggested extending the danger zone to include Ailinginae and Rongelap and evacuate its residents, the Interior Department balked.

Trust Territory High Commissioner Elbert Thomas, the highest ranking U.S. official in Micronesia, was reluctant to displace more Marshallese again. "Their reaction to an enlargement of the area of activity will be apprehension, and fear that future extensions may place any of them in the same homeless position as the Bikini people now occupy," he wrote in a memorandum to his superiors in Washington more than one year before Bravo. "While it is impossible to predict the exact nature of the reactions, experience has shown that the most probable result would be first, a lowering of morale with a consequent reluctance to fend for themselves, followed by the expectation that the Government would provide their food in return for the land that had been taken." He therefore suggested that the boundaries of the danger zone be drawn precisely to exclude these atolls:

I find it difficult to accept the proposals of the Atomic Energy Commission even with full realization of the significance of the work they are doing. I do urge you to do everything in your power to limit the boundaries of the proposed Danger Area to exclude Ailinginae Atoll in its entirety, as well as any other atolls or islands in the Marshalls other than Bikini and Eniwetok.

As a compromise, he proposed expanding the danger zone to a point three miles off the western shore of Ailinginae Atoll: "This would at least avoid the necessity of informing the Marshallese of the expanded Danger Area and so protect them and the administration from the results of what would be, at the very best, unsettling knowledge for them to have."³⁸

³⁷Warren to JTF-1, memorandum entitled "Evacuation of Atolls Neighboring to Bikini," March 13, 1946, DOE/CIC 140512. If it became necessary to jettison the atomic bomb on Able Day, Warren recommended that it be dropped on Taongi Atoll, an uninhabited atoll located some 225 miles northeast of Bikini and more than 200 miles from the nearest inhabited Marshallese atoll.

³⁸February 5, 1953 letter from Thomas to James P. Davis, Director, Office of Territories, U.S. Department of the Interior, Record Group 326, DMA Collection, Box 3782, U.S. Department of Energy Archives, DOE/CIC 30094.

The AEC agreed, and the results were tragic.³⁹ Here is how the AEC explained the decision:

If the danger area had included such inhabited atolls as Rongelap and Utirik it would have required that the natives of those atolls be evacuated and that a permanent home be found for them elsewhere. [T]he Department of the Interior was not sympathetic to removing the natives, having experienced considerable difficulty with the Bikini natives who were relocated. . . .⁴⁰

The irony was painful. For an atomic bomb the size of the ones dropped on Hiroshima and Nagasaki, the Navy in 1946 had evacuated Marshallese for hundreds of miles to the east, west and south of Bikini. For a hydrogen bomb in 1954 that the government knew would be at least 400 to 500 times more powerful than those bombs, no one was evacuated from these atolls.

E. Inadequate planning

The radsafe planners were not really sure what to expect at Bravo, largely because the United States had only conducted one previous hydrogen bomb test -- the 1952 Mike shot at Enewetak. There was very little local fallout at Mike, and the radsafe teams had been unsuccessful in tracking the bomb's radioactive cloud. "Although conscientious efforts were made to document the fallout from MIKE," wrote the Bravo Task Force commander, "only about 5% of the total debris could ever be accounted for."⁴¹ Nevertheless, the radioactive cloud from Mike had risen to a height of 26 miles, and government scientists knew that dangerously high levels of fallout

³⁹Marion W. Boyer to Chief of Naval Operations, memorandum dated March 31, 1953, DOE/CIC 137067; Cushing to CINCPAC, "Radiological Hazards in the Marshall Islands Area during Operation Castle" (July 30, 1953), attachment to DOE/CIC 26198; Richard G. Hewlett and Jack M. Holl, Atoms for Peace and War 1953-1961 (1989), pp. 170-71.

⁴⁰Vincent G. Huston to Kenneth D. Nichols, "Chronology of Establishment of Danger Area around Pacific Proving Grounds" (March 30, 1954), DOE/CIC 29635,

⁴¹April 12, 1954 memorandum for the record by Alvin C. Graves and P. W. Clarkson entitled "Bravo Shot, Operation Castle," DOE/CIC 17859.

could occur on atolls even hundreds of miles away from the site of a hydrogen bomb shot.⁴²

As a result, several scientists expressed doubts about the weather forecasting plans for the Bravo shot. Listen to the words of Harold F. Plank of the Los Alamos Test Division criticizing a technical report on the expected configuration of the test, the rise of the plume and weather tracking:

The approach of the whole report is felt to be based on too few observations by observers with too little experience. The result has been the creation of a theoretical picture and conclusions based on this picture which are not supported by the facts.⁴³

F. Winds

Ever since March 1, 1954, the U.S. government has explained that there was an unexpected "shift of the winds occurring after the detonation," which carried the radioactive fallout from Bravo eastward over Bikini and most of the islands in the atoll, as well as over Rongelap, Utrik and other atolls in the Marshall Islands.⁴⁴

We now know that this is not true. The shot was deliberately set off despite the fact that AEC officials knew exactly which way the winds were headed. According to now-declassified documents, the weather briefing at 7:00 a.m. the day before the shot predicted "no significant fall-out . . . for populated Marshall Islands," but later in the day "the trend was toward an unfavorable or marginal condition," and by 6:00 p.m. "conditions were getting less favorable."⁴⁵

⁴²Meril Eisenbud, An Environmental Odyssey: People, Pollution, and Politics in the Life of a Practical Scientist (1990), pp. 74-75, 82.

⁴³July 17, 1953 memorandum from Plank to Alvin C. Graves entitled "Comment on the Pate-Palmer Report to CJTF-7 Dated 30 June 1953," DOE/CIC 120579.

⁴⁴U.S. Atomic Energy Commission, Major Activities in the Atomic Energy Program, January - July 1954 (1954), p. 51, DOE/CIC 40054.

⁴⁵March 1, 1954 memorandum for record by Richard A. House, RadSafe Officer, entitled "Command Briefing, 1800, 28 February 1954," House memorandum entitled "RadSafe Narrative Sequence of Events," memorandum by C. D. Bonnot, USAF Staff Weather Officer, entitled "Summary of Weather Situation for Bravo

The midnight briefing, less than seven hours before the shot, showed "less favorable winds at 10,000- to 25,000-foot levels." Winds at 20,000 "were headed for Rongelap to the east," and "it was recognized that both Bikini and Eneman Islands would probably be contaminated."⁴⁶ The final weather and radiological safety check, at 4:30 a.m., shows that the AEC knew there was a problem: "The general recommendation for this briefing was one of minimizing the effects of the low level northerly and westerly winds."⁴⁷

Was the shot postponed? No. Were precautions taken for the Marshallese downwind? No. Were precautions taken for the U.S. personnel downwind? Yes. Following the midnight briefing, Bikini's weather outlook was downgraded to unfavorable, and Joint Task Force Seven ordered several of its ships to move 20 miles farther out to sea and to the south, to get out of the path of the fallout.⁴⁸

This evidence puts the Bravo shot in a different category from an "unexpected" wind shift. This attitude -- getting the Americans out of harm's way but taking no action to protect the Marshallese -- is perfectly consistent with the attitude displayed in some of the radiation experiments that were conducted in the 1940s and 1950s. Those experiments weren't conducted on Harvard Law School

Shot," Tabs A and B to April 12, 1954 memorandum for the record by Graves and Clarkson, note 41, above.

⁴⁶ Bonnot memorandum entitled "2400M Weather Briefing Prior to Bravo Shot," House memorandum entitled "Command Briefing, 0000, 1 March 1954," Tab A to April 12, 1954 memorandum by Graves and Clarkson, note 41, above; Edwin J. Martin and Richard H. Rowland, Castle Series, 1954 (1982), pp. 201-02 (DNA 6035F).

⁴⁷ March 1, 1954 memorandum for record by Richard A. House, RadSafe Officer, entitled "Final Weather and RadSafe Check, 0430, 1 March 1954," Tab A to April 12, 1954 memorandum by Graves and Clarkson, note 41, above.

⁴⁸ House, "Radsafe Narrative Sequence of Events," 1, Tab B to April 12, 1954 memorandum by Graves and Clarkson, note 41, above; Bonnot, "Summary of Weather Situation for Bravo Shot," note 45, above; March 22, 1954 memorandum from H. C. Burton to Chief of Naval Operation entitled "Radioactive Contamination of Ships and Radiological Exposure of Personnel of Task Group 7.3 due to BRAVO, the First Nuclear Explosion of CASTLE," p. 1 (DOE/CIC 76555); House, "Final Weather and RadSafe Check," note 47, above; Martin and Rowland, Castle Series, note 46, above, p. 202.

students. They were conducted on the handicapped, the uninformed, people with no political power.

This attitude existed at the Bravo shot. Some of the Americans were moved out of harm's way. The "natives," as they were called, were left in place. This obviously gives rise to the charge of using the Marshallese as guinea pigs. Have I seen evidence of U.S. government officials deliberately planning to expose Marshallese to fallout? No. Have I seen evidence of U.S. government officials failing to take immediate action to get Marshallese out of harm's way? Yes. And either way, the result -- irradiated Marshallese enabling U.S. scientists to measure the long-term effects of low-level radiation -- is the same. If the weather forecast created enough risk to move the ships, either the Marshallese in danger should have been moved or the shot should have been postponed.

Let me review parenthetically the attitude of American officials toward the Lucky Dragon incident, the Japanese fishing vessel whose 23 crewmen were sprinkled with fallout from the Bravo shot. AEC chairman Lewis Strauss declared that the boat, despite its 800 pounds of tuna, was really a "Red spy outfit" snooping on the American tests. This attitude was echoed by John M. Allison, the American ambassador in Tokyo, who cabled Secretary of State John Foster Dulles that the Lucky Dragon accident was followed by a "period of uncontrolled masochism," as the nation, aided by an unscrupulous press, seemed to revel in fancied martyrdom." Allison claimed that this breakdown was triggered by a small group of Japanese doctors, whom he described as "fuzzy-minded leftists" who had "vistas of nation-wide publicity at home and world-wide scientific prominence as exclusive proprietors of the world's first hydrogen bomb patients." Allison also recommended a quick lump-sum settlement with the crew in order to weaken "the position of neutralists, pacifists, feminists, and professional anti-Americans."⁴⁹

G. Publicity.

As you know, the 236 inhabitants of Rongelap and Utrik atolls, 28 American servicemen on Rongerik and 23 crewmen of a Japanese fishing vessel were sprinkled with fallout from the Bravo shot. AEC

⁴⁹Allison to Secretary of State, memorandum entitled "Fukuryu Maru," May 20, 1954, DOE/CIC 71978.

chairman Lewis Strauss immediately opting for total secrecy, advising all personnel that "no public release will be made in regard to fallout or evac[uation] in Trust Territory unless forced by leak or other circumstances. . . . Wash[ington] presently plans no [report,] no announcement and urgently requests you not make anything public on these matters."⁵⁰

Los Alamos test division leader Alvin Graves strongly objected to this policy. In an "Eyes Only" cable to Kenneth E. Fields, the Task Force Director of Military Application, he said he was "very concerned" about Strauss' order. "I should regret very much the impression that we are being furtive in our actions with regard to these people," he said.⁵¹

No one really paid much attention to the Marshallese after the Bravo shot. They petitioned the United Nations to ask the U.S. Government to take all "possible precautionary measures" in future tests, but the Trust Territory High Commissioner dismissed this action. In a May 18, 1954 letter to the Interior Department, he described the petition as "one of the things the Micronesians are so fond of doing -- passing resolutions and getting up petitions. They spend a great deal of time doing just that."⁵²

Bikini would still be the site of 20 more nuclear tests over the next four years, all of which caused even more destruction at the atoll. For example, the shots following Bravo in the Castle series were designed in part to measure the size of new craters caused by atomic and hydrogen bombs, and the May 28, 1956 Zuni shot vaporized most of the western end of Bikini's Eneman Island.

The rest of the story has already been made public, except for the AEC's plan to return the people of Rongelap to their atoll. For you English literature majors, it was called "Project Hardy (The Return of

⁵⁰Naval message 041905Z from Combined Joint Task Force 7 to CINCPAC Fleet, March 4, 1954 (AEC files, Record Group 326, box 3772, folder MRA7 Caste, DOE/CIC 28581).

⁵¹Naval message 042202Z from Graves to Fields, March 5, 1954 (Los Alamos National Laboratory files, Bravo fallout folder), DOE/CIC 125331.

⁵²Records of the Office of Territorial and International Affairs, U.S. Department of the Interior.

the Native)." It's nice to know that the AEC could find a chuckle in this tragedy.⁵³

V. Committee Action

Where does all of this leave the Bikini people today and what steps should this Committee take?

A. By calling on the U.S. Government to declassify and release all remaining documents related to the nuclear testing program in the Marshall Islands, this Committee can help determine whether the "changed circumstances" provision of the Compact Section 177 Agreement should be invoked. Releasing all the documents will level the playing field and help all sides make a more informed decision.

B. The people of Bikini are the recipients of a Resettlement Trust Fund, designed in part for a cleanup of their islands. But in appropriating this trust, Congress only took into account the cost of cleaning up two of Bikini's 23 islands. No funding was provided for a cleanup of any of the other 21, and the Bikinians do not want to go back to a half (or really one-tenth) clean atoll. This Committee should call on the House Interior Appropriations Subcommittee to provide more funding for the cleanup of all of the atoll.

The Bikinians, I might say, take very good care of their trust funds and spend their money wisely. In fact, in the 12 years since Congress first appropriated the Resettlement Trust Fund, every penny has been audited and accounted for to the Interior Department and the Auditor-General of the Marshall Islands, who, incidentally, has determined that there is only one local government in the entire Marshall Islands whose books are in good enough shape to audit -- the Bikinians.

C. Immediately following the Bravo shot, the AEC contracted with Brookhaven National Laboratory to monitor the health of the people of Rongelap and Utrik. Section 103(h)(1) of the Compact of Free Association Act (Public Law No. 99-239) indefinitely continues that program for the populations of Rongelap and Utrik.

⁵³April 14, 1954 memorandum entitled "Project Hardy (The Return of the Native)," DOE/CIC 125302.

Brookhaven doctors briefly monitored the people of Bikini following their abortive nine-year return to Bikini in the 1970s, when the Bikinians had experienced what was described as an "incredible" one-year 75% increase in their body burdens of cesium-137.⁵⁴ One report prepared for DOE by Lawrence Livermore Laboratory in 1976 made the Bikinians feel that they, too, were human guinea pigs. The report said:

Bikini Atoll may be the only global source of data on humans where intake via ingestion is thought to contribute the major fraction of plutonium body burden. . . . It is possibly the best available source of data for evaluating the transfer of plutonium across the gut wall after being incorporated into biological systems.⁵⁵

Responsibility for monitoring the Bikinians was later turned over to the Marshall Islands Government under the Section 177 health care program established by the Compact. As I have explained in detail to your staff and to the Interior Department, that program has not been successful, and the Bikinians have slipped between the cracks -- excluded by Congressional legislation from the Brookhaven program and victimized by an inefficient Marshallese health care program. The Bikinians are entitled to better health care, and I urge this Committee to take the lead in amending Brookhaven's mandate to include the people of Bikini.

D. Section 103(h)(2)(B) of the Compact of Free Association Act continued for five years, through 1991, the U.S.D.A. supplemental food program for the people of Bikini. Following that five-year period, Congress, in §304 of P.L. No. 102-247, extended the program for another five years and included the peoples of Bikini, Enewetak, Rongelap and Utrik. However, this extension set an annual cap on funding of \$500,000, which is no longer enough to provide for the food needs of the people of Bikini.

The primary reason the Bikinians rely so heavily on this program is because they are still not back on their atoll. Most of

⁵⁴Washington Post, May 22, 1978, p. 1.

⁵⁵Quoted in Washington Post, April 3, 1978, p. 9; Jonathan M. Weisgall, "The Nuclear Nomads of Bikini Atoll," Foreign Policy 39 (Summer 1980), p. 90.

them live on Kili Island, 425 miles south of Bikini, which has neither lagoon nor atoll and therefore cannot begin to meet the food needs of the people. The Bikinians therefore call on this Committee to amend P.L. 102-247 by providing that U.S.D.A. food will be provided strictly on an eligibility basis, without regard to an appropriations ceiling. This is more in keeping with how the Department of Agriculture runs its supplemental food program for Native Americans.

* * *

The people of Bikini gave the United States everything they had -- their land and their home. They demanded nothing in return; they asked only that the United States care for them until their land had served its purpose and could be returned to them. The United States promised that it would do so, but 48 years later, the Bikinians are still not home. They lived up to their side of the deal, and the United States did well by them. The tests in the Marshall Islands cost hundreds of billions of dollars (in 1994 dollars), but the United States never questioned their value, because they assured U.S. nuclear superiority over the Soviet Union and led to immediate savings of billions of dollars in the defense budget in the late 1940s and 1950s. As the AEC told Congress:

Each of the tests involved a major expenditure of money, manpower, scientific effort and time. Nevertheless, in accelerating the rate of weapons development, they saved far more than their cost.⁵⁶

Bikini was a real bargain for the United States.

I would be pleased to answer any questions you may have.

⁵⁶U.S. Atomic Energy Commission, Thirteenth Semiannual Report of the Atomic Energy Commission (1953), p. 18.

Mr. MILLER. Thank you very much, Mr. Weisgall, for your testimony.

Before I ask you questions, I would like to recognize Mr. Lane Evans, a member of this committee and also ranking member of the Veterans' Committee.

Mr. Evans do you have a statement?

STATEMENT OF HON. LANE EVANS

Mr. EVANS. Yes, Mr. Chairman, I appreciate the opportunity, and I want to salute you for holding this very important hearing.

Since the acknowledgement by the Clinton Administration that the Federal Government performed radiation experiments on uninformed Americans, there has been a flurry of activity and, of course, widespread media coverage.

I am certainly pleased with the Administration and particularly Ms. O'Leary's policy of revealing information pertaining to radiation experimentation, but I am dismayed that the U.S. nuclear testing program conducted in the Marshall Islands and its health impact on U.S. military personnel and the citizens of the Marshall Islands had not been included in the comprehensive investigation conducted by the White House's Human Radiation Interagency Working Group.

At the time the group was formed, I and 27 colleagues in the House wrote to the President to request that this investigation include the thousands of service personnel that have been exposed to ionizing radiation over the last 50 years, including those serving in the Marshall Islands.

The Administration has argued that there is no significant evidence that radiation experiments were conducted on the people in the Marshall Islands at the time of the BRAVO shot. However, today we are hearing testimony and will be examining documents and data that suggest that the Federal Government may have knowingly used the citizens of and the military personnel stationed in the Marshall Islands as human guinea pigs.

As we know, the BRAVO shot is arguably the largest and most destructive nuclear test in nuclear history. The 15-megaton thermonuclear shot was 1,000 times more powerful than the bombs dropped on the Japanese during World War II. Furthermore, BRAVO's radioactive fallout is proven to be far more devastating in its effects on the Marshall Islands, its citizens, and our veterans on the islands at the time than previous data have suggested.

It is my understanding that since learning of this hearing Secretary O'Leary has promised to turn all formerly classified documents regarding the BRAVO shot and Operation Castle to this subcommittee for review. I would request the chairman look into obtaining the same kind of cooperation from the Departments of Defense, Veterans' Affairs, Interior, and State so that we can bring this matter to resolution.

I am the son of an atomic veteran who was stationed at Bikini Atoll. I feel a personal bond with the people of Bikini and the Marshall Islands. We have to put this behind us.

I have worked on legislation for years to help the atomic veterans of our Armed Forces and very much appreciate this commit-

tee's interest in this issue and of the light that it will bring on this subject, and thank you again for holding the hearing.

Mr. MILLER. Thank you very much, and we appreciate your support, and we look forward to joining with you, Lane, on these requests.

Let me state for the record where we are on that before we get into questions.

We have made a request for information both from the Department of Energy and from the Department of Defense. The day before yesterday, Secretary O'Leary called me and said that she would be turning over to us very shortly all of the classified documents in their possession and they would be gathering all of the documents not in their possession that were classified and be turning those over to us, again, as soon as possible, and we really welcome that openness.

At the moment it appears that if we can think of exactly the right question, the Department of Defense will give us exactly the right answer. This is a game that has gone on for 50 years in this Government. We would hope that the President and the Secretary of Defense would recognize their duty and their obligation to simply come forth with those classified documents and hopefully the other Departments that may have information.

I think the country clearly applauds Secretary O'Leary for what she has done and the candor with which she has done it and the speed with which she has tried to put this information out on to the public record. We want to thank her for that participation. I think it will be very helpful to the issues surrounding this event.

We will simply continue in that manner, but I think clearly the Department of Veterans' Affairs, the Department of the Interior, and the Department of Defense have got to cooperate.

We have also requested, as you and as Chairman Dingell and others have, that this be made part of the White House Inter-agency Task Force on Experimentation. I think at the moment we are playing with semantics here about experimentation because they may not have designed a protocol for this experiment, but clearly after they started acquiring knowledge of what they had and their failure to act upon that knowledge, we were into an experiment with the future of the people of the Marshalls and the veterans who were there.

We are taking requests for top 40 hits here from other Members of Congress who want to testify.

Let me again thank you, Mr. Weisgall, for your testimony and for your help and assistance to the committee.

On the issue of the unpredictability of the fallout and the information that you have pertaining to the expected weather and the variances of information that were available about the atmosphere and the stratosphere and the winds at different levels, is there any reasonable explanation for why they would not have carried out an evacuation of the downwind atolls before BRAVO?

Mr. WEISGALL. I came across one document from 1953 saying that the task force will be ready to evacuate if necessary. I came across one other document—that would take me too long to find right now but that I will submit for the record—talking about budget constraints, if you could believe it.

But you had seven ships east of Bikini available, and I do not at this time have any explanation. The kindest one I can give with the situation with the servicemen on Rongerik was that some of the radio messages seem to have gotten garbled because the servicemen there informed Kwajealein immediately that there was a problem.

There was also one weather-tracking plane that was in the wrong location. So there was a lot of sloppiness, a tremendous amount of the sloppiness.

But to me, we still have more questions about this test today than we have answers.

Mr. MILLER. But in terms of the information that was gathered in the periodic weather reports leading up to the BRAVO shot, your testimony is and the documents seem to suggest, that that information was in fact acted upon. It may have been discounted to some extent, but it was acted upon at least to the extent of getting the movement of the ships prior to the shot. Is that correct?

Mr. WEISGALL. You have pinpointed the very point I am trying to emphasize. It is one thing to know the winds are shifting. It is another thing to take precautionary measures.

So yes, the U.S. Government did try to take precautionary measures after that midnight briefing for some of those U.S. personnel, meaning that that wind shift was real, meaning that they were concerned about it, but, again, there is a line drawn here on the one hand between the Americans, or some of the Americans, and on the other hand the Marshallese.

Mr. MILLER. And so the early public information that this was in fact unpredictable simply isn't credible. It was predicted to such an extent that overt actions were taken.

Mr. WEISGALL. I am not even talking predictions, I am talking facts, I am talking the weather briefing.

You know, it is one thing to say a week before, "We might have a problem." It is another thing to say 12 hours before, "It is looking bad"; seven hours before, "The winds are headed to the east." These are no longer predictions, this is what is happening at the time. It is worse than a prediction.

Mr. MILLER. On the issue of changed circumstances, the issue is not so much whether the circumstances have changed since the compact was signed or negotiated and signed. Is not the issue whether information at the time of the negotiations was in fact withheld from one of the parties to the negotiations?

Mr. WEISGALL. I think that is right. As I said, those negotiations were largely one-sided. Yes, you have got article 9 with its changed circumstances, but I would direct the committee's attention to article 8 of the compact 177 agreement that says that the northern Marshalls radiological survey and related environmental studies conducted by the Government of the United States represent the best efforts of that Government accurately to evaluate and describe radiological conditions in the Marshall Islands.

Now here was the U.S. Government saying in a treaty-like agreement in 1985, "We have made our best efforts," when we know today, and I hope with this initiative by Secretary O'Leary in the future, these were not best efforts in 1985.

So you are absolutely correct. We are not looking just at changed circumstances from 1985 until today, although that is a factor and you are going to hear about some of these thyroid studies.

Mr. MILLER. But in terms of the threshold that would have to be considered in order to consider invoking that clause, it is not that we have learned something since 1985 that would cause us to consider reopening or not reopening that? The fact is, those circumstances were present then and were known by the U.S. Government. The wider exposure, the physical damage, the human exposure was all known at the time; it was simply withheld and misrepresented by the Government.

Mr. WEISGALL. And was not known by the other parties to the negotiations, the Marshallese people.

Mr. MILLER. If you do that in criminal work, if you withhold State's evidence from the defendant, you usually get a new trial.

Mr. WEISGALL. Well, if you do it in a civil setting in a contract, in fact, it is called fraud. If you and I have a contract and I am going to buy a house from you and you forget to tell me that the foundation was constructed in a faulty way, that is fraud. It is not full disclosure.

Mr. MILLER. You mentioned that, in your opinion, the public statements and documents support the effort, to be polite, to limit access to information and public knowledge of what took place and/or even a cover-up took place the next day, or immediately following the BRAVO shot.

I am looking at a document from March 31, 1954, signed by James Reeves, who was the commander of Task Force Group 7.5, where there appears to already be an attempt to start gathering their legal defenses and/or information and to start characterizing various groups of people that could present or not present a case based on whether they were wearing badges or in groups of people where not everybody had radioactive film badges on them.

So clearly the legal consequences were well within the purview of the negotiators in 1954 given that in March legal defenses were starting to be formed.

Mr. WEISGALL. Exactly as happened in Operation Crossroads.

Mr. Chairman, listen to the AEC press release ten days after BRAVO.

Here is what the AEC did say publicly on March 11, 1954: "During the course of a routine atomic test, some Marshallese were unexpectedly exposed to some radioactivity. They were moved to Kwajalein, according to plan as a precautionary measure, but there were no burns and all are reported well."

Well, that is about as disingenuous as you can get in a press release with these forecasts and this bomb 2-3 times bigger than expected. That is not a routine atomic test, as the press release said. Plan—they were moved according to plan. That was no plan; that was an emergency evacuation.

"Some radioactivity." Well, some of the Rongelapese, yes, they got some radioactivity. It was the equivalent of being located less than two miles from Ground Zero at Hiroshima. That was the "some radioactivity" that they got.

And the statement, "They were reported well." You will hear more about that, but I mean they were already displaying the clas-

sic symptoms of radiation diseases when they got to Kwajalein: The hair loss, the skin lesions, the lowered white blood cell counts.

So, yes, the cover-up began the day after the press—day after. The press release was disingenuous. You are correct, the information has been there, but it simply has not been public. I think that is what this hearing is beginning to get at.

Mr. MILLER. Thank you.

Mr. Evans.

Mr. EVANS. Thank you, Mr. Chairman.

I appreciate your testimony.

Let me get at a few things here.

First, the attitude of the Administration, I think, seems to be focusing on experimentation conducted on involuntary or uninformed subjects. I take it that perhaps the Human Radiation Interagency Working Group feels that the citizens of the Marshall Islands were either not subjected to experimentation or voluntarily agreed through these uneven negotiations to subject themselves to atomic tests and that perhaps they have a feeling that, since our servicemen were in the military, that just by the fact that they were in the military, that they were, in effect, just following orders and not being involuntarily subjected.

Did you detect that attitude on the part of the Administration?

Mr. WEISGALL. Mr. Evans, I guess the response I can give you is, I got a call from a captain in the U.S. Navy about a month ago from the interagency task force saying, "We just want to make sure there were no Navy experiments on human subjects, and we hear you have got some book that you are writing, and I just want to confirm that there were no experiments," and I said, "No, with the exception of 42,000, there were not any."

You had military personnel in Bikini in 1946 who were put in harm's way and they weren't told a damn thing. That is where I say this is even more compelling than one of these patients, as awful as those human radiation experiments are, where there may or may not have been informed consent.

Of those 42,000 people at Bikini, you had 38,200 sailors. They were not told anything about the radioactive dangers. Many of them—you see it in the documentary footage—they are washing down ships, they are wearing shorts, sneakers, and sailor hats, and the RadSafe monitors are coming aboard in the little white footies, completely clothed, knowing that there is a problem.

Mr. EVANS. So your opinion is, if there wasn't a direct individual kind of experiment conducted on an individual, that the interagency working group doesn't feel that that is an experiment?

Mr. WEISGALL. That seems to be the attitude, and I think the Chairman put it very well, that after the fact the U.S. Government has had to track the people of Rongelap. To a certain extent, it has tried, it has made some effort to track the medical conditions of veterans.

I guess the difference is that when you set up an experiment, you have a protocol, you have control groups, you set it up that way.

I might say that putting the people back at Rongelap in 1957 with a so-called control group certainly smacks of an experiment to me. That is another issue, but, as you know, the exposed people were put back.

Mr. EVANS. That was the 28 people that were—

Mr. WEISGALL. That is correct, and then the so-called control group was also put back.

I mean if it is okay to go back, what do you need a control group for?

Mr. EVANS. Okay.

To your knowledge, were any of the 42,000 servicemen stationed at Bikini Island during the BAKER shot or the BRAVO shot ever informed of the possible dangers of participating in nuclear tests?

Mr. WEISGALL. Absolutely not.

Mr. EVANS. And were they, in fact, told that this was their patriotic duty to be there and that they would be okay if they were not incinerated by the bombs themselves?

Mr. WEISGALL. It permeates the entire test; yes, sir.

Mr. EVANS. What documentation do you believe exists that suggests that the medical legal board established at Bikini by Stanford Warren was designed to bury any paper trail that would aid our U.S. military personnel in their future legal claims against the Government arising from the Operation Crossroads testings, and are you aware of any other type of medical legal board established after BRAVO?

Mr. WEISGALL. If you give me a second, I will give you an answer.

Okay. Again, I don't have to make this up, I am just reading from documents.

Here is something that the medical legal board wrote on June 30, 1946, the day before the first test at Bikini.

There are some 40,000 persons engaged in these operations. Among them are sure to appear sooner or later a number of diseases, some of which will be attributed to radiations from the atomic bomb, but these claims will be without merit because these diseases appear spontaneously in the human race without previous exposure to man-made radiations, so their occurrence will be statistically insignificant.

We expect that no attribution will be well founded, and we expect that the records under the radiological safety section will be adequate to show that the quantity of radiation received by that particular person was well below the threshold or perceptible biologic injury.

Well, this is before the test, and they are saying, "Here's what we are going to do, we have reviewed everything, there is no problem."

By the way, the tolerance standards—this is really, I think, an important point—the tolerance standards acceptable at Operation Crossroads in 1946 were .1 roentgen a day. That tolerance dose has now been lowered for the general population by a factor of approximately 365, meaning that the current recommended dose for one year for the general population of the United States is the dose that was recommended as the maximum exposure for one day at Operation Crossroads.

By the way, at Crossroads it was known from the studies of the radium dial painters in the 1920s and 1930s, the women who would lick the tips of brushes as they painted watches, that even a millionth of a gram of radium could prove fatal if ingested.

Plutonium, which was the paint component of the bomb at Bikini, has the same effects. It is actually more toxic than radium. The BAKER test did not involve millionths of grams of radium or even hundredths of grams. I have here the Navy reports. The

BAKER shot involved thousands of tons of radium, and the medical legal board was set up and said there is not going to be a problem. There is not a problem, and we were set up, as I said in my statement, that it was specifically set up to assure the RadSafe section that there would—to give what assurance was possible that no successful suits could be brought on account of the radiological hazards of Operation Crossroads. That is a document written by the chairman of that board about a month after the tests were held.

Mr. EVANS. Any other evidence of other boards of this type established after BRAVO, that you know of?

Mr. WEISGALL. Not offhand. I will submit it for the record, Mr. Evans, rather than take everyone's time now. I do have more information in the book. I was just quickly looking in the index under "Medical Legal Board." That was certainly an important part of my own research. There are some other statements and other documents, and I will get them to the committee.

Mr. EVANS. Mr. Chairman, I have some other questions I could ask on a second round. I think my time has expired. Thank you.

Mr. MILLER. Mr. Underwood.

Mr. UNDERWOOD. Yes, thank you, Mr. Chairman. I have one question.

In your testimony, Mr. Weisgall, you discuss the role of the Department of the Interior, and especially Trust Territory High Commissioner Elbert Thomas in perhaps redrawing the boundaries in terms of the recommendation for evacuation by the Atomic Energy Commission.

I am just curious about the role that the Department of the Interior and, in particular, the trust territory high commissioner played at the time. Was the role that they were playing in the whole process—and what eventually happened with the BRAVO shot—a very large role in your estimation? Do you have any evidence connecting perhaps some Interior involvement in the decision, or was it the thinking of the people who were running the test that how to deal with the people from the Marshalls was essentially an Interior decision in terms of any decision to evacuate as opposed to their own decision, as opposed to a scientific decision, as opposed to a military decision?

And in analyzing or perhaps researching the role that Interior played in that, are you satisfied that all the documents relative to Interior's role have been disclosed, or do you think that there might be additional documents somewhere?

Mr. WEISGALL. Well, let me answer your last question first. Yes, there are more documents. In fact, the document I quoted from I have got here from Elbert Thomas, the high commissioner, written to the director of the Office of Territories. His name was James Davis, and this was February 5, 1953. We are talking a year before BRAVO. This decisionmaking—should we move these people off?

There are references to other letters, and there are references to AEC proposals for continued use of Bikini. There are other documents that are classified. It is a catch-22 when you have got classified documents: What do you want? I don't know.

I do have a chapter-verse citation of what I have been able to get, but that doesn't mean that that is the universe of what remains classified. Yes, there are still classified documents on this

subject. For example, this letter talks about Rongelap but then talks about drawing a danger zone near Ailinginae. The AEC went along with this recommendation.

One question I have asked myself, and I have had this document for five days, but I don't know if this high commissioner had the slightest idea that this was a hydrogen bomb shot.

You know, MIKE, the IVY-MIKE shot at Enewetak, had only been detonated about two months earlier. This is part of the secrecy. I mean how is the high commissioner of the trust territory to know when a hydrogen bomb has been tested—nothing has been made public, nothing has been made known about the danger zone. There was very little local fallout at the MIKE at Enewetak, which of course led to the lessened need to evacuate or take precautionary measures at BRAVO. I don't even know if this fellow had the slightest idea that this was a bomb that was going to be at least 400-500 times more powerful than an atomic bomb.

So here you have got an Interior Department official trying to make a scientific or medical judgment, and I am not sure that he was in a position to do so.

Mr. UNDERWOOD. So would it be fair to say that the people in Interior, I guess, were in charge of the political fallout from these decisions and that that perhaps overwhelmed any kind of scientifically based decision regarding—

Mr. WEISGALL. Here it is. It is 1953. The Bikinians have already been moved now for seven years. They are unhappy on Kili, they are making that known. The Enewetak people have been moved to Ujelang.

I think the Interior Department is looking at this and saying, "My God, we are going to have to evacuate the whole Marshall Islands if you want to conduct this kind of a testing program, don't do it."

I am sure the fellow had the best of intentions. I mean here is what he says about what happens if you do have to move the people of Rongelap, slightly or not so slightly paternalistic:

While it is impossible to predict the exact nature of the reactions, experience has shown that the most probable result would be, first, a lowering of morale with a consequent reluctance to fend for themselves, followed by the expectation that the Government would provide their food in return for the land that had been taken.

It goes on saying, "I don't want this to be another Bikini, so let's not move the people." And, by the way, he is very sympathetic to the people of Bikini. He says, "The Bikinians feel they have been badly used by the Government of the United States and they resent it." I am afraid I must agree with them.

So here is someone with the best of intentions saying, "Let's just leave them on their islands. This will avoid the necessity of informing them of the expanded danger area and protect them." Really very sad—protect them and the Administration from information that would be unsettling, meaning that they have to leave.

Mr. UNDERWOOD. Okay, thank you, and thank you for your well documented testimony.

Mr. MILLER. Chairman de Lugo.

STATEMENT OF HON. RON de LUGO

Mr. DE LUGO. Thank you very much, Mr. Chairman.

I have an opening statement, which I ask to be inserted in the hearing record.

[Prepared statement of Mr. de Lugo follows:]

**Statement of the Hon. Ron de Lugo
opening a hearing on
Radiation Exposure
from Nuclear Tests in the Pacific
February 24, 1994**

Thank you Mr. Chairman.

As chairman of the subcommittee of jurisdiction, I want to begin by publicly thanking you for this hearing...not as Members sometimes do for reasons of mere protocol; but because it responds to my request that our Committee use its oversight subcommittee resources to further investigate very troubling information that our legislative subcommittee obtained earlier.

And, because I plan to retire this year, I want to note how comforted I am to know that you will continue a cause first championed here by our mentor, the late Phillip Burton.

I also want to note that its continuation is the one request made by my predecessor, John Seiberling, when he retired. We should, additionally, remember that much of our work on it was made possible by a former member of the staff who passed away just the night before last, Pat Krause.

The cause is to adequately address the contamination and health problems that our government's testing of nuclear weapons created for people in the Marshall Islands. And we can't be sure that what needs to be done has been until the whole truth about the problems is revealed.

Phil, John, I, and others have felt especially strongly about it because the islands and people had been irradiated while our nation was obligated to protect them as trustee for the international community and they were powerless in our system.

Yet, some in our government have apparently regarded these responsibilities as less important than other objectives, like developing weapons, avoiding embarrassment, minimizing the costs of cleaning-up and compensation, and, possibly, ending overall U.S. responsibility for the Marshalls and other Pacific islands.

The concerns of the peoples of the atolls that were clearly affected by the testing were a major sticking point in the negotiations for the agreement that was to establish the Marshalls as a sovereign state. The Reagan Administration's initial settlement said that it was based on a premise that the adverse impacts had been identified.

We, by contrast, agreed with the people clearly affected that the compensation provision of the Marshalls association compact didn't do enough. Before our country was let off the hook, we wanted to ensure that contamination would be found and cleaned-up so islanders could return to their homelands. We also wanted to ensure that medical care and food that could no longer be grown on contaminated islands would continue to be provided as long as needed.

Several of us, therefore, spent a couple of years forcing others in the Federal Government to agree to amendments to the legislation that authorizes the association.

I assumed my chairmanship a few months after the compact went into effect. Later, Mr. Chairman, you asked me to conduct oversight that led to the broader investigation we are now conducting.

The issue was the implementation of our Committee's amendment concerning Rongelap, the populated atoll which received the greatest amount of fallout from the massive Bravo test. It required a full study of Rongelap's habitability if an independent review didn't support the Energy Department's conclusion that the island was safe and it committed our government to do whatever was necessary to make Rongelap safe.

Due to the courage and persistence of Rongelap's late Senator, Jeton Anjain, and the effectiveness and energy of one of his representatives, David Weiman, what we found were among the most disturbing facts that I have come across in 20 years in Congress. It wasn't just the findings of the review, which were bad enough -- for example, Rongelap was habitable so long as parents didn't have their children there.

It included information that made it clear that the alleged Bravo "accident" was no accident and suggested that more atolls -- and people -- than had been admitted had been

dangerously irradiated.

It also raised questions of whether the Rongelap victims were being monitored for medical research without their knowledge and whether the Bravo cover-up was continuing.

Specifically, those who detonated the bomb knew well before they did that the winds were blowing in the direction that could carry fallout to populated islands. Alarming rates of thyroid abnormalities were showing up in people from atolls which had supposedly not received dangerous fallout. There were significant radiation levels on atolls not even evacuated after the fact or on which any subsequent measures have been taken. Medical data was being collected from individuals without being shared with them. The safety and dose standards being used were unclear.

There was also reason to suspect resistance intended to avoid revelation of the facts. Federal officials had continued to insist that Rongelap was safe. Senator Anjain and his representatives here were undermined back in the Marshalls when they pressed the issue. There were efforts to force the Rongelapese back to their island in spite of their understandable concern about its safety. When that didn't work, there were efforts to entice them back with resettlement promises.

I have spoken about our Rongelap findings because they led to our hearing today, included information regarding

the entire Marshalls contamination issue, and provide a case study regarding this matter.

An Arizona lawyer wrote me with advice about Ron [unclear] that I would apply to the overall situation. Bruce Babbitt urged quote decisive action to produce the facts necessary for [the people of Rongelap] to make decisions about their lives and those of their families end quote.

I hope that what is exposed today will result in the Administration undertaking that kind of investigation regarding the entire Marshalls testing story. I was somewhat concerned when officials reacted to our request to make this a part of the human radiation experimentation investigation launched by Secretary O'Leary by saying that they would handle it separately.

But I am now more encouraged that she has promised to expeditiously provide the documents that we have been seeking. Let us hope that it will finally lead to the entire Marshalls story being told and the prompt taking of whatever remedial measures are necessary.

The Marshalls testing played a role in winning the Cold War. Now that it has been, there surely is no good reason not to explore the whole truth and ensure we are fulfilling our obligations regarding the people who sacrificed.

Mr. DE LUGO. Let me ask Mr. Weisgall some questions here.

To what do you attribute the basis for the high commissioner of the trust territory recommending that only a limited area of the Marshall Islands be evacuated? What do you think was the basis of that recommendation?

Mr. WEISGALL. This is complete speculation on my part. My guess is that for the 1946 smaller test, the atomic bomb test, when people were evacuated off of Enewetak to the west, Rongelap to the east, and Wotho to the south, there was pretty much localized fallout at Bikini. There was no problem; fallout did not go drifting anywhere other than on the target vessels at Bikini Lagoon.

So here it was, 1953, and the Navy is saying, "Well, we should define some danger zone, and we think we had better move it to the east," and I think this fellow is saying, "Gee, we didn't have a problem in 1946. We loaded these people up and moved them."

This is a little-known fact in Marshallese history, but those people were moved, they were moved to Lae—L-A-E—Atoll for a couple of months. It was disruptive. Word was out in the trust territory at the time that the Bikinians were unhappy, and I think the fellow just didn't want to have a headache on his hands and he said, "Let's not do it," and then, as I said, there is no indication in the documents that this man was aware that this was a different order of magnitude of testing.

Mr. DE LUGO. Let me ask you this. Do you think human error or confusion can be responsible for ignoring the Pate-Palmer report with the concerns of the director of health of the Atomic Energy Commission regarding the weather report? What possible explanation can there be for that, for what at best could be called negligence?

Mr. WEISGALL. Mr. de Lugo, aside from the ongoing thread of arrogance and ignorance—a thread, by the way, that explains Hanford, Savannah River, and Rocky Flats today—where the AEC said to hell with the environmental guidelines, we will do it our way, that whole secrecy that started with the Manhattan Project continued. So you have got those themes of ignorance and arrogance.

I would add only two other factors that I can think of: Number one, tremendous pressure on the AEC to develop a deliverable hydrogen bomb.

Remember, BRAVO was the first of six shots in Operation Castle that were planned in 1954, and that went off. Those were from March 1 until May 13, 1954. They had a schedule they had to keep.

The other factor—again, this is speculation on my part—but believe it or not, you had people in the United States like Joe McCarthy of Wisconsin accusing the Administration of delaying the development of the atomic bomb, and he was asking questions at this very time.

This, of course, gets into the whole Oppenheimer hearing and the whole question of the development of the atomic bomb. There was a genuine debate about going ahead with that document, and Senator McCarthy in 1954, March of 1954, was accusing the Government of delaying the development of this weapon.

Mr. DE LUGO. What explanation do you have for the Interior Department excluding Rongelap from the area that needed to be evacuated when scientists suggested that it should be?

Mr. WEISGALL. Nothing more than I can say earlier—you know, inconvenient, it would be a major headache, and going on. I will add one other factor. At the MIKE shot at Enewetak—that was the first hydrogen bomb shot—only about 5 percent of the fallout could be accounted for. The radiological safety team simply couldn't track much of the radioactive cloud.

So there may have been a view that there might not be as much of a problem, but I can't buy that. I see an Interior Department that is looking pretty much for the easy way out.

I mean when a fellow says, "I urge you to do everything in your power to limit the boundaries of the proposed danger zone to exclude Ailinginae as well as any other island or atolls in the Marshalls other than Bikini or Enewetak," what I hear is, "I don't want to have to deal with this." But, again, that is speculation. The document speaks for itself. It is callous, it is patronizing, but that was the attitude.

You know, it is an interesting point, everyone is called a native here, you know; nobody is called an islander. Even in 1946, you didn't want to call the Bikinians, Bikinians. That would imply that they actually lived somewhere; they were natives. You know, what is the image of a native? I don't know, some sort of peripatetic wanderer or something like that. Everyone was a native. You couldn't even be called an islander. I mean that was just the attitude, and you know, to call it politically incorrect I guess is an understatement. No one really cared.

Mr. DE LUGO. Do you think the fact that some of the information that you have discussed here was not available during the compact negotiations deliberation?

Mr. WEISGALL. It sure was convenient. I mean almost everything I have told you today has been the result of my own research since 1984, and a lot of it, I swear to God, is in the last seven days. I mean I found enough about Operation Crossroads to write a book, and God knows, people don't publish books about things that are already known.

There is a tremendous amount unknown. I think that the declassification process is an incredibly slow and painful one.

I have worked with a fellow at Temple University working on a biography of Arleigh Burke who has been working for ten years to get documents declassified, and I will say one thing—and I think this Administration is making some changes. You know, the Carter and Ford administrations put much lower levels of years on the number of years that documents from their own Administrations would be classified. I think 25 and 30 in the case of Ford and Carter. This is an issue for archivists and historians, but it is important. The preliminary Clinton Administration position is a 40-year embargo on documents, in other words, being created today.

But even if you use that limit, we are coming up on 40 for BRAVO, and we are at 48 for Operation Crossroads. I can't put myself in the mind of the U.S. Government. I can say that it was convenient, and I will say at least the negotiators for the Marshall Islands, myself included, fought like hell to get in a changed-circumstances provision that would say, "Look we don't think there is everything here, we want to have a second bite at the apple if more comes out."

Mr. DE LUGO. Thank you very much.
Mr. MILLER. Mrs. Mink.

STATEMENT ON HON. PATSY T. MINK

Mrs. MINK. Thank you very much.

This is an issue that many of us in Hawaii have been struggling over for many decades, so I commend the Chair for calling these hearings and bringing attention to this travesty of human concern in the Pacific. You are absolutely right that there was not only a callous, arrogant attitude about the experiment and its importance to the security of the United States but an utter disregard for the people who inhabited these islands.

So I join you in everything that you have said in describing the attitude of people that went ahead with these tests without providing the safety necessary for them.

My concern right now is, some of the comments that you make in your testimony about still-undisclosed information that remains classified. To what extent would the release of this information that remains classified make it possible for this whole chapter to be reopened and the opportunities for the families involved—not just the service personnel, the 42,000—but the people out there in the Pacific, to have complete, adequate compensation, adequate understanding of what happened to them and the price that this Nation must pay, I believe, for the callousness and secrecy under which they conducted these tests?

What value would it have if we could get this information declassified today?

Mr. WEISGALL. I think it would be a tremendous value for a number of reasons.

Let's divide up your question. For the Marshallese, it would put them finally on a level playing field with the United States. I mean there is no reason not to have the information out now. The imperatives of the Cold War are gone. I mean it is over.

Mrs. MINK. Is there any national security justification left for keeping this information secret?

Mr. WEISGALL. Mrs. Mink, there may be some aspects of the details of the weapons, the construction of the weapons themselves, and that is nothing that I, as a part-time researcher, care about quite as much. It is useful, by the way, in terms of the exposures of people.

But no, I think with some very minor exceptions, most of the material can come out.

I have got documents here with complete sections blacked out still. I mean there is a lot that remains classified. I don't think there is an ongoing need. I think that there has got to be leadership though, and this really is where I do applaud Mrs. O'Leary. I think she has taken an incredibly bold move, and I will bet you there are people at the Defense Department and the Justice Department who were shocked when she came out and called for declassification and called for compensation. It is about time. I mean if there is bad news, let's just get it out on the table and let's deal with it.

Now, for the veterans, you know, I have spoken to many of them; I have spoken to children of many of them. You know what they

want more than anything? I am not even sure that compensation is the issue. They want to know what happened. They want something like an apology, and they want some recognition.

You know, it is almost like the Vietnam Memorial. The cathartic effect that has had is probably equal to more than all the compensation you can pay to a paralyzed veteran. There are children of veterans whose dads were out there at Bikini, at Enewetak, at the Nevada test site. They were told not to tell their family members what they were doing. Many of these men have developed illnesses—not all, but many have, many have died. The children are confused. They are very angry. There is a lot of anger. They want facts. They want a certain amount of recognition. They would like an apology.

That stuff doesn't cost a lot of money, you know. These aren't necessarily budget issues. Compensation is one, but these are the other matters. It would go a long way towards closing the door to this legacy. It is still open, and it still hurts a lot of people.

Mrs. MINK. Take an individual case of a veteran who was exposed, one of the 42,000 you mentioned. Supposing they filed a claim connecting their current injuries or their children's conditions to what happened to them out there. What does the military do in that instance when they haven't quite admitted to what happened? Do they simply deny the connection, deny the service connection, deny the disability has any relevance to the exposure out there at the test?

Is there any kind of record that we can find in our search or in getting this information declassified which would open the door to a real hard look at the consequences of this exposure?

Mr. WEISGALL. Mrs. Mink, in 1979 the Defense Nuclear Agency said that 12 additional cancers would have occurred among the 250,000 U.S. veterans who participated in the U.S. nuclear testing program—12.

By the way, the Veterans' Administration ruled in favor of veterans in 8 of 291 claims brought until 1979.

Now what did Congress do? In its wisdom, I think Congress eventually realized that you couldn't look at this cancer and that radiation. It passed the Radiation Exposed Veterans Compensation Act of 1988, Public Law 103-21 and simply said, if a veteran can show that he suffers from a certain form of cancer specified in the legislation and that he participated in a nuclear test or other activity likely to result in exposure to radiation, he receives compensation according to a set schedule much like the Nuclear Claims Tribunal set up in the Marshall Islands for the Marshallese. The scientific questions are unanswered, so the solution was a political one. It wasn't a medical; it wasn't a scientific; it wasn't any other way to answer it.

Mrs. MINK. Thank you, Mr. Chairman.

Mr. MILLER. The gentlewoman's time has expired.

Mr. Faleomavaega.

Mr. FALEOMAVAEGA. I apologize. We had a two-hour delay on the traffic this morning, and I am sorry that I was not here earlier.

Mr. MILLER. So I understand.

STATEMENT OF HON. ENI F.H. FALEOMAVAEGA

Mr. FALEOMAVAEGA. Mr. Chairman, I do have an opening statement to make at the hearing this morning, and I would be remiss if I did not first express my sense of appreciation to some of the members that had carried on this long-standing issue not only with the committee but certainly here in the Congress, and I would like to express my appreciation to the late Congressman Phil Burton who previously chaired this subcommittee that dealt with the territories, also the name of the former Congressman Bob Lagomarsino, also Chairman Sid Yates who has been most helpful in dealing with this case for the Marshallese, former Congressman Seiberling, and certainly the former staff member Pat Krause who has been one of the most outstanding staff members who worked on this issue for all these years. I want to express my condolences for Pat Krause who passed away, just a couple of days ago, and certainly to her family.

Mr. Chairman, thank you for giving me the opportunity to present a short statement on this very important issue. With the chairman's permission I would like to submit a fuller statement for the record.

Mr. MILLER. Without objection.

Mr. FALEOMAVAEGA. As you know, hundreds of reports have been written on this issue. This is not a new issue. This has been ongoing now since the mid-1970s since I was here formerly as a staff member, and very few arrive at the same conclusion about the extent of our responsibility to the people of the Marshall Islands.

But one conclusion that remains constant, Mr. Chairman, is that between 1946 and 1958 the United States detonated about 66 atomic devices on the group of islands known as the Marshall Islands and forever altered not only the landscape of these central Pacific islands but, more importantly, the lives of its inhabitants.

Despite its protestations, I remain convinced that the scientists employed by the U.S. Government deliberately misled the inhabitants of Rongelap because they wanted to conduct radiation tests on them after they dropped, especially, the BRAVO test in 1954. This was the first thermonuclear device that the U.S. had exploded in 1954 supposedly 1,300 times the destructive force of the atomic bomb that was dropped at Hiroshima.

Our friends in the U.S. Government did not tell about the Rongelap test in advance. Approximately five hours after the detonation, it began to rain radioactive fallout at Rongelap. Within hours the atoll was covered with a fine white, powder-like substance. No one knew it was radioactive fallout. The children played in what was quoted as snow. They ate it, not knowing what it was. The people of Rongelap and radiation became linked perhaps for all time.

I believe, Mr. Chairman, the U.S. Government officials were not truthful to the people of Rongelap and have lied to the American people since then about the extent of the damage resulting from these nuclear tests.

I am very appreciative of the fact that the Department of Energy and Mrs. O'Leary are now bringing this out into the open for us to see what exactly transpired, with not only the people of the Mar-

shalls but also many of the Americans who served in the armed services and what happened to them as well.

Mr. Chairman, today's hearing is about truth. It is time for the Department of Energy also finally to tell the people of the Marshall Islands and the American people the truth about what happened out there in the Pacific.

I want to thank you, Mr. Chairman, for your tireless efforts and leadership in this committee to see what has happened. I also want to thank other Members of the Congress, Mr. Dingell, and the President, and this Administration and to see that we will get to the truth and to the bottom of this.

I finally would like to thank the late Senator from the Marshall Islands, the Honorable Jeton Anjain, who spent a great deal of his life bringing world attention to this shameful part of our history. Ironically, Senator Anjain died last year of cancer.

Thank you, Mr. Chairman.

[Prepared statement of Mr. Faleomavaega follows:]

COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OVERSIGHT HEARING
ON
RADIATION EXPOSURE FROM NUCLEAR TESTS IN THE PACIFIC
Thursday, February 24, 1994

ENI F. H. FALEOMAVAEGA
Member of Congress

Mr. Chairman: Thank you for giving me the opportunity to submit a statement on this very important issue.

As you know, hundreds of reports have been written on this issue -- very few arriving at the same conclusion about the extent of our responsibility to the people of the Marshall Islands. But the one conclusion that remains constant is that between 1946 and 1958, the United States detonated several atomic devices on a group of islands known as the Marshall Islands -- and forever altered not only the landscape of these central Pacific islands, but more importantly, the lives of its inhabitants.

It is my hope that some of the witnesses today will address the events and consequences surrounding the "BRAVO" Shot -- a U.S. hydrogen bomb test which took place near the Bikini Atoll on March 1, 1954.

According to official records, this 15-megaton thermonuclear device was 1,000 times more powerful the bombs dropped on Japan during World War II. Rongelap, an inhabited island, was only a hundred miles away and directly downwind of the explosion. None of the 239 islanders were warned.

In a statement to Congress in 1989, the late Senator

from the Marshall Islands, Jetson Anjain, said, "Approximately five hours after detonation, it began to rain radioactive fallout at Rongelap. Within hours, the atoll was covered with a fine, white, powdered-like substance. No one knew it was radioactive fallout."

The Department of Energy (then known as the Atomic Energy Commission and the Energy Research and Development agency) did not tell the Rongelap people about the BRAVO test. "The children played in the snow-like substance. They ate it," said Senator Anjain.

The third day after BRAVO, suffering from a near lethal radiation dose, the Rongelap people were finally evacuated to another atoll known as Kwajelein, where they stayed until 1957 ...when the DOE concluded it was "safe" for the residents to return to one of the primary residence islands, Rongelap Island.

In 1988, documents from the archives of the old Atomic Energy Commission's Advisory Committee on Biology and Medicine were found in which the word "safe" applied only to the Rongelap people.

By early 1960, the DOE doctors began discovering significant "unanticipated" medical problems and began performing operations to remove thyroid nodules. Between 1960 and 1982, 24 operations were performed on Rongelap people to surgically remove thyroids. During the same period, another 15 similar cases were found at Utirik, a

neighboring atoll also irradiated by BRAVO. Thyroid neoplasia (benign and malignant) can be a direct result of over-exposure to radiation.

Since 1957, the Brookhaven National Laboratory (BNL) has been under contract by the DOE, to perform medical examinations on Marshall Islanders exposed to nuclear fallout. According to BNL, the most prevalent long-term health effect in the Marshallese population has been the development of benign and malignant thyroid neoplasms. Approximately 30% of adults and 60% of children (exposed when younger than 10 years of age) developed thyroid nodules, some of which were thyroid carcinoma (malignant). Other long-term health effects have included growth retardation. Several deaths have resulted from acute myelogenous, leukemia and gastric carcinoma.

Mr. Chairman, the question that keeps haunting me is "why didn't we evacuate the residents of Rongelap before or immediately after the BRAVO test?" According to an article written by Dr. Thomas Hamilton in the March 1991 issue of PSR (a journal of medicine and global survival), "no formal investigation of the decision to conduct the test with the wind blowing toward Rongelap, and of the failure to evacuate these inhabitants immediately, has ever been made public."

Although many details may be unrecorded or classified as secret, a Defense Nuclear Agency report published in 1982 provides data that indicate it was logistically possible to

evacuate the people from Rongelap Island and the nearby island of Ailingnae. The report shows that the U.S.S. Gypsy lay within a few miles and just outside the lagoon of Rongelap. In addition, at least six other naval vessels (the U.S.S. Curtiss, Sioux, Tawakoni, Estes, Belle Grove, and Bairoko) were in position between Rongelap and Bikini at the time of detonation.

Dr. Hamilton goes on to say that if the people of Rongelap had been evacuated immediately or within hours after BRAVO, "they could have been spared most of the wholebody doses from external radiation, and the organ doses from internal radiation exposure, that they eventually received."

Although many reasons might be offered for the failure of the United States government to evacuate the residents of Rongelap, one conclusion is inescapable: the personal safety of the Rongelapese and other Marshallese people was not a high priority of U.S. officials on hand.

Worse yet is an assertion made recently in the Washington Times by Chairman John Dingell of the House Committee on Energy and Commerce, that "the inhabitants of Utirik Atoll may have used as human guinea pigs." Residents of Rongelap have also voiced a similar belief with Chairman George Miller. If this assertion is true, then the DOE, is guilty of nothing less than genocide.

The Times article refers to documents found in the

archives of federal agencies which "reveal a callous attitude by U.S. scientists toward using Pacific islanders as test subjects after atomic blasts in the 1950's.

Mr. Chairman, I have attached a record of a disturbing conversation between two U.S. scientists: Dr. Merle Eisenbud, and a Dr. Failla, from the files of the U.S. Atomic Energy Commission. Following is a brief part of that conversation:

Mr. Eisenbud: Thank you John. Gentlemen, the adjournment time is 5:15, it is now 5:00. I had hoped to be able to make a few summary remarks and project a little bit of this into the future, but I don't need to do this now, I can do this tomorrow.

Dr. Failla: It might be better to do it now.

Mr. Eisenbud: I want to re-emphasize that the program you have heard today is a program that is in progress now.

If you heard it six months ago, it wouldn't be very different with one exception. None of the items have been reported in internal reports.

We have a few things that we are thinking about for the immediate future and I would like to mention a few of these.

We think that one very intriguing study can be made and plans are on the way to implement this -- "Uterik" Atoll is the atoll furthest from the March 1st shot

where people were exposed got initially about 15 roentgens and then they were evacuated and they returned.

They had been living on that Island; now that Island is safe to live on but is by far the most contaminated place in the world and it will be very interesting to go back and get good environmental data, how many per square mile; what isotopes are involved and a sample of food changes in many humans through their urines, so as to get a measure of the human uptake when people live in a contaminated environment. Now, data of this type has never been available. While it is true that these people do not live, I would say, the way Westerners do, civilized people, it is nevertheless also true that these people are more like us than the mice. So that is something which will done this winter."

Mr. Chairman, the record supports my personal belief that the residents of these islands were left there deliberately in order to provide scientists working for the U.S. government with "human" specimens to test the after-effects of radiation exposure.

I know that shortly after this statement was made , the U.S. Government, through the Brookhaven National Lab and Lawrence Livermore Lab, began extensive environmental and health studies of the Rongelap and Utirik peoples -- of the

very kind that were made in the attached transcript of the 1956 meeting of the AEC Advisory Committee on biology and Medicine.

This issue certainly deserves our attention and a thorough investigation. At the same time, and even as we go forward in today's hearing, let us not lose sight of the fact that, ultimately, the real concern is and must be the impact the nuclear weapons testing program has had upon the health of the people exposed. Do we really know what the true health consequences have been to the people of the Marshall Islands result' from the fallout blown upon their lands and waters?

Whether conducting human radiation experiments or serving more legitimate medical purposes, we do know that Brookhaven National Lab has conducted over 40 years of research and studies on the Rongelap and Utirik peoples. We also know that the health data collected on the people has never been subjected to outside, independent medical review and evaluation, notwithstanding the efforts of Marshallese leaders such as my dear departed friend Senator Jeton Anjain. As an editorial that appeared in the Marshall Islands Journal almost a year ago notes, Senator Anjain "doggedly pursued access to and Rongelap control over medical records and raw scientific data that up to now has either not been made public or had never been provided to the Rongelap community." The editorial, a copy of which I

provide to the committee for inclusion in the record, notes that failure of Senator Anjain's "quest for access to an independent scientific review of the 40 years of Rongelap medical records locked in the vaults at Brookhaven National Laboratory."

Section 177 of the Compact of Free Association signed by the United States and the Marshall Islands Government set aside money for further medical studies, and some of this money was used to hire doctors. Under the direction of the Nuclear Claims Tribunal, a review was made of at least some of the Brookhaven medical records. However, I am concerned that this review was anything but independent. It certainly was not comprehensive.

Mr. Chairman, I will be satisfied if nothing results from these hearings other than that this Committee ensures that Senator Anjain's last remaining and unfinished quest be finally achieved: that the Department of Energy immediately allocate funds for an outside, independent medical evaluation of all of the health data that Brookhaven has gathered on the Rongelap and Utrik people. Moreover, it is essential that the Rongelap and Utrik people as well as the Marshall Islands Government, be fully involved in establishing the protocols for this study and in the selection of the doctors that conduct this study. It is also important that they be involved in the selection of the doctors that conduct this undertaking. An excellent model

to follow in pursuing this objective would, in my opinion, be the Memorandum of Understanding that was negotiated with the Department of Energy by Senator Anjain on behalf of the Rongelap people that has ensured an independent environmental assessment of the radiation conditions on Rongelap atoll.

Mr. Chairman, in closing, I would like to commend you for your tireless efforts to seek the truth about the people of Rongelap. I also commend Chairman John Dingell and other members of Congress for their tireless efforts to seek justice in dealing with this sensitive issue. But mostly, I would like to take this opportunity to remember and honor my dear departed friend Jeton Anjain. If he were here today, he would surely be before this Committee to testify, and he surely would have concluded his remarks with this closing salutation, "Mr. Chairman, On behalf of the Rongelap people, and especially the children, I thank you."

Mr. MILLER. Thank you.

At this point in the record I would like to insert a statement by Congressman Norm Dicks of Washington on this topic.

[Prepared statement of Mr. Dicks follows:]

**STATEMENT OF CONGRESSMAN NORM DICKS
HEARING ON RADIATION EXPOSURE FROM NUCLEAR TESTS
NATURAL RESOURCES COMMITTEE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS**

FEBRUARY 24, 1994

Mr. Chairman, I want to express my appreciation to you for calling these hearings on a very important issue that has life and death implications for hundreds of people who were exposed to dangerous levels of radiation from atmospheric nuclear testing beginning in 1946.

I am especially concerned about the potential exposure to U.S. military personnel who were stationed in and around the Marshall Islands during this period. In addition, there have been questions raised with respect to radiation levels on Navy ships which subsequently returned to

the United States and may have exposed not only their crews, but federal civilian workers who overhauled these vessels to dangerous radiation levels.

I hope that as you review these events, you closely question representatives of the Department of Defense as well as the Department of Energy. Among the steps that should be given serious consideration is comprehensive testing of anyone who may have been exposed to these dangerous radiation levels.

Clearly, the federal government has a responsibility to fully inform, and to the extent feasible, provide treatment or compensation, for any individuals who have paid for these tests through years of suffering or early death. I stand ready to work closely with the Committee

toward this end and again appreciate your providing me this opportunity to appear.

Mr. MILLER. Mr. Evans is recognized.

Mr. EVANS. Thank you, Mr. Chairman.

You alluded to the Nuclear Claims Tribunal established by the agreement with our Government and the Marshall Islanders. I understand that they have awarded compensation for 27 presumptive conditions. I might note for my colleagues, 13 of those are presumptive for our U.S. veterans, atomic veterans, but they have 14 additional conditions that they are awarded presumptive compensation.

But I understand—is this correct?—that no awards have been made to the people of the Marshall Islands whose conditions may be radiogenic in nature but not on the presumptive list. Is that correct?

Mr. WEISGALL. Mr. Evans, I don't think I am as good a witness to answer that as a gentleman who is from the Nuclear Claims Tribunal, so not meaning to duck it, but I think you can get a better answer from the tribunal.

Mr. EVANS. I have a whole line of questions in that regard, so I will reserve them and appreciate your testimony. It has been very helpful to us.

Mr. MILLER. Thank you very much for your testimony and for your assistance, and we look forward to continuing to work with you.

Mr. WEISGALL. Thank you, Mr. Chairman.

Mr. MILLER. The next witness before the committee will be Professor Merrill Eisenbud.

Professor Eisenbud, welcome to the committee. We look forward to your testimony, and, as you can see, the questions being raised are rather numerous, and again I want to thank you for your assistance to this committee in helping to put together this hearing and to start unraveling this problem.

STATEMENT OF MERRIL EISENBUD, DISTINGUISHED SCHOLAR IN RESIDENCE, DUKE UNIVERSITY MEDICAL CENTER, DIVISION OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH

Professor EISENBUD. Thank you, Mr. Chairman.

I was asked to include some information about my professional background. I am professor emeritus of environmental medicine at New York University Medical Center where I served for 26 years as professor of environmental medicine and director of the Environmental Studies Laboratory.

I went to New York University after a 12-year career with the Atomic Energy Commission where, for the most part of that period, I was director of the Commission's Health and Safety Laboratory located in New York City. For many years, that laboratory was known by the acronym HASL—H-A-S-L—but the name was changed in the mid-1970s to the Department of Energy's Environmental Measurements Laboratory.

I hold the degree of bachelor of science in engineering and two doctor of science degrees, both honorary. I am a member of the National Academy of Engineering, an honorary member of the National Council on Radiation Protection, a fellow of the New York Academy of Medicine, an honorary life fellow of the New York Academy of Sciences, and a foreign member of the Brazilian Academy of Sciences.

Since my retirement from New York University in 1985, I have resided in Chapel Hill, and I currently hold the position of distinguished scholar in residence, Duke University Medical Center.

I began my career in environmental health science in the mid-1930s, nearly 60 years ago. At various times during these many decades, I have been involved with research and teaching and administration in programs concerned with air and water pollution, occupational health, the urban environment, and both the ionizing and nonionizing radiations.

Environmental radioactivity has been a major interest of mine for many years. I published the first edition of a textbook called *Environmental Radioactivity* in 1963, the fourth edition of which will be published by Academic Press in 1966. I have published more than 200 peer review articles in the scientific journals, and in 1990 my professional memoir entitled *An Environmental Odyssey*, was published by the University of Washington Press. A little later I will request that certain pages from that book which relate to the BRAVO tragedy be entered into the record of this hearing.

For your purposes today, the period of my career that will be of most interest was from 1951 when I first became involved in studies of fallout from nuclear weapons tests to the end of 1954, the year of the BRAVO explosion.

It is important that I begin by telling you why HASL was organized and how it became involved in the fallout measurements and the central role it played in the BRAVO episode.

When AEC was created by the Congress in 1947, it was realized that many of its contractors both in academia and in industry would require assistance in dealing with problems in industrial and radiological hygiene. It was decided that an AEC laboratory should be created in New York to provide the required technical assistance to the many plants and laboratories under contract with the New York operations office.

The uranium and beryllium industries, both of which were confronted with serious health problems, made the bulk of the work that was done in the first few years. A laboratory of high quality was put together with a staff of industrial hygienists, physicians, physicists, engineers, and chemists who were willing to work under field conditions; that is a key point.

When the weapons testing program began in Nevada in 1951, our staff was not initially involved in any way. We learned about Operation Ranger in the news broadcasts, just like most other people.

A few days after the test began, I received a call from Rochester that the Eastman Kodak Company had detected radioactive particles in the air intake filters of their film manufacturing plant. From telephone calls I made to Washington and the Nevada test site, I was amazed to learn that no fallout monitoring network had been established by AEC. This was obviously a major deficiency in planning since it had been known that fallout from the New Mexico test explosion in the summer of 1945 had spoiled photographic film packaged with interleaving paper made from fallout-contaminated corn stalks in Iowa, hundreds of miles from the test.

As a result of that experience, the Eastman Kodak Company wisely adopted the practice of routinely monitoring its plants and laboratories for radioactive dust.

As a result of that experience, HASL was requested by the AEC Division of Military Applications to prepare a national network of fallout monitoring stations. This network was extended worldwide in the following year.

A collection system was operated on an unclassified basis, and the first summary of our findings was published in the *Journal of Science* in February 1953. This was the first of many publications on the subject in the open literature, and they are noteworthy because they show that the AEC at that time was not attempting to conceal the fact that fallout of radioactive dust from test explosions was occurring.

Our early studies led me to become very much concerned about the possibility that lethal levels of radiation might occur at great distances from explosions in the megaton range of TNT equivalent.

In addition to the global network of monitoring stations, HASL requested and was granted the assignment to monitor fallout intensively in the 200- to 500-mile annulus around the test site. We first undertook these studies in Nevada during Operation Jangle in the fall of 1951. This series consisted of two small explosions, one on the surface and one just below the surface. I believe the yields were of the order of one kiloton.

My associates and I became particularly concerned about the levels of fallout measured in about 400 miles from the test site. The measured fallout intensities we measured were not so high as to be alarming of themselves, but they were the result of explosions equivalent to explosive yield of no more than one kiloton of TNT. Since explosions more than 10,000 times larger were being planned for the test in the Marshall Islands, it took but a simple calculation to show that very dangerous levels of fallout might occur at great distances.

Using aerial survey methods of our own design, we undertook intensive monitoring of all northern Pacific atolls after the MIKE Detonation in the fall of 1952. We found no significant fallout and concluded that whatever fallout had taken place was in the open ocean within which the atolls were very thinly distributed.

We then began to prepare for Operation Castle scheduled to begin on March 1, 1954. In the interim, we had been consulting with the late Colonel N.H. Lulegian, an Air Force meteorologist who took quite seriously our concerns about the potential dangers from massive fallout following explosions in the megaton range of yields.

He sent me a highly classified report he had prepared in which he confirmed by rigorous analysis what we had concluded almost intuitively based on our limited field experience; i.e., lethal levels of fallout could occur at great distances from near-surface explosions of megaton weapons. For some unexplained reason, that report was recalled within a few days after I had received it, and I have not seen it since.

What happened on March 1, 1954, as a consequence of BRAVO is now a part of history, but the full story is largely untold. The fact that heavy fallout was occurring was first recorded about

seven hours post firing by a continuous gamma radiation detector placed by HASL in the care of Air Weather Service personnel on the atoll of Rongerik. These are the 26 servicemen that have been referred to previously.

The HASL representative aboard the task force flagship was immediately notified by radio. There was no confusion about that message. I had a copy of it; it was quite clear. But what happened thereafter is still a matter of mystery. There were delays in confirming that the fallout had occurred and in measuring its extent. I was then in the New York laboratory and was notified of the Rongerik report immediately, but thereafter there was a blackout of information for about a day.

The reason why aerial confirmation was not permitted and why prompt evacuation procedures were not implemented has never been explained.

My knowledge of the events prior to the explosion and immediately afterwards are summarized from my notes as well as official documents in *An Environmental Odyssey*. Of particular interest to you will be the material on pages 72 through 103 which also covered the effects of the BRAVO fallout on the Japanese fishing boat, the *Lucky Dragon*. These pages have been made available to the committee, and I request that they be included in the record of these proceedings.

[The document follows:]

AN ENVIRONMENTAL ODYSSEY

*People, Pollution, and
Politics in the Life of a
Practical Scientist*

MERRIL EISENBUD
"

UNIVERSITY OF WASHINGTON PRESS
Seattle and Washington

FIVE

Atomic Energy
Commission*Studies of Radioactive Fallout*

THE FIRST EXPLOSION of a nuclear weapon took place on a steel tower in the New Mexican desert in July 1945, about one month before two bombs were dropped on the Japanese cities of Hiroshima and Nagasaki. The test explosion in New Mexico, known by the code name TRINITY, caused skin burns on grazing cattle several miles downwind where radioactive particles deposited on them. The radioactive cloud drifted over Iowa, where a thunderstorm washed particles of radioactive dust into a corn field, the shocks of which were subsequently shipped to a factory of the Eastman Kodak Company, which manufactured the black interleaving paper used to separate sheets of X-ray film. The radioactive particles became incorporated into the interleaving paper and caused black spots to appear on developed film that had been packaged with the contaminated black paper. Eastman Kodak described its experience in a scientific article, but it attracted little attention.

Dangerous fallout of radioactive particles occurs when a nuclear bomb is exploded so close to the ground that particles of soil and other materials are sucked into the cooling fireball as it rises. When bombs are exploded at greater altitudes, the debris takes the form of fine particles that settle to the ground, usually with rain or snow, at great distances from the explosion, after most of the short-lived radionuclides have decayed. The two bombs dropped on the Japanese cities were exploded high in the air, which tended to minimize fallout, but rain showers shortly after the explosions did result in slight, but measurable levels of fallout at both Hiroshima and Nagasaki.

The first nuclear bombs exploded after the war were at Operation

CROSSROADS, a well-publicized demonstration that took place in 1946 on the Pacific atoll of Bikini. CROSSROADS was a festive occasion attended by invited guests from many nations and a vast corps of reporters. It was apparently hoped that a demonstration of the power of nuclear weapons would have a beneficial effect on the outcome of a conference on control of atomic energy that was in progress at the recently formed United Nations.

In preparation for the tests, 162 Bikini natives were moved to another atoll. A fleet of warships, some surrendered by the Japanese and Germans and some antiquated vessels from the U.S. fleet, were anchored in the lagoon to demonstrate the effects of the new weapons on naval vessels. The first bomb was detonated high above the lagoon and the radioactive cloud drifted away without incident. The second bomb was exploded below the lagoon surface and created a massive and spectacular geyser that doused the ships with so much radioactivity that some had to be sunk. Others were towed to naval stations where they served as laboratories for development of decontamination methods. The underwater explosion caused so much contamination of the ships and lagoon that a third planned explosion was cancelled.

In July 1947, the AEC announced that it was establishing a "proving grounds" for the testing of nuclear weapons on the atoll of Eniwetok, also in the Marshall Islands. The 120 natives who lived on that atoll, like the Bikini natives in 1946, were removed to another island, thus beginning a sad saga that continues to this day. The first tests of Eniwetok took place in 1948, the year in which the Soviet Union exploded its first nuclear weapon at a test site in Siberia. This latter event took the U.S. by surprise and resulted in the acceleration of nuclear weapons development. Additional testing facilities were needed, and because of the logistic problems associated with the Pacific Test Site, a decision was made to develop a site in the United States. The site selected was near Las Vegas, Nevada, and the first exercise, Operation RANGER, began on January 27, 1951.

Preparations for the weapons tests at both the Pacific and Nevada test sites were undertaken in great secrecy by the AEC. Since NYOO was not involved, I learned about the tests as did the general public, by hearing of them on the radio. A few days after the first series of tests began in Nevada, I received a call from Harry Blair of the University of Rochester, who informed me that Eastman Kodak Company had reported that radioactive dust was accumulating on the air intake filters at their Roches-

ter film manufacturing plant. It seems that the experience of the company after the TRINITY explosion in 1945 had alerted them to the need to take precautions against the presence of radioactive dust in the air of their many manufacturing facilities. The presence of radioactivity at the Rochester plant was reported by radiation detectors installed for that purpose. Blair also reported that the radiation background in the university laboratories was also higher than normal. The levels were not high enough for concern about their effects on human health, but they were high enough to justify the concerns of the Eastman Kodak officials about the integrity of their film-making process. The increased background was also affecting the sensitive measurements being made at the University of Rochester laboratories.

A test explosion had taken place high above the Nevada desert about thirty-six hours previously, and the radioactive cloud had drifted over the Rochester area during a snowstorm that was blanketing the Northeast. I first called the medical director at the Nevada test site and advised him of the reports we had received. He thought it was nonsensical that fallout was reported so far away. He had been to ground zero a few hours previously, and there was only insignificant residual radiation. What he failed to realize was that the bomb was detonated so high in the air that there was no local fallout, but the cloud of radioactive debris had been carried in a northeasterly direction and brought to the ground by the precipitation in the Rochester area. I immediately advised the Division of Biology and Medicine in the AEC headquarters, and was told, much to my surprise, that the Brookhaven National Laboratory on Long Island had been alerted that the tests were about to take place, and that its staff had been asked to install radiation monitoring stations "somewhere in the Northeast."

When I called Brookhaven I was told they had installed two monitoring stations, one at the laboratory and another somewhere in Maine. The instrument at the laboratory was recording nothing but the normal radiation background, which meant that that part of Long Island was not in the path of the cloud. What about the station in Maine? It was unattended in a remote area, and they would be unable to recover the information for several days! In view of the fact that there was apt to be considerable interest in the subject, I thought it was worthwhile for them to send someone to the station immediately, but I was not persuasive enough.

It had been snowing throughout the Northeast, the temperatures were

below freezing, and the snow was still on the ground. It would thus be possible to measure the amount and extent of the fallout by examining samples of snow. The HASL branch chiefs, Harris, LeVine, Harley, and Blatz, conferred with me and we decided to take advantage of NYOO's many contracts with industrial companies and universities throughout the Northeast states and request that those organizations assist in collecting snow samples for analysis. We asked them to purchase quart ice cream containers, collect snow samples along designated routes, seal the containers, and deliver them by messenger to HASL over the weekend. We wanted the samples collected as soon as possible, but not until it had stopped snowing, so that we could be certain that all the precipitation would be collected. By early Saturday morning, samples were being collected in the northeastern U.S. by personnel dispatched from St. Louis, Cleveland, Rochester, Albany, New York City, and Boston. The HASL staff worked throughout Friday night assembling the equipment to evaporate the water samples for measurement in beta radiation counters, the easiest way to assay radioactivity in those days. The staff performed magnificently over that weekend and by Tuesday afternoon prepared a map showing the pattern of radioactive fallout. It was the first time this had ever been done, and Shields Warren was anxious to see the map because he was scheduled to testify at a congressional hearing and thought the committee would be interested in what we had found. I took the map to Washington that night, and Warren presented our findings to the congressional committee on the following day.

HASL had already attracted attention within the AEC for the effective way in which the beryllium studies had been conducted. The Rochester incident drove home the message that the nature of AEC activities required an in-house troubleshooting group that was responsive to the special needs of the commission whenever and wherever they might arise.

At the time of the Rochester fallout there was little appreciation of the fact that some of the nuclides present in the bomb debris were capable of being absorbed by plants and animals and could eventually find their way into food and the human body. Such information was available from studies that had been conducted at Hanford and other nuclear centers, but the information was still secret in 1951, and at HASL we didn't know it existed. What is disappointing in retrospect is that the Division of Biology and Medicine at AEC headquarters had paid so little attention to the matter that there were no advance preparations for fallout measurements. Immediately following the Rochester incident there was interest in

the subject, but only because it was a scientific curiosity, not because the fallout should be investigated for its public health implications. HASL might not have been involved in further fallout studies were it not for the fact that Eastman Kodak needed information to protect its processes and requested the AEC to provide it with advance notice when a cloud from a weapons test was approaching one of their manufacturing facilities. This request was relayed by the AEC Division of Military Applications to Wilbur Kelley, manager of NYOO, with instructions for HASL to assist Kodak in any way possible.

By the spring of 1951, preparations were already well underway for tests to be conducted in Nevada that fall in two parts—BUSTER, a series of explosions above ground, and JANGLE, which consisted of a surface and an underground test. Although the latter two explosions would be relatively small, they could be expected to result in much higher levels of fallout than had the previous Nevada tests. I was invited to Los Alamos for a briefing on the proposed tests and learned that the test organization was planning to monitor the environment only to two hundred miles from the bursts. I was of the opinion that intensive monitoring should be extended to at least five hundred miles. I was told the test organization would be unable to go beyond two hundred miles, but that they would support a recommendation to monitor out to five hundred miles if HASL or others could develop a feasible plan. I stated HASL would be willing to assume monitoring responsibility for the 200–500 mile annulus around the test site if the military provided us with logistic support. It was agreed that this would be done.

We now had two responsibilities during the forthcoming tests. In addition to monitoring the 200–500 mile annulus around the test site, we would establish a network of fixed stations throughout the world.

The design of the remote monitoring system received a good deal of thought. Ideally, we would have liked to make measurements of external gamma radiation, airborne dust, and individual nuclides deposited on the ground. This was not feasible because we had a very modest budget, and the logistic problems could not have been solved if we had had the funds. Hanson Blatz came up with a practical suggestion. He had investigated commercially available adhesive films and had found gummed plastic sheets that would retain their adhesive properties when exposed out of doors in inclement weather. We ordered a quantity of one-square-foot sheets and had them placed about three feet above the ground on a simple stand that we had manufactured. With the cooperation of the U.S.

Weather Bureau, we established an initial network of forty-five stations at which the gummed films were exposed for twenty-four hours before being changed. The films were then folded, placed in an envelope, and mailed to HASL where the beta activity was measured, using an ingenious automatic counting system designed by Harry LeVine and his group. That simple sampling collection system was eventually extended worldwide and for many years provided the only available information about the levels of radioactive fallout. It was originally considered at best a simple method that could provide semiquantitative information about the passage of the clouds of weapons debris and about the places where fallout was occurring. It later developed that the data could be used to infer the rates of fallout of individual nuclides of special interest, such as iodine 131, cesium 137, and strontium 90. It is now more than thirty-five years since the gummed films were used, but the data we collected continue to attract the attention of investigators who use the information in various ways to reconstruct the radiation doses received by inhabitants in various parts of the U.S. and elsewhere.

For studies in the 200–500 mile annulus, the army detailed fifteen enlisted men to HASL in addition to two DC-3 aircraft and their crews. These men, with HASL supervisors, were based at convenient airfields and deployed to monitoring locations selected on the basis of meteorological information at the time of detonation. Our objective was to establish stations across the trajectory of the cloud, to begin sampling prior to arrival of the cloud, and to sample continuously for 36 hours. We usually established three stations following each burst. There were so many military installations near the test site that it was usually possible to establish the temporary stations at airfields attached to those bases. Each station set up gummed film stands, air samples equipped with inertial particle size sorters, and gamma radiation recording instruments. The plan worked extremely well and was repeated for each of the test series during the next five years.

For most of the period of its operation the mobile sampling program was supervised in the field by Paul Klevin, Al Breslin, John Harley, and William Harris. It was dangerous work because of the need to fly into small airfields in all kinds of weather, and I recall one tense episode in which the aircraft to which Klevin was attached was missing for half a day, which was a long time considering that the aircraft was never more than five hundred miles from its base. We sent radio messages to all air fields inquiring about the plane but received no reply because the radio

operator at Hill Air Force Base in northern Utah, where Klevin had landed for purposes of monitoring, thought the plane was on a secret mission! The HASL mobile teams functioned efficiently during several series of Nevada tests during the early 1950s, and there were fortunately no mishaps.

Our studies were classified "secret" for a while but before long we were allowed to disseminate the information without restriction. John Harley and I prepared the first summary of our findings, which we published in *Science* in 1953.¹ This was the first of several articles on the subject.² The policy of publishing our data in the open literature was a wise one. It would have been wrong not to have done so, and from a practical point of view there was no way in which the presence of radioactivity in the environment could be kept secret. By the mid-1950s most research laboratories used sensitive radiation detectors, and many scientists were reporting increases in the background levels, which they realized was due to fallout from the weapons tests. Some of the scientists began to complain to their elected officials who made inquiries to the AEC, and these were referred by Washington to HASL because we had the needed information. Richard Nixon, Senator from California, was among those who asked for information in May 1953, when tests were in progress in Nevada. Reports of fallout began to be made even in Europe, and the distinguished British physicist Sir John Cockroft visited me to report his estimate (ten curies) of the amount of bomb debris that had deposited on the Thames valley from the tests that were conducted in the fall of 1951. The existence of radioactive fallout from the weapons tests could not, need not, and should not have been kept secret.

Although the first concerns about fallout were because of the effects on film manufacturing and radiation detection equipment, it wasn't long before many scientists raised questions about effects on human health. The studies of the fallout patterns following the surface and underground tests in the fall of 1951 led us to conclude that the effects of radioactive deposits from the explosion of nuclear weapons in time of war could be comparable to, if not greater than, the effects due to blast and heat. Although the radioactivity from the two relatively small JANGLE explosions was deposited close to the site, we concluded that the fallout from the thermonuclear weapons being contemplated could contaminate thousands of square miles of territory with lethal or near-lethal levels of radioactivity.

The sizes of nuclear explosions are described by their equivalence to

Defense, using Joint Task Force 132, commanded by Major General Percy Clarkson. The task force was not planning extensive monitoring operations beyond the atolls in the immediate vicinity of Eniwetok. Increased surveillance was essential to better understand fallout phenomena and, above all, to protect the inhabitants of the Pacific islands. The first test of the IVY series was named MIKE. This test was of particular concern to me.

The survey methods would be far more difficult than in Nevada because the land to be monitored consisted of tiny islands scattered over thousands of square miles of ocean. However, we believed that the amount of fallout could be measured by flying low over the islands with scintillation counters. Instruments of the kind required didn't exist but they could be designed and built in our laboratory. When Bugher was with the Rockefeller Institute he had studied tropical diseases in the jungles of South America, so he had a "field man's" appreciation of the challenge that existed. Time was short, the logistics were difficult, and there were organizational hurdles to be gotten over. His eyes gleamed as he said he would try to arrange for us to monitor the Pacific islands.

With encouragement from Bugher, but without approval to proceed, we began to design and construct the instruments we needed. It would be necessary that the detector be self-contained so that it could be used in any aircraft assigned to us. It had to have a fast response time, so that changes in the radiation level could be detected from low-flying planes (200-500 feet) at normal flying speeds, and it had to have a logarithmic response so that it would be useful from 0.01 mr/hr to 100 mr/hr. In addition to the aerial measurements, we would also install land-based monitoring instruments on a few islands, but these could be of a type with which we had considerable experience, so little additional development would be required.

We received approval for our plan by the end of July and began the hectic preparations for the program. The officers of JTF-132 in Washington cooperated splendidly, and in early September I flew to the headquarters of General Clarkson at Pearl Harbor to review our final plans and confirm that the required logistic support would be made available. By that time I was high up in the civil service system, with the grade of GS-17, only one step from the top, and I found that when I travelled with the military I was given the privileges of a general officer. I found it remarkable that information about my assigned equivalent rank always pre-

ceded me and the red carpet was always rolled out. Military protocol was at a high level of efficiency.

One of the important decisions that was made while I was in Pearl Harbor was that we would be supported by CINCPAC, the headquarters of the Commander in Chief of Pacific Operations. This had the advantage of not burdening JTF-132 with providing the planes and personnel we required. In addition, the support we received from CINCPAC added prestige to our mission, and we were given space on the U.S.S. *Festes*, the flagship of JTF-132.

The instruments were completed on schedule and in mid-October we shipped several thousand pounds of equipment and supplies to Kwajalein, the atoll on which we would be based. John Harley, Melvin E. Cassidy, Al Breslin, and I followed a few days apart. I arrived in Honolulu on October 14 and conferred again with the CINCPAC staff, who seemed to have developed even more interest in our program since I had last seen them. Of special importance was their decision that all the islands of the Pacific Trust Territory should be surveyed, regardless of the fallout predictions based on meteorological forecasts. CINCPAC had reason to be concerned about the forthcoming tests. Most of the islands of the central Pacific had been Japanese possessions prior to World War II. After the war they became a trust territory, assigned by the United Nations to the U.S. for administration and protection. These functions were in turn assigned to CINCPAC with responsibility for safeguarding the indigenous population.

From Pearl Harbor I proceeded to Kwajalein which, like many of the Marshall Islands, had been the scene of violent battles only seven years before. This atoll would serve as headquarters for the HASL staff of three, who had arrived ahead of me and had already departed for the other islands on which instrumentation would be installed. I was really enjoying the VIP treatment I was receiving. I ate and slept with the admirals and generals and was extended all the privileges expected by them.

On October 25, 1952, Harley, Breslin, Cassidy, and I travelled to Eniwetok for a final test of our newly built instruments. This time we flew over the radioactive craters and debris left from the previous tests. We flew over the radioactive areas, measured the radiation levels within the aircraft, and then monitored the same places on foot. We found, as we had calculated, that the levels of radiation we were recording at 500 ft. were almost exactly one-tenth of the intensities measured at ground

level. The results were quite reproducible on repeated passes over the areas measured.

On October 30 I transferred from my shore billet to the *Estes*, which was the task force command ship. I shared a comfortable room and private shower with three officers, with all of whom I was well acquainted. The next day was occupied with readiness reviews and meteorological briefings preparatory to the detonation scheduled for the early morning of November 1. The test, code-named MIKE, would be the first large thermonuclear explosion and it was expected to yield in excess of ten megatons of explosive power. There was some uncertainty about the meteorological conditions, and the final decision to proceed was not made until 2:00 A.M. on November 1, only a few hours before firing time.

Listening to the final countdown on the loudspeaker, I stood on the deck of the *Estes* as dawn approached. The deck was crowded with officers and civilians of a wide variety of backgrounds. There were congressmen, senators, top officials of several governmental agencies, and a number of prominent scientists. Sir William Penney, a British explosives expert who had been involved with the bomb project at Los Alamos during the war, stood next to me and commented about the comfortable quarters to which we had been assigned. "I must say," he said with typical British humor, "if one must join the Navy, there are advantages in being an admiral." The contrast in the various types of chitchat during that last nervous hour was remarkable. There were more than a few observers who expressed the hope that, for some reason, the thermonuclear reaction would fail. It would be a better world without thermonuclear weapons. Others were betting on the yield of the explosion. One prominent physicist was particularly somber: he had told me the night before that he could not fully rule out the possibility that the thermonuclear reaction might "ignite the atmosphere." There was a good deal of the normal gallows humor in which men indulge at tense moments.

The explosion was unexpectedly awesome. First we saw the fireball, perhaps one mile in diameter, through the dark glasses we were required to wear, and at first it didn't look very different from much smaller nuclear explosions I had seen because we were witnessing the event from a distance of thirty miles, whereas the small bombs, sometimes only one one-thousandth the size of MIKE, were seen from much smaller distances. It wasn't until we were permitted to remove our dark glasses that we appreciated the full magnitude of the event. As the fireball cooled on its way up to the stratosphere (I later learned that it reached an altitude of

twenty-six miles), it entrained enormous quantities of water vapor that condensed in progressive stages to produce a great inverted ziggurat with sharply defined steps as it punched its way through successive inversion layers of the atmosphere. As in the last minutes before the explosion, there were marked differences in the behavior of the observers. Most, like myself, were dumbstruck, but many cheered. I couldn't understand how they could cheer the fact that we had witnessed the beginning of an era when wars might be fought with bombs having as much as a thousand times the destructive power of those that destroyed the two Japanese cities in World War II, only a few years before.

The plan called for me to be in the first plane back to Kwajalein, so that we could begin our surveillance of the islands. One hour after the detonation, when the head of the mushroom cloud had expanded to a diameter of about sixty miles, and was drifting to the west at twenty miles per hour, I left the *Estes* by helicopter for the aircraft carrier *Renderov*. There I boarded a plane with a forward cockpit for the pilot, and a rear seat for one passenger, but two of us, George Cowan, a chemist from Los Alamos, and myself were squeezed into it! We were catapulted from the carrier and spent the next two hours under such cramped conditions that thirty years later George insisted that his shoulder never fully recovered from the flight! For the first hour we had to fly around the enormous mushroom cloud, but the dosimeter I was carrying recorded very little radiation from it.

When we arrived at Kwajalein, the naval officers assigned to that island were standing at attention on the tarmac awaiting us. This was in part a matter of protocol, but it was also because they were eager to hear about the results of the test. We could tell them very little except that it was apparently successful, but this they already knew since they had seen the flash of the fireball nearly two hundred miles away.

Our plan called for the sweeps over the islands to begin on the first day after the test and to continue for four days. On the morning after my arrival, Cassidy and I left Kwajalein in two PBMs, sturdy long-range Navy flying boats. We were each to sweep about a thousand miles of ocean over which the cloud should have already passed. When we departed at 5:30 A.M., the radiation background at Kwajalein was about ten times its normal level, indicating that part of the cloud had passed our way. During that first day I made measurements over fifteen exquisite atolls with Polynesian names like Taongi, Utirik, Wotho, and Bikini. The weather was very bad, and there was no way to avoid frequent squalls that inter-

tered with our visibility and made the flight uncomfortable. From time to time we would fly through a piece of the cloud and particles of radioactive dust would impact on the leading surfaces of the aircraft, which would increase the radiation background within the aircraft. We found that the particles would wash away when we flew through a squall. I found only minor levels of radiation on the atolls despite the fact that I had chosen the sector which I thought would receive the heaviest fallout. I thought that perhaps I had been wrong to believe that heavy fallout would occur. I did detect elevated radiation levels on a few atolls, but the highest level at the surface was only 0.6 mr/hr, which is much lower than we had seen in many parts of Utah and Nevada after tests near Las Vegas.

We realized that the islands were so far apart that significant fallout might miss them, and this was what had happened. As a matter of fact, there were a number of times on that flight when my instrument reading began to drift upscale. I interpreted these readings as the result of instabilities in the instrument, which was only recently off the drawing board. The instrument was in fact behaving properly and was recording radiation from fallout in the water. It had not occurred to me that the radioactive materials would remain near the surface long enough to be detectable, even with the effect of shielding by the water.

On November 6, after four days of essentially negative results, I flew to Guam in the western Pacific to join John Harley, who had been monitoring the islands of the Mariana and Caroline groups. The final sweep of our program was a flight from Guam to Tokyo in which we flew low over many volcanic islands, including Iwo Jima, on which one of the fiercest battles of World War II had been fought.

We ended our surveys of the Pacific islands without finding significant amounts of fallout. CINCPAC was delighted with the negative results. However, there would be other multimegaton tests in the future, and I was of the opinion that the good fortune and careful meteorological control that had resulted in minimal fallout following MIKE might not always be the case. Improved monitoring methods were needed to obtain the knowledge we needed to better understand the dangers of fallout.

I spent much of 1953 at conferences on the subject of weapons fallout, and how to do a better job of documenting the phenomenon. In the spring of that year, during the tests called UPSHOT-KNOTHOLE in Nevada, there was another occurrence similar to the Rochester fallout during RANGER. This time it was centered on Troy, New York, where it

was detected by Dr. Herbert Clark, John Harley's former mentor at Rensselaer. The fallout was associated with heavy thunderstorm activity in the area and resulted in ambient gamma radiation levels of about one mr/hr. Unlike the Rochester incident, the fallout at Troy received attention from public officials, but in telephone conversations with the commissioner of health of New York State I found no sense of alarm, but only an interest in obtaining information. Professor Clark estimated that the gamma exposure to the residents from the deposited radionuclides was about 100 milliroentgen, which is about the dose received from natural sources in one year. John Harley and I flew up to define the extent of the fallout with our scintillometers but were turned back by heavy thunderstorms in the area. It wasn't until May 4, six days after the initial report, that the weather cleared sufficiently to allow a flight. Harley found that the city of Albany had accumulated even more fallout than Troy, and the ground level radiation levels averaged about 0.4 mr/hr. despite the fact that by this time much of the radioactive deposit must have been washed away by the heavy rains.

The fallout incidents were beginning to attract considerable media attention, especially in the southwestern states, where many scientists were becoming concerned about the levels of exposure being received by the general public. The photographic industry was also increasingly concerned and in late May the National Photographic Manufacturers Association sent a formal protest to AEC about the problems created in their industry by the accelerated testing schedule.

WEAPONS TESTING AND STRONTIUM 90

In the spring of 1953 I learned about Project GABRIEL, which had been underway since 1949 in great secrecy, and had as its purpose the calculation of the number of nuclear weapons that could be exploded in a nuclear war before the world would be so contaminated with fallout that long-lived effects of radiation would develop. It was then believed that there was a "threshold dose," below which no delayed effects of radiation would occur. This is no longer believed to be true, at least so far as cancer and genetic effects are concerned, but until the late 1950s the concept of threshold dose prevailed.

The last report of Project GABRIEL had been issued in 1951 and concluded that the critical radionuclide in fallout was Strontium 90 (Sr-90)

which has properties similar to radium in that it deposits in the skeleton, from which it is eliminated very slowly. The limit for "threshold lethality" was estimated at between forty thousand and forty million megatons of fission equivalent. The great uncertainty implicit in the thousandfold range between the upper and lower limits was a reflection of the ignorance that existed about the manner in which the dust from nuclear bomb explosions was transported in the atmosphere, the rates of surface deposition, and the kinetics of Sr-90 uptake by plants, animals, and humans. Even the lower limit seemed huge in 1951, when there were very few nuclear weapons, but a desire to narrow the uncertainty in the GABRIEL estimate began to develop in 1953 because of the experiences with weapons testing, much of which had been documented by the HASL research.

The responsibility for reinvestigating the matter was given to the RAND Corporation, a "think tank" established by the Air Force after World War II. That organization assembled a group of about fifty scientists at their headquarters in Santa Monica for a series of discussions of the matter in July 1953.¹ I attended and was pleased that most of the available data for the discussions came from the HASL reports. The meeting was a turning point in our understanding of the hazards of fallout because it was attended by many prominent scientists who recognized that far more information was required about the physical, chemical, and biological aspects of weapons fallout. Out of the meeting came a new project code-named SUNSHINE, after the excellent weather we enjoyed while in California. This was a most unfortunate selection that inadvertently gave a much more cheerful connotation than was appropriate for the somber matters with which the project was to deal.

SUNSHINE confirmed that Sr-90 was the critical radionuclide in fallout and recommended that specific measurements of this isotope should be emphasized in future studies. Willard F. Libby of the University of Chicago (well known for his development of methods of archaeological dating by the use of carbon 14, for which he later received the Nobel Prize) attended the meeting and served as leader of many of the discussions.

A satisfactory method for the measurement of Sr-90 in samples of soil, water, or biological material did not yet exist, and Libby, who was a superb radiochemist, agreed to develop a procedure. Both he and J. Laurence Kulp, then at Columbia University, perfected procedures during the next few weeks and opened the way to systematic studies of the ecological behavior of Sr-90. It was agreed that since Sr-90 is similar to calcium

in its chemical properties, and will tend to behave like it in soils and biological systems, that it would be convenient to report the results of analyses as microcuries of Sr-90 per gram of calcium ($\mu\text{Ci Sr-90/gm Ca}$). This ratio became known for a while as the Sunshine Unit, but was changed after a while to the strontium unit (SU), which is still used to some extent. Libby later was appointed an AEC commissioner and occupied an important, though often controversial, position as the senior government spokesman on the subject of the public-health implications of nuclear weapons testing in the atmosphere.

During the 1953 conference the estimates of Project GABRIEL were revised on the assumption that Sr-90 would contaminate the calcium pool of the biosphere, and that the dose to the world's population could be calculated from knowledge of the behavior of that element. It was concluded that the limit of "safe" Sr-90 contamination would result from 40,000 megatons of fission, which happened to be the lower limit of GABRIEL.

A big question that emerged from the RAND conference was the whereabouts of the debris from the MIKE explosion. Our worldwide network accounted for only a small fraction of that produced, and our aerial surveys found very little fallout close to the site. We know now that a substantial fraction was probably deposited within a few hundred miles from Eniwetok, but was missed by us because it fell into the vast expanse of ocean between the Pacific islands. Could it be that a major fraction was injected into the stratosphere from which it would take many months or years to fall to the earth's surface? This was what we came to believe, but how could the hypothesis be demonstrated?

One way would be to send instruments into the stratosphere to sample its thin air for radioactive dust. I had long been interested in electrostatic methods of collecting dust samples, and had actually improvised such an air sampler in the kitchen of our first apartment in Philadelphia in 1939. On the return flight from Los Angeles I prepared a schematic diagram of a precipitator that could be lifted by balloon to an altitude of about 100,000 feet, and upon my return I discussed his possibility with LeVine. We knew that the next major series of tests would take place in the Pacific starting in March 1954, and that it would involve the explosion of many multimegaton devices. It would be useful to obtain dust samples from the stratosphere before the March tests (code-named CASTLE) began, but that was only a little more than seven months off. The instrument was only a schematic diagram and it would have to be designed,

built, and tested. It would be necessary to arrange for balloon flights, a technology with which we had no experience. Could all of this be done in seven months? It didn't seem possible, but it was done, thanks to hard work by the HASL staff and excellent cooperation from the U.S. Weather Bureau, which arranged for a series of twelve flights to about 100,000 feet. These were completed by late fall. Although too few samples were collected to permit an estimate of the amount of Sr-90 in the stratosphere, we did demonstrate that the nuclide was present. I believe this was the first time dust samples were collected from that altitude but there was no interest by others, although we would have been happy to share our samples so that the characteristics of stratospheric dust could be studied.

Preparations for monitoring the Pacific islands during the tests of March 1954 took much of my time during this period, but it was also necessary to decide the needs of the distant monitoring program. The gummed-film network by then extended around the world, and we were beginning to place occasional stainless steel pots at representative locations so that we could collect total fallout for comparison with the data obtained from the films. As a result of the RAND conference, there began a worldwide search for Sr-90 in all sorts of materials. Samples of rain water, soils, foods, ice cores from Greenland, vintage wines, and old cheeses were only some of the materials that were analyzed to obtain an understanding of the rates of accumulation of Sr-90 in the ecosystems of the world. We quickly came to the conclusion that, because of its similarity to calcium, Sr-90 was present in minute but detectable quantities in all forms of life.

In the fall of 1953 there was little information to guide us in the design of our sampling programs. An important suggestion was made by D. Lyle Alexander of the U.S. Department of Agriculture who noted that the amount of Sr-90 in the milk produced in an area should be inversely proportional to the amount of soil calcium available to the grass consumed by the dairy cows. On the basis of his suggestion, we established a milk-sampling network that included places in which the soil calcium spanned the known levels in the U.S.

Alexander and I were at an agricultural field station at Logan, Utah and decided to take advantage of the fact that some sheep were being confined to a pasture where we could collect samples of soil, manure, milk, and bone. Analysis of the samples for strontium 90 would add to our knowledge of the processes by which the radionuclide passes from

the soil to man. We were crawling around the pasture making our collections of grass and manure when he turned to me and asked, "Merril, is what we are doing in your job description?" We were both high up in the civil service system, and I am certain that he was right in his implication that the bureaucrats would have demoted us on the spot if they could have seen us collecting bags of grass and sheep droppings!

The procedure for measuring Sr-90 in minute amounts is very tedious. Although originally developed by Libby at the University of Chicago and Kulp at Columbia, Harley and his associates at HASL deserve much of the credit for perfecting the method, developing a system of quality control, and adapting the method to the routine measurements of thousands of samples.

PREPARATIONS FOR CASTLE

In the fall of 1953 I returned to Pearl Harbor to discuss our participation in CASTLE, which was scheduled to start on March 1 with a multi-megaton explosion from a barge anchored on the reef of what I erroneously thought was to be Eniwetok atoll but actually turned out to be Bikini. I was received warmly by the CINCPAC staff, who I knew were very pleased with our surveys during IVY, in the fall of 1952. We had obviously developed a symbiotic relationship with CINCPAC, even though our interests and objectives were very different. CINCPAC had the practical need of assuring that the inhabitants of the Pacific islands were not affected by the fallout. The HASL objective was to obtain information about fallout because we believed that its effects were being underestimated by both the Department of Defense and the AEC.

The HASL plan was to use the same general methods developed for IVY, except that our ground instrumentation had been improved and would be located on islands on which military weather stations would be maintained during the exercises. These units would be equipped with continuous gamma radiation recorders. The military personnel would monitor the units and report the readings to the HASL coordinator aboard the *Estes*, the flagship for the task force designated JTF-7, again under the command of General Clarkson. The ground-level measurements would assist us in the deployment of the aerial sweeps.

The HASL calculations, based on extrapolations from the fallout encountered following the two JANGLE explosions in November 1951, had

indicated that dangerously high levels of fallout could occur on atolls as far away as a hundred miles following the large explosions contemplated for the CASTLE series. I discussed with the CINCPAC staff the need to provide an evacuation capability for the atolls closest to the explosions, but I had not seen the plans for CASTLE and was under the erroneous impression that the tests were to take place at Eniwetok again, as was the case during IVY. This is another example of the problems created by secrecy. I had been sent a list of the contemplated detonations, their expected yields, and the approximate times, but was not given their locations. That was in another document which I didn't know existed and thus did not ask for. One result of this confusion was that at the time of the conferences with CINCPAC, seven months before the start of CASTLE, I thought the nearest atoll to the blasts would be Ujelang because it was the closest to Eniwetok, and I made a recommendation that JTF-7 provide the capability to evacuate the natives of that atoll in the event conditions so warranted. This recommendation was supported by CINCPAC, but the staff of JTF-7 decided that such an evacuation capability would not be needed because the tests would not be conducted if there was any possibility of fallout on the atolls.

At HASL we were faced with the dilemma that if CASTLE was conducted properly, and the meteorological predictions were valid, the fallout would land mainly in the ocean, as apparently happened during IVY. This would be a very desirable result from the standpoint of the natives of the islands, but would not give us the information we needed to demonstrate the danger of fallout in wartime. We conceived the idea of laying oil slicks downwind of the explosions, so that particles that fell on them might be retained long enough to permit them to be measured from the air. This would make it possible to fly over the slicks with our scintillometers and measure the amount of fallout. Experiments designed to test the feasibility of this method were conducted off the New Jersey coast in January 1954, but the ocean was so rough that coherent oil slicks could not be maintained long enough to obtain useful information. We decided to continue the tests in the calmer waters of the Pacific. John Harley, who was already in Hawaii, made plans to obtain the required oil, which would be dropped from low-flying aircraft. We even experimented with methods of dropping the oil. Plastic bags that would rupture on contact? Oil drums that would be dropped and be riddled with bullets? These and other schemes were discussed and some of them tried. In the end we de-

cided that the method simply was not feasible because we couldn't lay an oil slick that would hold fallout particles for more than one hour.

Regrettably or fortunately, depending on the point of view, it proved unnecessary to lay the oil slicks because massive fallout occurred on several atolls about seven hours after BRAVO, the first detonation of the CASTLE series, which was exploded near dawn on March 1.

The preparations for BRAVO were similar to those for MIKE, except that Breslin was assigned to the *Estes*, which permitted me to remain in the laboratory in New York to supervise the oil slick experiments which we planned to continue as long as possible in the hope that it would be possible to use the technique sometime during CASTLE. In addition, automatic monitoring instruments were placed on certain atolls in the care of military personnel. About seven hours post-shot, Breslin received a message from the Air Weather Station on the atoll of Rongrik, about a hundred miles east of the explosion, informing him that our gamma radiation detection instrument had gone off scale, i.e. the radiation level exceeded 100 mr/hr. He immediately forwarded the information to me and attempted to confirm the Rongrik report with surveillance flights by our aircraft based on Kwajalein. However, for reasons that have never been explained, the Task Force prevented Breslin from using the radio transmission facilities aboard the *Estes* for about thirty hours. The operating procedures developed by HASL and approved by JTF-7 called for immediate aerial confirmation but Breslin's hands were tied for many crucial hours after his telegram to me.

At about thirty hours post-shot, the twenty-eight weather station personnel were evacuated by air, but by that time they had accumulated a dose of 78 rem, which is barely below the dose at which the acute effects of radiation would be experienced. More serious was the fact that when the surveillance aircraft flew over other nearby atolls it found that the atoll of Rongelap, about forty miles west of Rongrik, had received even greater fallout. Nearby Utirik and Ailinginae had also received heavy fallout. A decision was made to evacuate the Marshallese natives from the three atolls, and a total of 258 persons were removed by ship, but not until more than fifty hours after the fallout occurred.

When a medical team was sent to examine and treat the evacuated natives, they concluded that the Rongelaps had received whole body doses of about 175 rem, with much higher doses to their thyroids due to the radioactive iodine to which they had been exposed. Some of the Rongelaps

have developed thyroid abnormalities, including cancer, as a result of their exposure. If the HASL instrument had not been in place, there would have been no way of knowing that the fallout had occurred, and the doses received by the natives would have been very much higher. On the other hand, had the HASL procedures been followed, the natives could have been evacuated sooner, and the doses received would have been very much less.

The circumstances surrounding the BRAVO fallout have been shrouded in mystery for more than thirty-five years. Published references to the incident frequently refer to it as an "accident" that resulted from an unexpected shift in wind direction. But was the shift greater than normally allowed by the margin of safety provided? Did the forecast properly interpret the available meteorological information? Why was a gag placed on Breslin? Why weren't the confirmatory flights made as required by the written procedures and dictated by common sense? Why was there never a formal inquiry of the episode?

THE LUCKY DRAGON INCIDENT

Unknown to anyone until the fishing vessel returned to its home port of Yaizu in Japan on March 14, the inhabitants of the Marshall Islands and the twenty-eight servicemen on Rongrik were not the only ones affected by the BRAVO fallout. At the time of the explosion, the *Fukuryu Maru* (*Lucky Dragon*) No. 5, a 100-ton tuna fishing boat with a crew of twenty-three, was about eighty miles east of Bikini when the crew saw a bright flash and realized that they had witnessed a nuclear explosion. They immediately sailed away from Bikini, but after four hours encountered a fallout of white particles so large as to be individually visible. The fishermen later reported that by the time the fallout stopped, the ship appeared to have been coated by a thin layer of snow.

The U.S. had declared the area around Bikini a restricted zone, which was known to the fishermen. The evidence indicates that they were just outside the specified boundary at the time of the explosion and were nervous about being apprehended by the U.S. authorities because the same crew had been found poaching in Indonesian waters one year earlier and had spent some time in jail as a result. It was apparently for this reason that the crew made no mention by radio of the fact that they became sick,

starting a few days after the fallout. By the time they reached their home port 14 days later, all the crew were seriously ill.

I learned about the *Fukuryu Maru* the same way most people did, from Japanese news reports that a fishing boat had returned to its home port of Yaizu (south of Tokyo) with twenty-three crew members suffering from radiation sickness. The story did not seem credible to me at first because I was familiar with the extensive precautionary sweeps made over the area in advance of a test. I had in fact flown on one such search and was impressed with what I thought was the thoroughness of the procedure. Nevertheless, Bugher contacted John Morton, newly appointed director of the Atomic Bomb Casualty Commission in Hiroshima, and asked him to obtain whatever information was available. I knew also that John Harley was in Japan, and attempted to alert him to the fact that he might be needed but he had already departed for home.

It took very little time for Morton to confirm from his Japanese colleagues that the men were suffering from radiation sickness, and that the boat was highly radioactive as was its cargo of tuna fish, which had been disposed of by burial. On the morning of March 19, Bugher and I participated in a conference call from Morton who said a consultant was badly needed to advise the U.S. embassy as well as the Japanese on the radiological aspects of the matter. It was decided that I should proceed to Tokyo immediately.

That call came at a particularly awkward time. I was attending an important meeting of the NYOO staff at which it had just been announced that the office would be reorganized and that Burke Fry, manager of the NYOO, was to retire. Alphonso Tammaro, the Assistant General Manager for Research and Development on the Washington staff, was present at the meeting, and when it became apparent that I had to leave, he and Fry drew me aside to inform me that I had been selected as the new Manager of Operations. That came as a total surprise. I responded that while I was flattered to be asked to assume greater responsibility, I thought it important that I remain as head of HASL, at least for a while. They suggested that I could fill both positions if I wished to do so. I agreed, quickly took off, and didn't have a chance to think about the matter in the weeks ahead. That was one of the major decisions in my life, but they proposed and I accepted in no more than five minutes!

In an organization like the U.S. government it is amazing how fast things can move when an emergency arises. For security reasons, the

passports of all AEC employees in those days were kept in the Washington headquarters, and preparation for foreign travel normally required about one month during which the travel application form crept from one desk to the next collecting authorizing signatures. The call from Morton came at 11:30 A.M., at the conclusion of which it was decided that I should proceed to Washington for a conference at AEC headquarters before leaving for Japan. It took me a few hours to collect the instruments and reference material I knew I would be needing, and I left on the four P.M. plane from La Guardia where Irma, my mother, and our three boys were waiting for me with the bags she had packed. When I arrived in Bugher's office, he had my passport, my authorization for travel to Japan, my tickets, and an ample travel advance. We discussed the important implications of what had happened in the Pacific, and he told me that about one million pounds of tuna were suspected of being contaminated. This added a new dimension to an already complicated situation.

A flight to Tokyo from the East Coast now takes about fourteen hours, and can be nonstop. In 1954, it took twelve hours to reach the West Coast, about ten more to Honolulu, another six or eight hours to Wake Island, and a final ten-hour leg to Tokyo. Forty hours total, with an additional three or four hours consumed at the stopovers. But travel was much more comfortable, and the planes even had sleeping berths for those that wanted them. We reached Honolulu at 5:30 A.M. and only then did I find that the *Lucky Dragon* affair had blossomed into a full blown international incident. I was met at the airport by Commander Deller, who was on the CINCPAC staff and was my liaison with JTF-7. He briefed me on the latest developments in the Marshalls. A medical team from the U.S. had arrived there and were keeping the evacuated natives under observation. Rumors about the evacuation had reached the international press, abetted of course, by the sensational stories from Japan. The problem was exacerbated, so far as I was concerned, by the announcement of a small pharmaceutical company that they were sending a drug to Japan that would help the fishermen. The medicine was no more than a common over-the-counter skin burn lotion, but Bugher, who of course knew nothing about the shipment, had cabled prominent members of the Japanese medical profession that I was on my way to Japan to assist them, and when they learned of the announcement of the publicity-seeking pharmaceutical company, it was assumed that I had some miracle drug with me. As I left Honolulu, I was surprised to read about this in the *Honolulu Times*, and it disturbed me more than a little.

I reached Tokyo at 10:30 P.M. totally unprepared for the reception I received. After the plane had rolled to a stop, one of the stewardesses tapped me on the shoulder and introduced me to an officer of the U.S. Military Police, who was my escort for the next few minutes. He asked for my passport and baggage checks, and told me that there were representatives from the press waiting for me, but that I should make no statements. Because I had been sitting on the opposite side of the plane, I was not aware of the large number of reporters and photographers waiting for the plane and, had I seen them, I would have assumed they were waiting for another passenger. There were about thirty of them, behind a barricade at the edge of the apron. They were close enough to take pictures, which appeared in the newspapers the next morning, but except for the few seconds it took for me to descend from the plane, they saw no more of me that evening. An embassy sedan was at the bottom of the ramp and I stepped into the rear seat where I found William Leonhart, who introduced himself as First Secretary of the U.S. embassy. Without waiting for my baggage, the car took off for the Sanno Hotel, at which I had stayed during previous visits. It had been taken over by the United States Army during the occupation of Japan to billet officers in transit.

En route, Leonhart briefed me efficiently about the state of things. The Japanese people were angry about the fallout on the *Lucky Dragon*. They were the only people ever to have been hurt by atomic bombs, first during the war, and now again. The Japanese scientists were making sensational statements to the media. The formal peace treaty between the U.S. and Japan had only recently been signed, and this was the first postwar crisis in the relations between the two countries. The bottom had dropped out of the tuna market. No one in Japan fully understood the technical implications of the event, and I should expect to spend considerable time providing information to both the Japanese and the Americans.

After a restless night I had a breakfast conference with John Morton, who was also staying at the Sanno. He was in a very difficult position. His entire career had been spent as a surgeon on the staff of the University of Rochester Medical School, from which he had recently retired as chairman of the Department of Surgery. He knew nothing about radiation medicine, but was invited to come to Japan because he had developed a good reputation as a scientific administrator. He was in no position to answer the kinds of questions that were being asked. How should the doses to the fishermen be calculated? What radioactive substances

were in the fallout? What was the allowable level of contamination in tuna fish? How is radiation illness treated?

After breakfast we began a round of conferences and visitations that continued for three weeks. I spent the first hour reading the cables that had been going back and forth between Tokyo and Washington, from which I could sense the deterioration in the relationship between the two countries during the few days in which Japanese scientists, newspaper writers, and some officials had vented their fears and hatreds against the U.S. and its military forces in Japan. These troops had been an army of occupation from 1945 until the formal peace agreement was signed in 1952, but the U.S. still maintained a large military establishment in Japan. This was the first serious interruption in the otherwise smooth relationship that had existed between the two countries since the end of World War II. It was suggested by some Americans that the fishermen were spying on the U.S. bomb tests. Could this have been so? In the end there was no evidence to support the allegation. Were the fishermen as sick as claimed by some of the Japanese physicians? They were indeed sick and getting sicker by the day. Could the U.S. provide medical assistance? Very little. After all, the Japanese had been through the atomic bombings of two cities only nine years before, and many of the physicians involved in treatment of the survivors were now treating the fisherman.

However, the Japanese had no understanding of the biophysics of radioactive contamination, and they needed and wanted assistance in that area and welcomed any help I could give them. Immediately after my arrival, the Japanese scientists expressed a desire to meet with me. Unfortunately, there was a considerable amount of rivalry between different groups of scientists. The staff at Tokyo University was at odds with the group at the National Institute of Health, and the local physicians in Yaizu were unhappy because some of the fishermen had been transferred to a hospital in Tokyo. The Japanese government had appointed an official committee to investigate the incident and recommend the steps that should be taken. The ambassador was advised that all communications of a scientific nature between the U.S. and Japanese should be through that committee, which was chaired by Dr. Rokuzo Kobayashi, Director of the Japanese National Institute of Health. I met with his committee on March 24, accompanied by Morton, and representatives of the Far East Command and the embassy. It was a difficult conference because very few Japanese scientists spoke English and the interpreters from the diplo-

matic offices were not familiar with many of the scientific terms being used.

It was at that meeting that I had my first example of the misunderstandings that can arise from subtle errors in translation. Dr. Masao Tsuzuki, a physician who had been barred from his position as professor of surgery by General MacArthur because he had held the rank of rear admiral in the Imperial Navy (i.e., he had been "purged" in the vernacular of the times), was in Yaizu on the day of our meeting, but left word with one of the committee members that he would return to his home by eleven o'clock that evening and that it was urgent that I call on him. That seemed a strange time for a visit, but since the message was transmitted by a member of the Japanese Foreign Office, arrangements were made for an embassy car to pick me up at the Sanno in time for our meeting in his home. When we arrived the house was dark, but our knock on the door wakened Tsuzuki, who received us in his kimono. It turned out that he did want to speak to me, and had left a message that I should *call* him at the designated time, not *call on* him. Fortunately he spoke enough English to understand the humor of the situation and we sat for more than one hour getting acquainted. That private conversation early in my visit was very fortunate because Tsuzuki became very relaxed as we sipped warm saki. I developed an understanding of him that was to prove useful in the difficult days ahead, and would lead to a close friendship that lasted until his death in 1961.

Tsuzuki had been one of the most controversial of the Japanese scientists and had not shown a willingness to accept the assistance of the ABCC staff, represented by the director, John Morton. Tsuzuki was surprisingly frank in telling me of his resentment because the U.S. occupation forces had confiscated a report he had written following his survey of the effects of the bombings in Hiroshima and Nagasaki. He had led the team of Japanese physicians that entered the two cities to provide medical assistance, but he was never allowed to publish his report. I was familiar with that report, which actually had been translated into English and published, under his authorship, as an appendix to a report issued, but not widely circulated, by the U.S. National Research Council. It was true that Tsuzuki's report, which was a classic, did not receive the recognition that it deserved.

During that hour-long conversation, Tsuzuki also discussed his unhappiness about the fact that he had been placed on MacArthur's list of former officers that were purged from their civilian positions. I reasoned

that in the aftermath of a long and cruel war there were bound to be inequities, but I knew that he was respected as a medical scientist in the U.S. and promised that I would look into his status. (This I did, and with such success that he was invited to the U.S. by the State Department a few months later.) In addition I assured him that he would be free to publish his studies of the injured fisherman, and that my position was that of a U.S. scientist and government official who was there to advise my government about the circumstances of the accident and assist the Japanese scientists in any way possible.

Following the long day of conferences, first with the committee and then with Tsuzuki, it was clear to me that there were a number of separate but interrelated problems to be addressed:

1. The clinical management of the twenty-three fishermen: In my opinion there was little help to be offered. The U.S. had no methods of treating acute radiation sickness that were not already known to the Japanese physicians.
2. The dose received by the fishermen: This included that delivered by external radiation because they lived for fourteen days on a ship covered with radioactive dust, and by internal radiation because the fallout particles were inhaled or ingested.
3. The concerns of the Japanese that the Pacific tuna would be contaminated.

By the time of my arrival, the Japanese physicists had already estimated the external radiation dose using crude instruments that were nevertheless quite reliable in their expert hands. However, they did not know how to estimate the dose delivered by radionuclides deposited in the bodies of the fishermen. In 1954, even the radioactive species present in bomb fallout were secret, but by the time I arrived, Japanese radiochemists had made progress in analyzing particles of fallout collected from the *Lucky Dragon*. However, their results were purely qualitative, and they were unable to separate nuclides that had similar chemical properties. They were fortunate to have the assistance of Professor Kenjiro Kimura, an internationally respected radiochemist who had attracted attention after the bombings by concluding, correctly, that the Nagasaki bomb utilized plutonium because he had found traces of that element in samples of soil collected from an area in which rainout had occurred. He had also discovered previously that he could produce U-237 in the laboratory by

bombardment of U-238 with fast neutrons. In my first meeting with him he told me he had found U-237 in the "Bikini ashes" from which he concluded that the March 1 explosion involved the fission of U-238, which was still a secret known by only a few scientists back home.

In response to my cable to him, Harley advised that the isotopic content of the bomb debris would be similar to the tables of fission products that had been published in the open literature, from which the Japanese scientists concluded that Sr-90 was the isotope that would be of greatest danger to the fishermen.

I had requested samples of urine from the fishermen with the understanding that I would send them to Harley for analyses at HASL. The amounts of the various nuclides in the urine would give us a clue as to the quantities that were deposited in their bodies. On the basis of the results received from the laboratory I advised the committee that the amount of radioactivity deposited in the bodies of the fishermen was insignificant in relation to the dose received externally.⁴ This came as a big surprise to me because the men had lived for fourteen days in an environment contaminated with radioactivity to an unprecedented extent. In fact, the analytical results were so unexpected that I initially wondered about their validity but any doubts were dispelled a few months later when one of the fishermen died of serum hepatitis and his tissues were analyzed for the major radionuclides by Professor Kimura. He confirmed our findings: only insignificant amounts of radioactivity were found in the body of the deceased fisherman.

Shortly after my arrival in Japan, General Hull, who had replaced Douglas MacArthur as Supreme Commander of the Allied Forces in the Pacific, asked to meet me and some of his staff at their headquarters in the Dai Ichi building. By the time of our conference, the true importance of the BRAVO fallout seemed obvious to me: Thermonuclear weapons had the ability to contaminate tens of thousands of square miles with lethal amounts of radioactivity. This was what we at HASL had suspected but now we had the proof.

In my briefing of Hull I made it clear that I was in no position to discuss the full military and political implications of the Bikini fallout, but it was quite obvious that thermonuclear weapons were far more destructive than had been anticipated by the military planners with whom I had been discussing this possibility for the past two years. Hull didn't pursue this point, which was understandable, considering my position. However, he did ask repeatedly about the security implications of the fallout residues

present on the ship. He was aware that a radiochemical analysis of the particles of fallout could reveal classified information about the design of the *BKAVO* device. If it was in the U.S. interest to do so, he was prepared to seize the fishing boat. I was surprised to hear him speak so strongly about the security aspect because it was obvious that most of the fallout had already been removed from the boat. Much of the material had undoubtedly been passed to innumerable scientists throughout Japan and possibly elsewhere. As a matter of fact, I had in my pocket a vial of fallout particles that had been given to me by one of the Japanese scientists that very morning. I told Hull that the people who were in the best position to advise on the security implications were at that very time with JTF-7 at Eniwetok, and that I would consult with them as to whether any action was required to secure whatever fallout particles remained on the boat. I sent a radiogram to General Clarkson asking for the opinion of the Task Force intelligence personnel, and when he replied promptly that the boat was of no interest, the matter was put to rest.

During the first week of my visit, much of the time of the embassy staff, as well as Morton and myself, was spent negotiating with the committee to get permission for American physicians to examine the fishermen. The Japanese scientists were reporting daily on their medical status. The condition of the men was said to be deteriorating: they had lost their hair, had developed skin ulcers from burns caused by the beta particles emitted from the fallout that deposited on their skin and, more ominously, their white blood counts were continuing to decline. The interest of the ABCC in having contact with the cases was understandable. ABCC was responsible for one of the largest medical follow-up studies in history, which was concerned with the delayed effects of exposure to radiation. The twenty-three Japanese fishermen were the largest group of persons suffering from the immediate effects of radiation since the bombings of World War II. In the United States, physicians who were interested in developing methods of treating acute radiation injury wanted to collaborate with the Japanese physicians. But the Japanese were adamant that they wanted no help in dealing with the patients, although they did welcome any assistance I could provide that would help them to understand the physical and radiochemical problems they were facing.

I was anxious to visit the *Lucky Dragon*, and the committee not only arranged for this, but suggested that while we were in Yaizu we should pay a courtesy call on the twenty-one fishermen who were hospitalized

there. On March 26, Morton, Dr. Lewis, who was an ABCC hematologist, and I, accompanied by several Japanese physicians and physicists, flew to Yaizu, ninety minutes southwest of Tokyo, in a C-47 provided by the U.S. Air Force.

When we arrived, we were welcomed impassively by the school children of Yaizu, who were lined up along the short airstrip. We proceeded to the hospital followed by a few carloads of reporters who had also met us at the field. The visit to the patients was only a courtesy call; they were evidently glad to see us. They were resting on mats, surrounded by their families who, in the Japanese custom, were preparing food for them on hibachis within the room. The reporters were not allowed into the hospital, but since the windows were at ground level and wide open, the photographers had no trouble taking all the photographs they needed. I had broken the Geiger-Mueller tube of one of the two radiation detectors I had brought with me, but with the remaining instrument I was permitted to scan the bodies of some of the fisherman. Although it was now nearly four weeks since the accident, their thyroids still contained readily measurable amounts of iodine 131 . The information I obtained was very scanty because there was not time for more systematic measurements. Many of the men had skin burns, particularly on their scalps and along the line of their trouser belts where the fallout particles had become lodged as they stood shirtless on deck when the fallout was occurring.

For some reason I never understood, the American media carried reports that I was not permitted to examine the fishermen because I had neither an M.D. or Ph.D. The fact was that the Japanese scientists requested me to visit the fishermen when we visited Yaizu. Unreliable media reports can be very troublesome.

We spent no more than thirty minutes with the fishermen and then went to a picturesque bay-front hotel where we were greeted by the mayor of Yaizu who had arranged what must have been a very expensive lunch for the mayor of a small fishing community in postwar Japan.

After our lunch we visited the fishing boat, where the Japanese scientists who accompanied us donned lab coats and gauze masks before boarding. We Americans brought no protection, nor did I believe it was necessary for the type of contamination we were to encounter. However, when we saw our pictures in the Tokyo papers next morning, I did regret that, compared to the Japanese, we seemed so cavalier in our attitude towards radioactivity. Before leaving Tokyo I had requested that the em-

bassy provide me with a household vacuum cleaner, and this I used to collect fallout particles from some of the less accessible exterior surfaces of the boat that I thought might have escaped the pickings of the many Japanese scientists who preceded me. On the roof of the cabin I found a loose piece of wood about eighteen inches long that was coated with many white grains about 0.2 mm. in diameter. With the permission of the Japanese, I took the board back to HASL as a souvenir of my visit. The dust collected by the vacuum cleaner was divided for study by several laboratories in Japan and the U.S.

The first opportunity to meet members of the committee socially came after about one week, when William Leonhart and his wife entertained the Japanese scientists at dinner. He and I were busy at the embassy and didn't arrive at his home until exactly 6:30 P.M., when the reception and dinner were about to begin. We found that most of the Japanese were already there, my first experience with the customary promptness of the Japanese people. It was a pleasant evening but the language problem was insurmountable. Thirty years later I was entertained at a reception in Tokyo following a talk in which I was invited to reminisce about the events of that period. Several members of the committee attended that pleasant reunion and I was greatly impressed with the ease with which we communicated in English.

During the last week in March, nearly one month after their exposure to the fallout radiation, the white blood counts of most of the fishermen were continuing to decrease, and alarm increased over the possibility that some of them would not survive. In one case the count dropped to 800 cells per cubic millimeter and others hovered just above 1000. This is a dangerous phase of the acute radiation syndrome, in which the body is less able to resist infection. If infection can be prevented for a few weeks, the damaged bone marrow, which produces a reduced number of blood cells, will gradually repair so that recuperation of the white blood count can begin. The ABCC physicians were of the opinion that they could possibly make practical suggestions that would reduce the probability of infections, but the Japanese doctors continued to decline their assistance, and neither Morton nor his American assistants were ever consulted concerning medical management of the cases. Fortunately, the blood counts began to return to normal after four to six weeks, and the men returned to normal health after one year, except for the radio operator who developed jaundice in June (about three months after exposure) and died in

September. The cause of death has been attributed to serum hepatitis, probably a consequence of the large number of blood transfusions he received. It was accepted practice in Japan at that time to transfuse only about 100 cc at a time. This required a great number of transfusions, with a proportionate increase in the risk of infection by the hepatitis virus. Although the radio operator did not die directly from radiation injury, his death was clearly a secondary result of his exposure.

The Tuna Panic

The *Lucky Dragon* incident had implications beyond concern over the health of the crew. The *Lucky Dragon* had landed with 28,000 pounds of fish that were quickly disposed of by burial. When reports were received of the *Lucky Dragon* incident, the U.S. Food and Drug Administration decided to monitor incoming shipments of tuna, which was a sensible precautionary step and would have created little problem because there was no general contamination of tuna. However, the U.S. tuna companies sent notice to Japan that they would not pay for shipments of fish unless they were certified as "nonradioactive" before the shipments left Japan. Consumption of tuna in Japan dropped immediately as a result of this action. Concern—unwarranted, as it turned out—about the radioactivity of tuna had serious economic consequences in Japan, where the tuna fleet consisted of about 1000 vessels, with an annual catch estimated to be worth twenty-six million dollars.

When I arrived on March 22, the Japanese had already monitored and cleared the first outgoing shipment of frozen tuna. Technicians had been trained in the use of Geiger counters, and were assigned to the five major ports at which tuna was received and shipped. All fishing boats were instructed to deliver their catches to one of the designated ports. Radiation detection instruments were loaned to the Japanese by the U.S. Far East Command.

At a conference with Japanese officials two days after my arrival, they requested that I recommend monitoring procedures and standards to determine if the tuna could be cleared for shipment. Because of my unfamiliarity with the manner in which fish are processed in the course of shipment, I requested and was given permission to inspect the loading of tuna at a dock in Yokohama. I was flabbergasted by what I saw. Hundreds of tons of frozen tuna were moved from a refrigerated warehouse to the

dock, from which they were promptly transferred to the hold of the ship. With only a few instruments available, and in the hands of inexperienced inspectors, how could the huge cargos be surveyed?

I suggested that, as a first step, measurements be made of one in every ten fish before they were loaded on the ship. The fish should be examined for one minute by passing a Geiger counter over its surface, with particular attention to the gills, because they filter large volumes of water during the process of respiration. The instrument probe should then be inserted into the mouth of the fish, and into the abdominal incision through which the viscera had been removed. Additional instruments would be needed and the number of trained inspectors would need to be increased.

There remained the question of the criteria for rejection of fish as contaminated. It is not a simple matter to estimate the risk to consumers of fish from measurements made in this way, and I told the Japanese officials that I could not recommend a standard without further study. However I did not believe fish with more than insignificant contamination would be found. Low levels of radioactivity on the skins and gills were a possibility, but this would not be important to the canners, who routinely strip the skins and remove the heads as the first step in processing. I suggested to the Japanese that since I would be in Tokyo for several more days, I wanted to be informed when contaminated tuna were found. I would arrange for immediate air transport as needed to any of the five ports that had been designated to receive and ship tuna to the states. My recommendations for certifying the tuna would depend on what I found.

Many reports of contaminated tuna appeared in the newspapers, and several times I was alerted that I should fly to one or another of the five ports, but each time I was soon informed that we had received a false alarm and that no trip would be necessary. Between March 24, when the Japanese Foreign Office first discussed the matter with me, and April 9, when I left Japan, there were many such reports but I never saw radioactive fish. In some cases the reports were received after the catch was dumped at sea. It was suggested to me that the refrigeration systems on the boats sometimes failed at sea, causing the fish to spoil. With all the publicity being given to radioactive fish, a resourceful captain could dump his cargo and later claim that he did so because it was radioactive! This would make it possible for him to prepare a claim against the U.S. government. The suggestion was only anecdotal and I have no way of knowing whether it explains why I never saw radioactive fish despite the

fact that I had a C-47 and helicopter at my disposal and could quickly reach any of the five Japanese tuna ports.

WHATEVER WAS HAPPENING IN WASHINGTON?

During my stay in Japan I had excellent rapport with the AEC in Washington as well as with HASL in New York. There was hardly a day when I didn't cable for information, copies of literature requested by the Japanese scientists or, in some cases, equipment. I had excellent support and all my requests were answered promptly. My only problem was personal, because Tokyo was ten hours behind the East Coast of the U.S. Soon after I tumbled into bed at 11 P.M. after a long hard day, my colleagues were reporting for work in Washington and New York with a thirst for the latest information from Japan. Each day I helped the embassy staff prepare a detailed telegram to Secretary of State Dulles. This was dispatched in the early evening Tokyo time, but could not possibly provide all the information that was needed, so many of the calls I received during the night were unavoidable. Had I anticipated the demands for information, I would have asked for assistance in Japan by other radiological specialists from the States, but by the time I realized how weary I was getting, it was too late to obtain help. The ambassador recognized what was happening and arranged to screen the night calls so that I could get some rest. One day he insisted that I get away for twenty-four hours and arranged for me to be driven to a hotel near Mount Fuji which the U.S. was using as a rest and recreation center for field-grade officers. The hotel cost me one dollar for a twenty-four hour stay with meals. Thirty years later, when it had long since been returned to private hands, I stopped with my wife at the same hotel and the rate was \$100 per person per night!

My greatest concern with Washington was the near absence of official statements. A terse statement that a new test series had begun in the Pacific was issued to the press immediately following the BRAVO detonation, but no other information was given at that time despite the fact that it was already known that unexpectedly high levels of fallout had occurred. No further information was released for many days. The evacuation of the natives and the dispatch of a team of medical specialists all took place without public announcement. But JTF-7 was a task force of

many thousands of personnel, and the magnitude of the event was such that it was impossible to keep rumors of the disaster from reaching the public. It was not until March 10 that the AEC issued its second report in which it announced that 236 Marshallese had been evacuated from their home atolls "according to plan as a precautionary measure."⁵ This was a clear understatement of the facts. The statement said nothing about the early effects of the heavy radiation exposures that were already evident.

The magnitude of the fallout became known everywhere in the world on March 16 when the Japanese newspapers announced that the *Lucky Dragon* had returned to its home port of Yaizu with twenty-three fishermen suffering from radiation sickness. The news created a sensation throughout the world, but no immediate statement was issued by Washington. In the absence of information from the U.S., newspapers in western countries, including the United States, were forced to rely on reports from Japan which were in many cases exaggerated.

On March 24, shortly after my arrival in Tokyo, the U.S. government announced that it was expanding the restricted area around the Pacific test site, and that the surveillance procedures were being increased to provide greater assurance against unauthorized entry into the restricted zone.⁶ The statement went on to say that because of the slow movement of the water around the Marshall Islands, the radioactivity would become harmless beyond a few miles, and would be undetectable within 500 miles or less. This last statement bothered me greatly because while I did not believe the contamination levels in the Pacific Ocean would be hazardous to consumers of tuna fish, the radioactivity would certainly be detectable.

By March 31 there were no additional announcements from Washington and Ambassador Allison decided it would be necessary for me to conduct a background briefing for the American members of the Tokyo press corps. Since it was assumed that the reporters, although a sophisticated group, would know little or nothing about fallout, contamination of ecosystems, the effects of radiation exposure and, in particular, how the fallout occurred, I was asked to provide a two-hour tutorial as well as the opportunity to answer questions they would ask. It was understood that I could not divulge classified information, but I did not think this was a handicap for them or myself, since secret information about the BRAVO device itself would add nothing to their understanding about the circumstances of the fallout. Besides, I knew next to nothing about the classified aspects of the matter. The briefing was off the record, which

meant that the reporters could use the information to interpret what they were hearing, but could not quote what they were being told and could not refer to the fact that they had attended a briefing arranged by the embassy.

What I could not explain to the reporters, because I did not know, was why our government had released so little information. It was now a full month since the fallout occurred, and about two weeks since the *Lucky Dragon* had returned to Yaizu. The Japanese scientists were making statements that were being reported in the world press. The statements they were making were frequently inflammatory, which was understandable under the circumstances. Sensational stories were being published in the U.S. newspapers as well. The ambassador and his staff were puzzled that so little information had been released.

The press briefing took place during the afternoon of March 31, Tokyo time, which was early on March 30 in Washington. Unknown to me, President Eisenhower had scheduled a televised press conference for the following day and had invited Admiral Lewis L. Strauss, chairman of the Atomic Energy Commission, to join him and to make a statement about the BRAVO fallout. I believe that it was a coincidence that the briefing in Tokyo coincided with Strauss's statement. The president was responding to the same pressure for information that caused the ambassador to arrange the briefing. When the Strauss statement, which was made in the presence of the president, was received in Tokyo, it came as a shock to Morton and myself as well as to senior officials at the embassy. The statement said the fishermen "must have been well within the danger area," which could not be supported by any evidence of which I was aware, but was a convenient assumption from the point of view of the liability of the U.S. for damages sustained by the fishermen and the owner of the *Lucky Dragon*.⁷

The statement then went on to say that the skin lesions "are believed to be due to the chemical activity of the converted material in the coral, rather than to radioactivity. . . ." In other words, the burns were due to the fallout of corrosive particles of calcium oxide produced by the action of the great heat of the fireball on coral. This was particularly painful to read since it was not so, and because in the same paragraph that contained that statement, Strauss mentioned that the commission was represented in Japan by Morton and myself. There was every reason why the Japanese scientists, whose confidence we were struggling to develop, should have believed that the misinformation originated with us.

On April 9 Morton and I decided that our usefulness was at an end in Japan and arranged to leave for what I thought would be a brief visit to Eniwetok to meet our colleagues who were ministering to the needs of the Marshallese. The ambassador issued a press release in which he reviewed what we had accomplished, and the foreign minister delivered a note of thanks to us together with gifts of appreciation. I was concerned that a large cloisonné vase he presented to me would be too heavy to carry home and tried to give it to one of the secretaries at the embassy who declined it with the advice that it was a beautiful piece of art that my wife would certainly enjoy. This turned out to be so.

One reason why I wanted to leave it behind was that I had promised our three sons that I would bring home some rice birds (Java sparrows), attractive gray and pink birds that can be easily tamed. I had found a dealer who had some week-old birds and bought a small bamboo cage containing six fledglings that required feeding every two or three hours during the day. I left Japan with both the large vase and the cage of birds, having arranged with Pan Am to keep the cage in the cabin with me.

The story of the birds is in itself a saga. I thought I would be in the Marshall Islands for only a few days but it turned out that I remained for one month during which the birds outgrew their cage twice. All six of the birds eventually arrived home with me, by which time they were full grown and brought many months of pleasure to our family. The birds were all given Japanese names, often had the run of the house, and frequently flew away on brief excursions that usually ended when a neighbor called to say that one or more of them had interrupted a picnic by lighting on a guest's shoulder!

The fallout of March 1 had proved that we were correct in our belief that massive fallout covering large areas of land would be a consequence of nuclear war. But in my absence from the laboratory, the staff recognized that it was important to obtain more quantitative information. It was necessary to define the area of fallout and the fraction of the radioactive debris that would be deposited. Our experiences had taught us that a nuclear explosion creates clouds of debris that behave in different ways. If a bomb explodes so high above the ground that the fireball does not touch the ground, the particles formed are so small that they deposit very slowly and do not create a serious danger. If the bomb is big enough (greater than 100 kilotons of TNT equivalent), much of the debris will penetrate into the stratosphere, from which it will deposit gradually over a period of many months, by which time the short-lived radionuclides

will have decayed. The fraction that does not reach the stratosphere will remain in the lower atmosphere from which the particles will deposit over a period of a few weeks, largely with rain or snow. Such fallout will contain some of the short-lived radionuclides, such as radioactive iodine, but the dose to people will not be sufficient to result in radiation sickness. However, if the fireball touches the ground, or if it is exploded so close to the ground that relatively large particles of smoke or soil are convected into the mass of gases as it cools, the radionuclides will deposit on the surface of large particles which will deposit within a few hours. It was important that this fraction of "close-in" fallout be better understood so that the dangers of nuclear war could be better understood.

William Harris and Harry LeVine, with typical HASL ingenuity, had reviewed the results of our failed oil slick experiments and had decided for the remainder of the CASTLE series to substitute styrofoam rafts that could be dropped in the expected fallout area, and could be surveyed from the air. They had calculated that a floating four foot square slab of styrofoam would be sufficient, and in the excitement of the weeks following BRAVO had no trouble in convincing the Air Force to supply a pair of giant C-97s to transport hundreds of the rafts of Kwajalein. Each raft was equipped with a radio transmitter that would broadcast a homing signal to assist the survey aircraft in finding it. My staff didn't bother to tell me about the plan, called Operation DUMBO, until I arrived in the Marshalls. The plan was well conceived but there was simply not sufficient time to develop all the details. After three weeks of frustrating trials, the project was abandoned.

In between tests of the feasibility of DUMBO, Morton and I caught up with the status of the Marshallese who had been exposed to fallout and, in turn, briefed our colleagues on the condition of the fishermen. Even on so somber an occasion there was time for fun and good humor. On the evening of our arrival a barbecue was arranged on an Eniwetok beach, and Morton and I were inducted into the "Eniwetok County Medical Society." He, being a physician, was made a full member and I, the non-physician, was inducted as an associate member. This was not my last visit to the Marshalls, but it certainly was my most memorable one. I had several days to visit a number of atolls on which HASL had installed radiation detection equipment. I was able to see first hand how the natives lived, played, and worked on their remote strings of islands that circled cobalt blue lagoons like necklaces. Each of the palm-covered islands rested on circular coral reefs that could be seen easily from the air

through clear turquoise water. It was particularly interesting to hover over the reefs in a helicopter from which could be seen the intricate surge channels carved through the coral by the pounding surf.

The most thrilling parts of my visits to the atolls were always the underwater explorations of the reefs. Scuba diving techniques were just coming into vogue and the lagoons were the perfect places for being introduced into the marvelous world of living coral and the dense populations of interrelated colorful creatures it supports. The water is so clear that one can see for forty or fifty feet as though looking through unpolluted air, although sometimes the diver is enveloped by great schools of multicolored fish, and when this happens visibility can drop to zero for a few seconds. The giant clams, waving purple mantles, intricate coral shapes, giant rays, and countless brightly colored fish all combined to produce an unreal sensation at being in another world. I have since had opportunities for underwater exploration in many other parts of the world, but I have never seen anything to match the beauty of those undisturbed Marshall Islands coral reefs, in water that must surely be as clear as any in the world.

During those few days of Eniwetok I had time to reflect on what had happened in the previous weeks. I speculated on why the AEC had taken so long to announce what had happened, and why the press releases were so misleading. I have never learned what happened, but I can only assume the AEC was unable to obtain the required agreements of other agencies such as the Departments of Defense and State. The fallout episode must have caused consternation at the Defense Department because they learned that it would be necessary to shelve the plans which, in the event of war with the Soviets, called for destruction of Eastern European air bases with megaton bombs that would create giant craters when exploded at ground level. They were building bombs they couldn't use! That is, unless they wanted to cover western Europe with lethal levels of fallout! The North Atlantic Treaty Alliance (NATO) had only recently been formed and was depending on the U.S. nuclear shield to defend Western Europe. What would be the effect on the NATO alliance of the knowledge that thermonuclear bombs could produce such heavy levels of fallout?

I also reviewed the experiences I had had with the nuclear weapons testing program during the previous three years. The sophistication of our fallout studies program had increased from analyzing hastily collected fresh snow in the Northeastern states after the report we received

from the University of Rochester, to measurement of the worldwide patterns of fallout, using sophisticated instrumentation of our own design and advanced radiochemical methods of analysis. We had been proved correct in our belief that the explosion of megaton bombs could cover thousands of square miles of territory with lethal levels of radioactivity.

Because the instrument we placed on Rogerik provided prompt notice that heavy fallout had occurred after BRAVO, the doses received by the American airmen and Marshallese natives were much less than would have been the case had we not alerted the Task Force to the fallout. Some of their lives had undoubtedly been saved, despite the delay in implementing emergency procedures.

Nuclear weapons were abhorrent to me, as they still are, but they existed and it was important that their effects be understood. Our studies were adding to that understanding, and perhaps the prospect that extensive areas of land would be blanketed with radioactive dust would be one more reason why nuclear weapons would never be used in war.

In early May 1954, after an absence of nine weeks, I returned to New York to assume my new responsibilities as manager of the AEC's New York Operations Office. I had been so busy that I had had little time to think about the day on which I had received the phone call from Tokyo, just as I was being offered the new position. I looked forward to it with mixed feelings. At the age of thirty-nine I was being promoted into one of the more important positions within the AEC. I would be involved in the administration of large-scale government research and development contracts and would have the opportunity to participate in the application of nuclear energy to civilian needs such as the production of energy and exploration of outer space. The immediate impact of this change in my career would be softened, however, by the fact that I would continue to serve as the director of HASL.

Professor EISENBUD. I call your attention to some of the key points in that book. One, the general lack of initial preparedness for fallout monitoring despite the experience after TRINITY. TRINITY was the test explosion in New Mexico in 1945.

That AEC recommended a standby evacuation capability for Operation Castle which the task force declined to provide as being unnecessary.

That had the instrument on Rongerik not been installed by HASL, there would have been no notification that the fallout was occurring with possible lethal consequences to both the Air Weather Service personnel and the residents of Rongelap.

That had the people of Rongerik and Rongelap been evacuated by air, which was perfectly feasible when the HASL report was first made, the doses sustained would have been greatly reduced with far less severe consequences to the people of Rongelap.

That the task force did not plan to provide a monitoring capability beyond Enewetak and Bikini.

Because of his concern for the safety of residents of the Pacific islands, Commander-in-Chief Pacific, CINCPAC, located in Pearl Harbor, requested that HASL undertake the monitoring program and supported it with aircraft, personnel, equipment, and communications.

That the task force support of the HASL program was limited to the single billet aboard the flagship for the use of the HASL coordinator. However, when the emergency arose, he was prevented from implementing the procedures which both JTF-7 and CINCPAC, and HASL, had agreed.

That the AEC public announcements, particularly with respect to the *Lucky Dragon*, left much to be desired, and this is discussed in detail in the pages I refer to you.

And that, most amazing to me, to my knowledge, there has never been a formal investigation of the circumstances that led up to the BRAVO tragedy.

In another few days, it will be 40 years since the events of March 1, 1954, but today is the first time that I have ever been invited to report on my knowledge of the events.

My prepared testimony is now completed, sir, and to the best of my ability I will answer your questions.

[Prepared statements of Professor Eisenbud follows:]

INTRODUCTORY STATEMENT BY PROFESSOR MERRIL EISENBUD
BEFORE THE
HOUSE COMMITTEE ON NATURAL RESOURCES

February 24, 1994

I am Merrill Eisenbud, Professor Emeritus of Environmental Medicine at New York University Medical Center, where I served for 26 years as Director of the Environmental Studies Laboratory. I went to New York University after a twelve year career with the Atomic Energy Commission where, for the most part of that period, I was Director of the Commission's Health and Safety Laboratory, located in New York City. For many years that laboratory was known by the acronym, HASL, but the name was changed in the mid-1970's to the Department of Energy Environmental Measurements Laboratory. I hold the degree B.S.E.E. and two Sc.D degrees (honoris causa). I am a member of the National Academy of Engineering, and an Honorary Member of the National Council on Radiation Protection, a Fellow of the New York Academy of Medicine, a Foreign Member of the Brazilian Academy of Sciences, and an Honorary Life Fellow of the New York Academy of Sciences. Since my retirement from New York University in 1985, I have resided in Chapel Hill, North Carolina. I currently hold the position of Distinguished Scholar in Residence, Duke University Medical Center, Division of Occupational and Environmental Health.

I began my career in environmental science in the mid 1930's nearly 60 years ago. At various times during these many decades I have been involved with research, teaching, and administration,

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in programs concerned with air and water pollution, occupational health, the urban environment, and both the ionizing and non-ionizing radiations. Environmental radioactivity has been a major interest of mine for many years. I published the first edition of a textbook called Environmental Radioactivity in 1963, the 4th edition of which will be published by the Academic Press in 1996. I have published more than 200 peer-reviewed articles in the scientific journals, and in 1990, my professional memoir, titled An Environmental Odyssey was published by the University of Washington Press. A little later I will request that certain pages from that book which relate to the BRAVO tragedy be entered into the record of this hearing.

For your purposes today, the period of my career that will be of most interest to you was from 1951, when I first became involved in studies of fallout from nuclear weapons tests, and the end of 1954, the year of the BRAVO explosion. It is important that I begin by telling you why HASL was organized, and how it became involved in fallout measurements.

When AEC was created by Congress in 1947 it was realized that there were many contractors, both in academia and industry that would require assistance in dealing with their problems in industrial and radiological hygiene. It was decided that an AEC laboratory should be created in New York to provide the required technical assistance to the many plants and laboratories under

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contract with the Commission's New York Operations Office. The assistance provided by HASL in the first years was mainly to the uranium and beryllium industries, both of which were confronted with serious health problems. To provide this help, a laboratory of high quality was needed together with a staff of industrial hygienists, physicians, physicists, engineers, and chemists who were willing to work under field conditions.

When the weapons testing programs began at the Nevada Test Site (NTS) in 1951, our staff was not initially involved in any way. We learned about Operation RANGER in the news broadcasts, just like most other people. A few days after the tests began, I received a call from Rochester that the Eastman Kodak Company had detected radioactive particles in the air intake filters of their film manufacturing plant. From telephone calls I made to Washington and the NTS I was amazed to learn that no fallout monitoring network had been established by AEC. This was obviously a major deficiency in planning since it had been known that fallout from the New Mexico test explosion called TRINITY in August 1945 had spoiled photographic film packaged with interleaving paper made from fallout-contaminated corn-stalks harvested many hundreds of miles from the explosion. As a result of that experience, the Eastman Kodak Company wisely adopted the practice of routinely monitoring its plants and laboratories for radioactive dust.

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We received that call on a Friday afternoon when it was snowing throughout the Northeast. Over the weekend we collected samples of snow throughout the northeastern states, and by early the following week we were able to draw a map showing the extent of the fallout. That experience was undoubtedly the first investigation of fall-out at great distances from the site of a nuclear explosion.

As a result of that experience HASL was requested by the AEC Division of Military Operations to prepare a national network of fallout monitoring stations. This network was extended worldwide in the following year. The collection system was operated on an unclassified basis, and the first summary of our findings was published in the journal Science, in February 1953. This was the first of many publications on the subject in the open literature and they are noteworthy because they show that AEC at that time was not attempting to conceal the fact that fallout of radioactive dust from test explosions was occurring.

Our early studies led me to become very much concerned about the possibility that lethal levels of radiation might occur at great distances from explosions in the megaton range of TNT equivalent. In addition to the global network of monitoring stations we then maintained, HASL requested and was granted, the assignment to monitor fallout intensively in the 200 to 500 mile annulus around the test site. We first undertook these studies

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in Nevada during Operation JANGLE in the Fall of 1951. This series consisted of two small explosions, one on the surface, and one just below the surface. My associates and I became particularly concerned about the levels of fall-out measured in northern Nevada, about 400 miles from the test-site. The measured fall-out intensities we measured were not so high as to be alarming of themselves, but they were the result of explosions equivalent in explosive yield to no more than about one KT of TNT. Since explosions more than ten thousand times larger were being planned for the tests in the Marshall Islands, it took but a simple calculation to show that very dangerous fallout might occur at great distances.

Using aerial survey methods of our own design, we undertook intensive monitoring of all the North Pacific atolls after the MIKE detonation in the Fall of 1952, but found no significant fallout. We concluded that whatever fallout had taken place was in the open ocean, in which the small atolls were thinly distributed.

We then began to prepare for CASTLE, scheduled to begin on March 1 1954. In the interim we had been consulting with Col. Lulegian, an Air Force meteorologist, who took quite seriously our concerns about the potential dangers from massive fall-out following explosions in megatons range of yields. He sent me a highly classified report he had prepared, in which he confirmed

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by rigorous analysis that what we had concluded almost intuitively based on our limited field experience: i.e. Lethal levels of fallout could occur at great distances from near-surface explosions of megaton weapons. For some unexplained reason, that report was recalled within days after I had received it. I have not seen it since.

What happened on March 1 1954 as a consequence of BRAVO is now a part of history, but the full story is largely untold. The fact that heavy fallout was occurring was first recorded about seven hours post-firing by a continuous gamma radiation detector placed by HASL in the care of Air Weather Service personnel on the atoll of Rongerik. The HASL representative aboard the Task Force flagship was immediately notified by radio. What happened thereafter is still a matter of mystery. There were delays in confirming that the fall-out had occurred and in measuring its extent. I was then in the New York laboratory, and was notified of the Rongerik report immediately. Thereafter there was a blackout of information for many hours. The reasons why aerial confirmation was not permitted and why prompt evacuation procedures were not implemented has never been explained.

My knowledge of the events prior to the explosion and immediately afterwards are summarized from my notes as well as official documents in An Environmental Odyssey. Of particular interest to you will be the material on pages 72 to 103, which

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also covers the effects of the BRAVO fallout on the Japanese fishing boat Fukuryu Maru (The Lucky Dragon). These pages have been made available to the Committee, and I request that they be included in the record of these proceedings. I call your attention to some of the key points made in my book:

1. The general lack of initial preparedness for fallout monitoring despite the experience after TRINITY.

2. That AEC recommended a standby evacuation capability for CASTLE, which the Task Force declined to provide as being unnecessary.

3. Had the instrument on Rongerik not been installed by HASL, there would have been no notification that the fallout was occurring, with possible lethal consequences to both the Air Weather Service personnel and the residents of Rongelap.

4. That had the people on Rongelap and Rongerik been evacuated by air when the HASL report was first made, the doses sustained would have been greatly reduced with far less severe consequences.

5. That the Task Force did not plan to provide a monitoring capability beyond Eniwetak and Bikini. Because of his concern for the safety of residents of the Pacific islands, Commander-in-Chief Pacific (CINCPAC), located in Pearl Harbor, supported the HASL program and provided supporting aircraft, personnel, equipment, and communications. The Task Force support of the HASL program was limited to a single billet aboard the Flagship for the use of the HASL coordinator. However, when the emergency arose, he was prevented from implementing the procedures to which both JTF-7 and CINCPAC had agreed.

6. That the AEC public announcements left much to be desired.

7. That to my knowledge there has never been a formal investigation of the circumstances that led up to the BRAVO tragedy. In another few days it will be 40 years since the events of March 1 1954, but today is the first time I have been invited to report on my knowledge of the events.

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My prepared testimony is now concluded and, to the best of my ability, I will be pleased to answer any questions you may have.

Mr. MILLER. Thank you very much.

Let me ask you with respect to the discussions that took place before the BRAVO shot about what the expectations were as to both the yield and what would happen with the radioactivity downwind or after that shot. What took place then? What was the context of those discussions?

Professor EISENBUD. Well, the context is broader than that and was referred to early. You have got to remember that these tests were conducted at a time when we were teaching our school-children to dive under desks to escape the effects of the nuclear bombs. I mean this was the overall context in which the tests were conducted. There was great urgency on the part of our Government.

My recollection was that the BRAVO test was going to be about the same size of MIKE, roughly 15 megatons. I have indications in my notes that confirm this, and I have requested many times over the years a letter of, I believe it was November 3, 1953, two months before the test, which provided me with the schedule of the tests and the yields. I have been unable to obtain that letter.

Mr. MILLER. So your testimony this morning is that this was not an unexpected yield. There had been the discussion of a yield of this magnitude.

Professor EISENBUD. I think this should be examined, and I have talked with your staff about this.

I want to add, however, that had the yield been twice what it was expected to be, it would not have had a greater difference in the consequences. Cloud height for a 6-megaton explosion I believe is somewhere around 80,000 feet, would be the top of the cloud, and for a 15-megaton explosion it would go to 110,000 feet. This is not a great difference. And the fallout pattern would, of course, be different, but I think it would be different to a degree perhaps sufficient to have made a difference in the early effects on the Rongelap people.

Mr. MILLER. But in terms of constructing what was given to the public after the shot—and after there was the realization that something publicly would have to be said because of the *Lucky Dragon*, that really appears to me spurred something to be said publicly—the suggestion is that there were sort of two components to this accident.

One was that there was a last minute shift in the winds. We just heard from the previous testimony that, in fact, there is documentation to suggest that that wind shift was anticipated; it was dealt with in one fashion or another, may or may not have been discounted, but the fact is, this was not something that just came out of the blue.

Now with respect to the yield, again, the suggestion was there that the yield was much higher than anticipated. Your testimony is, in fact, that that is not the case, that there was documentation of a discussion of a yield of somewhere around 15 megatons or more. Is that correct?

Professor EISENBUD. What I would say is that there is no reason why we should have to speculate.

Mr. MILLER. I understand that.

Professor EISENBUD. If we ever find that letter—

Mr. MILLER. This is the first of the hearings. Hopefully we will not have to speculate down the road, but at the moment we are trying to construct—

Professor EISENBUD. I repeat that the most amazing thing about this whole story is that there was, to my knowledge, no board of inquiry set up and no formal investigation conducted in Government, military and civilian.

If you have an accident that damages \$100,000 worth of equipment perhaps, injures a few people, you have a board of inquiry and a formal report. I know of no such report. I fully expected that I would be expected to testify before such a board. Apparently such a board was never constituted.

Mr. MILLER. If the Navy runs a tugboat aground, we have a board of inquiry. So we know the threshold is not high.

My concern is that Government officials use the term "accident" rather loosely. It is sort of an all-encompassing phrase to get you out of the room when you are trying to disclose to the public why something went wrong, and this kind of reminds me of the *Challenger*, the space shuttle. An accident, tragic accident, national mourning. But when we started to sift through what took place with the board of inquiry, we in fact found that the information was made available to the those people controlling the launch of the shuttle about the temperature, the problems, and some concern about the O-rings, but that was simply overridden. It was discounted. A determination was made to go forward with that, and later we found out that was unfortunately a fatal mistake.

Here, in fact, it appears that the parties had within their possession and their knowledge information as to the winds, information as to what might be expected of the flow of radioactivity, and in fact the expected yield and the resulting yield of the blast. So the accident isn't that this was unforeseen, the accident is that, when given the information, people made the decision not to react in a proper fashion to that information and to so discount it to allow them to continue on with an event that was already set in motion.

Professor EISENBUD. We are getting into semantics. If a young lady is walking down the street in high heels and trips because she was wearing high heels, that is an accident; but I might have warned that young lady well in advance that she should get rid of those high heels because she was going to have an accident.

I think that what we should say about the circumstances on March 1 was that those people running the task force apparently did not expect that there would be serious fallout. From my perspective, it was unavoidable.

It was an accident to the extent that it was an unforeseen event from the perspective of the people that were conducting the test. From my perspective, it was avoidable, and had they been lucky, it would have fallen into the ocean again, which was highly probable because the percentage of the ocean surface that is covered by atolls out there is very small, must be less than a fraction of 1 percent.

But I don't think we should get into the semantics.

Mr. MILLER. I think it goes to the issues of what transpires later, about a pure accident—and this is somewhat semantic—but with a pure accident you can start to discharge your obligations with re-

spect to that event rather easily because that is an acceptable term that was not avoidable.

But the question of whether people made decisions that may border on negligence or malfeasance then goes to what people think they have to do to save a reputation of a program or personnel or what-have-you for legal obligations that stem from those actions.

The public generally is fairly dismissive of an accident, but if the public finds out that people had information and said, you know, "Well, that doesn't matter, we are going to go forward," the public gets a little less dismissive and wants to know who is running the show here, as we found out again with the shuttle. We all of a sudden said, "Wait a minute, who is running the show here? Who had the decisionmaking capability? Why did they not bring this to another level for decisionmaking?"

There is a difference in the inquiry that takes place based upon what knowledge was available to people prior to their taking actions.

Professor EISENBUD. Normally, this would be determined by inquiry. That was done for the shuttle accident and should have been done for the BRAVO test, but I know of no such inquiry. I think I would have known about it had there been one.

Mr. MILLER. So far, there is no evidence that there was one.

Professor EISENBUD. One bit of information, sir. I think that as we look at this whole problem of classification, and I have got a feeling of *deja vu* here because some of you must remember that this question came up sometime during the reign of Chairman McComb as chairman of the Department of Energy, and he ordered all documents relating to health be declassified. Everybody scurried around for months, and they thought it was done. We are going through the same exercise again.

I think in many cases people don't even know where to look. Forty years is a long time, and with our personal affairs, we know what happens after just a few years when we try to find papers.

But let me try to simplify the problem. My feeling is—and I think that this will be discussed later by others, in particular Dr. Simon—that the information needed for purposes of risk assessment (namely, the levels of radioactivity, the extent of the fallout), I think that that information is probably available in unclassified form. In any case, if some of it is still classified, it could be easily retrieved.

I could certainly have helped at that, and it is interesting that apparently people have been looking for this information some months now. Had they come to me, I could have told them where to look and given them the name of one secretary that probably could have found it for them. That is one category of information, and I think that is the information that is of most concern to the people of Micronesia.

The other category is one of culpability and responsibility: What were the circumstances pre-shot? What were the weather forecasts? What were the predictions? Who voted to shoot, and who voted not to shoot? And why was there a several-week delay in informing the public what happened when the Japanese knew about it and were spreading the information all over the world?

The first meaningful statement was made, I believe, on April 9, and it was full of misinformation, particularly with respect to the fallout on the *Lucky Dragon*, which at that point I happened to be heavily involved in. I was in Japan trying to unravel the many problems that arose out of that fallout.

So I would differentiate between the secrecy associated with what happened on March 1 at the time of the shot and why my representative on the flagship could not send a telegram to Kwajelein to get his aircraft off the ground to Rongerik to confirm whether there was a fallout or not and why they didn't send flying boats in.

They sent flying boats in—but 24 or 26 hours late—to get the servicemen out, and they should have done the same to get the Marshallese out. I believe they sent an LST. That is why it took 50 hours to get them off. That should have been investigated. It should have been a matter of public record.

Mr. MILLER. Thank you.

Mr. de Lugo.

Mr. DE LUGO. Thank you, Mr. Chairman.

Professor, I think that when you were discussing the BRAVO shot and the after effects on March 1, the identification of heavy fallout, you said heavy fallout was occurring and it was identified seven hours after the firing by your health and safety organization. I believe you digressed from your written statement and you made mention of a message that was sent regarding this.

Professor EISENBUD. I didn't think I digressed at that point. The message was sent by the Air Weather Service personnel on Rongerik—

Mr. DE LUGO. Right.

Professor EISENBUD [continuing]. Was received by my representative, who was Alfred Breslin on the flagship, and he immediately put a prepared operating procedure into effect.

One of the first things he was supposed to do was notify me at our headquarters in New York, which he did, and then he was supposed to request the three aircraft assigned to him that were based on Kwajelein to confirm the fallout, and measure the extent of it, which we could do by aerial measurements.

I was later informed he was prevented from the use of radio facilities at that point for about a day.

Mr. DE LUGO. I believe you made mention of the message, and you said you still had the message. You don't have that in your statement, but I thought that you made that statement when you were reading that portion of the—

Professor EISENBUD. Well, the message I got was a military-style communication which probably exists in the file somewhere. I recall it. I don't have it. I am sorry.

Mr. DE LUGO. All right.

In your book you found the radiation level at Kwajelein about ten times the normal level. Is that dangerous?

Professor EISENBUD. I don't think so, no. No. Ten times the normal level would be—well, let's say we take as normal what it is on the sea coast of the United States. It is two or three times that in Denver.

Mr. DE LUGO. I just wanted to establish that in my own mind.

Professor EISENBUD. Particularly since it is going to be falling off with the short half-life.

Mr. DE LUGO. All right, Professor. You said that your recommendation for evacuation plans was not acted upon by the joint task force because the tests would not be conducted "if there was any possibility of fallout on the atolls."

Now since you clearly knew that there was a possibility of fallout, why was this explanation given to you? Why did they refuse to act on your warning?

Professor EISENBUD. Well, I think you would have to ask them. Again, this is a question that should have been investigated at a proper inquiry held while people were still alive. Unfortunately, most of the people involved in the decisions at that time are no longer with us.

Mr. DE LUGO. In your book you say, "Our staff was less optimistic and predicted that dangerous levels of fallout could occur for hundreds of miles downwind of the explosion," and you have stated here today that it was known that radiation levels were high seven hours after the firing, after BRAVO, and that the proper course would have been to evacuate by air the people of Rongelap and Rongerik.

Professor EISENBUD. Yes, an amphibious aircraft could have been dispatched from Kwajalein, confirmed that fallout had occurred within an hour, and probably gotten those men and the Marshallese out probably in the next few hours. I don't know how long it would have taken, maybe 2 or 3 hours, certainly not 50 hours, which is as long as it took for the Rongelapese to be evacuated.

Mr. DE LUGO. A comment that you made in 1956 about the people of Utiirik living on the atoll which was subjected to fallout has been widely quoted as being insensitive to the people in suggesting that the people were being monitored for research rather than health purposes. Is there a context that we should understand about that statement?

Professor EISENBUD. Yes. I had hoped it would not come up because this has come up repeatedly in the media.

Mr. DE LUGO. Well, I am giving you the opportunity to put it on the record.

Professor EISENBUD. I understand, and I have prepared a supplementary statement that deals with that. If I may, I would like to read it into the record.

Mr. MILLER. Sure.

Professor EISENBUD. I wish to place into the record my response to comments that have been made about a statement contained in an unedited transcript of a meeting of the Atomic Energy Commission Advisory Committee on Biology and Medicine in January 1956.

I had long ago forgotten about the meeting and had never seen the transcript until about 4 years ago when four of the 327-page record was made public by the Washington representative of the Republic of the Marshall Islands. That representative is here today. It is Mr. David Weiman who may wish to comment on what I am saying.

Since that time, it has been quoted in the media on a number of occasions and has been the subject of inquiries I have received from reporters during the past few days.

In one page, I mentioned experiments that were then being planned for the atoll of Utirik in the Marshall Islands. These experiments did not involve studies of the effects of the fallout on the health of the residents. We wanted to study the relationships between the amounts of fallout on the ground, the amount that is absorbed into food, and how that correlates to the amounts excreted in human urine.

This is the kind of data that is essential for purposes of risk assessment and by January 1956 was already being gathered by many countries in many parts of the world, including many places in the United States. The United Nations Scientific Committee on the Effects of Atomic Radiation, which was just being organized and had had its first meeting the month before, placed great emphasis on the need for such data.

The same quotation also made it seem that I was guilty of a cavalier reference to the advantages of data obtained from Marshall Island residents compared to mice. I have my own brief notes of the meeting which indicate that there had been mention of laboratory mouse experiments then under way in an AEC laboratory. However, the experiments did not involve fallout or the Marshall Islands in any way. The discussion of the mouse experiments was not on the agenda of the advisory committee meeting but might have taken place during a coffee break or at lunch.

The statement as it appears in the transcript makes no sense. It is somehow out of context. The exact wording of the transcript suggests that I referred to the mice involved in a specific experimental context and not in a generic sense.

After nearly 40 years, I have no way of knowing how to explain what appears in that transcript. However, I can appreciate why the reported statement, although out of context, may nevertheless have offended the people of the Marshall Islands. I regret that misunderstanding, and I apologize to them.

Mr. DE LUGO. One final question. Do you consider the resulting effects of the BRAVO test to be an accident, as was described by the joint task force, or given the fact that there can be no question that there was a high probability that there would be significant fallout from this test and that seven hours after the test the warning was given that there was a high fallout and yet there was no effort made to evacuate the people of the atoll, do you consider it an accident?

Professor EISENBUD. I consider it negligence. Whether it is an accident or not is a matter of semantics. As I say, if a person perceives it to be an accident, then it is an accident, just like the young lady in the high heels going downstairs. To me, if she falls because of the high heels, it is not an accident, she should have known not to wear them. But to the young lady, it was an accident.

This was an accident, I think, in a semantic sense. It probably could have been avoided, but, having happened, the effects could have been minimized.

Mr. DE LUGO. Mr. Chairman, no further questions.

Mr. MILLER. Mr. Faleomavaega.

Mr. FALCOMA. Thank you, Mr. Chairman.

Professor Eisenbud, I appreciate your testimony, and I just want to raise specifically my questions on the BRAVO test that was taken in 1954.

I think at the height of the Cold War because the Soviet Union had exploded a hydrogen bomb in 1953, I suppose this was part of the competition. We had to do something likewise; we were somewhat behind on the testing effort. I wanted to ask you, it is ironic that next week will mark the fortieth year of the BRAVO test which was exploded on March 1, 1954. Can you explain what is basically the difference between a hydrogen bomb and an atomic bomb? I know the two bombs that were dropped at Nagasaki and Hiroshima were atomic bombs. What is the difference? Is the hydrogen bomb more lethal than an atomic bomb?

Professor EISENBUD. It is bigger. There are two processes involved in the hydrogen bombs. You have fission, the splitting of plutonium or uranium from which you get energy, and you have that in both the atomic bomb and the hydrogen bomb. In the hydrogen bomb you also have a mechanism for producing high energy—

Mr. FALCOMA. By fusion, I know that, yes.

Professor EISENBUD. Through fusion, you produce high energy neutrons which then makes it possible to have a third stage of fission, and most of the yield of those megaton explosions of that vintage were due to fission in that third stage.

So from the point of view of the products of the explosion, there wasn't much difference. They both produce almost the same ratio of strontium to cesium to iodine and so on per megaton.

Mr. FALCOMA. But the magnitude of this BRAVO test that was conducted in 1954, was this considered the largest and most powerful hydrogen detonation?

Professor EISENBUD. Of course, it is debatable. I guess it was roughly the same magnitude as MIKE in 1952 so you could say it was as large as anything that had been fired up to that time.

Within a few years though, the Russians went as high as, I think, 70 megatons, and we went considerably higher than 15. I don't remember, maybe as high as 20.

Mr. FALCOMA. I didn't get from your testimony, were you physically present in the vicinity of the area where the testing took place, or were you in the United States?

Professor EISENBUD. I was on the flagship for MIKE but not for BRAVO. For BRAVO I was in our laboratory.

Mr. FALCOMA. And from your statement, you were not aware of the precautions those who administered the whole program had taken before the detonation of the BRAVO test?

Professor EISENBUD. I never saw the pre-shot briefings. Normally, as has been described, there were briefings at various intervals starting maybe 24 hours in advance, and I have never seen those documents.

Also, it ought to be a matter of record as to who voted to shoot and who voted not to shoot. I know from my visit out there, about six weeks after BRAVO I was there, and a number of people who were present at the briefing volunteered that they had voted against shooting.

Mr. FALCOMA. But was it a matter of voting or was it someone responsible had to make the final decision whether to take the shot?

Professor EISENBUD. The decision was made by the task force commander, who in that case was General Clarkson.

Mr. FALCOMA. Okay. Our whole program at the time was conducted by the Department of the Army. Am I correct?

Professor EISENBUD. It was conducted by a joint task force that had the Army, Navy, and Air Force personnel, and civilians from the AEC laboratories.

Mr. FALCOMA. Again, I guess the question: Was the Administration aware that the winds had shifted prior to the testing of the BRAVO?

Professor EISENBUD. I don't know. I don't know.

Mr. FALCOMA. And wasn't—

Professor EISENBUD. This should not be a matter we should have to speculate about.

Mr. FALCOMA. Well, that is why I am asking. I want to know specifically to your knowledge.

Professor EISENBUD. I do not know. I wasn't part of the task force. This is from my participation and the participation of my staff.

Mr. FALCOMA. Wasn't the usual practice at that time that the islanders would be evacuated prior to any of these tests?

Professor EISENBUD. There wasn't any established pattern. There were no evacuations for MIKE.

Mr. FALCOMA. But the islanders were evacuated at other times when the tests were conducted. But on this specific one, there was no warning, no efforts on the part of the Navy to evacuate the 278 people living on Rongelap?

Professor EISENBUD. My judgment, which was transmitted to the task force through the Division of Biology and Medicine in a memorandum which should be made available, was that there was no need for pre-shot evacuation, that it would be sufficient to have standby evacuation capability, because if you could get people off in an hour, they are not going—

Mr. FALCOMA. Were you aware that there were 28 Americans on the island of Rongelap at the time of the BRAVO test?

Professor EISENBUD. Yes.

Mr. FALCOMA. Were these Americans aware in any way by communication that perhaps telling the flagship that the winds are shifting and there should be reconsideration for the shot to take place?

Professor EISENBUD. I don't know. These were airmen attached to the Air Weather Service. They were meteorologists and technicians. I don't know how much they knew.

Mr. FALCOMA. I would hope that we do have records of those 28 Americans that were on that island on that date. We do have records.

Professor EISENBUD. Those records are available.

Mr. FALCOMA. Okay.

I have a book here, if I may, Mr. Chairman, just for a minute. It is a book written by Ms. Jane Diblin called *The Day of Two Suns*. It was published in 1988 by the New Amsterdam Book, and

I just want to quote a couple of things here I wanted to ask your opinion on. I quote,

The pale powder continued to fall late afternoon—this was, the tests had taken place—by which time it was about one and a half inches deep. The powder was one and a half inches deep on the island of Rongelap. Later it emerged that it was, in fact, a particle of lime which is calcium oxide formed with Bikini's coral reef. A formation of calcium carbonate, melted in the intense heat of the bomb and was sucked up and scattered for miles. The exact dose of radiation received by the islanders was never measured, but it was estimated that people on Utirik received 14 rems.

Professor EISENBUD. People on?

Mr. FALCOMAEGA. On Utirik people received 14 rems,¹ and those on Rongelap 175 rems.

Now the understanding here is that the International Commission on Radiological Protection recommends that a maximum permissible total body dose to a member of the general public be .5 rems. What does that mean in scientific terms? If my body is exposed to 175 rems after this explosion, what does this do to me?

Professor EISENBUD. If you are exposed to 175 rems, there is a high probability that you are going to show the effects of the acute radiation. You are going to lose some hair, you are going to show signs of nausea, you will become nauseated, your blood count is going to be affected, and perhaps others after me can testify as to what the risk of mortality is at that point. Certainly the risk of developing cancer in the future is increased.

Of course, the dose to the thyroid was very much higher than 175, as I recall.

Mr. FALCOMAEGA. It is 100 times over?

Professor EISENBUD. Well, I would not say \$1,000, maybe between 10 and 100.

I must put into the record something which I hope is known to the committee, and that is that all of these numbers have never been classified.

Did she say that there were no measurements of the radiation? That is not so.

Mr. FALCOMAEGA. They did not take measurements until after two days, and that was going to lead to another question.

Professor EISENBUD. But let me say that there have been a whole string of reports, mostly out of the Brookhaven Laboratory, dealing with the levels of exposure and the health consequences. I myself have had no trouble by 1963. Of course, that was nine years later, when I wrote the first edition of *Environmental Radioactivity*. I had a whole chapter on BRAVO and had access to plenty of information in the open literature.

I don't know of any information on health effects that was ever classified.

Mr. FALCOMAEGA. You stated earlier that these people could have been rescued in a matter of hours after the explosion. According to some documentation, they were not rescued until at least two or three days after the explosion. Why the delay?

Professor EISENBUD. Well, that is something that should have been the subject of inquiry. The airmen were taken off, I think, in 26 hours as I recall, maybe 28. They were taken off by air. The Rongelapese were removed by, I think, LST after 50 hours, and

¹ Roentgen equivalent man.

that was a dreadful error on somebody's part because they could have been evacuated. There were plenty of amphibious aircraft out there at the time. We used to use them in our work regularly. When we visited the atolls, we did it with amphibious aircraft and had no trouble getting in and out.

Mr. FALEOMAVAEGA. Thank you, Mr. Chairman.

Mr. MILLER. Mrs. Mink.

Mrs. MINK. Thank you, Mr. Chairman.

I am somewhat confused by your testimony because I think that much of what has been written and certainly the testimony of the prior witness and my own personal investigations indicate that there are justified conclusions by people that have been researching this whole matter of prior knowledge, prior information, failure to assess that information so as to prevent unnecessary hazards to people who were living in that area, and yet you insist in characterizing what happened after BRAVO as an accident.

I am confused. How could it possibly be an accident of misery or tragedy that occurred on these people if there was the possibility of forewarning to the Government that could have prevented this tragedy from having occurred?

Professor EISENBUD. I am being drawn into a semantic argument.

Mrs. MINK. No, it is not a semantic, it is a very important argument. You insist that information that has heretofore been kept classified and secret is available to you. My question is, Have you attempted to make an inquiry of the Government for yourself, as other individual investigators have done, to determine the extent to which the Government should have known that hazardous conditions did exist at the time that would indicate that there would be a very dangerous fallout on the people of the Pacific islands?

Professor EISENBUD. The predictions by some people, including myself and Colonel Lulegian, and there were others, was that the danger that massive fallout could be lethal, even out to hundreds of miles, was very real.

At the time, not everybody believed it. There were reputable physicists who said that this explosion was going to be so big that it would blow the radioactive particles into outer space and that would never come back to Earth. I am serious. That is what some people believed. I didn't believe that.

Mrs. MINK. But you believed that there was a sufficient hazard to the people there from the dangers of fallout.

Professor EISENBUD. That was why I recommended a standby evacuation capability. I didn't see the need for evacuating them for a period of two or three months, whatever would be required. I thought that either boats—

Mrs. MINK. So if you believed firmly that that possibility existed when the bomb was detonated and the fallout occurred and the hazard was put upon the people out there, that is not an accident. That was something you could have foretold from your own personal conclusion, and that is all I am asking you to do today. I am not asking you to make a conclusion on behalf of the Government. I am asking you to render your best conclusion insofar as the information you had at that time and the expertise that you possessed at that time.

Professor EISENBUD. If you review the things that I have written on the subject, Mrs. Mink, I don't think you will find many places where I have said that it was an accident.

Mrs. MINK. I am only referring to the record that you are creating today, and I want to make sure that the record states precisely what your belief was at that time and as you are reporting it to the committee today.

Professor EISENBUD. I believe it was an accident just as the shuttle *Challenger* event was an accident. The *Challenger* accident could have been prevented, and this could have been prevented. That is as far as I will go.

Now, I have heard suggestions that perhaps this test was conducted under the conditions that existed because somebody wanted to conduct an experiment, a human experiment. There is no evidence to that. There is no reason for it. It would be a cruel thing to accuse anybody of doing, and the information was not needed.

Unhappily, as a result of the events in Japan, there were about 100,000 survivors of the two bombings that provided enough material so that we knew quite well what the effect of radiation was. It is inconceivable to me that there would be anybody in a position of responsibility who would want to conduct an experiment of this kind. It would be murder. It wasn't done.

Mrs. MINK. Well, Mr. Chairman, I don't quite know how to assess the witness's answers on his definition of an accident.

However, I do want to note for the record, Mr. Chairman, that as one who wears high-heel shoes, I don't consider it my fault if I should stumble on the sidewalks of the District of Columbia.

Thank you.

Mr. MILLER. Professor Eisenbud, let me ask you a question following on to that. The Lulegian report that you referred to, this report more or less predicted what later occurred. Is that a fair characterization of that?

Professor EISENBUD. It concluded that megaton bombs exploded so close to the surface that the fireball would touch the ground, would be capable of producing radiation for thousands of square miles—lethal radiation for thousands of square miles—and this was what we had been saying simply by extrapolating the information we gathered after the Jangle test in Nevada. But we did not have the technical expertise to really go at it in an organized, scientific way. Lulegian agreed to do it for us, and he came to that same conclusion.

Mr. MILLER. So the genesis of his report was what? You asked him to do this or to take this into consideration?

Professor EISENBUD. I wouldn't say we asked him to do it, but we had many discussions with him. We sort of used him as an advisor, and he decided to take a good look at it and put out a report, which I have the number of. It is ARDC, Report C3-36-417, classified secret November 1953, and I don't understand why that report can't be made available and why nobody seems to know that it exists.

But again, we should not be speculating about these things 40 years later. The culpability is in those people who decided not to have a formal investigation.

Mr. MILLER. I understand.

What was the circulation of that report, to your knowledge?

Professor EISENBUD. Oh, I don't know. I got a copy, and then it was recalled.

Mr. MILLER. Recalled by?

Professor EISENBUD. I remember it was somebody from Los Alamos, but I can't be more specific than that.

Mr. MILLER. From the AEC.

Professor EISENBUD. From the AEC laboratory.

Mr. MILLER. Was that report intended to be circulated to members of the joint task force, do you know?

Professor EISENBUD. I don't know. I had heard afterwards—

Mr. MILLER. Why did you get it?

Professor EISENBUD. Why did I get it? Because I had been having discussions with him, and I think the motivation was the studies that we were conducting—

Mr. MILLER. Do you know of anybody else that got it.

Professor EISENBUD. Let me just complete this, sir.

The motivation for what we were doing—and we were putting a lot of effort in that that could have been devoted to other things—was that we felt that we needed to find out, the world needed to find out, whether these bombs could be used in the way they were planned to be used.

Mr. MILLER. You say we. I assume you are referring to the HASL organization.

Professor EISENBUD. HASL, supported by the Division of Biology and Medicine.

Mr. MILLER. Did other members of the HASL organization get a copy of this report?

Professor EISENBUD. They wouldn't have gotten a copy, but they would have read it, probably three or four people who were my immediate associates.

Mr. MILLER. Do you know that that is the case, that others within HASL read it?

Professor EISENBUD. It is 40 years later. I don't know.

Mr. MILLER. Was it sent to the organization? Was it sent only to you? I am trying to determine whether there were other people who would have, in fact, read this report, because this apparently was a matter of general discussion—What can we expect if we detonate it in the following manner?—is what you were saying.

Professor EISENBUD. It was sent to me, and I read it, and I don't remember my reaction except that I know, because it made such an impression on me, I probably would have called my immediate branch chiefs in and reviewed it with them, but I don't remember that I did that.

Mr. MILLER. So you haven't had subsequent discussions about that report with others who were involved in HASL or in the general discussions of the impacts of various types of detonation.

Professor EISENBUD. Oh, we had much discussion about it because it influenced what we—

Mr. MILLER. Did you discuss this report? Did you six months later or a year later or ten years later with your colleagues, did you say, "Gee, you know Lulegian said this, that or the other thing"? I mean was this report a matter of comment?

I appreciate it was recalled, but did people understand the contents of it in terms of discussing what may have been expected or not expected or how you would modify this report based upon what you subsequently learned within the field?

Professor EISENBUD. It definitely affected our planning for Castle. Mind you, his report was right after Mike, and we were beginning to plan for the Castle, and it affected our planning. Our plans were just that much more sophisticated. Do you want me to go into that?

Mr. MILLER. Well, I think it is important because, again, I am looking at your background and your training, and apparently a question was raised about what would our expectations be if we continued to detonate bombs in a certain manner, and then a report was written, and then it went into your planning process.

Now whether or not that was followed through with or not is a different issue, but the report had some currency in discussions among people who were scientifically involved in constructing the tests?

Professor EISENBUD. Very much so, and I remember discussing the implications of the Lulegian report with field grade officers and perhaps one or two admirals at the CINCPAC headquarters in Pearl Harbor.

Mr. MILLER. And the purpose of those discussions was?

Professor EISENBUD. Well, it had been explained to us—and I may not be legally correct on this—but it had been explained to us that the Marshall Islands were assigned by the United Nations to the United States for administration and that within the United States Government the Commander-in-Chief, Pacific, a military person, had responsibility for the security of the natives.

I use that word again, but they were natives, natives of the Marshall Islands. I am a native of New York and North Carolina.

And when we had our first discussions with CINCPAC prior to MIKE, it was on the basis that there could be no assurances of the safety of the people not only on the Marshall Islands but the Carolines and even out as far west as Guam unless there was a very sophisticated monitoring program installed, and he agreed to support it. The task force did not see the need for it, and we were just as happy because we got good support from CINCPAC, and it worked very well.

I should explain what we did at HASL because it has some relevance and emphasized the urgency that we saw in the Castle series.

We had mixed feelings about Castle. We, of course, didn't want to see any fallout on the atolls. But we knew that if the same thing that happened as happened at MIKE, all of the fallout went into the ocean, this enormous expanse of ocean between the atolls, that we would not get the information that we needed, and we conceived the idea of spreading oil slicks on the surface of the ocean downwind of the blast. We would wait for the test, see which way the cloud was going, and then we would fly in and dump oil on the surface of the ocean and allow the fallout particles to collect on the oil so that we could then fly over the oil slicks with our scintillometers and make measurements. We had trouble finding oil that had the properties we needed, and the reason I stayed in

New York and didn't go forward to the Marshall Islands was that I felt it was very important that we carry on that experiment which was under way on both coasts of the United States in the ocean up to the last minute. As it turned out, we didn't need the oil slicks.

Mr. MILLER. The oil slicks which didn't turn out and the discussions with CINCPAC were moving forward from the Nevada test and your New York experience and the recognition of no monitoring, and yet radioactivity is showing up at least across the country from Nevada to New York. I think you said in Iowa that this was happening, so you said, "We need a monitoring program."

In the discussions with CINCPAC where they said, "Fine, we agree we should do this," because you were thinking this could conceivably go as far as Guam or elsewhere, the discussion of that and of the type of device to be detonated was clearly an ongoing discussion of the potential of really substantial amounts of radiation traveling very, very long distances.

Professor EISENBUD. That was what motivated our interest in it. Actually—

Mr. MILLER. What I am trying to determine here is not that you tied down every corner—recognizing that you were dealing on the frontier of a lot of knowledge here about what to expect—I mean we look backwards and say that was one hell of a lot of explosions, but at the time, you were at the front end of a series of tests. You are not looking back 40 years; you are there at that moment.

But this was not a surprise that radioactivity would be carried long distances. You didn't know whether it would turn out to be so, but apparently there was the discussion that this was clearly within the possibilities and then started taking actions based upon that to determine kinds of monitorings and what you might do to collect the data so you would know whether or not that was so.

Professor EISENBUD. We were concerned about two kinds of fallout. It was recognized by 1952 that there would be worldwide deposition of fallout particles. It may seem cruel 40 years later to even discuss it, but there was a Project Gabriel that was carried on for some years, starting I think in 1946, to answer the ugly question of how many atom bombs could you explode before you contaminated the world so badly that everybody was going to get cancer. It doesn't seem possible that there could be such a study, but there was. HASL took the theoretical calculations and put them into practice by establishing a worldwide network so that we could make measurements throughout the world.

This is a different kind of fallout than the fallout that occurs within a matter of minutes or hours after the blast of very high level fallout. It was that kind of fallout about which there was considerable argument.

Not everybody agreed with me on what my view was, but my experience came from two tests. The TRINITY test was about a 15-kiloton test from a tower which produced particles that burned cows some miles away and contaminated cornstalks in Iowa which were then processed by Eastman Kodak into that black interleaving paper that goes between x-ray films, and the films came out spotted. I have got a sample with me if you want to see it.

Mr. MILLER. I guess my point being that this wasn't a matter of first impression with the BRAVO detonation and what happened after that; this wasn't all hindsight. There were theoretical discussions going on prior to and in the construction and the design of the test and of the monitoring that fallout could travel long distances and may, in fact, have harmful impact and that we ought to know that.

Professor EISENBUD. Certainly, and the astonishing thing, as I said earlier, was that having had the TRINITY experience and knowing that they were going to explode nuclear bombs on towers or air bursts relatively low to the ground, it is astonishing and inexplicable that at least a nationwide monitoring program wasn't in place by the time they started.

Mr. MILLER. Thank you.

Any further questions?

Congressman Evans.

Mr. EVANS. Thank you, Mr. Chairman.

Professor Eisenbud, you stated that there was no need for such human experimentation because there was significant data from Hiroshima, but that was an atomic test. Wouldn't BRAVO, being the first hydrogen bomb being detonated, wouldn't the effects of the radiation fallout from that test be the first important scientific data we have concerning fallout and other health impacts as far as hydrogen bombs were concerned?

Professor EISENBUD. There is not a significant difference between the kind of radioactivity produced by the hydrogen bomb and the nuclear bomb. There is some difference, but it is not a significant difference.

Mr. EVANS. How did we discover that there was no difference, or virtually no difference?

Professor EISENBUD. Well, on theoretical grounds, most of the bang from the thermonuclear bombs comes from fission, the difference being that it involves fission uranium-238 rather than uranium-235, and the distribution of fission products that are produced by the two mechanisms was known.

Now having said what I have said, let me say that there is another difference between the Japanese experience and what happened on BRAVO, and that was that the Japanese did not sustain fallout. These bombs were exploded high in the air, and there was essentially no fallout at either Hiroshima or Nagasaki. There was some, but it resulted in very small doses.

At BRAVO, we had the combination of about 175 rem of external exposure plus the concomitant exposure from internal emitters. These are the radioiodine and the cesium that gets inside the body and irradiates the body from the inside.

Mr. EVANS. So there was significant data collected in these tests at Bikini in terms of fallout for whatever reasons they might have been conducted for the purposes of gathering data, if that was one of them; there would have been significant in terms of the return of information that was received.

Professor EISENBUD. There was very valuable information obtained after BRAVO. Whether it is an accident or an act of nature or deliberate sabotage, generally there are lessons to be learned,

and people would be remiss if they did not go in and get whatever scientific information that can get out of it.

Mr. EVANS. You basically indicated that data was sufficient from Hiroshima and Nagasaki, I take it, for purposes of determining the impact on human beings.

Professor EISENBUD. The data from the Japanese experience was much more meaningful because the numbers of people were very much larger.

Mr. EVANS. Except for fallout.

Professor EISENBUD. Except for fallout.

Mr. EVANS. Which is a pretty important reason to be conducting tests, I would assume.

Professor EISENBUD. I think I am trying to differentiate between what one does after you have the fallout. You say, "Well, these poor children have had 1,000 rem to the thyroid; we had better have a medical team monitor them to see what is going to happen." Now that may produce new scientific information, but the initial motivation, hopefully, is that you want to look after the health of those children so that, if there are signs of their developing nodules or premalignant changes, necessary intervention can be arranged.

Mr. EVANS. All right.

Thank you, Mr. Chairman.

Mr. MILLER. Thank you very much for your testimony, Professor Eisenbud.

As I predicted, we are running into a time problem. I am going to combine panels three and four to make sure that we can get all of this testimony on the record, before we start to get disrupted by votes and the committee has an opportunity to question these.

So I would ask Mr. David Weiman, and Howard Hills and Dr. Thomas Hamilton, Dr. Steven Simon, and Dr. Edward Radford to come forward, please, to the committee. This is occasioned both by the fact that people have irrevocable travel plans and we are about to start Floor consideration of the education bill.

As you can see, the questions are numerous, so to the extent to which you can please summarize your testimony to the points that you think are most important for this initial hearing. We will obviously be following up with additional questions by the committee and by all of the Members.

Mr. Weiman, welcome to the committee.

PANEL CONSISTING OF DAVID M. WEIMAN ON BEHALF OF THE PEOPLE OF RONGELAP; HOWARD L. HILLS, ESQ.; THOMAS E. HAMILTON, M.D., CHIEF OF ENDOCRINOLOGY, DEPARTMENT OF MEDICINE, PACIFIC MEDICAL CENTER, SEATTLE; STEVEN L. SIMON, PH.D., DIRECTOR, NATIONWIDE RADIOLOGICAL STUDY, REPUBLIC OF THE MARSHALL ISLANDS; AND EDWARD RADFORD, M.D., CONSULTANT TO THE PUBLIC ADVOCATE, NUCLEAR CLAIMS TRIBUNAL, REPUBLIC OF THE MARSHALL ISLANDS

STATEMENT OF DAVID M. WEIMAN

Mr. WEIMAN. Thank you, Mr. Chairman. It is a pleasure to be here.

For two and a half years I represented the people of Rongelap, between 1988 and 1990. What I am presenting to you today are some of the results of research I completed at the end of 1990 and gave to Rongelap.

This is an important hearing, and today your real constituents are the afflicted, the powerless, the irradiated, and, Mr. Chairman, a group of people who are uninformed.

During my work for Rongelap, one of the things that we subsequently discovered is that medical and environmental programs in the Marshall Islands, established years after the BRAVO test, were being managed inside the Department of Energy by the Weapons Division. The Weapons Division was making medical and environmental decisions, management decisions, budget allocations, about what would be done and what wouldn't be done.

Secretary Watkins in the Bush administration found this unacceptable, and he transferred the program. Senators Nunn, Warner and Exxon and others in the Senate, Senator Glenn in particular, found it unacceptable and put an amendment on the 1990 DOD bill. The program was transferred.

As a result of that revelation, Senator Anjain asked me to begin looking at other programmatic aspects of the program. I began a search that took me through tens of thousands of pages of historical documents, and at this point I want to pause and say particularly to Mr. de Lugo and to this committee condolences for Pat Krause. Pat was one of the members of this staff who greatly assisted my effort. Senator Glenn's committee, Mr. Chairman, Dan Beard, and the staff here, Ms. Doherty, and others were very instrumental several years ago in helping to assemble a body of information that we went through. We went through page after page, and during that search one of the things that we found was this. All the discussion this morning has been on BRAVO. BRAVO was one of 66 tests, and most of the literature will have you believe that the only off-site fallout came from BRAVO, and that is simply not the case. The BRAVO cloud went further, it exposed more people, it contaminated more land, and a lot of that, most of that, has remained undisclosed as of 1994.

The Department of Energy's official position as to who got what is found on the basis of a 1978 survey. Within a year of that survey President Kabua of the Marshall Islands came to the United States and had a meeting down at the Interior Department with the U.S. Government. He said, "Our people don't believe that only 13 atolls got hit." That was a 1978 survey, and his concerns were expressed in 1979. The Department of Energy was firm, only 13 atolls.

One of the things we found in the files was a draft report done in 1973 that indicated 17 or 18 atolls got hit from BRAVO alone, but more tests produced off-site fallout. The real question is not where did BRAVO go. That is a question but the real question is, What is the footprint, the radiation footprint, the fallout footprint, from the entirety of the tests?

In 1982 the Defense Department published a history of the Castle series. It has got a table in there, and instead of 13 atolls and islands, there are more than double that listed as having received some off-site fallout. We know about the acute fallout. We know about Rongelap. We know about Rongerik. We know about

Ailinginae. We know about Utirik. Those have been well established in the literature, but it is incomplete. All of the maps they show you, report after report, they show a picture of the fallout cloud.

But, Mr. Chairman, that cloud is frequently listed as the intermediate boundary, if it is listed that way at all. We never get to see the entire boundary. One of the interesting things about the planning documents for the 1978 survey, they acknowledge that seven or eight of the tests had fallout, and in the planning document they show the BRAVO fallout cloud. They have six other tests; no fallout pattern is shown for them. Why is that withheld?

But that survey led to something that happened in this very room. In this very room, this committee approved enabling legislation for the Compact of Free Association. Mr. Weisgall earlier referenced article 8. Article 8 is very important in today's discussion because it is your yardstick. We can talk about bombs, and we can talk about fallout, but you have got to have a yardstick. The yardstick was this committee. The people of the Pacific, the people of the Marshall Islands, they were told everything that there was to know, and that is simply not true. The U.S. Government knew it not to be true at the time, and the supporting evidence of that is found in scores of memos, letter, documents, and other things.

Right after the Castle series—the Castle series concluded in May of 1954—eight weeks later there was a conference. The conference was convened here in Washington, DC. There was a 250-page transcript from that conference, and it is a veritable Who's Who of the AEC at this conference. They sit and discuss what studies they will make about the Castle series, and in the course of the transcript there is a discussion about taking a body counter out to the islands to deal with the Marshall Islanders who received fallout. And they said, "Well, where can we put it?" And there is some discussion about that, and it ends up with a comment that, "Majuro got a pretty good sock." Well, the significance of that is, Majuro is never listed as an atoll as having had fallout.

Last night we saw on ABC an interview with a woman in New England who was a young woman at the time in Kwajalein. The significance of what you saw on television last night is, Kwajalein is listed as not having had fallout. But Kwajalein is where they evacuated the victims to. So we are taking people who were irradiated acutely, and we take them to an area that itself received fallout. Then three months later Utirik people go back to Utirik, and three years later the Rongelap people go back. They live in a chronically contaminated area now.

Now the interesting thing about the 1978 survey is that at the very time this survey took place, and the need for this survey was recognized, scientists within the AEC at Brookhaven National Laboratory were looking up and they were troubled. Why were they troubled? Because about nine years after BRAVO the first thyroid cancers and thyroid abnormalities showed up. This was not supposed to happen. It was unexpected. That is acknowledged in the literature. In laymen's terms I will characterize it as the first spike. Six years later, where the doses were still lower at Ailinginae, a second spike occurs, and in the mid-1970s at Utirik

a spike occurs. It is very upsetting in the Marshalls, and it is very troubling.

The Brookhaven team assembles, and they ask the question, maybe, just maybe, the fallout went to a different place. Maybe the cloud was a little different. Maybe the direction of BRAVO and some of the other tests—and they begin a study. None of this is disclosed during the compact negotiations, none of it.

This study goes on for eight years, and, coincidentally, does not get completed until March of 1985 at the very time that Chairman Seiberling in this very room is getting ready to move the enabling legislation for the compact.

And what did that study conclude? The dose assessments for Rongelap and Utirik for thyroid were 10–100 percent higher. The question turns, what about the people in the outlying zones? We now know that people out there were getting hit, and if we understate in 1978, 1979, and 1980—and, coincidentally, this is exactly when in the compact terms the negotiations began. This is exactly when they started to figure out what to do with the nuclear claims settlements, but this information is withheld. This information is not advanced.

One of the things we saw in a recently declassified document—we knew about Rongelap, we knew about Utirik, we didn't know about Ailuk. Yet in 1954, six weeks after the test in the official memorandum of the record—which I obtained about three years ago from the Defense Department, it was still classified in 1985 when the committee was considering the compact legislation, and it wasn't declassified until later—there is another populated atoll that is acknowledged to have received fallout, Ailuk.

But they made a decision, they made a decision. There were too many people to evacuate, so they didn't. They made a medical judgment at the time that they thought that the doses those people would receive over time would be medically insignificant. But over time those doses were larger than the people at Utirik got. They never go back when the Utirik spike occurs. They never go back. To this day, I don't think that has happened.

March of 1985 is a very interesting month because it is also the month—and I don't want to preempt Dr. Hamilton's statement—but that month a confidential statement he writes based on his medical work two and a half years in the Marshalls in looking at 7,000 people, that comes to this committee.

Chairman Seiberling takes the confidential statement, which raises the specter that the cloud went the wrong way, it went further than admitted and exposed more people than acknowledged. The chairman takes that letter, that confidential statement, and he sends it down to the Interior Department and to the DEO negotiators. They write back to the committee in April of 1985, "I'm sorry, we can't comment. We can't comment because there is pending litigation and the physician was hired by the litigants."

If the Department wasn't on notice from its own file material, it was surely on notice because of what the people, the Marshall Islands victims community, provided this committee, and they chose to do nothing. They chose to ignore this body of evidence, and today because of that there was a special provision added to the compact at the last minute. The Marshall Islands Government got special

funds to conduct their own radiological survey. You will get the report of that subsequently.

Mr. Chairman, you asked how did some of this all happen and how did it happen in the compact? Well, there is a very interesting little correlation. The individual within the Department of Energy who was overseeing the Brookhaven study and deciding that this would somehow be a seven- or eight-year study was a man named Roger Ray. He is here today. He is in the audience. The same person was assigned by the Department of Energy to the compact negotiations team. So the very person who is making a recommendation on claims settlements is also in charge of the studies that reveal that the clouds go further. That information never makes it out on the table, notwithstanding the victims stepping forward and saying, "We don't believe it," notwithstanding President Kabua, notwithstanding Phil Burton, notwithstanding Mo Udall, notwithstanding John Seiberling, notwithstanding Ron de Lugo, and now yourself. This committee asked; they asked the right questions. The people asked the right questions, and they knew they weren't getting straight answers.

Mr. MILLER. We need you to wrap this up so we can give this panel its due time.

Mr. WEIMAN. Whatever BRAVO was, BRAVO was not an accident.

One of the things we also found—Mr. de Lugo made reference to it earlier—was the Pate-Palmer report. You were asking Professor Eisenbud a lot of questions about the decisions associated with the BRAVO test. Let me take just a quick moment to tell you about that report.

In 1953, eight months prior to BRAVO, a report is made directly to the commander of the joint task force, and this is by weather experts. They said, "Folks, you don't have a clue about the tropical weather patterns, and when you explode or detonate a thermonuclear device, you could lose control of it. It could react with condensation in the atmosphere, and you could lose control of this thing."

That report was circulated; it was criticized. That was written in June of 1953, eight months before BRAVO on December 21. Christmas Eve, 1953, there is a letter from the commander of the task force, General Clarkson, to Al Graves, I believe, at Los Alamos. He says, "Look, when I disagree with my staff"—I am characterizing now; the committee has been provided a copy of the report and these letters—"I think we should recall all the copies, stick it in the file, and kill it," and they do. It disappears, and interestingly enough, in some of the histories that are discussed about what happened, we see nothing about that.

Mr. Chairman, I had the pleasure and the privilege to represent Jeton Anjain for two and a half years. He died last year of cancer, and in many ways I think this hearing today and the reason we are gathered here today, all of us, is as much to do with the work of Jeton Anjain and his belief that he was not told the truth. He demanded to know more. He was not told more.

He would come here frequently, and he would testify before Congress. In the private conversations that I would have with him, he knew that he could not change BRAVO, he knew that for his gen-

eration BRAVO was fixed in history and was fixed in their bodies for whatever would happen, but he cared about the children. He cared about the future. Every statement that Jeton Anjain gave to Congress ended with, "I thank you, Mr. Chairman. I thank you on behalf on Rongelap and especially the children."

Jeton Anjain is not here today, so, Mr. Chairman, on his behalf, on behalf of him for all the Marshallese people, I thank you, especially for the children.

[Prepared statement of Mr. Weiman follows:]

DAVID WEIMAN
SUMMARY KEY FINDINGS AND IMPLICATIONS

1. FALLOUT

- (a) Fallout extended further, exposed more people, contaminated more land than ever admitted by DOD or DOE.
- (b) DOE never displays or reveals "radiation footprint" fallout pattern of all 66 tests (critical for establishing who might have received fallout).
- (c) Approximately one-in-three of 66 tests created offsite (other atoll) fallout at some level.

Findings supported by:

- DOD and AEC/DOE file materials, studies, reports, letters, memos and other documentary evidence
- Radiation measurements by ships, airplanes and hand-held meters, as reported in DOD reports
- Medical analysis (Dr. Hamilton, 1985)
- Medical prediction (Conard, 74)
- Testimonials (first hand accounts)

2. UNDISCLOSED CLASS OF RADIATION VICTIMS IN MARSHALL ISLANDS

- (a) Entire generation of nuclear orphans in the Marshalls.
- (b) Risk never evaluated, medical condition never ascertained.

3. COMPACT OF FREE ASSOCIATION (1986)

- (a) US, in Compact with Marshall Islands, declares full disclosure about radiation from atomic testing program, but US declaration false, and US either knew it to be false or had responsibility to know it was false.
- (b) US lied to UN, Congress, Marshall Islands Government and public.

4. BRAVO TEST – SUPPRESSED WEATHER REPORT

- (a) DOD killed, at highest command level, weather report warning of weather-wind risks 8 months prior to Bravo.
- (b) H-Bomb test Commander recalled report and it remained classified until recently.

5. 40th ANNIVERSARY OF BRAVO COVERUP

- (a) March 1, 1994, 40th anniversary of Bravo test.
- (b) Story remains incomplete.

6. IMPLICATIONS

- (a) Thyroid disease among "unexposed" Marshallese population not anticipated.
- (b) Opportunity to avoid thyroid disease – early detection -- ignored by DOE.
- (c) Integrity of Compact threatened.

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STATEMENT OF DAVID M. WEIMAN
ON
MARSHALL ISLANDS RADIATION
BEFORE THE SUBCOMMITTEE ON OVERSIGHT AND
INVESTIGATIONS
HOUSE COMMITTEE ON NATURAL RESOURCES
February 24, 1994

The invitation to appear before this Committee is appreciated.

Mr. Chairman, you are to be commended for holding this hearing -- on the eve of the 40th Anniversary of the infamous Bravo thermonuclear test. The nation and the world owes you and this Committee an enormous debt of gratitude. This investigation is one of the most important to be undertaken by the 103rd Congress. Today, the afflicted, the powerless and the irradiated are your constituents.

Rongelap Representation. From 1988 until 1990, I represented the Rongelap Atoll Local Government and its leader, Senator Jeton Anjain. Throughout this period of representation, the Department of Energy vigorously opposed Rongelap's work. An atoll government -- for the members of this Committee not familiar with the Pacific -- is, politically, roughly equivalent to a State. My client relationship ended October 1, 1990.

65,000-Page Review. During the course of my work for Rongelap, historical materials from the Department of Defense (DOD) and the Department of Energy (DOE) were extensively reviewed -- approximately 65,000 pages of documents. What I am presenting has been taken from this large body of information. In addition, a series of interviews with individuals who participated in the Pacific testing program -- at the time or since -- was conducted.

Bravo Fallout Pattern Bigger than DOE Ever Admitted.

FALLOUT FROM THE MARCH 1, 1954 "CASTLE-BRAVO"
TEST WENT FURTHER AND DIRECTLY EXPOSED
MORE PEOPLE AND CONTAMINATED MORE LANDS
THAN AEC/DOE OR THE MILITARY'S JOINT TASK
FORCE 7 EVER ADMITTED. THE IMPLICATIONS
TODAY -- MEDICAL AND POLITICAL -- ARE FAR-
REACHING.

Fallout "Footprint" – All Tests – Bigger than DOE Ever Admitted. Offsite fallout occurred (fallout on atolls outside the test site), not just from Bravo, as most of the official literature indicates, but perhaps from more than one in three tests (20-25 of the 66 tests), according to DOD and AEC/ERDA/DOE files.

Medical Controls Likely "Exposed" to Fallout. Immediately after Bravo in 1954, when AEC/DOE established the medical program, it created medical "controls" -- a group of individuals, similar in age and sex, but who were not exposed to fallout, for purposes of medical evaluation. The "unexposed" class of individuals, however, were selected from atolls which likely received some exposure to radiation directly from fallout or were individuals who lived in contaminated areas after the tests. In other words, the medical controls were themselves "exposed." The medical evaluations over forty years, at the very least, are, understated or otherwise compromised.

DOE and DOD Fallout Records Unavailable At Time of Compact. According to DOE and DOD documents and records unavailable at the time (a) when the Compact was negotiated and (b) when Congress considered the Compact, radioactive fallout from the US Pacific nuclear testing program extended *throughout* the Marshall Islands to Kwajalein, Arno, Majuro, Ailuk and many other atolls and islands. Bravo's fallout -- at significantly lower radiation levels -- even reached populated areas in the Caroline Islands (Federated States of Micronesia) such as Kusaie and Ponape 400-600 miles to the south and southwest of Bikini.

Throughout 17-Year Compact Negotiations, Key Fallout Data Withheld. Marshall Island leaders and their representatives demanded full disclosure regarding the nuclear testing program. The US Government negotiators asserted that everything was disclosed. The negotiators had access to DOD and DOE fallout data, but failed to disclose it or the resulting health and safety implications to the RMI Government, the Marshallese people, the Rongelap people, the High Commissioner of the Trust Territories, the United Nations, the U.S. Congress or the public throughout the 17-year negotiations on the Compact and its subsidiary agreements.

Implications. There are two primary implications of DOE actions.

- (1) **Nuclear Orphans.** By neglect, deliberate or otherwise, DOD and DOE have created a generation of "nuclear orphans," individuals, Marshallese and Non-Marshallese, exposed to radiation from the 66 atomic tests, but never examined or treated during or since the program was established in 1946.
- (2) **Compact Declaration False.** Significant data and previously unavailable information have been

obtained which overwhelmingly suggests that a key baseline declaration in the Compact is false and that the US knew it was false.

Compact of Free Association – Diplomatic Framework Between US and Marshall Islands. On June 25, 1983, the United States and the Republic of the Marshall Islands (RMI) signed the Compact of Free Association and enabling legislation from the US Congress, advanced by this Committee, was enacted on January 14, 1986 (Public Law 99-239). Consistent with the UN Charter, RMI began the process towards self-governance and the United States concluded almost 40 years of trusteeship pursuant to the UN Charter.

US Compact Declaration – Radiation Testing History Disclosed. From the Marshallese Government's perspective (notwithstanding intense local opposition) the Compact's centerpiece was the comprehensive nuclear claims settlement provisions, known as the Section 177 Agreement. In Article VIII, the US Government declared that:

The Government of the United States has concluded that: (a) The Northern Marshall Islands Radiological Survey and related environmental studies conducted by the Government of the United States present the best effort of that Government accurately to evaluate and describe radiological conditions in the Marshall Islands.

Compact Declaration -- False -- and US Knew It. The Compact's declaration was not accurate. It was not true. It was not close. Almost every aspect of Article VIII was false. The US Government negotiators either knew it was false or surely had the ability to know it was false. The US Government had the responsibility to disclose. It elected not to do so. The US Government -- and DOD and DOE in particular -- sought to limit liability and restrict accountability. The basic premise, that the US evaluated and described "accurately" the radiological conditions in the Marshall Islands, was plainly wrong.

Had Negotiators Been More Forthcoming, US Would Have Revealed:

- * John Harley, AEC scientist, stated at July 1954 AEC meeting shortly after the conclusion of the six-test Castle series in Room 1201, Temporary 3 Building in Washington, "Majuro got a pretty good sock." Majuro, according to the DOE in past 40 years of official reports, was not among those atolls listed as having received fallout. Majuro is the Capitol of the Marshall Islands.

- * Kwajelein Atoll, one of the largest and most populated atolls, received fallout from US atmospheric tests conducted in the Pacific. Like Majuro, 40 years of official DOE reports do not acknowledge Kwajelein as having received fallout.
- * DOE's scientists at Brookhaven and Lawrence Livermore, following unexpected thyroid problems at Utrik in mid-70's, began to realize that fallout was more widespread and began programmatically to address the possibility. This work, performed while Compact negotiations were pending, was not fully disclosed in a timely or forthright manner.
- * DOD stated, in April 1954, that the *"only other populated atoll which received fallout of any consequence at all was Ailuk,"* but the Ailuk people have not been told or considered part of the 40-year medical follow-up program. Given the medical problems at Utrik, Ailuk, which was estimated to get a similar dose over time, should have been included in a comprehensive medical review at least beginning in the mid-1970's.
- * In 1974, Dr. Robert Conard, head of the AEC's Marshall Islands Medical Program at Brookhaven National Laboratory, stated a report, *"...from our surveys of the unexposed people of Rongelap and Likiep (a nearby atoll not exposed to [Bravo] fallout)."* Likiep did receive fallout, but the error has never been acknowledged or corrected.
- * Fallout extended to populated and unpopulated atolls in approximately one out of three tests, but much of this story remains unknown and undisclosed.

Files Reveal and the Files Conceal. Documentary evidence supporting this information is contained in DOD or AEC/ERDA/DOE files. Some of it was classified and some of it wasn't. During the 1980's, and particularly after 1985, DOD and DOE began to declassify some important documents, although many are only partially declassified. Declassification does not mean "instant access" or even awareness.

DOE 1978 Survey Plan – Stated Purpose. The stated purposes of the 1978 DOE Survey¹ – referenced in the Compact (Article VIII, Section 177) – were:

...to provide a documentation of the remaining radioactivity from nuclear testing and to provide support data for an assessment of the radiation dose to people before the termination of the United Nations Trust Agreement. (emphasis added)

DOE Determines Which Atolls and Islands in Northern Marshalls to be Surveyed. There were four formal objectives of the survey, the first of which was to, "obtain aerial photos and aerial radiological maps of the Northern Marshall Atolls and islands."

The DOE survey plan then stated:

A study has identified 11 atolls and 2 islands as those most likely to have received fallout from one or more nuclear tests conducted at Bikini and Eniwetok during the U.S. Pacific testing program.

The 13 Atolls and Islands. The survey plan then identifies the individual eleven atolls and two islands included in the survey:

- | | |
|----------------|---------------|
| • Ailinginae | • Ailuk |
| • Bikar | • Bikini |
| • Likiep | • Rongelap |
| • Rongerik | • Taka |
| • Ujelang | • Utirik |
| • Wothe | • Jemo Island |
| • Mejit Island | |

Significance – List of 13. This list is significant for two reasons. First, the DOE has never been able to produce this "study" cited in its planning report. DOE is unable, to this day, to explain how or why these determinations were made. Apparently the unidentified study no longer exists. Second, this list more than doubled the number of atolls acknowledged to have received fallout from the nuclear testing program. DOE's Brookhaven National Laboratory (BNL) regularly published reports from 1954 to the 1980s on Bravo and its follow-up, but specifically indicated that six atolls, not 13, received fallout from Bravo.

DOE Contractor Survey Report – Contradiction as to Purpose. In DOE's 1977 internal memos and the 1978 planning document for the 13-atoll survey, it was characterized as a "screening" survey, but by the time the report was completed, it was transformed into a "complete and

¹ *Radiological Survey Plan for the Northern Marshall Islands*, August 22, 1978, U.S. Department of Energy.

comprehensive radiological survey" according to EG&G, a DOE contractor. In their report, EG&G stated:

The United Nations trust agreement is presently scheduled to end in 1981. It was felt that a complete and comprehensive radiological survey was required, prior to the termination of the agreement, over those atolls known to have been, or suspected of having been, contaminated during the U.S. Pacific testing program.

Real Purpose of Northern Marshalls Survey Uncertain – Even Today. Today, a question remains: what was the purpose of the DOE survey? Was it a "screening" survey or was it the "complete and comprehensive radiological" survey? How and why was EG&G able to make its stated claim? EG&G concluded that Ailuk, Likiep, Wotho, Ujelang, Mejit and Jemo "do not appear to have received any significant direct contamination from the Bravo event or the other tests..." What does "do not appear" mean? What does "significant" mean? Those phrases and terms are never defined.

DOE Report on Fallout from Pacific Tests. The 1978 DOE Northern Marshall Islands Survey Plan contained two documents identified as "*Fallout from Pacific Tests*," and "*Fallout Pattern-Bravo Event 1954*." The first is a one-page listing which identified the specific atolls in the fallout area and identified the specific atmospheric tests which affected these atolls. This listing indicates that seven³ different atmospheric nuclear tests contaminated 13 atolls and islands. The contaminated areas are limited to the "northern" Marshall Islands.

Bravo Fallout Pattern – As Reported In Survey Plan. DOE displays what is reported to be the Bravo fallout pattern on a regional map which identifies each of the 11 atolls and 2 islands in the Northern Marshalls (except Ujelang). This map suggests the fallout pattern is definitive and in no way suggests any uncertainties.

Undisplayed Fallout Patterns. The only fallout pattern displayed, though incomplete, is Bravo, one of the seven acknowledged tests that deposited fallout in the Marshall Islands. Fallout patterns from the six other identified tests are not displayed, including:

- * Sandstone Zebra
- * Castle Union
- * Castle Yankee
- * Hardtack Maple
- * Ivy King
- * Hardtack Magnolia

³ There were 66 announced tests. According to the DOE study plan, seven of these tests produced fallout which impacted 13 atolls and islands during the 12-year period of testing.

Yields From Other Offsite Tests Similar to Bravo. Bravo was a 15 Megaton (MT) test and is the largest thermonuclear device ever detonated by the US in its history. Castle Union was estimated to be 6.9 MT and Castle Yankee was 13.5 MT. It should be noted that the Castle Series produce, from six tests in ten weeks, a collective 48 MT yield. Offsite fallout may have scattered across all atolls and islands in the region.

Bravo – Fallout Pattern Restricted, Incomplete. What is displayed from the Bravo test in the Survey Plan is also limited. Only seven of the 13 identified atolls are within the displayed Bravo fallout contours. The Survey Plan only displays fallout from two conditions -- the "High Level Contours" (Bikini, Ailinginae, Rongelap, Rongerik) are shown identifying four specific areas with solid lines. A second zone, identified with dash-lines, indicated the boundary of the "Estimated Intermediate Contour" for the Bravo event. Three additional atolls -- Bikar, Utirik, and Taka -- fall into this category. Wothe, Ujelang, Ailuk, Likiep atolls, and Jemo and Mejit islands are outside the two identified fallout zones. Bravo's ultimate boundary is not displayed.

DOE Aware That Fallout Extended Further Than Reported – Resulting in Serious Medical Implications. DOE knew that fallout extended further than ever publicly revealed. This data and information, however, was not included in the Northern Marshalls Survey, which, as previously indicated (Page 3) according to the Compact⁴, represented "the best effort of [the US] Government accurately to evaluate and describe radiological conditions in the Marshall Islands." Significantly, this statement is not restricted to the "Northern" Marshall Islands. It references the entire Marshalls. In general, consider the following:

- * *Brookhaven staff, medical and radiological, were concerned by the unexpected development of thyroid disease at Utirik in mid-70's. As a result, an eight-year programmatic effort was initiated beginning in 1977 to examine the cause including the possibility that the Bravo and other fallout clouds extended further than ever known. Funding for the BNL review was provided by DOE. This effort, its questions and findings, are not disclosed to Marshall Islands Government or atoll governments in any timely fashion.*
- * *Lawrence Livermore National Laboratory (LLNL), under contract to Brookhaven, in an unpublished study, examines direction of Bravo.*

⁴ The Compact of Free Association, Section 177 Subsidiary Agreement, Article VIII.

- * AEC, in a 1973 draft report, had determined that the Bravo fallout cloud may have contaminated as many as 18 atolls and islands, including populated atolls such as Kwajeleir and Majuro.
- * Official reports published by DOD/DNA in 1982 indicate that as many as 25 atolls and islands, including islands in the Caroline Islands, were contaminated by Bravo.
- * Rongelap consultant Dr. Thomas Hamilton submitted a "Confidential Statement" to the House Interior Committee in March 1985 in which he sets forth the proposition that the Bravo fallout pattern extended further. As a result, many more Marshallese citizens, categorized as "unexposed" where actually exposed in 1954, which may distort DOE Marshall Islands medical analysis. It suggests that these cancers can occur with very small exposures. Chairman Seiberling requests, immediately prior to markup of Compact legislation, DOE and DOI response to Hamilton. The Administration refuses comment on the grounds that litigation was pending.
- * Dr. William Bair, Chairman of DOE's Marshall Islands Advisory Group, reported his Committee's opposition to the Northern Marshalls survey. The opposition was based on the stated assumption that Bravo fallout pattern "was well characterized." However, in the same memo, Bair reveals that "learned that the fallout patterns were modeled by several agencies, that the models differed substantially...that characterization of the fallout patterns were not precise...Some surprises could result from the survey."
- * Marshall Islands Government, in May 1979, immediately after approving their new Constitutional Government, attended a meeting in Washington with US officials at which they asserted the fallout from Bravo and other tests extended further than the acknowledged 13 atolls and islands. They then demanded all documentation

on the tests. It is not known whether or not this request was ever complied with, and if so, how. DOE never wavers in its declaration that 13 atolls and islands represent Bravo's boundary.

- * *DOE has not published a complete and comprehensive radiation fallout footprint of Bravo.*
- * *DOE has not published a comprehensive radiation fallout footprint of, singularly or collectively, all 66 tests.*
- * *Finally, DOE has had full and complete access to all classified documents regarding the 66 announced tests and their collective fallout patterns from the inception of the testing period. DOE has had full and complete knowledge of the fact that the fallout pattern was more extensive than admitted in the Compact.*

Comparison – Fallout From Bravo and Other Tests as Revealed by AEC/DOE. The following table displays "fallout disclosure" at different times and from different sources. Brookhaven, in their reports, defined fallout for more than 20 years in the most limited manner. DOE, during the Compact, defined the parameters of fallout exclusively by the Northern Marshalls Radiological Survey. However, some five years before that survey was initiated, the AEC, in a draft staff paper on fallout from the Pacific tests, estimated that fallout from Bravo and the other tests reached 18, not 13 atolls and islands. The DOD, in 1982, defined fallout from just Bravo as being far more extensive. From the AEC and the DOD, it is learned that Ailuk with 401 individuals would have realized a dose over time similar to that experienced in Utrik at the time of the test. Many of the most heavily populated atolls, such as Kwajelein and Majuro were exposed to Bravo fallout.

Somewhat ironically, the disclosures from the Defense Department are far more forthcoming than similar disclosures from DOE.

| FALLOUT – AFFECTED ATOLLS – PACIFIC NUCLEAR TESTS | | | |
|---|--|------------|---------------------|
| BROOKHAVEN MEDICAL REPORTS 1954-1990 | NORTHERN MARSHALLS SURVEY (1978) | AEC (1973) | DoD (1954, 1982) |
| Rongelap | Rongelap | Enewetak | Lae |
| Rongerik | Utirik | Bikini | Ujae |
| Ailinginae | Taka | Ailinginae | Wotho |
| Utirik | Bikar | Rongelap | Ailinginae |
| Bikini | Rongrik | Rongerik | Rongelap |
| Bikar | Ailinginae | Taka | Rongerik |
| Taka | Likiep | Bikar | Taongi |
| | Ailuk | Utirik | Bikar |
| | Jemo | Ujelang | Utirik |
| | Mejit | Ailuk | Taka |
| | Wotho | Likiep | Mejit |
| | Ujelang | Jemo | Ailuk |
| | Bikini | Wotho | Jemo |
| | Likiep | Kwajelein | Likiep |
| | | Wotje | Nam |
| | | Taongi | Ailinglapalp |
| | | Ujae | Arno |
| | | Lae | Majuro |
| | | | Aur |
| | | | Maleolap |
| | | | Erikub |
| | | | Wotje |
| | | | Kusaie |
| | | | Ponape |
| | | | Ujelang |
| | | | Pingelap |
| | | | Bikini |

Brookhaven Medical Reports – Fallout Officially Defined For Quarter Century. The Department of Energy's most visible description of Bravo fallout was published by Brookhaven National Laboratory in a series of reports on the medical conditions of the so-called "exposed" populations of Rongelap and Utrik. These reports, until approximately 1980 and published every few years, each contained charts of the Bravo fallout pattern. Over the years, Bravo fallout patterns were displayed by BNL at least three different ways.

DOE/Brookhaven Limits Scope of Exposed Communities and Individuals. In addition to charts and figures, narrative statements in these reports affirm the limitation of the fallout profile. According to Dr. Conard, the long-time director of the BNL MI Medical Program, in September 1975, stated in the BNL Report, "*A Twenty Year Review of Medical Findings in a Marshallese Population Accidentally Exposed to Radioactive Fallout:*"

The atolls involved in the 1954 accident are located in the northern Marshalls: Rongelap and Ailinginae about 100 nautical miles east of Bikini, Rongerik about 135 miles east of Bikini and Utrik about 275 miles east of Bikini.

There is NO discussion in any of these reports the fallout extended further in any direction.

AEC/DOE, Fallout, and the Term "Significant". In documents, reports and other materials, AEC/DOE consistently characterizes Bravo fallout as "significant." There was significant fallout here or there. Or, the opposite is stated. There was NO significant fallout in this place or that place. AEC/DOE consistently avoids identifying where the Bravo fallout pattern ends. A map displaying Bravo's complete fallout pattern has never been seen. Maps displaying other test fallout patterns have never been included in any Brookhaven reports.

AEC Documents in 1954 Indicate that Ailuk Atoll Received As Much or More Fallout Than Utrik. Ailuk Atoll lies approximately 75 miles south and slightly west of Utrik. The earliest AEC Bravo reports acknowledge that Bravo fallout reached Ailuk. According to documents declassified after the Compact was negotiated and submitted to Congress:

The only other populated atoll which received fallout of any consequence at all was Ailuk...Based on the best estimate of fallout time it was calculated that a dose to infinite time would reach approximately 20 roentgens. Balancing the effort required to move the 400 inhabitants against the fact that such a dose would not be a medical problem it was decided not to evacuate the atoll.

Utrik, By Mid-70's, Experiencing Thyroid Cancers From 10-15r Exposure – What Happened At Ailuk?. Rongelap thyroid problems were acknowledged by AEC/DOE to have been unexpected when they began occurring in 1963. They were also unexpected when they

occurred in the Ailinginae group beginning in 1969. The Utrik "spike" in thyroid related problems occurred in the mid-1970s. This was considered noteworthy because Rongelap received a dose estimated to be almost 20 times greater than Utrik. Ailuk was estimated to receive over time a dose greater than Utrik. In 1985, BNL reevaluated the Rongelap thyroid exposure estimates and increased them by factors of 10 to 100. DOE has not indicated what this means for thyroid doses at Utrik, Ailuk, and other Marshall Island atoll communities. Would these exposures be higher by a factor of 10 to 100 as well? Remember, Ailuk was not evacuated because AEC determined the dose received over time would not be a health hazard. Giving AEC/DOE the benefit of the doubt (the March 1954 decision not to evacuate was made in good faith), DOE should have gone back and undertaken a comprehensive medical review of the Ailuk people. It did not happen. Brookhaven's medical program has not, to the best of my knowledge, included Ailuk in its medical review program.

Dr. Hamilton – Fallout Patterns and Thyroid Cancers – The Medical Connection. In the early 1980's Rongelap retained Dr. Thomas Hamilton to medically evaluate persons injured by radiation from Bravo and the other tests. In March 1985, he completed his extensive report. Additionally, Hamilton submitted a three-page Confidential Statement to the Honorable John Seiberling, Chairman, Subcommittee on Public Lands and National Parks. Given the significance of this statement, and its exceptional analytical insight, the complete portion of this statement is presented here. According to Hamilton:

The second issue I wish to address is the geographical extent of the nuclear fallout from the 1954 BRAVO test and the potential health hazard to people presently living in these northern Marshall Islands. As you may know, the only inhabited atolls considered by Brookhaven National Laboratory to have been "exposed" to nuclear fallout in March 1954 are Rongelap and Utrik. In the Brookhaven study, people from the remaining northern atolls are considered to have been unexposed to radiation and are designated as a "control" group. However, while the external radiation doses to the people living on Rongelap and Utrik on March 1, 1954 have been well published, I have been unable to find any documentation in the Brookhaven literature that the other northern atolls were actually determined to be unexposed in 1954; I have found only assertions to that effect. In fact, an August, 1978 Department of Energy document entitled "radiological Survey Plan for the Northern Marshall Islands contains an unreferenced statement that, "in addition to Enewetak, Bikini and Rongelap atolls, there are eleven other atolls or single islands that received intermediate range fallout from one or more of the megaton range tests".

In 1982, I began to find what I felt were excess numbers of thyroid nodules among people who resided in the northern Marshall islands in 1954. I was also given vivid descriptions by people who saw and felt fallout powder from the BRAVO test on inhabited atolls other than Rongelap and Utrik. I therefore began a systematic evaluation of thyroid neoplasia in people living in the northern Marshall Islands. I use the term thyroid neoplasia interchangeably with thyroid tumors and thyroid nodules; these can be either benign or malignant.

By the end of this month, I will have performed thyroid examinations on over 7,000 people from the northern atolls and from 3 southern atolls; I consider these southern atolls to be the best available unexposed control group in the Marshall Islands.

While I am just beginning to process this information for publication, there are two important patterns which have emerged. The first is that there are several northern atolls in which the prevalence rates of thyroid neoplasia (benign and malignant) are equal to or greater than those observed by Brookhaven on Utrik Atoll where the radiation dose is known. Secondly, the rates of thyroid neoplasia in two of the southern atolls are two to three times lower than the "control" rates determined by Brookhaven for the northern islands, suggesting that these northern islands may not have been valid control groups. If these preliminary conclusions are substantiated, Mr. Seiberling, they will suggest that nuclear fallout from the 1954 BRAVO test (and possibly other tests) was considerably more extensive than previously asserted. A critical question, therefore, is whether people now living in the northern Marshall Islands are at increased risk for developing cancer (other than thyroid cancer) and genetic defects as a result of terrestrial and food chain contamination from nuclear fallout.

I would like to elaborate on why my work suggests this may be the case. Thyroid nodules arising from radiation from nuclear fallout are caused chiefly by isotopes of radioactive iodine. These isotopes are very short-lived and decay rapidly within several months. Therefore, since radioiodine from that test would have decayed by Summer, 1954, people must have been present at the time in order to have received radioiodine from the BRAVO detonation. It is thus my opinion that the excess thyroid nodules which I am finding in people from the northern Marshall Islands had to have been caused by direct injury from radioiodine exposure in March, 1954, rather than by chronic food chain contamination: If

radiiodine was present in the northern Marshall Islands in 1954, then it would have been accompanied by long-lived isotopes (cesium-137, strontium-90 and plutonium-239) which most probably are still present in 1985. Even in low levels, these long-lived isotopes in the food chain could be responsible for producing increase risk of developing cancer of all types.

Congress Requests Response and Explanation of Hamilton's Studies. Hamilton's "Confidential Statement" along with a second paper on medical findings was submitted at the March 1985 Interior Committee hearing on the Compact. Chairman Seiberling submitted both reports by Hamilton to the Department of Interior's Assistant Secretary Montoya for immediate response. In April 1985, Interior responded for itself and DOE refused to comment on Hamilton's report on the grounds he was a consultant to Rongelap attorneys and litigation was pending. The DOI/DOE response, it appears, deliberately avoided Hamilton's statement regarding fallout and thyroid cancers. Regardless, DOE was "on notice" regarding the problem and DOE elected to be silent about it.

Hamilton Work Never Considered During Kohn's Rongelap Reassessment Project Report. This Committee authored a special provision of the Compact mandating that a special review of the habitability of Rongelap be undertaken. Dr. Henry Kohn, whose work has been largely discredited, for reasons he has not been willing to reveal, elected to exclude Hamilton's work from the statutory review.

Hamilton and Brookhaven Both Question Relationship Between Fallout and Thyroid Cancer. Hamilton, based upon two and a half years (1982-85) of medical examinations in the Marshalls, drew a powerful connection between fallout and thyroid cancer. Brookhaven, it turns out, was doing the same thing. Both reported their findings in March, 1985. By 1976 unexpected thyroid cancers began appearing in the Utrik community. BNL's resident physician (Kotrady) issued a highly critical report in January 1977 shortly after leaving the program. A few months later, BNL held meetings to discuss the medical and radiological inconsistencies between Rongelap and Utrik. This led to a major BNL review that would last eight years -- until March 1985 -- when BNL published a report. Brookhaven concluded that fallout went in different directions than previously known and doses to Rongelap and Utrik were understated, by 10-100%.

Brookhaven Review -- Excluded From Northern Marshalls Survey. The BNL review, funded and supported by DOE, included a full review of fallout from Bravo and the other tests. It began just before the Northern Marshalls Survey was initiated. It ended two and a half years after the survey was completed. Coincidentally, it was published just as Compact legislation was finalized. However, none of this work and none of the findings would be integrated into the Northern Marshalls Radiological Survey. Brookhaven's investigation was held separate and apart from the Northern Marshalls Survey. Their findings failed to trigger a major review, which, given the findings, was fully warranted.

BNL Fallout Review Contract. BNL speculated that perhaps, after a quarter of a century, the original belief about Bravo fallout was incorrect -- or at least insufficient. Perhaps the unexplained thyroid cancers were caused by direct exposure to Bravo fallout from the time of the test. New techniques and improved fallout modeling were available by the late 1970's, BNL contracted with LLNL to review the Bravo fallout pattern using these new computer technologies. The LLNL investigator, Kendall Peterson, concluded the Bravo cloud went further south than previously believed in a "draft" report submitted to BNL in May 1981. It is believed that Peterson's report was never published by LLNL, though it was issued an LLNL number. BNL references Peterson's work in their March 1985 report on the subject. By 1985, the focus of the BNL effort is limited to the implications for Rongelap and Utrik, with little or no concern for the greater implication -- others in the Marshalls were exposed to low doses and the medical control group may have been exposed to fallout.

LLNL Bravo Fallout Study -- New Issues Raised. Peterson's computer generated fallout pattern showed the Bravo cloud turned south, but the issue is not developed, nor are the implications pursued. An additional issue, of considerable significance is raised. Peterson indicated that ingestion of contaminated water or food creates a "radiation multiplier effect" implying that a relatively low environmental dose from fallout can be multiplied many times -- as many as 50 -- by ingestion (external radiation is multiplied many times to obtain an internal dose). If "rainouts" occurred, then the water catchment system would have, at the time, been highly contaminated and individuals could have received relatively high exposures, particularly for children's exposures and not even been aware of it. Again, these matters are not pursued.

Fallout and the Compact Process. US officials with responsibility for the negotiation of the Compact had the ability to know and understand all of these radiological, scientific, medical and programmatic developments. First, all classified information was readily available. Second, the BNL study was undertaken by the overall management of DOE/NV and Roger Ray, DOE's Deputy for Pacific Operations. Uniquely, BNL's March 1985 Report is a report to "Roger Ray" (no other formal BNL report is "to" an individual). Since May 1981, Ray was DOE's official representative to the Status Negotiations Office. And, in November 1982, following years of bureaucratic infighting, he took over management responsibility for the entire Marshall Islands medical and environmental monitoring programs. His first act was to deregulate radiation standards. Little was disclosed to Rongelap. Less was disclosed after December 1982 when the DOE's Bilingual Report was published. Marshallese leaders and their people were never informed of any of these revelations or concerns, or if they were, never in a way they could possibly understand.

Bravo Test and Nuclear Typhoons in the Sky -- DOD Suppresses Weather Report. Bravo, the subject of endless study and speculation for 40 years, was always called an accident by the US Government. The winds, it was claimed, "unexpectedly" blew the wrong way. The "blew the wrong way" statement is correct. The "unexpectedly" part of it may not be accurate -- at all! A serious warning from DOD weather experts was in the hands of JTF 7 at least

eight months prior to the test -- but was then deliberately suppressed. A report⁴ submitted to the Military Commander concluded that the military knew almost nothing about the weather in the Marshalls, that the weather patterns were deceptive, and that a high yield test (such as contemplated in the Castle series) could create an uncontrollable nuclear typhoon in the sky. Six months to the day after the report was submitted, Major General Clarkson, Commander, JTF 7, wrote Dr. Graves at Los Alamos declaring the Pate-Palmer Weather Report "a troublesome item." Clarkson then advises Graves that he will not:

...give anybody a copy of the report from here on out, and I am proposing to General McGinley, Cowart and Bonnot that we recall all copies heretofore distributed and instruct Pate to do the same thing. In other words, I propose to treat the report the same as I would a report from any other member of my staff when I do not agree with him. In short, we will kill it and stick it in the file.

Pate-Palmer Weather Report – Ignorance and Risk. The Pate-Palmer Report is dated June 30, 1953. The following is a sampler of some of the more salient conclusions:

The behavior of the tropical atmosphere is little understood by the professional meteorologist and therefore, not surprisingly, by the majority of military and civilian staff officers at all levels. Seasonal variability of the important weather elements does not conform to the calendar. Casual statistical analysis of available weather records lead more often than not to erroneous operational conclusions.

* * * * *

It is entirely possible that a high yield detonation can "trigger" a self-sustaining circulation which will derive its energy through the condensation process.

* * * * *

With the larger bombs, provided they are exploded in an atmosphere with pronounced cyclonic shear, a cyclonic system of approximately the size and intensity of the weaker tropical depressions in the Marshall Islands could be set up. Whether such a system could ever become self-perpetuating, through the supply of energy set free by condensation, is a matter about which it is

⁴A Report to the Commander, Joint Task Force Seven, *A Study of Certain Operational Weather Considerations Involving the Test and Delivery of High Yield Weapons*, by Commander Elbert W. Pate, USN, Staff Weather Officer and Professor Clarence E. Palmer, Professor of Geophysics, UCLA, 30 June 1953.

impossible to reach definite conclusions as yet; at the same time, it must be said that the triggering of such a self-sustaining circulation is not at all impossible. The energy for the circulation would be derived, not from that initially released in the fireball, but from the atmosphere, the energy source of tropical depressions and typhoons. Comparison of the relative energy release of typhoons and nuclear (or thermonuclear) devices is irrelevant.

* * * * *

The detonation of MIKE and KING induced spectacular and widespread weather changes which persisted for several hours.

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Any comparison of bomb yield to the energy liberated in a tropical storm is not an issue. The bomb, by establishing a definite vertical and horizontal circulation "triggers" the atmosphere and the energy liberated through the condensation process dwarfs that originally released by the bomb itself.

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In summary, God did not design the tropical atmosphere to AEC specifications.

Pate-Palmer – Implications. The explanation of Bravo, which has eluded scientists and bomb makers for more than three decades -- MAY -- have been in the possession of AEC eight months prior to the test. If this is verified, then the AEC/DOE is guilty -- at the very least -- of gross negligence and the complicity to cover up this negligence. From the published literature, it is widely known that JTF-7 "lost control" of the test within moments of detonation. Perhaps "nuclear typhoons" were unleashed in the Pacific skies above Bikini. And, perhaps they were warned of appropriate risks in advance. And perhaps, those risks were simply ignored.

The Compact of Free Association – All Is Not Disclosed. The Compact's Section 177 Agreement -- the provision settling all nuclear claims issues -- contains an all-important Article VIII. In that Article, the U.S. Government, "concluded that" the Northern Marshalls radiological survey represented "the best effort...accurately to evaluate and describe radiological conditions in the Marshall Islands." Simply stated, it did no such thing. As the DOE Marshall Islands programs are reviewed, it becomes quite clear the DOE was fully aware of the limitations to the document and more importantly, to the body of radiation knowledge in the Marshalls. DOE's own files powerfully contradict this "treaty-like" declaration.

Recommendations:

- Committee and DOE Secretary O'LEARY should establish a formal independent Marshall Islands Program Review – Perhaps a San Luis Task Force type review should be considered, legislatively or administratively.
- Committee should ask DOE to undertake, particularly with new modeling techniques now available, an independent study of fallout patterns from the entire Pacific testing program.
- DOD, DOE, State, Interior and other departments must embrace a program to fully disclose all relevant documents. The problem, of course, is that these same agencies control the definition of "relevant."
- Marshall Islands should be incorporated into DOE program priorities in human testing reviews, application of radiation standards, and disclosure initiatives.
- Consideration should be given to moving Brookhaven's medical program to the Marshall Islands.
- Given the recent preliminary report from the Marshall Islands Government regarding thyroid findings, a medical team, perhaps Brookhaven, should be organized.
- Brookhaven Medical Program should be independently reviewed.
- Committee should undertake full review of Compact, especially the Section 177 Agreement. The Administration should publicly release all documents related to nuclear claims from those negotiations.

- * DOD conducted nuclear tests, and they should not be excluded, from a policy or budgetary perspective. This is not just DOE's problem.
- * A full investigation of Safeguard C and why the Marshall Islands medical and environmental programs were incorporated into a standby readiness program to resume atmospheric testing.
- * There should be a full review and disclosure of a long-standing civil war between two DOE labs involved in the Marshall Islands program, Brookhaven and Lawrence Livermore.
- * DOE should conduct independent program reviews of Lawrence Livermore, Brookhaven National Laboratory, and the Nevada Operations Office.
- * Committee investigation of this matter should continue.
- * All of above, if it is to be successful, should be undertaken in cooperation with the Government of the Marshall Islands and the Marshallese people.

Cold War Warriors – Marshallese Role in Cold War. This testimony would be incomplete without addressing a fundamental, all too frequently glossed over proposition -- just who are the Marshall Islands people and what do they mean to the people of the United States and the world. When the Berlin "Wall" came down, when the USSR began to crumble, when global communism collapsed, the world neglected to thank the Marshallese. The Marshallese people were, and in so many ways, still are the front-line cold war warriors. For the cause of world freedom, Marshallese health was damaged, its culture was compromised, its food supply was poisoned and its land was contaminated. As a community, they have given as much as any and more than most. The United States Government -- and our friends and allies throughout the free world -- owe the Marshallese appreciation and dignity. The Marshallese deserve a future with less pain, fewer anxieties, and far more respect.

Outstanding Due Bill – Truth. There is an outstanding due bill -- the Marshallese are still owed the truth. They can handle it. For 48 years, they have lived with radiation, contamination, death, disease and illness resulting from the Nuclear Testing Program.

Senator Anjain – Especially for the Children

For two and a half years, Senator Jeton Anjain was my client. Senator Anjain was the leader of the Rongelap people. A simple, direct, and softspoken man, he did not believe Rongelap's people were being told the truth by DOE. His life-long quest -- find out that truth, whatever it is. He was relentless, stubborn and uncompromising when it came to the health and safety of the Rongelap people -- especially the children.

The Senator's insatiable demand for truth came from his inner hope and prayer the children would never confront that which so greatly challenged his generation. He would close every statement to Congress with "*I thank you on behalf of the Rongelap people, and especially the children.*"

Mr. Chairman, the Senator is not here to close with those words. So I conclude for him and say, thank you, Mr. Chairman, and your fellow Committee members. This statement is submitted on behalf of Senator Anjain for Rongelap and all of the Marshallese people, and yes, especially the children.

Thank you.

Mr. MILLER. Thank you.
Mr. Hills.

STATEMENT OF HOWARD L. HILLS

Mr. HILLS. Thank you, Mr. Chairman.

George Shultz said that nothing is ever over in this town, and I think the fact that I am back here with Jonathan Weisgall and some of the Members and staff and others that have been present throughout this process is an illustration that he spoke the truth.

I wanted to begin, Mr. Chairman, with a procedural house-keeping matter by disclosing and notifying you that I have an attorney-client relationship with the people of Rongelap right now. The committee invited me to come up and provide some testimony not as an advocate or in my capacity as counsel to Rongelap but, rather, to bring sort of an historical, legal perspective to this section 177 agreement and some of its provisions. I got permission from my clients to do that, and I do not represent the people of Rongelap on the claims that were settled by the section 177 agreement. My affairs are in order, but I am a registered agent and I do have an attorney-client relationship with Rongelap.

Again, in an effort to cooperate with the committee, they gave me permission to accept the invitation to come and testify about the section 177 agreement, and I am pleased to do that. Rather than spending a lot of time going into a lot of gory details, maybe I should just make a general statement and then invite at the appropriate time some questions, because it is perhaps in questions that we could get into some of the issues that are of most concern or interest to you and the members of the committee.

I think by way of overview, what I want to say is that I think this committee was put in an exquisite dilemma in the mid-1980s because there was the prospect of the U.S. Government, this committee, this Congress, holding the decolonization of the Trust Territory of the Pacific Islands hostage to the fully satisfactory resolution of all of these claims arising from the nuclear testing program. You had competing values involved there because decolonization of Micronesia, getting the Federal Government out of the role of being the landlord, culturally, politically, legally, and economically, and putting the people there in control of their own lives and their own futures was something that was a positive value that I think was recognized by the members of this committee. The competing value of making sure that the United States honorably and responsibly acquitted itself of its obligations with respect to people who were injured and people who had their lands contaminated by the nuclear testing program was a set of problems which required the United States to continue to have a great deal of control over local affairs that in the context of decolonization properly would be turned over to the constitutionally democratically elected governments. There was example after example after example of where, when the United States Government tried to do things for people out there it didn't do a very good job, and when the people took responsibility for their own affairs they did a much better job.

And so, as I say, I think this committee was put in an exquisite dilemma. I think the Marshall Islands, the new constitutional government of the Marshall Islands was put in an exquisite dilemma.

I would also add that I think the claimant groups here themselves were in a very difficult position because in the 30 years that had transpired since the nuclear testing program, frankly, the amount of compensation and the amount of assistance that these people had received under the policies and practices of the Federal Government, including the appropriations and the programs and what-not that had been produced by this committee, did not redeem in an entirely honorable way, I think it is an understatement to say, the U.S. obligations.

So in the context of the political status change that was being offered and the more comprehensive element of nuclear claims that was being offered in the context of the Compact of Free Association, they faced the prospect of receiving much larger compensation payments than they had ever received. I think that there is an accurate, objective, historical argument to be made that the political status process was used to acquire for them from the United States Government more in the way of recovery than they would have if the status quo had been maintained.

I think one way of looking at it is that the need that the United States Government had to redeem the commitment to decolonization and make the transition to self-government was used to leverage \$150 million out of the David Stockman OMB in 1982, which was pretty rough going at that time. If that had not been going on, the question is, What kind of compensation could have been obtained for the people at that time? The prospects were not very good. That is why they had brought court actions, that is why they were pursuing their claims, that is why this committee had the interest that it did in this set of issues.

I think that against that backdrop people need to know that there was an intense internal debate within the executive branch about how to proceed, and there were those who thought that this was something that Congress should handle, that Congress should deal with it on an ad hoc basis whenever they could get appropriations.

But if you think about it, in the 30 years that had transpired since the testing program, the total compensation that was paid over 30 years was less than \$50 million. In one year we were in a position to deliver \$150 million. And so, Mr. Chairman, I think the question was: Would we wait until all the lawyers and doctors and scientists and medical people got through debating the ultimate issues here while the people languished in the islands, or would we try to do something to put them back in control of their own destinies?

And that was the theory of the Compact of Free Association, the section 177 agreement. It was that these issues are going to be debated for years. It is going to go on and on. What can we do short term in the context of decolonization to do something more comprehensive than had ever been done? And the decision was not to leave the fate of the nuclear claimants in the hands of the scientists and lawyers and doctors and others who were debating these issues and would be debating them for years but in the context of ending the trusteeship, self-government for the Marshall Islands, to have an agreement that would deliver some economic

empowerment to the victims rather than leaving them disempowered while everybody debated the long-term issues.

Against that backdrop, the 177 agreement was negotiated. I am prepared to answer questions about the statements I have just made about the historical process, and I have some documents and research I have done, too, in terms of some of the internal debates, but I want to switch, because I know the committee is concerned about time, to the present, having made those historical comments.

With respect to the present, I think the important thing is, I have heard a lot of talk recently about what is going on here. New information that has come out, the openness initiative of the Department of Energy, the press attention that is being given to these issues now, and the fact that there is speculation that the Marshall Islands may invoke its rights under article 9 of the section 177 agreement, changed circumstances, and seek additional compensation.

And I am very concerned that people understand clearly, both people in the U.S. Government and people in the claimant communities, and people in the Marshall Islands, and people up here, that when you talk about article 9 you are not talking about reopening the negotiations. You are not talking about reopening the settlement. You are not talking about reopening claims. You are talking about invoking a provision of the agreement. You are not talking about unraveling it; you are not talking about undermining it or overturning it.

When we got down—and I think Mr. Weiman's account of it actually had some very accurate elements to it—when we got down to the wire on this agreement, it was obvious to us that the facts, all of the facts, were not nailed down. It was obvious to us that the potential scope of damage and injury to people, persons, and loss of property was not entirely nailed down.

In fact, I think it is safe to say that the United States would never have agreed to the article 9 provision if it hadn't been the conclusion of the Department of the Interior, the Department of Energy, the State Department, and others involved that we had to leave open the possibility that new information or newly discovered information—and that would include information that existed but hadn't been discovered by the Government of the Marshall Islands or the claimant groups—would come out and would provide a basis for this Congress to conclude that as a matter of moral responsibility the United States had to provide additional compensation.

The way the solution to the problem was handled was to leave the matter with this Congress and with this committee. Frankly, given the fact that this Congress and this committee was not decided—and I think their judgment was correct—not to stop decolonization in order to get complete and total satisfaction on these issues. Because it was clear that that wasn't going to happen, this committee, I think correctly, made the decision to let the process go forward, as did the Government of the Marshall Islands and, frankly, as did the claimant groups, because even those who voted against it and even those who had lawsuits in the end ended up accepting the money and moving on with the process and successfully using the state of U.S. law and policy to vindicate their rights to the extent it was possible.

Now, this committee, I think, also welcomed having included in the agreement a provision which would leave reposing with this committee a procedure that was recognized in U.S. law, recognized by the Executive Branch, and recognized within the context of the government-to-government relationship between the Marshall Islands and the United States that there would be a possibility to pursue a request for further compensation. I think I will conclude, Mr. Chairman, by saying that article 9 of the compact is a somewhat extraordinary provision because article 10 closes the door to the Federal courthouses, or at least that is what its intent is, and terminates legal claims. The section 177 agreement is a full and final settlement of legal claims by its terms.

But then article 9 basically says we recognize the appropriateness of a foreign government coming to our Congress directly with requests to provide additional compensation given the possibility, the recognized possibility, that there could be—and I think, frankly, that there was some anticipation that there would be—further claims and matters which the Congress would want to take up as a matter of moral responsibility by the United States.

I have a lot of additional material, but in deference to the Chair's expressed concern about time, I will forego them. I have got some very good stuff here, but perhaps I should close here and wait for some questions.

[Prepared statement of Mr. Hills follows:]

**STATEMENT OF
HOWARD L. HILLS
BEFORE THE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
COMMITTEE OF NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES**

February 24, 1994

The decision of this Subcommittee to conduct a hearing on the legacy of the U.S. nuclear testing program in the Marshall Islands could not have been more timely. This is not merely because the 40th anniversary of the Bravo incident is just a few days away, or because the U.S. Government's nuclear science and technology program during the Cold War is a hot news item here in this country.

Rather, this hearing is necessary and appropriate at this time because the United States needs to renew, and in my own view expand, its commitment to understanding the effects of the nuclear testing program on the Marshallese people and their islands. It is in the U.S. interest to do so for two reasons.

First, the U.S. Government is going to need to respond to new information being developed about radiological conditions in the Marshall Islands. In order to respond in a way that is credible, appropriate and consistent with applicable U.S. law and treaties, the U.S. needs to have the most accurate and complete information available.

The second reason is that, by providing the people of the Marshall Islands and their government with all available information relating to the effects of radiological contamination on the health of people and the environment there, the U.S. may be able to make further contributions to mitigation of harm to individuals which can be attributed to the testing program.

It also is the right thing to do, and we owe it to the people concerned. My view in this regard is based in part on what I saw and heard during recent visits to Majuro, the capital of the Republic of the Marshall Islands. It is my observation that recent press accounts of experimental medicine in this country involving radiation, as well as reports on contamination of lands and waters near weapons production facilities, has stirred very deep feelings among the people of the Marshall Islands.

I do not presume to know precisely what all the attention to these issues means to the Marshallese, but there are a few observations I can share with you.

For example, it does not appear the Marshallese view the new scrutiny of U.S. Cold War nuclear programs merely as an occasion to express outrage or launch broadside condemnations of the U.S. for contaminating their people and islands. There will

be some of that, because outrage is not an irrational or abnormal human response to the stress associated with an insidious health threat such as that faced by these islanders.

However, generally it did not appear to me that many Marshallese see the value of increased press interest as being limited to coverage of pyrotechnic allegations of racist and genocidal intent on the part of the United States. Again, we will see that coverage, and anyone who knows the true story of how the Marshallese people were treated understands why the "guinea pig scenario" is compelling to many concerned people.

But instead of turning up the volume on these themes of suspicion and anger, I sensed among the individuals and officials to whom I spoke a more complicated array of emotions and ideas. There is, for example, a sense of sagaciousness among the Marshallese about dealing with the legal, political, economic and cultural impact of radiological damage. They also seem very serious about the question of whether the new scientific findings about radiation effects since the Section 177 claims settlement constitute changed circumstances under Article IX of the settlement.

The Marshallese have as much experience living with radioactive contamination and dealing with the risks of nuclear science and technology as any other population. Irrespective of what may or may not have been done in secret, that which was done openly in the Marshall Islands testing program, and the measures taken to deal with the consequences, certainly represents one of the most sustained efforts to manage radiation damage and on-going hazards ever experienced by a civilian population.

So the Marshallese understand the anxiety among communities in the U.S. as more is disclosed about radiation carried by the winds and waters, plants and animals, in our own country. In a sense, Marshallese leaders are seasoned veterans of the nuclear era, and have a more sophisticated understanding of the risks associated with nuclear science and technology than most Americans.

Forty years of experience managing the devastating effects of the nuclear testing program now is translating itself into a calm resolve to direct anger and fear into constructive problem-solving. For example, eight years of experience managing the implementation of one of the most comprehensive radiation claims settlements has given the Marshall Islands government unparalleled hands-on experience with nuclear claims administration.

Understanding risks, providing legal remedies, supporting individuals and communities in cultural and economic recovery, replacing distrust with confidence building cooperation — these are skills which the Marshallese have acquired. It hasn't been all smooth sailing, but I suspect we could learn from their experience.

The Marshallese are in recovery from over forty years of being victims, and they have a mature attitude about what has happened to them. A critical transaction in their transition from disempowered victims to recovering victims taking control of their own futures was the nuclear claims settlement negotiated on a government-to-government basis between the Republic of the Marshall Islands and the United States in implementation of Section 177 of the Compact of Free Association (U.S. Public Law 99-239).

The principles underlying the Compact and most of its basic provisions, including Section 177 which authorized the nuclear claims settlement, were originally negotiated and initiated by representatives of the Carter administration and the new constitutional governments instituted by the people of the former Trust Territory of the Pacific Islands -- including the government of the Republic of the Marshall Islands. The Reagan administration negotiated the actual terms of the Section 177 settlement itself.

Having served as counsel and Department of Defense Adviser to the NSC negotiating team and during Congressional hearings on the Compact, I am pleased to provide testimony today and answer questions you may have about the history and nature of the Section 177 Agreement. The points I can make which perhaps will be most useful to the Subcommittee are as follows:

1. The United States had "settled" personal injury and land claims arising from the nuclear testing program previously by making payments and executing releases with the peoples concerned, but new illnesses in the claimant communities and upward revisions in dose assessments at some islands rendered these arrangements ineffective. There was an active debate within the NSC system as to whether the nuclear claims should be part of the political status negotiations at all for the very reason that the record of attempts to quantify damages and limit liability through settlements and compensation had failed due to what one senior official called "a dismal record of miscalculation" by the U.S. with respect to assessments and predictions on contamination and health effects, respectively. Opponents of a comprehensive settlement argued for ad hoc measures funded from appropriations to be sought as the need might arise. The counter argument was that the need for resources to meet the needs of the victims was chronic and no political status agreement would be politically viable in the Marshall Islands which did not address the nuclear claims in a comprehensive way.

2. It was determined that ad hoc measures and limited settlements were part of the problem rather than a solution, and that a more comprehensive approach was required to resolve outstanding legal claims in existence at that time, and to satisfy the political demand for a serious program of compensation and assistance to the affected peoples. The Section 177 Agreement provided \$150 million to be invested and managed for the benefit of the affected people. In the entire thirty years prior to the Section 177 agreement the total amount of funding and ad hoc measures to

compensate the affected people was less than \$50 million. Although the settlement was controversial and less than satisfactory to all concerned, the amount of funding in the Section 177 Agreement proved sufficient to overcome claimant community political opposition to the Compact. Indeed, in the U.N. plebiscite the approval rate for the Compact and the Section 177 Agreement was higher among the entire class of those who had nuclear test claims filed in the federal courts than it was among the general population in the Marshall Islands. The Bikini people voted against the Compact, but later agreed to a settlement providing \$90 million in addition to the more than \$100 million in grants and assistance they had received under the Compact and other U.S. programs for their benefit. The Rongelap people also voted against the settlement, but that community is still awaiting the additional funding required to provide for their resettlement. Having made this observation, it probably is incumbent upon me to note here that I am acting as counsel and a registered agent for Rongelap in its quest for resettlement assistance. Rongelap resettlement was not addressed in the Section 177 negotiations in which I was involved while serving as a federal official.

3. The concepts underlying the Section 177 Agreement included empowerment of the affected people by providing each of the communities concerned with its own resource base so that each such community could begin to recover its identity and control its own future to a greater extent. Ending virtually total claimant community dependence on the Department of Interior and DOE, as well as other federal programs, was an objective of the settlement as well. The settlement also was structured to settle legal claims and cut off U.S. liability in the federal courts for damages arising from the nuclear testing program. However, it was recognized that the settlement should not completely close the books on U.S. responsibilities with respect to the nuclear claims. This was due to the history of AEC and DOE difficulty in defining health risks and island rehabilitation requirements. The result was Article IX of the settlement agreement.

4. Read carefully, Article IX constitutes U.S. recognition of the appropriateness of a request from the government of the Marshall Islands to the U.S. Congress for additional compensation and assistance if new information emerges in light of which the terms of the settlement appear manifestly inadequate. The underlying theory of Article IX is that the Section 177 Agreement was a good deal for both sides since it significantly increased U.S. compensation to the people concerned but also closed the federal courthouse door to further claims. However, everyone recognized that the state of knowledge about radiological conditions in the islands was not adequate to justify final termination of access to further U.S. assistance or compensation.

5. As new information emerges about the effects of the testing program, it should not surprise anyone that the affected communities and their national government are considering an Article IX request. It should not be viewed as clever, opportunistic or devious for the Marshallese parties to proceed under Article IX. It was fully contemplated and intended that this would be the case if credible evidence

came to light to indicate that the definition of affected people was too limited in scope, or that there were injuries and damage that reasonably could not be viewed as fully and fairly compensated by the agreement.

6. The U.S. got what it bargained for in the Section 177 Agreement because Article IX is essentially a commitment to ensure that a request from the Marshalls will be accepted and considered. While the U.S. obligation is primarily of a moral nature rather than a matter of legal compulsion, the use of a treaty provision to give a foreign government direct access to the U.S. Congress strengthens the case that a changed circumstances request for further measures to address test related problems was allowed and perhaps even anticipated based upon the history of changed circumstances and on-going efforts to improve our understanding of the effects of the testing program.

I hope the preceding discussion is helpful to the Subcommittee as it considers the options available to it in addressing issues that may arise from the disclosure of all existing information and the discovery of any new information concerning the effects of the nuclear testing program in the Marshall Islands.

Mr. MILLER. Thank you.
Dr. Hamilton.

STATEMENT OF THOMAS E. HAMILTON, M.D.

Dr. HAMILTON. Thank you, Mr. Chairman.

I have been asked to provide this committee with information resulting from my experiences and studies of the Marshallese people from 1982 to 1985.

I am a practicing endocrinologist and a clinical researcher in Seattle. My present position is chief of endocrinology in the Department of Medicine at Pacific Medical Center in Seattle. I am also on the clinical faculty in endocrinology and environmental health at the University of Washington. I am also the clinical director of the Hanford Thyroid Disease Study, which is a congressionally mandated study to determine if excess thyroid disease resulted from radioiodine emissions from the Hanford facility during nuclear weapons production in the 1940s.

I would like to summarize three areas of information for you today relevant to radiation exposure from the BRAVO test. The first is a study I published in 1987 reporting excess thyroid tumors or nodules in Marshall Islanders who were residing on islands which were not previously thought to be exposed by BRAVO fallout.

Second, I will summarize a collection of personal histories from Marshallese who provided their observations to me from their islands during the first few days of the BRAVO test. These persons resided on six northern atolls said to be unexposed to nuclear fallout.

Third, I wish to make some specific comments relative to the Rongelap exposures and regarding the decisions to evacuate the Rongelapese.

During my comments today, you may find it useful to refer to figure 1 on page 7 of my testimony which is a map of the Marshall Islands. The first topic, the study I published in 1987, culminated a three-year investigation of thyroid nodules in the Marshallese population. The field work for this study was conducted from 1982 to 1985 when I served as a consultant to a litigation project. The analysis and the publication of this data occurred at the University of Washington from 1985 to 1987.

During this study, I examined over 7,000 Marshallese people for thyroid nodules. These individuals lived on 14 northern and southern Marshall Islands, atolls, not previously said to be exposed—12 of these atolls were said not to be previously exposed to BRAVO fallout.

Now the reason for conducting these examinations was based on both anecdotal information and at least three internal Government documents which suggested that BRAVO fallout extended farther than Rongelap and Utirik, and I have referenced those for you in Appendix A.

The results of this study show two important findings. First, the prevalence or percentage of palpable thyroid tumors in persons living on these 14 atolls varied very widely, from less than 1 percent in the southern Marshall Islands to over 30 percent on Rongelap Atoll. If Rongelap and Utirik are excluded, there is still a wide

range of thyroid tumor rates, ranging from less than 1 percent to over 10 percent.

Second, there was a striking relationship between the percent of thyroid tumors in people on each of these atolls and the distance of each of those atolls from the Bikini blast site, specifically the BRAVO test site.

There was a strong inverse linear relationship such that high rates of thyroid tumors found in atolls close in to Bikini, with decreasing rates the further the distance from the Bikini blast site. This relationship was highly statistically significant, meaning that whatever factor or factors were responsible for causing this finding, that it was highly unlikely to be due to chance.

This finding did not prove that radiation exposure from nuclear fallout caused excess thyroid tumors. However, one must ask, what other known risk factors for thyroid nodules exist in the Marshall Island? There was no evidence of iodine deficiency in the Marshall Islands, no prior head and neck radiation therapy for benign diseases of the head and neck as was done in the United States, and there were no known dietary goitrogens, which are substances that might cause thyroid enlargement.

In my opinion, the absence of any other known risk factors for causing thyroid tumors and the presence of the statistically significant findings of this study using distance from the BRAVO test site as a proxy for radiation exposure and radioiodine exposure suggested that radioactive fallout, specifically the radioiodines, was the most likely cause of these thyroid neoplasms. These findings also suggest that these excess thyroid nodules were not limited to just the atolls of Rongelap and Utrik but occurred throughout other northern atolls.

Now the methods used in this study were validated by a second thyroid specialist. These findings were extensively peer reviewed by colleagues at the University of Washington, some of the most noted epidemiologists and biostatisticians that worked there. They were presented at local and national scientific meetings, and finally, this information was published in the *Journal of the American Medical Association* in 1987.

Now the second area that I want to cover is a set of unpublished personal histories from Marshall Islanders who lived on atolls which were said to be unexposed to nuclear fallout, and I have the details of these histories located in Appendix B.

I obtained these histories by asking open-ended questions of people that were living on some of these northern atolls other than Rongelap and Utrik and asked for their observations for the first few days immediately after the BRAVO shot. These individuals were present and lived on the atolls of Lae, Ujae, Likiep, Ailuk, Wotje, and islands in Northern Kwajalein. These histories are remarkable because of their similarity despite the fact that these people lived on very different atolls hundreds of miles from each other.

There were three common themes. The first is that on the day of the BRAVO test, people described powder or ash falling from the sky which covered plants and leaves. The color was variably described as yellow or white or off-white.

The second common observation was that the leaves from the coconut and breadfruit trees turned color or began dying within days after the BRAVO test, and there were some reports that chickens were sick and dying as well.

The third and most striking observation in my mind was obtained from several groups of people on Ujae Atoll. This is an atoll that is south of Bikini, and this observation was that there were individuals, especially children not wearing clothes, who developed lip and skin burns.

These anecdotal, personal histories provide compelling information that BRAVO test fallout likely extended to other atolls in the Marshall Islands, and it is particularly remarkable to me that the histories from the people on Ujae Atoll, an atoll that I suspect many of you have not heard much about, that suggest the possibility of acute radiation sickness correlate with the high prevalence of thyroid nodules found in my 1987 study.

Now the third issue I want to discuss relates strictly to the high-dose exposures incurred by the Rongelap people, which is an issue that I have to say has troubled me greatly over the last ten years. As you know well, the people suffered acute radiation sickness as well as long-term health effects, particularly thyroid neoplasms secondary to their exposure from BRAVO test fallout.

There were at least three factors which contributed to their high radiation doses. We are not talking about low-dose radiation here; these are high radiation doses. The first was that they were not evacuated to prevent radiation exposure as they had been during the 1946 Crossroads series.

Second, as Mr. Weisgall has covered fairly well, the wind direction was due east toward Rongelap prior to the detonation of BRAVO. Several weather briefings, as he has already told you, indicate that at 20,000 feet they were headed due east to Rongelap.

Now there was a question raised earlier about what action might have been taken on that. I have at least one DNA document that indicates that they felt that the predicted speed of these winds was low enough to be of no concern, and I have referenced that in my Appendix C for you.

Third, the Rongelap population was allowed to remain on their home island for at least two days before they were evacuated. During these two days before they were evacuated, as you have already heard, they continued to live on an island that was contaminated with fallout snow and continued to eat contaminated food and water. Therefore, one of the key determinants of their high whole body radiation dose was the two-day length of time they were allowed to remain on Rongelap.

Now Professor Eisenbud has indicated that there may have been some air capability to evacuate these islanders, and I would like to focus on another means of transportation. A DNA agency report published in 1982 provides data which show that there were naval vessels in position so that it at least appeared possible to evacuate the Rongelap people on the day of the BRAVO test. This is reference 7 in Appendix C.

This 1982 report documents the operations and the radiologic safety of U.S. military personnel during the BRAVO test, and it in-

cludes the nautical positions and the radiation monitor logs of all naval vessels at the time of detonation of BRAVO.

Figure 2 of my testimony shows a map for you that indicates that the *USS Gypsy* lay within a few miles and just outside the lagoon of Rongelap 80 miles southeast from the Bikini test site.

In addition, there were six other naval vessels that were in position between Rongelap and Bikini at the time of detonation. I came by this information by seeing these ships on a map in this DNA report, and having traveled to all the Marshall Islands, I was somewhat stunned that there were no islands on the map, only Bikini and all of these ship locations.

Having had access to nautical maps, I plotted all of the ship locations on this map, and that is what appears in Figure 2 of this testimony which was taken from an article that I published in 1991, Appendix C.

So despite the presence of these vessels, no evacuation took place until two days after the BRAVO shot. I want to say the obvious: I am not a military expert; I am not knowledgeable about military operations; I have very few details about naval or air operations on the day of the BRAVO test. However, I have been long concerned about the apparent possibility to have evacuated Rongelap earlier and spared them the significant radiation exposure.

I have been unable to find any public information as to why available transportation was not used to evacuate the Marshallese people when radiation monitor logs on board ship showed increasing levels that morning on March 1.

While there might be numerous reasons for the failure to evacuate these people, such as risk of exposure to U.S. military personnel, poor communication, poor weather, lack of available landing craft, one conclusion seems inescapable to me, and that is that the personal safety of the Rongelapese was not a high priority on March 1, 1954.

As we approach the fortieth anniversary of BRAVO, I wish to emphasize that the full understanding of radiation-related health effects of Marshall Islanders as well as U.S. military servicemen and U.S. citizens has been repeatedly compromised by incomplete or classified information. There is no justifiable reason why information from the nuclear testing program relating to public health continues to be kept secret from U.S. taxpayers or the Marshallese people. I urge this committee to mandate full disclosure of classified documents pertaining to the U.S. atmospheric nuclear testing program.

I appreciate the opportunity to testify here today and thank you for your efforts in elucidating this problem.

[Prepared statement of Dr. Hamilton follows:]

Thomas E. Hamilton, MD, PhD, MPH

Testimony Regarding Marshall Islanders Exposed to Nuclear Fallout
From the BRAVO Test

February 24, 1994

Presented Before

United States House of Representatives
Committee on Natural Resources

Investigative Hearing

Radiation Exposure from Nuclear Tests in the Pacific

My name is Tom Hamilton. I have been asked to provide you with information resulting from my experiences and studies of the Marshallese people from 1982 to 1985. I am a practicing endocrinologist and a clinical researcher in Seattle, Washington. My present position is Chief, Division of Endocrinology in the Department of Medicine at Pacific Medical Center in Seattle, and I am on the clinical faculty in endocrinology and environmental health at the University of Washington. I am also the Clinical Director of the Hanford Thyroid Disease Study which is a congressionally mandated study to determine if excess thyroid disease resulted from radioiodine emissions from the Hanford facility during nuclear weapons production in the 1940's and 1950's.

I would like to summarize three areas of information for you today relevant to radiation exposure from the Bravo hydrogen bomb test on March 1, 1954. The first is a study I published in 1987 reporting excess thyroid tumors in Marshall Islanders who were residing on islands which were not previously thought to be exposed to nuclear fallout from the BRAVO test.

Second, I will summarize a collection of personal histories from Marshallese who provided their observations on their islands during the first few days after the BRAVO test. These persons resided on 6 northern atolls said to be unexposed to nuclear fallout.

And third, I wish to make several comments specific to the Rongelap exposures from the BRAVO test regarding the decisions to evacuate Rongelap on the day of the BRAVO test.

I. Thyroid Nodularity in Marshallese from atolls previously said to be unexposed to BRAVO test nuclear fallout.

In 1987 I published a study which culminated a 3 year investigation of thyroid nodules in the Marshallese population. The field work for this study was conducted from 1982-1985 when I served as a consultant to a litigation project. The analysis and publication of the data occurred at the University of Washington from 1985 to 1987. During this study I examined over 7,000 Marshallese people for thyroid nodules. These individuals lived on 14 atolls in the northern

and southern Marshall Islands including 12 atolls not previously said to be exposed to BRAVO test fallout.

The reason for conducting these examinations was based on both anecdotal information and at least 3 internal government documents which suggested that BRAVO fallout extended farther than Rongelap and Utrik (Appendix A, ref 43,44,46)

The results of this study were based on 2273 persons from 14 atolls who were present during the 1954 BRAVO test and born during or before 1954. This is important because the radioactive iodine from the BRAVO test decayed within weeks to months. Therefore only those persons born during or before 1955 could have been exposed to radioactive iodine. Most of these individuals resided on 12 northern and southern atolls which were said to be unexposed to nuclear fallout.

The results of this study showed two important findings: First, the prevalence, or percentage, of palpable thyroid tumors in persons living on these 14 atolls varied widely, from less than 1% in the southern Marshall Islands to over 30% on Rongelap atoll. If Rongelap and Utrik are excluded, there was still a wide range of thyroid tumor rates from less than 1% to over 10%; Second, there was a striking relationship between the percent of thyroid tumors in people on each of these atolls and the distance of each atoll from the Bikini test site. Specifically, there was a strong inverse linear relationship such that high rates of thyroid tumors were found in atolls close to Bikini with decreasing rates the further the distance from the BRAVO test site. This relationship was highly statistically significant, meaning that whatever factor or factors caused this finding, it was highly unlikely to be due to chance.

This finding did not prove that radiation exposure from nuclear fallout caused these excess thyroid tumors. However, one must ask what other known risk factors for thyroid nodules exist in the Marshall Islands? There is no evidence of iodine deficiency in the Marshalls, there is no prior head and neck radiation therapy for benign diseases as occurred in the United States, and there are no known dietary goitrogens which could cause thyroid enlargement. Thus, if unknown risk factors for developing thyroid disease are present in this population, it must be postulated that these factors exert their effect in a manner that decreases with distance from the BRAVO blast site on Bikini atoll. It is my opinion that the absence of

other risk factors for thyroid tumors in the Marshall Islands and the presence of the statistically significant findings of this study, that radioactive fallout, specifically radioactive iodines, was the most likely cause of these thyroid neoplasms. The findings also suggest that excess thyroid nodules were not limited to the atolls of Rongelap and Utrik, but occurred throughout other northern atolls.

The methods used in this study were validated by a second thyroid specialist, the findings were extensively peer-reviewed by colleagues at the University of Washington, they were presented at local and national scientific meetings, and published in the Journal of the American Medical Association in August, 1987 (Appendix A).

II. Historical Observations from Marshallese people living on atolls in March, 1954 which were said to be unexposed to nuclear fallout.

The second area I want to cover is a set of unpublished personal histories from Marshall Islanders who lived on atolls which were said to be unexposed to nuclear fallout (Appendix B). I obtained these histories by asking open-ended questions of these people about what they observed during the days following the 1954 BRAVO test. These individuals were present on the atolls of Lae, Ujae, Likiep, Ailuk, Wotje, and northern Kwajalein at the time of the blast (Figure 1).

These histories are remarkable because of their similarity despite the fact that they lived on different atolls. There were three common themes. The first is that on the day of the BRAVO test people described powder or ash falling from the sky which covered plants and leaves. The color was variably described as yellow or white. The second common observation was that leaves from coconut and breadfruit trees turned color or were dying during the days following BRAVO and there were some reports of chickens becoming sick or dying. The third striking observation obtained from several groups of people on Ujae atoll, was that on the day of the BRAVO test there were individuals, especially children not wearing clothes, who developed lip and skin burns.

The details of these histories are located in Appendix B. These anecdotal personal histories provide compelling information that BRAVO test fallout likely extended to other atolls in the Marshall

Islands. It is remarkable that the histories from Ujae atoll, which suggest the possibility of acute radiation sickness, correlate with a high prevalence of thyroid nodules found in my 1987 study.

III High dose radiation exposure to Marshall Islanders on Rongelap.

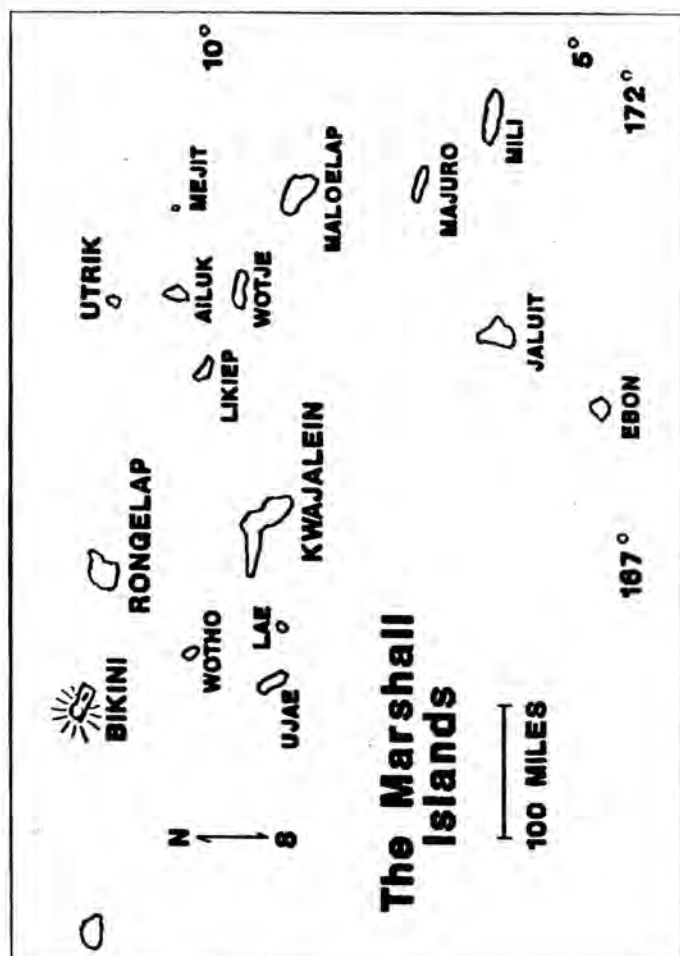
I would like to present some information relating strictly to the high dose exposures incurred by the Rongelap people which has troubled me during the past ten years. As you know well, the Rongelap people suffered acute radiation sickness as well as long term health effects, particularly thyroid neoplasms, secondary to their exposure from BRAVO test nuclear fallout. There were at least three factors which contributed to their high radiation doses. The first was that they were not evacuated to prevent radiation exposure as they had been during the 1946 Crossroads test series. Second, the wind direction was due east, toward Rongelap, prior to the detonation of BRAVO. Several weather briefings before the detonation indicated that winds at 20,000 feet were headed for Rongelap, however, it was felt that the predicted speed of these winds was low enough to be of no concern (Appendix C, ref 7). Third, the Rongelap population was allowed to remain on their home island for at least two days after the BRAVO test before being evacuated. During these 2 days before they were evacuated, they continued to live on an island which was contaminated with "fallout snow" on the ground and ate and drank contaminated food and water.

One of the key determinants of their high whole-body radiation dose was the two day length of time they were allowed to remain on Rongelap. No formal investigation regarding this issue has ever been made public. However, a Defense Nuclear Agency report, published in 1982, provides data which show that naval vessels were in position, such that it appeared possible to evacuate the Rongelap people on the day of the BRAVO test (Appendix C, ref 7). This report documents the operations and radiologic safety activities of US military personnel during the BRAVO test and it includes the nautical positions and radiation monitor logs of all naval vessels at the time of detonation of BRAVO. Figure 2 shows that the USS Gypsy lay within a few miles and just outside of Rongelap lagoon, 80 miles southeast from the Bikini test site (from Appendix C). In addition, 6 other naval vessels were in position between Rongelap and Bikini at the time of detonation. Despite the presence of these vessels, no evacuation took place until two days after the BRAVO detonation.

I am certainly not knowledgeable about military operations nor do I have many details about the naval or air operations on the day of the BRAVO test. However, I have been concerned about the apparent possibility to have evacuated Rongelap earlier and spared them significant radiation exposure. I have been unable to find any public information as to why available naval transportation was not used to evacuate the Marshallese people from Rongelap on the day of the BRAVO test, at a time which radiation monitor logs on board ship were steadily increasing. While there might be numerous reasons for the failure to evacuate these people, such as risk of radiation exposure to US military personnel, poor communication, poor weather, or lack of landing craft, one conclusion seems inescapable to me: the personal safety of the Rongelapese was not a high priority on March 1, 1954.

As we approach the 40th anniversary of the BRAVO hydrogen bomb test, I wish to emphasize that the full understanding of radiation-related health effects in Marshall Islanders, as well as in US servicemen and citizens, has been repeatedly compromised by incomplete or classified information. There is no justifiable reason why information from the nuclear testing program relating to public health continues to be kept secret from US taxpayers or the Marshallese people. I urge this committee to mandate full disclosure of classified documents pertaining to the US atmospheric nuclear testing program. Thank you.

Figure 1



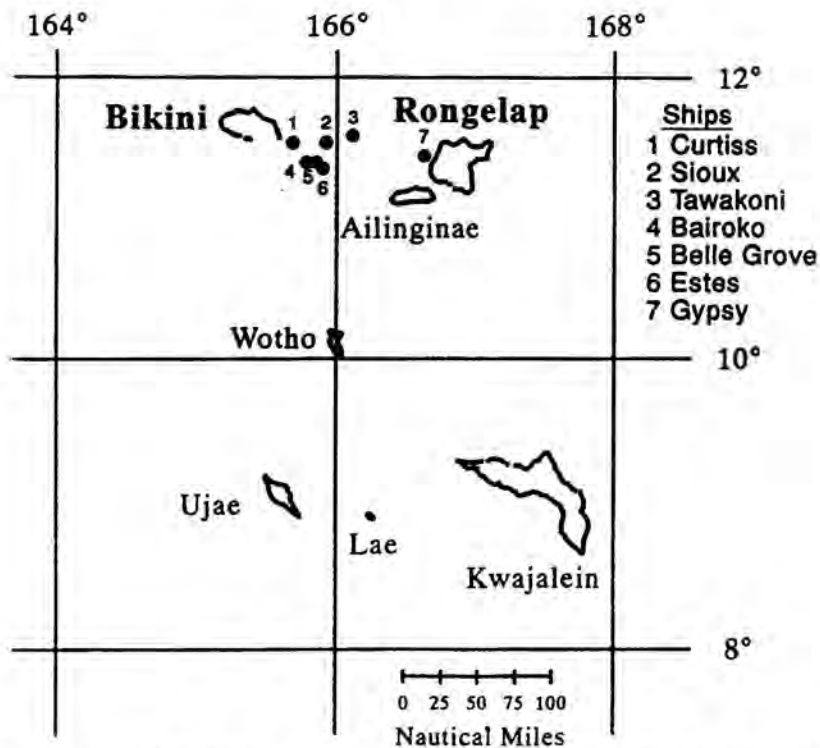


FIGURE 2. Locations of naval vessels (solid circles) at the time of BRAVO detonation in relation to Rongelap Atoll. Adapted from Defense Nuclear Agency report [7].

Appendix B

HISTORICAL COMMENTS

1983, 1984

- Age 64 - Lae Atoll

This man was on Lae Atoll during the March 1, 1954 Bravo hydrogen bomb detonation. "I was in a coconut tree and saw a bright light and explosion. I do not remember anything falling overhead, but saw yellow smoke at a distance. The sky overhead was clear."

- Age 46 - Likiep Atoll

This man was age 16 on March 1st, 1954 and remembers coming from the church. The church was shaking and the ground was shaking. He saw a bright light over the entire sky like a bright sunset. He saw a yellow powder over all the plants. He could take the leaves and wipe layers of yellow powder off of the leaves. The powder was in the water. A Navy plane landed and the man took a metal machine (Geiger counter) and this person heard sounds from the Geiger counter and states he saw the needle go off the scale whenever he would put the machine near a cement water catchment. He stated that there were no restrictions on water and that they drank water. He also states that the Navy also took a tetherball pole away after it was measured with a Geiger counter.

- Age 40 - Likiep Atoll

This man was about 10 years old when he was fishing with his father ocean-side on March 1st, 1954. They were told of the blast ahead of time and were told not to expose themselves and to preserve water and food. He saw the lightning come from the sky. There was no smoke. Maybe one week later a ship came from Kwajalein and stayed there for one week. They examined the ground and water and trees. They took one canoe and burned it and threw it away. He doesn't recall anything on the ground.

- Age 73 - Ujae Atoll

This woman was on Ujae Atoll on March 1, 1954. She remembers the light and explosion and describes the sky as a "flame in the sky". She also states that the next day there were leaves of the plants that were dying. She does not specifically recall anything falling from the sky.

- Age 53 - Lae Atoll

This woman moved to Lae Atoll in 1947 and then to Ebeye in 1955. She was Lae Atoll during the 1954 Bravo detonation. She remembers seeing a rainbow in the sky. She was sleeping on that morning and the lantern fell to the ground and woke her up. She states that later in the day the sky was very foggy. She is not sure how to describe it but states the sky was not clear and that the foggy color was similar to a white color, but not exactly white.

- Age 69 - Kwajalein Atoll

This man was on Ebeye during the 1954 Bravo detonation. This comment, however, is relative to his experience in 1947 when he was on a ship (LST 1134) on Rongerik Atoll. They were delivering food to the Rongelap people who were living there. He distinctly remembers a 10 minute period where a yellow to green powder fell on the deck of the ship. They took hoses to wash the entire deck of the ship to remove this powder. He is not absolutely sure of the date, but feels it was in 1947.

- Age 42 - Likiep Atoll

This woman was born on August 31, 1942 on Jabwor Island. She grew up on Likiep Island in Likiep Atoll and lived there during the March 1, 1954 Bravo detonation. She vividly recalls the bright lights on the morning of March 1, 1954. She recalls a white dust in the air and remembers seeing this white dust on the green canvas which was the roof of one of their structures. This woman moved to Majuro in 1960.

This woman has had six children. One child has a cleft palate. In 1972 at the third month of pregnancy, this woman delivered "grapes" by Dr. Wein at the Majuro Hospital. The woman says that Dr. Wein put these grapes in a large jar and that they are still present today in the Majuro Hospital. She stated the reason for doing this was because Dr. Wein stated he had never seen a delivery previously with this appearance. She subsequently has had a hysterectomy.

Lae Atoll

When I was visiting Lae Atoll in February, 1984, one person told me that people from Rongelap and Wotho temporarily moved to Lae prior to 1952 and stayed there for a short time and then returned home. A second individual stated that a camp was made for Rongelap and Wotho people and that they stayed there for a short while and returned home; this person could not recall the date.

Ujae Atoll

When I visited Ujae Atoll in February, 1984, I had a discussion with several 50-70 year old men. A few of these men recalled that there were some people on Enelamoj Island on Ujae Atoll who developed lip and skin burns after powder fell on their skin after the bomb blast in March, 1954. These men also said powder was seen on plant leaves.

Anonymous - Ujae Atoll

This woman was about 18 years old on Ujae Atoll during the 1954 Bravo test. Her first comments concern a conversation she had with her mother about one hour prior to this dictation, and her mother told her that she was on Enelamoj Island on Ujae Atoll and that the bomb blast caused a powder to fall on the ground which appeared like ashes. She said the color was a white to gray appearance. After a few days, all of the leaves on the coconut and breadfruit trees turned brown and red and were not green. Some of the men's skin became dark and brown and they acted as though they were drunk with loss of balance and dizziness, but they were not drunk. There

were two people who had skin burns on the face and arms, and a little boy who was burned all over his body because he had no clothes on.

The daughter says she does not remember very much, but does remember seeing a very big, red lightning on the horizon and she does remember seeing powder on the ground. She states that an American airplane came to the island and told them to stay inside their houses and to take their drinking water inside. She states the Americans spread a large canvas on the baseball field.

(The above comments were told to me in Majuro, March 5, 1985.)

- Ujae Atoll

This woman was 10 years old during the 1954 Bravo test and was living on Ujae Atoll. She remembers seeing a very bright light and that the ground was shaking. She states that the sky was very dark and looked like black smoke. She states that all of her ducks and chickens died several days after the blast.

- Kwajalein Atoll

This woman was approximately 20 years old during the 1954 Bravo test when she was living on one of the northern islands in Kwajalein Atoll. She states the name of the island was "Ebtan". She remembers the light and shaking of the ground. She states she was actually on Ebeye Island at the time of the blast but went to this small northwestern island about one or two days after the explosion. She states she saw white powder on the pandanus leaves.

- Ailuk Atoll

This man was 43 years old in March, 1954 during the Bravo explosion and was living on Ailuk Atoll. He remembers seeing the light and the shaking ground. He states that he saw ashes which were white colored falling from the sky. He does not remember anything on the plants or the ground.

- Ujae Atoll

This woman was 19 years old at the time of the Bravo detonation on March 1, 1954 and was living on Ujae Atoll. She remembers seeing the light and feeling the ground shaking. She states that it rained in the afternoon and that the arms of some people (unclear if herself) looked like they were burned with grease and people were having severe itching. There was no snow from the sky, but there was a fog in the sky. She states the skin felt better the next day.

- Wotje Atoll

This woman was 24 years old at the time of the Bravo detonation on March 1, 1954 and was living on Wotje Atoll. She remembers the explosion and states that she saw white "snowflakes" falling from the sky on the same day of the explosion.

- Wotje Atoll

This woman was in her mid-20's during the 1954 Bravo detonation and she was living on Wotje Atoll. She states that she remembers yellow "snowflakes" falling from the sky on that day.

- Lae Atoll

This man was approximately 40 years old during the 1954 Bravo detonation when he was living on Lae Atoll. He states he believes there was a pre-announcement of the Bravo test. He saw a very bright light and states that he lost his vision for about 15 minutes. He was on a boat in the lagoon and was looking at the bright light. He went back to land and later saw a white powder on the grass and coconut leaves. He says it was not exactly white, but an off-white color.

- Lae Atoll

This woman was approximately 34 at the time of the Bravo detonation on March 1, 1954 when she was living on Lae Atoll. She remembers hearing the blast and seeing a light which looked like a rainbow in the sky. She saw yellow smoke far away. She does not remember anything falling on the ground.

- Jaluit Atoll

This woman was 35 years old during the 1954 Bravo detonation on Bikini and she was living on Jaluit Atoll. She recalls seeing the bright light of the explosion but recalls nothing else. She moved to Majuro in the summer of 1954.

- Jaluit Atoll

This woman was 35 years old during the 1954 Bravo hydrogen bomb detonation on Bikini Atoll. She was living on Jaluit Atoll and states she remembers well the light and explosion and states that "trees were dying after the blast".

- Ailuk Atoll

This woman was 25 years old during the 1954 Bravo hydrogen bomb detonation. She was living on Ailuk at that time. She states she saw a bright light and felt the ground shaking. She cannot remember if she saw anything falling from the sky, however, about three weeks after the blast she stated that some friends told her that they saw powder fall from the sky on the day of the blast.

Response to DOE Comments received 2/19/94 to 1987 JAMA article on Marshall Islanders exposed to nuclear fallout from the 1954 BRAVO test.

Tom Hamilton, MD, PhD, MPH
February 22, 1994

1. No formal or official critique or response received to this 1987 article until these congressional hearings and then only a one page unidentified discussion.
2. DOE has never initiated studies to confirm or refute the 1987 findings.
3. DOE claims that this study is an ecologic study and therefore offers "the lowest level of evidence for establishing cause and effect relationships". While this is a true statement about ecologic studies the statement that the JAMA study is ecologic is completely false. Ecologic studies involve assessment of disease occurrence by some population characteristic and not by collecting individual exposure data and assessing individual outcome data. The JAMA article clearly states in the methodology that exposure data was collected on individuals prior to the determination of individual outcome data, eg diagnosis of thyroid nodules. The criticism by DOE stating that this study is ecologic are therefore completely without substance.
4. DOE claims that using only one physician to perform the examinations is a weakness. This was acknowledged in the article and was the basis for performing an in depth validation study which is described fully in the article and demonstrates that there was excellent agreement of thyroid examination results between the author and an independent thyroid specialist from the University of Washington who travelled to the Marshall Islands to participate in the validation study.
5. DOE claims that central atolls may have had a prevalence intermediate between the north and south. This of course may be true and would only serve to strengthen the "dose-response" nature of the findings and has no adverse bearings on the results of this study.
6. DOE claims that residence at time of test was not verified. This is true however the unique nature of small atolls between hundreds of miles of ocean prohibits significant movement in a short time. In addition the detonation of a 15 megaton hydrogen bomb detonation is such a remarkable experience that it is likely very well remembered, similar to the JFK assassination for example. In any event, for this to be a problem one would have to propose that inaccurate recall of residence during BRAVO was somehow differential which is highly unlikely.
7. The DOE recommends following the results of a recent thyroid study in the Marshall Islands done in collaboration with Japanese investigators. Did DOE in any way initiate or play any part in promoting this study?

Thyroid Neoplasia in Marshall Islanders Exposed to Nuclear Fallout

Thomas E. Hamilton, MD, PhD; Gerald van Belle, PhD; James P. LoGerfo, MD, MPH

We studied the risk of thyroid neoplasia in Marshall Islanders exposed to radioiodines in nuclear fallout from the 1954 BRAVO thermonuclear test. We screened 7266 Marshall Islanders for thyroid nodules; the islanders were from 14 atolls, including several southern atolls, which were the source of the best available unexposed comparison group. Using a retrospective cohort design, we determined the prevalence of thyroid nodularity in a subgroup of 2273 persons who were alive in 1954 and who therefore were potentially exposed to fallout from the BRAVO test. For those 12 atolls previously thought to be unexposed to fallout, the prevalence of thyroid nodules ranged from 0.9% to 10.6%. Using the distance of each atoll from the test site as a proxy for the radiation dose to the thyroid gland, a weighted linear regression showed an inverse linear relationship between distance and the age-adjusted prevalence of thyroid nodules. Distance was the strongest single predictor in logistic regression analysis. A new absolute risk estimate was calculated to be 1100 excess cases/Gy/y/1 $\times 10^4$ persons (11.0 excess cases/rad/y/1 million persons), 33% higher than previous estimates. We conclude that an excess of thyroid nodules was not limited only to the two northern atolls but extended throughout the northern atolls; this suggests a linear dose-response relationship.

(JAMA 1987;258:629-636)

IT HAS been 21 years since the publication of an early case series of thyroid neoplasia (including thyroid cancer and

benign nodules) developing in children of Marshall Islanders as a late effect of exposure to radioactive fallout.¹ This exposure resulted from the detonation of a 15-megaton thermonuclear device on March 1, 1954, on Bikini Atoll in the northern Marshall Islands (Fig 1). This atmospheric nuclear test, code-named BRAVO, heavily contaminated the islands of Rongelap Atoll (86 inhabitants), and to a lesser extent, Utrik Atoll (167 inhabitants). The acute radiation sickness that developed in most of the people from Rongelap has been well de-

scribed in previous reports.¹⁻¹⁰ The most common late effect from this exposure has been the development of thyroid nodules. Between 1954 and 1985, thyroid nodules developed in approximately 33% of the Rongelap population, including 63% of children less than 10 years old at the time of exposure, and 10% of the Utrik population.^{2,3} Previous investigators have assumed that Rongelap and Utrik were the only two northern atolls exposed to fallout radiation; in their studies they used as unexposed controls those living on other northern atolls during the 1954 BRAVO test and found the prevalence of thyroid nodules in this comparison group to be 6.3%.^{2,3} Although the estimates of thyroid dose for islanders from Rongelap and Utrik have been widely published, almost no information exists about the possible contamination of other northern atolls by radioiodines in 1954.^{2,3,11} There is no verification that exposure to radioiodine did not occur on the other northern atolls.

Radiation exposure to the thyroid gland in the Marshallese people resulted primarily from beta radiation from a mixture of radioiodines (¹³¹I, ¹³²I, ¹³³I, ¹³⁴I) and, to some extent, gamma radiation.^{12,13} Knowledge about radiation-induced thyroid neoplasia comes largely from two sources: (1) studies of children exposed to gamma radiation for benign diseases¹⁴⁻¹⁶ and (2) studies of survivors exposed to gamma radiation

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The opinions, conclusions, and proposals in this article are those of the authors and do not necessarily represent the views of the Robert Wood Johnson Foundation or the Marshall Islands Atomic Testing Litigation Project.

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at Hiroshima and Nagasaki.^{35,36} Studies of exposures to iodine 131 in humans have been limited largely to ¹³¹I therapy for patients with Graves' hyperthyroidism. It is unclear from these studies whether ¹³¹I alone results in an excess of thyroid nodules.³⁷⁻⁴⁰ Much less is known about the health risks of exposure to short-lived radioiodines other than ¹³¹I. This information may be important in assessing the impact of radioiodine exposure from nuclear reactor accidents.

While the people from Rongelap and Utrik have been exhaustively studied during the last 33 years, these previous studies of thyroid neoplasia did not include the total geographical extent of the Republic of the Marshall Islands. To define more carefully the risk of thyroid neoplasia from nuclear fallout containing radioactive iodines, we conducted a retrospective cohort study of thyroid nodules in 7266 Marshallese people from 14 atolls, including several southern atolls, which served as the source of the best available unexposed comparison group.

METHODS

Study Hypothesis

The objectives of this study were as follows: (1) to determine the prevalence of thyroid nodules in people who were living on 14 northern and southern atolls at the time of the 1954 BRAVO detonation; (2) to test the null hypothesis that no difference existed in the prevalence of thyroid nodules among the 12 atolls of this study previously thought unexposed to radioactive fallout; and (3) if the null hypothesis is rejected, to determine which factors might explain the variation in rates of thyroid nodules.

Study Location

The Marshall Islands are located 2400 miles southwest of Hawaii; approximately 35,000 people (1985) live on 24 atolls spread among 375,000 square miles in the central Pacific Ocean. This population is distributed roughly in thirds on the following atolls: Majuro Atoll, the administrative district of the government of the Marshall Islands; Kwajalein Atoll; and the remaining 22 atolls, known collectively as the "outer islands." This study took place between June 1983 and March 1985 on 14 of the 24 inhabited atolls in the Marshall Islands (Fig 1).

For this study, northern atolls were defined as those north of Majuro (Rongelap, Utrik, Mejit Island, Ailuk, Likiep, Wotje, Maloelap, Kwajalein, Lise, Ujae, and Wotho), and southern atolls were defined as those south of Majuro (Jaluit, Ebon, and Mill). These

14 study atolls were selected to include all northern atolls that could have possibly been in the path of fallout and as many southern atolls as logistically feasible. Atolls that were not studied included five central atolls, two currently uninhabited northern atolls (Rongerik and Ailingnae), one southern atoll, and two atolls west of Bikini.

Study Design and Sample

A population-based retrospective cohort design was employed. Among the 7266 Marshallese people screened in this study, 2273 persons were alive in March 1954 and were residing on one of the 14 study atolls; they were, therefore, potentially exposed to the short-lived radioiodines. Since only these people were at risk for radioiodine-induced thyroid neoplasia, it is this group of 2273 persons that makes up the sample in this study.

During the course of this study, all residents (age 5 years and older) of each island selected for screening were invited and encouraged to receive thyroid examinations. Extensive discussions with traditional leaders of each atoll were conducted prior to each trip to ensure maximal communication to residents of each island. One to two weeks were spent on each atoll performing the screening examinations. The population of each atoll at the time of screening was estimated from the 1980 Marshall Islands census data.⁴¹

To offset the effect of self-selection by islanders of each atoll population, we attempted to screen the entire population of 13 primary atolls. Since migration out of the country is rare, the primary problem was capturing those members of the population, especially the population of 1954, who had moved to either of the two population centers, Majuro or Kwajalein. Screening programs were therefore conducted on Majuro and Kwajalein for those individuals and their families who had lived on any of the 13 northern or southern atolls in 1954. However, since we screened nearly a third of the population of Kwajalein Atoll for thyroid nodules, we also included Kwajalein as a primary atoll, making a total of 14 study atolls.

Exposure Criteria

Since the short-lived radioiodines (¹³¹I, ¹³²I, ¹³³I) all have half-lives of less than eight days, the bulk of the radioiodine exposure from the BRAVO event occurred during the month of March 1954. Therefore, the most important historical information concerning the radioiodine dose was the location of residence in March 1954. Because most individuals can provide vivid descrip-

Table 1.—Distance and Direction of Study Atolls From Bikini Atoll

| Atoll | Distance, Miles* | θ, °† |
|---------------|------------------|-------|
| Rongelap | 120 | 20 |
| Utrik | 321 | 6 |
| Mejit Island‡ | 398 | 15 |
| Ailuk | 342 | 18 |
| Likiep | 309 | 26 |
| Wotje | 378 | 25 |
| Maloelap | 480 | 28 |
| Lise | 198 | 71 |
| Ujae | 197 | 80 |
| Wotho | 112 | 64 |
| Kwajalein | 182 | 51 |
| Jaluit | 500 | 54 |
| Ebon | 538 | 64 |
| Mill | 589 | 42 |

*Distance from atoll to BRAVO test site on Bikini Atoll in statute miles.

†Angle of atoll from 0° latitude line drawn through Bikini Atoll.

‡Mejit Island is classified as an atoll for the purposes of this study.

tions of what they were doing during the dramatic BRAVO test, the question was posed in the following manner: "Where were you living when the 'bomb' caused the Rongelap and Utrik people to be moved from their homeland?" Individuals born after March 1, 1954, but before Dec 31, 1954, were classified as in utero at the time of the blast, and their atoll of residence in 1954 was classified according to their atoll of birth. Because of the relative proximity of all the islands within each atoll and the long distance between any atoll and the blast site, all individuals from different islands within an atoll were classified by the atoll name for the purposes of 1954 residence status.

Since the people live on small land masses, the atolls represent discrete points in the vast ocean area of the Marshall Islands. The distance from each atoll to the site of the 1954 BRAVO test (Bikini Atoll) was therefore selected as a proxy for the radioiodine dose received in 1954.

A second variable was developed to better characterize the exposure status of the Marshallese people. A directional variable, θ, was selected as a proxy for meteorologic conditions, such as wind and precipitation, that may have influenced the distribution of the fallout cloud. We defined θ as the angle in degrees, measured clockwise, of each of the 14 atolls from a 0° latitude line drawn through Bikini Atoll, using Bikini as the vertex. Table 1 shows the distance of each atoll from the BRAVO test site as well as the angle θ of each atoll from an east-west line drawn through Bikini.

Diagnostic Criteria

We defined a thyroid nodule as one that was palpable, discrete, and estimated to be 1.0 cm or greater. Findings of indistinct or uncertain lesions and



Fig 1.—Marshall Islands. BRAVO test site is shown on Bikini Atoll. People on other atolls were screened for thyroid nodules.



Fig 2.—Prevalence of thyroid nodules. Atolls shown in color inset were previously assumed unexposed to radiiodine from nuclear fallout.

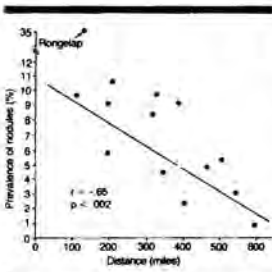


Fig 3.—Weighted linear regression. Age-adjusted prevalence of thyroid nodules weighted by inverse of population variance is plotted against distance from BRAVO test on Bikini Atoll.

Table 2.—Proportions of Atoll Populations Screened for Thyroid Nodularity

| Atoll | Estimated Population* | Total No. (%) Screened |
|------------|-----------------------|------------------------|
| Rongerik | 201 | 122 (61) |
| Ujae | 287 | 184 (64) |
| Mak Island | 278 | 263 (95) |
| Aluk | 353 | 217 (61) |
| Likiep | 419 | 137 (33) |
| Wotho | 486 | 364 (75) |
| Makelap | 534 | 445 (83) |
| Lae | 206 | 148 (72) |
| Ujae | 269 | 187 (70) |
| Wotho | 74 | 34 (46) |
| Jalut | 1295 | 759 (59) |
| Ebon | 792 | 517 (65) |
| Mil | 681 | 319 (47) |
| Subtotal | 5858 | 3735 (64) |
| Majuro | 10781 | 1723 (16) |
| Kwajalein† | 6081 | 1806 (30) |
| Total | 22707 | 7266 (32) |

*Projected from 1980 Marshall Islands census data.¹²
 †Screening of the entire Kwajalein and Majuro populations was not attempted; only persons from these two atolls who had lived on the other 13 primary atolls in 1954 were screened.

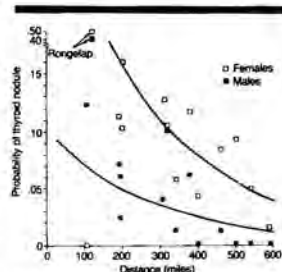


Fig 4.—Logistic regression analysis. Probability of thyroid nodule developing in an individual (from fitted logistic model) is shown for each sex, given mean age, as function of distance from Bikini Atoll. Actual prevalence data are also plotted. Females, top curve; and males, bottom curve.



Fig 5.—Probability contours. Graph shows fitted probability contours for thyroid nodules for females, computed from complete logistic model. Distance was calculated for each contour of fixed probability, given mean age of females, for values of θ from 0° to 80°.

Table 3.—Descriptive Statistics of 1954 Cohort and Prevalence of Thyroid Nodularity

| Atoll of Residence | Persons Alive in 1954 | Mean Age, y | Females, % | Solitary Nodules | Previous Thyroidectomy* | Total Nodules | Crude Prevalence, % | Age-Adjusted Prevalence, % |
|--------------------|-----------------------|-------------|------------|------------------|-------------------------|---------------|---------------------|----------------------------|
| Rongelap | 44 | 45.8 | 54.5 | 0 | 17 | 17 | 38.6 | 37.2 |
| Utrik | 87 | 47.4 | 56.7 | 1 | 5 | 6 | 9.0 | 10.3 |
| Majik Island | 167 | 46.2 | 54.8 | 3 | 1 | 4 | 2.4 | 2.4 |
| Alik | 177 | 45.6 | 58.0 | 7 | 1 | 8 | 4.5 | 4.9 |
| Likiep | 167 | 47.7 | 53.8 | 12 | 2 | 14 | 8.4 | 8.7 |
| Wojto | 161 | 47.8 | 48.7 | 9 | 5 | 14 | 8.7 | 9.8 |
| Maloklap | 183 | 46.5 | 53.5 | 7 | 2 | 9 | 4.9 | 4.7 |
| Lae | 95 | 48.4 | 48.4 | 6 | 1 | 7 | 10.6 | 10.2 |
| Ujae | 108 | 46.5 | 56.6 | 7 | 3 | 10 | 9.3 | 9.6 |
| Wotho | 25 | 44.8 | 86.7 | 1 | 1 | 2 | 8.0 | 8.8 |
| Kaajalein | 425 | 51.4 | 49.8 | 13 | 12 | 25 | 5.9 | 5.3 |
| Jakut | 313 | 48.6 | 56.2 | 15 | 2 | 17 | 5.4 | 5.2 |
| Ebon | 250 | 45.4 | 60.1 | 5 | 3 | 8 | 3.1 | 3.2 |
| Mil | 111 | 47.2 | 55.6 | 1 | 0 | 1 | 0.9 | 0.8 |
| Total | 2273 | 46.8 | 55.0 | 87 | 58 | 142 | 6.2 | 5.7 |

*Excludes five subjects in whom the pathologic findings indicated normal thyroid disease.

Table 4.—Predictors of Risk for Thyroid Nodules

| Logistic Regression Analysis | | | |
|------------------------------|------------------------|---------|--|
| Variable | Regression Coefficient | SE | Odds Ratio (95% Confidence Interval) |
| Constant | -1.872 | 0.8310 | |
| Age | 0.01914* | 0.0062 | 1.21/10 y (1.07/10 y - 1.37/10 y) |
| Sex† | 1.313‡ | 0.2180 | 3.72 FM (2.42 - 5.70 FM) |
| Distance | -0.01098§ | 0.0021 | 0.33/100 miles (0.22/100 miles - 0.50/100 miles) |
| § | -0.05312‡ | 0.0132 | 0.58/10° (0.45/10° - 0.78/10°) |
| Distance × § | 0.0001457‡ | 0.00004 | 1.16/100 miles × 10° (1.07/100 miles × 10° - 1.25/100 miles × 10°) |

*P = .003.

†Male = 1 and female = 2.

‡P < .001.

nodules less than 1 cm were classified as normal thyroid examination results. The term *thyroid nodule* does not connote the histologic characteristics of a lesion. We use the terms *thyroid neoplasia* and *thyroid nodule* synonymously in this article to indicate that such lesions may be either malignant or benign.

Because the hypothesis of this study pertains strictly to solitary thyroid nodules, individuals with Graves' disease, multinodular goiter, or simple diffuse goiter were not classified as having nodules for the purpose of this analysis. Individuals whose 1954 residence was not one of the 14 study atolls were excluded altogether from the prevalence data.

Previous Thyroidectomy

Almost all individuals from Rongelap and Utrik in whom thyroid nodules developed had had thyroid surgery, generally in the United States under the direction of Brookhaven National Laboratory, Upton, NY.⁴ This is also true for certain individuals in the comparison groups. The majority of the atoll popula-

tions, however, had had little access to physicians. As a result, most thyroid nodules in this study were newly diagnosed. Because cohort attrition from thyroid mortality is extremely low and because nodules generally do not spontaneously regress, we decided to count individuals with previous thyroidectomy as having had a thyroid nodule if the indication for surgery was the removal of a thyroid nodule. For Marshall Islanders with prior thyroidectomy, the indication for the surgery was ascertained from available medical records. The histologic characteristics of these malignant and benign neoplasms have been described previously.⁴ Individuals with previous thyroid surgery for Graves' disease, simple goiter, or indications other than a thyroid nodule were not classified as having a thyroid nodule in this analysis. Individuals whose surgical histologic findings were "normal thyroid tissue" were also not classified as having nodules. The net result of these classifications is that the prevalence data reported here are thought to approximate closely the cumulative incidence of thyroid nodularity since 1954.

Thyroid Carcinoma

The prevalence of solitary thyroid nodules was the outcome variable in this study. Because many individuals with new thyroid nodules were treated medically rather than referred for surgery, ascertainment of thyroid carcinoma was incomplete in this study cohort. However, since previous authors have provided absolute risk estimates for total thyroid nodules as well as for thyroid carcinoma, our risk estimates for total thyroid nodules in this study can be directly compared.⁴

Data Collection

A physical examination of the thyroid gland was carefully performed by one of us (T.E.H.) on all 7286 study participants. Detailed drawings and explanations were recorded for all thyroid abnormalities, including evidence of previous thyroid surgery. Nodules were described by location, consistency, contour, discreteness, and size. In addition to demographic information the following information was also obtained: a brief medical and surgical history, blood pressure, pulse, and examination of the cervical lymph nodes. Residence location in 1954 was recorded. Persons with thyroid abnormalities were referred for a comprehensive medical evaluation in the authors' (T.E.H.) central office on Majuro Atoll.

The same qualified Marshallese interpreter was present at all screening examinations. Travel to the 14 atolls and islands within atolls was accomplished by airplane, ship, small craft, and outrigger canoe.

To diminish observer bias, the thyroid examiner was masked to the history of exposure: the Marshallese interpreter asked each person about his or

her 1954 residence in their native language. Individuals who were too young to remember the 1954 thermoluminescent BRAVO test were asked where they were born, and their residence history for their first five years was noted.

Risk Assessment

The absolute risk coefficient for thyroid neoplasia is expressed as the number of excess nodules/thyroid dose/years at risk/1 million persons, where excess nodules are the observed minus expected nodules and the thyroid dose is expressed in grays (1 Gy = 100 rad). The most recent estimates for the mean dose of radiation to the thyroid gland in Marshall Islanders are 21 Gy (2100 rad) for Rongelap Islanders and 2.80 Gy (280 rad) for Utrik Islanders.¹⁰ To calculate a single absolute risk coefficient for both of these populations, previous studies used the following information: a mean thyroid dose of 8 Gy (800 rad), the mean number of years at risk (18), the observed number of nodules (46), and the expected number of nodules (16) for the combined population of 251 Rongelap and Utrik Islanders. The calculation for the expected number of nodules was based on a prevalence of 6.3% for atolls assumed unexposed to fallout.⁴

We determined a new value for the prevalence of nodules in unexposed Marshall Islanders. To calculate a new absolute risk coefficient, we used the expected number of nodules determined with this new prevalence value as well as the above information concerning mean dose, mean years at risk, and expected nodules for the original 251 Rongelap and Utrik Islanders.

Internal Validity

Since all thyroid examinations were performed by a single investigator (T.E.H.), it was important to validate these observations. A substudy was designed that compared, in a masked fashion, results of the author's physical examination of the thyroid gland with results of the physical examination by an expert in thyroid disease. A group of 173 individuals whom the author had examined during the previous two years was asked to participate in this study. Approximately 50% of these individuals had previously had normal thyroid examination results and were randomly selected from northern and southern atolls. The remaining 50% had nodular thyroid abnormalities. Each of the 173 people was examined separately by an experienced thyroid examiner from the University of Washington, Seattle. The second examiner had no prior knowledge of the author's previous examina-

tions. In addition, Dr Hamilton repeated examination of any individual (masked to his previous examination) when there was disagreement between his results and those of the visiting thyroid examiner. Approximately 95% of this 173-person cohort complied with these examinations. Excellent agreement was obtained between the two examiners (87% observed agreement, kappa = .80).

RESULTS Demographic Characteristics of Cohort

A mean of 64% of the populations of the 13 primary atolls was screened, with a range of 33% to 95% (Table 2). As discussed in the "Methods" section, selected screening examinations were performed on Majuro and Kwajalein atolls to find those individuals who had lived on any of the 13 primary atolls at the time of the 1954 BRAVO test. Because nearly a third of Kwajalein Atoll was screened, it was added to the other 13 primary atolls for the subsequent analyses, making a total of 14 study atolls.

Prevalence of Thyroid Nodularity

Of the 7266 persons screened, 2273 were alive at the time of the BRAVO test and were residing on one of the 14 study atolls on March 1, 1954 (Table 3). Exposure to the short-lived radioiodines ¹³¹I, ¹³²I, ¹³³I, and ¹³⁴I was therefore possible in this group. Since these isotopes have half-lives of eight days or less, exposure to radioiodines from the BRAVO test fallout was not possible in persons born after 1954.

The numbers of people with solitary thyroid nodules (mean estimated size, 2.1 cm), previous thyroidectomy for a thyroid nodule, total thyroid nodules, and the prevalence of thyroid nodules for the reconstructed 1954 population appear in Table 3. For the 12 atolls previously thought unexposed to fallout radiation, the prevalence of nodules ranged from 0.9% to 10.6% (Fig 2). If these atolls were not exposed to radioiodines from the BRAVO test, we would expect, in the absence of other risk factors for thyroid nodularity, to see the same prevalence of thyroid nodules in all the atolls. To test this hypothesis, we performed a χ^2 analysis. The results reject the null hypothesis that no difference exists in the prevalence of thyroid nodules among these 12 atolls ($\chi^2 = 23.45$, $df = 11$, $P < .025$).

Predictors of Risk for Thyroid Neoplasia

To better understand the wide variation in rates of thyroid nodules, we

performed multivariate analysis. Since thyroid dose estimates for people living on these 12 atolls are lacking, the distance of each atoll from the Bikini test site was selected as a proxy for the dose of radioiodine received by the thyroid gland. Weighted linear regression using the age-adjusted prevalence of nodules by atoll of residence in 1954 as the dependent variable shows a highly significant inverse linear relationship with distance from Bikini ($r = -.65$, $P < .002$) (Fig 3). Although northern atolls used in previous studies as a source for unexposed controls were found to have a prevalence of thyroid nodules of 6.3%,^{4,10} the prevalence of nodules in our study continues to decrease to less than 1% as the distance from the site of the BRAVO test increases. We believe a better estimate for the prevalence of thyroid nodules in unexposed Marshallese to be 2.45%, the mean prevalence of the two southernmost atolls.

To examine risk at the level of the individual, we used logistic regression analysis, in which the presence or absence of a thyroid nodule was the dependent variable. Not only distance but also age and sex, θ (the angle from 0° latitude), and the product of θ and distance were all significant contributors to the logistic model (Table 4). The addition of inverse distance terms or higher order polynomial distance terms was not significant.

The odds ratios obtained from the regression coefficients show that the probability of a thyroid nodule developing in a female is 3.7 times higher than that in males (Table 4), a finding consistent with those of other studies of thyroid exposure.⁴

The odds ratio for distance is 0.33 per 100 miles from the test site, and for θ , 0.59 for every 10°. In other words, the probability of a nodule decreases approximately threefold for every 100 miles farther from Bikini and twofold for every 10° going east to west in a clockwise direction. Figure 4 shows the fitted logistic model for males and females, given mean age, with the actual prevalence data plotted. Again, as seen with linear regression, the probability decreases as the distance from Bikini increases.

To better illustrate the interaction of distance and θ , we developed a set of probability contours on the map of the Marshall Islands using the logistic model with all five variables. We set the variable sex equal to females and the variable age equal to the mean age of females. For each of seven fixed probabilities between .5 and .01, the distance was calculated for possible values of θ . The values of θ selected were between 0°

and 80°, which bounds the area of this study. As shown in Fig 5, these probability contours illustrate that the chance of developing thyroid nodules is influenced by both distance and θ in a variable manner. For example, for a fixed distance of 300 miles from Bikini, the probability decreases as θ increases. However, for most fixed distances greater than 400 miles from the test site, the probability increases with θ . These results are consistent with previously published fallout patterns showing an initial eastern pathway of the BRAVO fallout cloud.¹⁴ They are also consistent with a computer simulation pattern that suggested that after a predominantly eastern direction, toward Utrik, the fallout cloud moved south and west from Utrik.¹⁴

Absolute Risk Assessment

The absolute risk coefficient has been used to compare the risk for thyroid nodules among exposed populations¹⁵ and can be expressed as follows: absolute risk coefficient = number of excess cases/Gy/years at risk/ 1×10^6 persons (number of excess cases/rad/years at risk/1 million persons), where number of excess cases is the number of observed nodules minus the number expected. Using a prevalence of nodules of 2.45% determined in this study for unexposed Marshallese, we determined a new absolute risk coefficient for the Rongelap and Utrik people exposed to radioactive iodines. Since estimates of the thyroid dose and years at risk for these populations were known from previous studies (see "Methods" section), we calculated a new risk coefficient of 1100 excess cases/Gy/y/ 1×10^6 persons (11.0 excess cases/rad/y/1 million persons).

COMMENT

This study demonstrates a strong inverse linear relationship between the probability of thyroid nodules developing in Marshall Islanders and the distance of their 1954 home atoll from the Bikini test site. The direction of each atoll relative to Bikini was also an important risk factor. Our results indicate that excess thyroid nodules in Marshall Islanders were not limited to the two northern atolls of Rongelap and Utrik but occurred throughout many of the Marshall Islands. These findings suggest that the geographic extent of radioiodine exposure from the 1954 BRAVO test was much broader than previously assumed.

Without thyroid dose estimates for people living on 12 of the 14 atolls in this study, radiation exposure cannot be proved as the cause of these neoplasms.

Other risk factors for thyroid neoplasia, however, do not appear to be present. There is no evidence for iodine deficiency in this population: the diet of the Marshallese population is well known to have ample iodine content, especially on the outer islands, where the diet is high in fresh fish.¹⁶ In contrast to the United States, no head and neck irradiation of Marshallese children was employed as therapy for benign diseases of childhood such as acne, presumed tonsillar or thymic enlargement, cervical adenitis, or fungal infections of the scalp. There are no known dietary or environmental goitrogens that are used in the Marshall Islands. If other unknown risk factors for thyroid disease are present in this population, it must be postulated that they exert their effects in a pattern such that the risk from exposure decreases with distance from Bikini Atoll. Thus, the absence of other known risk factors for thyroid nodularity and the presence of a strong inverse linear relationship between thyroid nodularity and the distance of each atoll from the BRAVO test site suggest radioactive fallout as the most likely cause of these neoplasms.

Although authors of previous clinical studies of Marshall Islanders assumed that 12 of the 14 atolls in this study were unexposed, other environmental assessment studies reported evidence that suggests that fallout contamination was not limited to Rongelap and Utrik. Robison and colleagues¹⁷ reported that several inhabited atolls other than Rongelap and Utrik contained low levels of long-lived radionuclides that were likely residual from intermediate-range fallout in the Marshall Islands. Although the dose extrapolations from 1978 to 1954 were not done for these atolls, the low doses received from the longer-lived isotopes, such as cesium 137 and strontium 90, would not have contributed significantly to the thyroid dose during these years.

An additional report documented a gamma dose at Aituk Atoll to be 0.01 Gy/h (1.0 rad/h) one hour after the BRAVO detonation;¹⁸ such data suggest that this atoll, previously thought to be unexposed, received fallout. A computer simulation of the fallout cloud utilizing all available meteorologic data predicted that after an initial eastern direction, the maximal point of radiation 16 hours after the detonation would have been midway between Rongelap and Kwajalein.¹⁴ This suggests that the fallout cloud may have shifted from an initial eastern path to a south or southwest direction. This simulation model is consistent with the results of our study, which show that, except for Rongelap, the prevalence of thyroid

nodules was highest in this region on the atolls of Lae, Ujae, Wotho, and Likiep (Fig 2).

The thyroid doses of people living on atolls previously assumed to be free from exposure to radioactive fallout may have been affected by long exposure times. While people on Rongelap and Utrik were evacuated 48 to 72 hours after detonation, no such evacuation took place on other atolls.¹⁹ Thus, people on those atolls may have had lower peak exposures than on Utrik, but because of continued exposure for the entire decay process of the radioiodines, their cumulative thyroid doses may have been as high as or higher than those on Utrik.

One methodologic advantage afforded by the Marshall Islands is that the geography of these islands has provided considerable variation on our proxy for exposure. While the thyroid doses for persons on these atolls is not known, the position of small land masses across thousands of square miles of ocean permits us to know the distance from the blast site exactly. Second, residents of these atolls could not easily move from atoll to atoll in short periods of time, especially in 1954, making it possible to ascertain on which atolls persons were living during the exposure period of the BRAVO test. These factors may in part explain why the variables distance and θ appear to be such strong proxies for radiation dose or conditions that affected the dose.

This study has several limitations that deserve mention. The ascertainment of exposure, which involves reports from participants, is subject to recall bias, especially in cultures such as the Marshall Islands that are not time oriented. Asking the question in terms of where one lived in March 1954 might yield answers of questionable accuracy. However, persons in this study were asked where they lived when the "bomb" exploded, causing the Rongelap and Utrik people to be evacuated from their homeland. The detonation of the BRAVO hydrogen test was a dramatic event: people on many atolls in the northern Marshalls could see the light, feel the blast, and see the fallout on vegetation hours after the blast. In much the same way as people recall clearly what they were doing at the time of Pearl Harbor or the assassination of John F. Kennedy, this dramatic hydrogen bomb affected the Marshallese people in a way such that they could provide vivid descriptions of what they were doing and where they were living in 1954 at the time of the test. For individuals living on southern atolls who could not

see the blast, some misclassification of exposure status is possible, since they would not have had the personal experience of this dramatic event to date their 1954 atoll of residence. However, if such persons incorrectly recalled their location in 1954, the error would have probably been another southern atoll, since they would likely have remembered the BRAVO test had they lived on a northern atoll. In addition, transportation to and from these islands in the 1950s was not frequent, so the likelihood of misclassifying exposure remains small.

The issue of multiple exposures arises in this study population since there were 66 announced nuclear tests in the Marshall Islands between 1946 and 1968.⁴ Many of these tests,⁴ however, took place on Eniwetok Atoll, which is located about 200 miles west of Bikini. In addition, most of these tests were conducted when the prevailing winds were heading away from the Marshall Islands. More importantly, the BRAVO test was the largest of the 66 nuclear tests; it is the only test that people on distant atolls recall having seen. Thus, while it is possible that atolls close to Bikini, such as Rongelap, may have been exposed on multiple occasions, it is unlikely that such exposure occurred on distant atolls.

Because this study was a retrospective cohort design, the important issue of latency cannot be addressed. Prospective studies of the Rongelap and Utrik populations reported a mean latency for thyroid nodules of 13 years for Rongelap children exposed at ages less than 10 years.⁴ The Utrik children, with lower thyroid doses, had a mean latency of 25 years. Whether persons exposed to smaller doses in the present study may exhibit even longer latent periods is unknown. Since latent periods at least as long as 34 years are thought to exist in other populations exposed to thyroid irradiation,^{5,6} it will be necessary to continue close follow-up of this population.

The results of this study suggest that the northern atolls used in previous studies as a source for unexposed controls, with a prevalence of nodules of 6.3%, were inappropriately selected, since the prevalence in our study continues to decrease to less than 1% for the southern atolls, which are located the

farthest from the Bikini test site. We believe that a better estimate of the prevalence of thyroid nodules in unexposed Marshallese is 2.45%, the mean prevalence of the two southernmost atolls. Since the prevalence continues to decrease to a value less than 1% for the atoll farthest from the blast site, 2.45% is probably a conservative estimate for the spontaneous or background rate of solitary thyroid nodules in the Marshall Islands.

Because authors of previous studies used the prevalence of 6.3% for presumably unexposed controls, their risk coefficient of 830 excess cases/Gy/y/1 × 10⁶ persons (8.3 excess cases/rad/y/1 million persons)⁴ underestimates the true risk. Using our estimate of 2.45% for the prevalence of nodules in unexposed Marshallese, our new risk coefficient is 1100 excess cases/Gy/y/1 × 10⁶ persons (11.0 excess cases/rad/y/1 million persons). This is 33% higher than the previous estimate and is quite close to a published composite estimate of 12.3 (1230) for gamma radiation.²⁵

The components of radiation dose to the thyroid gland in Marshall Islanders exposed to fallout are relatively unique among studies of humans in whom thyroid neoplasia has developed from ionizing radiation. While gamma radiation accounts for part of the total thyroid dose in the Marshall Islands exposure (4% to 16%), the majority of the thyroid dose came from the short-lived radioiodines, ¹³¹I, ¹³²I, and ¹³⁴I, and, to a lesser extent, ¹³¹I.²⁶ There is little information in the literature, other than that from exposures in the Marshall Islands, concerning the effects of these radioiodines in humans. Although ¹³¹I alone is known to induce thyroid neoplasms in animal studies,^{26,27} it is much less effective in the induction of human thyroid neoplasms, possibly 50 times less so than gamma irradiation.²⁸ Indeed, studies of ¹³¹I therapy in Graves' disease have led to doubts about whether ¹³¹I alone induces thyroid nodules in humans.^{27-30,31} One explanation for the ineffectiveness of ¹³¹I as a carcinogen in these studies may be that autoimmune thyroid disease renders the thyroid gland resistant to the development of neoplasms from ¹³¹I irradiation. An additional factor is the nonuniform distribution of ¹³¹I within thyroid tissue compared with

gamma radiation; the dose from this type of distribution can ablate tissue at localized "hot spots" and result in a lower dose to the remaining thyroid tissue. Other explanations include the lower dose rate of beta-emitting ¹³¹I compared with gamma radiation and the decreased potential of the thyroid gland to undergo malignant transformation once ablative doses of ¹³¹I have been received by the entire gland.³² However, while the role of ¹³¹I as an inducer of thyroid neoplasia remains controversial, it should be emphasized that radioiodine fallout contains not only ¹³¹I but a mixture of short-lived, higher-energy radioiodines.

The public health implications of these results are important not only to the Marshallese people but also to populations that may be exposed to short-lived radioiodines from fallout such as may occur during nuclear reactor accidents. These isotopes include the higher energy beta-emitters ¹³¹I, ¹³²I, and ¹³⁴I and do appear to be effective inducers of thyroid nodules. In our study, we found the absolute risk coefficient to be nearly identical to the estimate for gamma irradiation. Thus, populations exposed to radioiodine fallout should not only be considered for potassium iodide prophylaxis at the time of contamination but should also be carefully followed up for the late development of thyroid nodules. We anticipate the expected rates of such neoplasms to be similar to those found from gamma radiation.

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The Health Effects of Radioactive Fallout on Marshall Islanders: Health Policy Issues of Nuclear Weapons Production

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Between 1946 and 1958, the United States conducted 66 nuclear tests in the Marshall Islands. One such test, code-named BRAVO, contaminated individuals from at least two northern atolls. Decisions regarding this test, the details of which have not previously been published in the general medical literature, greatly affected the radiation dose received by the Marshallese people. Actions regarding resettlement of the Marshallese on their exposed atoll are examined as well as the epidemiologic health studies that have been conducted in this population since 1954. Analysis of these decisions and studies suggests that ensuring public health has not been a high priority of the Atomic Energy Commission or its successor agency, the Department of Energy. Furthermore, recent disclosures and a critical assessment by the Secretary of Energy indicate that similar problems characterize the Department of Energy policy of nuclear weapons facilities. An independent federal agency with a primary mandate to protect public health, worker safety, and the environment should be charged with all future monitoring and investigation of radiation-induced health effects in Marshall Islanders, as well as in populations surrounding nuclear weapons facilities in the United States. PSRQ 1991;1:15-23

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Between 1946 and 1958, the United States conducted a total of 66 nuclear tests at the Pacific Proving Ground in the Marshall Islands. This country, consisting of approximately 30 atolls (coral islands surrounding a central lagoon), is located

2,500 miles southwest of Hawaii (Fig 1). The testing of nuclear weapons on these islands, and particularly the 1954 BRAVO test, has had profound direct and indirect effects on the health of the Marshall Islands residents as well as on their environment and culture.

The responsibility for conducting these nuclear tests and for protecting the islanders from potential consequences of nuclear testing has rested with the Department of Energy (DOE) or one of its predecessor agencies, beginning with the Atomic Energy Commission (AEC). The Atomic Energy Acts of 1946 and 1954 specify the mandate of the AEC to protect and safeguard the public from hazardous activities stemming from nuclear testing and weapons productions [1].

In the last several years, the media and the public have given great attention to the health and environmental hazards from nuclear weapons production and testing facilities in the continental United States. These nuclear weapons production and testing sites include facilities in Washington, Idaho, California, Nevada, New Mexico, Colorado, Texas, Kentucky, Ohio, Tennessee, Missouri, Florida, and

South Carolina. The Marshall Islands continue to be a key weapons test site for activities relating to the Strategic Defense Initiative.

The recent critical evaluation of safety and environmental violations at U.S. nuclear weapons facilities by Secretary of Energy James Watkins is laudable and long overdue. However, information that is available to the public concerning the extent of the problem is still quite limited, in part because health studies of populations surrounding these sites have not been conducted.

On the other hand, information concerning the radiation exposure of Marshall Islanders from the 1954 BRAVO test is accessible in technical reports of the Departments of Energy and Defense. This information, useful for what it reveals about the U.S. testing program in the Pacific, also bears directly on health policy issues at other nuclear weapons facilities.

Although criticism by the Marshallese about the effects of nuclear testing on their health, their homeland, and their culture has been increasing for over 30 years [2], this history is largely unknown to the majority of Americans.

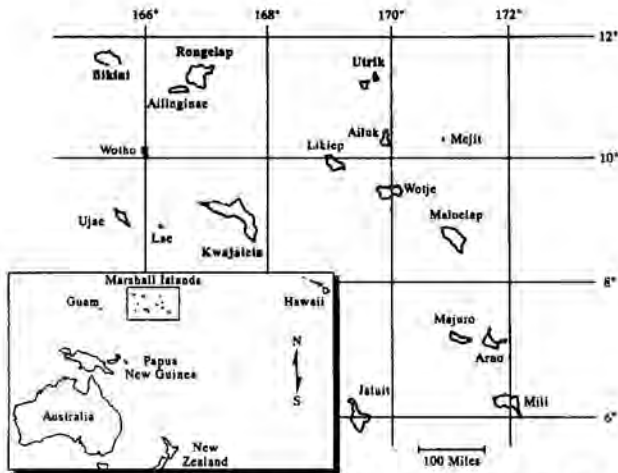


FIGURE 1. Marshall Islands. The BRAVO test site is on Bikini Atoll. Drawings outline atolls, with the solid lines representing the coral islands of each atoll surrounding its central lagoon.

The purpose of this article is to examine the events surrounding the radiation exposures to the Marshallese people in 1954, to present the known health consequences from this exposure, and to assess the epidemiologic health studies conducted to date. Although the nuclear weapons testing program has had a significant impact on the culture and society of the Marshallese, this report focuses on the impact that the radiation exposure has had on health. This report also considers whether the problems now recognized in protecting public health in the Marshall Islands are applicable to nuclear weapons facilities within the United States, and if so, what changes are required.

THE BRAVO TEST

The most powerful of the 66 nuclear tests conducted in the Marshall Islands by the United States was the 15 megaton thermonuclear BRAVO Test detonated on the surface of Bikini Atoll on March 1, 1954. Within 48 hours of exposure to radioactive fallout from this test, the majority of the small population (86 persons) from Rongelap Island, located at the southeastern tip of Rongelap Atoll (Fig 1), developed symptoms and signs of acute radiation sickness. Two days later they were evacuated to Kwajalein Atoll. Over the next several months individuals developed varying degrees of nausea, anorexia, vomiting, pruritis, beta burns of the skin, epilation, leukopenia, and thrombocytopenia [3]. Early health effects also included a transient increase in spontaneous abortions during the 5 years post-exposure in highly exposed Marshallese women [4]. A high level whole-body exposure (from external photon radiation) of approximately 190 cGy (rad) resulted from the 2-day post-BRAVO residence time on Rongelap, with lesser doses received by persons from Utrik farther east of Bikini [5,6].

The whole-body radiation dose of the Marshallese people, especially those living on Rongelap, was directly affected by at least three factors. First, the Rongelapese were not evacuated to prevent possible radiation contamination, as they had been in the 1946 Crossroads test series. Second, the wind direction was due east, toward Rongelap, prior to the detonation of BRAVO. Several weather briefings before detonation indicated that winds at 20,000 feet were headed for Rongelap. However, it was felt that the predicted speed of these winds was low enough to be of no concern [7]. Third, the Rongelap

and Utrik populations were allowed to remain on their home island for at least 2 days after the test, before they were evacuated. During this time, individuals were exposed to external whole-body radiation from the fallout cloud as it passed over the island, as well as fallout on the ground. In addition, children played in the "fallout snow" and many islanders consumed contaminated food and water.

No formal investigation of the decision to conduct the test with the wind blowing toward Rongelap, and of the failure to evacuate these inhabitants immediately, has ever been made public. Although many details may be unrecorded or classified as secret, a Defense Nuclear Agency report published in 1982 provides data that indicate that it was logistically possible to evacuate these 86 people from Rongelap Island and nearby Ailinginae Atoll [7]. This report documents the operations and radiologic safety activities of U.S. military personnel during the BRAVO test, including the nautical positions and radiation monitor logs of all naval vessels at the time of the BRAVO test. Figure 2 shows the position of some of the naval vessels relative to the location of Bikini and Rongelap, just prior to and during the BRAVO detonation. The U.S.S. *Gypsy* lay within a few miles and just outside the lagoon of Rongelap, 80 miles southeast from the Bikini test site, and adjacent to Ailinginae. In addition, at least six other naval vessels (the U.S.S. *Curtiss*, *Sioux*, *Tawakoni*, *Estes*, *Belle Grove*, and *Bairoko*) were in position between Rongelap and Bikini at the time of detonation.

If the people of Rongelap had been evacuated immediately or within hours after the BRAVO test, they could have been spared most of the whole-body doses from external radiation, and the organ doses from internal radiation exposure, that they eventually received. Why were the Marshallese people not evacuated on the morning of the BRAVO detonation when naval transportation was available? There is no public information that addresses this question. In fact, the above information concerning ship locations near Rongelap comes from a safety report of U.S. military personnel during BRAVO, which does not discuss safety issues of Marshall Islanders. Nor does the original map of naval ship positions include the inhabited atolls on it. In addition, none of the DOE or AEC health studies address this issue so that it is unclear whether any communication occurred between the AEC and

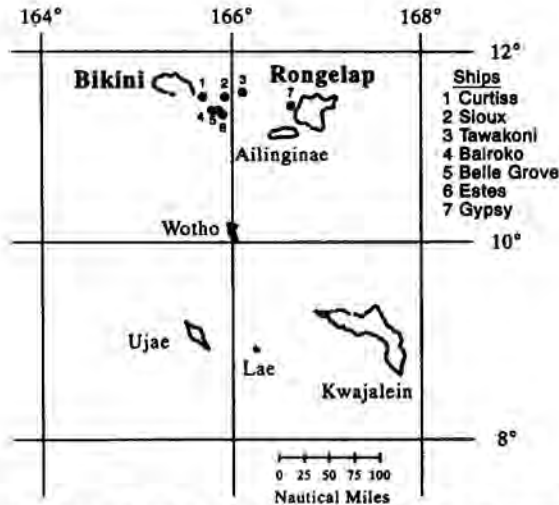


FIGURE 2. Locations of naval vessels (solid circles) at the time of BRAVO detonation in relation to Rongelap Atoll. Adapted from Defense Nuclear Agency report [7].

the U.S. Navy regarding possible early evacuation of the Rongelap people.

Although many reasons might be offered for the failure to act (such as risk of radiation exposure to the ships' military personnel, inadequate information about the extent of the fallout cloud, or poor communication), one conclusion is inescapable: the personal safety of the Rongelapese and other Marshallese people was not a high priority of the AEC in 1954.

The Resettlement of Rongelap

Three years after the Rongelap population was evacuated, the AEC decided that Rongelap Island, but not the entire atoll, was safe for habitation. Resettlement occurred in June, 1957 [3,4,8,9]. During the 5 years after their return to Rongelap, the Rongelapese people were monitored for body burdens of radioisotopes. The AEC found that the mean body burden of cesium-137 was 60 times higher in 1958 than in 1957 and that the mean body burden of zinc-65 was 8 times higher [8]. In addition, the cesium-137 body burden increased through 1961. In 1959 it was 300 times higher than that of the administering medical team, which was used for

comparison. The mean strontium-90 body burden was 6 times higher in 1962 than in 1958. During 1958 alone, the Rongelapese received an estimated bone marrow radiation dose of 559 mrad/year (68% from fission products, 32% from background radiation) [8].

These DOE reports state that these doses were generally felt to be within U.S. "maximum permissible levels" [8]. However, two important questions remain unaddressed. Why, over a period of 5 years, during which body burdens of radioisotopes were steadily increasing, was there no investigation of whether or not this population should continue living in this environment? Second, what was the wisdom of comparing current body burdens of radioisotopes in these people to "maximum permissible levels" established for the general (and presumably unexposed) population, when these people had already been acutely exposed to 190 rad (cGy) of whole-body radiation?

Thyroid Neoplasia in Marshall Islanders: Brookhaven Studies

Since 1957, Brookhaven National Laboratory (BNL) has been under contract by the DOE to per-

form medical examinations on Marshall Islanders exposed to nuclear fallout. The results of these studies have been published primarily in the BNL or DOE literature [3-6,8-19], although numerous articles on this subject appeared in the general scientific literature during the 1960s and 1970s [20-32].

The most prevalent long-term health effect in the Marshallese population has been the development of benign and malignant thyroid neoplasms [3,33]. Approximately 30% of adults on Rongelap (and over 60% of children exposed when younger than 10 years of age) developed thyroid nodules, a small proportion of which were thyroid carcinoma [3].

Long-term health effects other than thyroid neoplasia have included hypothyroidism [31], growth retardation in several individuals, and most probably two deaths, one each from acute myelogenous leukemia and gastric carcinoma, among the 86 Rongelapese persons who were highly exposed [3,28]. In addition, chromosomal aberrations in this group were increased relative to comparison groups 10 years after exposure to fallout radiation [3,20].

To evaluate thyroid neoplasia, Brookhaven researchers selected exposed and unexposed cohorts. Persons classified as exposed were present on Rongelap (and Ailinginae) and Utrik at the time of the detonation of BRAVO. Although dose estimates have been revised on several occasions [3,5,6], there is no question that persons residing on these two atolls, especially Rongelap, received significant radiation doses to the thyroid gland. The uncertainty around individual thyroid dose estimates is quite large, and there are large differences between the Rongelap and Utrik thyroid dose estimates; nevertheless, these people are correctly classified as exposed. These persons were prospectively followed and continue to be carefully examined on an annual basis by Brookhaven physicians.

The unexposed cohort was defined and examined in an entirely different manner. This cohort initially consisted of Rongelap and Utrik persons who were not present on their home atolls at the time of the BRAVO detonation. Because of attrition among the unexposed cohort, several hundred persons from other northern atolls were added to this control group in the 1970s, and their thyroid glands were examined. These persons were not prospectively followed, but the point prevalence of thyroid neoplasms among them was combined with the prevalence in the original unexposed cohort to describe

what was called the background rate of thyroid neoplasms in the Marshall Islands [3].

Although the assumption is repeatedly made in DOE and Brookhaven reports that these persons were unexposed to fallout radiation, no dosimetry information is available to support the contention that persons living on atolls other than Rongelap or Utrik were in fact unexposed. On the contrary, several reports from other agencies suggest that fallout radiation contaminated other northern atolls along with Rongelap and Utrik.

One fallout pattern, derived from an experimental model that used wind data and field radiation data at the time of BRAVO detonation, indicated a significant gamma radiation dose on Ailuk Atoll [34], located southeast of Rongelap (Fig 1). In addition, Peterson [35] used meteorological data to perform a computer simulation of the BRAVO fallout cloud with results suggesting that the fallout path changed from an initial eastern direction to a south or southwestern direction toward Kwajalein. A third report also indicated that several inhabited atolls other than Rongelap and Utrik contained long-lived radionuclides, which were likely residual from intermediate-range fallout in the Marshall Islands [36].

There are, therefore, several important design limitations of the medical surveillance program conducted since 1957. Although the exposed cohort appears to have been qualitatively correctly classified, and carefully followed and examined on a prospective basis, the unexposed cohort was not prospectively followed and examined, and it is not clear exactly how this group was selected. No evidence is available in the literature that indicates that the unexposed cohort was truly *unexposed* to radioiodine. Data from independent sources, described below, suggest that some members of the unexposed cohort may have resided on atolls that were exposed to fallout at the time of detonation.

Thyroid Neoplasia in Marshall Islanders: Independent Studies

Only one major epidemiologic study of thyroid neoplasia has been conducted in the Marshall Islands under auspices independent of DOE, and this study occurred more than 30 years after the BRAVO test. This retrospective cohort study of solitary thyroid nodules in approximately 7,000 Marshallese people was conducted from 1982 through 1985 [33].

The fieldwork was funded by a litigation project on behalf of the Marshallese people. The data analysis and publication were done at the University of Washington.

The purpose of this study was to determine the prevalence of thyroid nodules by physical examination of persons who were living on the following atolls at the time of the 1954 BRAVO test: Rongelap and Utrik; seven northern atolls previously thought by Brookhaven to be unexposed to fallout radiation; and, as the best available, unexposed control group, three atolls in the southern Marshall Islands. The prevalence of thyroid nodules in Rongelap and Utrik individuals was found to be 39% and 9%, respectively, in close agreement with prior Brookhaven data. The prevalence of thyroid nodules (including persons with prior thyroidectomy for thyroid nodules) in the remaining 12 atolls (which past researchers had assumed were *unexposed* to fallout), ranged from 0.9% to 10.6%. A strong, statistically significant, negative correlation exists between the prevalence of thyroid nodules on these 12 atolls and the distance of each atoll from the Bikini test site. The prevalence decreases in a linear fashion as distance from Bikini increases. Furthermore, the prevalence of thyroid nodules in people from the most distant atolls is two to three times lower than that among people from northern atolls who were previously assumed to have been unexposed to fallout radiation. These results strongly suggest that the geographic extent of the BRAVO fallout, and the distribution of health effects to the thyroid, were greater than previously reported.

Although the study did not prove that the decreasing prevalence of thyroid nodules was associated with decreasing radioiodine doses to the thyroid (no radiation dosimetry is currently available on atolls south of Rongelap and Utrik), it strongly suggested that there is a correlation between the proximity of an atoll to the BRAVO test site and the risk that a person residing on that atoll at the time of the BRAVO test would develop a thyroid neoplasm.

In order to provide additional data to determine whether the previously classified unexposed atolls may have received fallout radiation, a second study was conducted to determine the concentrations of cesium-137 (half-life of 30 years) in soils from the same northern and southern atolls used in the above study [37]. Preliminary results indicate that identi-

cally low concentrations of cesium-137 existed on the two southern atolls (Majuro and Mili) and that concentrations of cesium-137 on northern atolls previously thought unexposed to fallout were 1.5 to 3 times higher than cesium-137 concentrations in soils from the southern atolls. These preliminary results do not yet provide a basis for estimating thyroid doses, but they are consistent with the results of the earlier epidemiologic thyroid study, and indicate that atolls in addition to Rongelap and Utrik probably received radiation contamination from test fallout.

IMPLICATIONS FOR U.S. NUCLEAR WEAPONS FACILITIES

The information presented above indicates that the promotion and evaluation of public health in the Marshall Islands was not a high priority of the AEC or DOE, certainly not relative to their primary objective of producing and testing nuclear weapons. An important question is whether issues of public health have been given similarly low priority at nuclear weapons facilities within the U.S. Although much additional data are needed to answer this question definitely, several disturbing reports have surfaced recently.

One report concerns the Hanford Nuclear Reservation in Washington State, a major site for plutonium production. In 1986, the DOE, in response to requests filed under the Freedom of Information Act, released 19,000 pages of previously classified documents relating to the Hanford Nuclear Reservation in Washington State. These documents revealed that massive amounts of radioactive iodine (in excess of 500,000 curies) had been released to the atmosphere from Hanford during the late 1940s and 1950s. Although some details of these operations remain classified as secret, the major reasons for these environmental releases were the lack of technology to filter the radioactive emissions and shortened cooling times of spent fuel to increase plutonium production for nuclear weapons.

As a result of these revelations, two studies have been initiated. The Hanford Environmental Dose Reconstruction Project, directed by an independent Technical Steering Panel, will estimate individual radiation doses that individuals may have received from Hanford off-site exposures. A recent preliminary Phase I report from July, 1990, has indicated

that individuals exposed as infants in several counties from the states of Washington and Oregon may have received significant radiation doses to the thyroid gland from iodine-131 [38].

The Hanford Thyroid Disease Study is a second study, administered by the Center for Disease Control and funded by Congress in 1988. This study will attempt to determine whether thyroid disease is increased among individuals who were potentially exposed to radioactive iodine from the Hanford site.

More recent insight into the extent to which the DOE has given priority to issues of public health has come from a critical evaluation of the nuclear weapons industry by Secretary Watkins. In 1989, he selected an investigative panel to evaluate the nation's health research activities at nuclear weapons facilities. This panel, the Secretarial Panel for the Evaluation of Epidemiologic Research (SPEERA), concluded that the health and safety mandate of the Atomic Energy Act of 1946 to conduct studies for "the protection of health during research and production activities" was an appropriate mandate for the DOE [39]. They further concluded that the DOE "had not developed goals to guide people in carrying out the mandate." The SPEERA report recommended that the long-term and large-scale epidemiologic research program be transferred out of DOE to the Department of Health and Human Services.

If the United States continues to produce and test nuclear weapons, it is imperative that the public be both protected from, and informed about, potential risks emanating from nuclear weapons production. Rigorous and scientifically credible research must be conducted on past and future health hazards stemming from these production activities. Yet given the past history within the DOE, none of this is likely to happen unless the public health mandate is transferred from DOE to another agency, one that has expertise in public health and epidemiologic research and that does *not* have the competing mandate of nuclear weapons production. The scope of this mandate should include not only the Marshall Islands, but *all* facilities in the U.S. nuclear weapons complex.

CONCLUSIONS

1. The initial exposure of the Marshallese people to radiation from the 1954 BRAVO test could prob-

ably have been prevented entirely or significantly reduced by a) evacuating the residents prior to the test as had been done for earlier tests, b) postponing the detonation when it was known that winds were in the direction of Rongelap, or c) evacuating the residents immediately after the detonation, by using naval vessels stationed near Rongelap, and thus reducing or eliminating their 2-day exposure time.

2. Although acute exposure in 1954 was by far the most significant contribution to radiation dose, additional exposure to the Rongelap people could have been prevented by either postponing their 1957 return or by evacuating them again during the subsequent 5 years, when it was known that their body burdens of radionuclides were steadily increasing.

3. Thyroid dosimetry studies of Marshall Islanders have been limited to only two atolls in the northern Marshall Islands. The primary reason for this limitation appears to be the assumption that no atolls other than Rongelap and Utrik were exposed to fallout radiation. This assumption was not tested by DOE or its predecessor agencies, and there is now good reason to believe it is false.

4. The available medical and epidemiologic studies of thyroid neoplasia performed by DOE on Marshall Islanders have significant limitations. Although a reasonable protocol has been followed for examining exposed persons, entirely different methodologies have been used for unexposed persons. No evidence has been provided to validate the classification of the unexposed cohort as an appropriate control group that did not have radiation exposure. There is a strong possibility that the exposed and unexposed cohorts were in fact both exposed, leading to an underestimation of the extent of thyroid health effects in the Marshallese people.

5. No formal investigation of the BRAVO exposure, resettlement issues, or quality of the medical and research programs conducted by the DOE on Marshall Islanders has ever been conducted by an independent federal agency whose primary focus is to promote public health and environmental safety.

6. Preliminary information, both from nuclear weapons sites within the United States and from the SPEERA report, suggests that insufficient priority has been given to addressing epidemiologic research and public health issues at these facilities as well.

The record to date suggests that this situation is not just a matter of a few poor judgments by officials

in government regarding the public health of the Marshallese. Instead, a series of decisions over almost four decades has endangered the health of the Marshallese and has limited rigorous investigations, both scientifically and politically, of the consequences of their exposure to fallout radiation.

The intent of this report is not to impugn the integrity of individual scientists and physicians who have been involved with AEC, DOE, or BNL programs during the last 40 years. Indeed, clinicians and researchers who are well respected in their fields of expertise have been selected to participate in these programs and collectively and individually have contributed great effort in examining the Marshallese people. This report instead seeks to address a system that has failed to protect the Marshallese, and possibly Americans in general, from consequences of nuclear weapons production and testing. This failure has occurred despite the mandate given the AEC to protect public health and safety.

Protection of public health and safety requires research and monitoring programs whose findings are given to peer and public review. A key factor in the DOE's failure to protect is the heavy veil of secrecy placed over activities at nuclear weapons production and testing sites since the beginning of the Manhattan Project in 1942. Such secrecy has prevented the public, independent scientists, and non-DOE federal agencies from knowing which studies have been done, and more importantly, what health and environmental studies should have been conducted concerning hazards that may have occurred.

Nothing can reverse the radiation exposures of the Marshall Islanders, but changes can be implemented now. Permanent responsibility for health protection and health research can and should be transferred out of the nuclear weapons industry. Credible epidemiological research programs should be developed at all nuclear weapons sites. The results of such studies should be made easily accessible to the public and to independent investigators. As physicians and health care professionals we have an obligation to demand these reforms.

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Mr. MILLER. Thank you.
Dr. Simon.

STATEMENT OF STEVEN L. SIMON, PH.D.

Dr. SIMON. Thank you, Mr. Chairman. I am very happy to be here today, and I am very happy that you have called this important hearing.

I would like to assure you at this point in time of what my role is here. I was invited here to provide you with information, and indeed I will attempt to do. I see the role that I play for the Marshall Islands as one in which I will not try and sensationalize or exaggerate any of the harm that has been done to them.

I am a radiation scientist, and I have lived in the Marshall Islands for four and a half years and am employed by the Government there. I probably know as much as anyone does about the current radiological conditions there because that is my job, to find that information out.

In these comments that I am providing, I also want to state that I am certainly not attacking any U.S. agency or bringing accusations against the Department of Energy, in which I know many other scientists that have very high levels of training and are very skilled in their work. I simply would like to give you a summary of factual information or information that I have been able to collect by measurement and by objective observation.

One concern, Mr. Chairman, that I would like to express before I go any further is that I participated in many meetings about what radiation means to the Marshall Islanders. These meetings have been in the Marshall Islands without any congressional committee present, and what I have learned from those meetings is that these issues are very hard not only for you and I to understand, but these are very difficult for the Marshallese people to understand. My concern at the moment is that much of the audience here today are from the Marshall Islands, and I sincerely hope that through the rest of today we can ensure that they have an understanding of what I am saying and what you are saying and what other people are testifying to.

I want to remind everyone here today that we can talk about abstract concepts relatively easily because we have been trained to do so. The people that are here today from the Marshall Islands, English is their second language, and I have heard the testimony this morning, and it has become long and it is at some times difficult to follow. I hope that we can make statements during the course of the day that will be somehow succinct and provide real information not only to yourselves but to my friends from the Marshall Islands that sit behind me.

One observation that I had during Dr. Eisenbud's testimony was that the issues were very hard to understand about what exactly took place, but I want to say very clearly that the information that Dr. Eisenbud has presented surely testifies that he had an immense insight that I certainly appreciate. I believe he is a friend of the Marshall Islanders, and I say that because it is a very complicated state of affairs that we are trying to interpret.

How we go about assessing what happened to Marshall Islanders in the past depends on the very small amount of historical data

that is available, and I attribute virtually all of that to Professor Eisenbud. I have made extensive measurements in the Marshall Islands myself, that is my job, but all those have been made within the past three years and those show a different kind of information about radioactivity than what might have been shown immediately after the test. I say that because part of the radioactivity decays very quickly. I have presented to you in graph form in my presentation here a very illuminating graph which was due to the foresight of the HASL laboratory in placing a monitoring station at Kwajelein. What I would like to do during this presentation is to make sure that you understand exactly what I have presented to you here in paper form.

My objectives—I think maybe I have gone over those sufficiently. In addition, though, I want you to recognize that the Marshall Islands is a country that is attempting very strongly to take a sense of responsibility for their future with regard to these issues. Now I realize and you realize that there are not any trained radiation scientists within their community yet, but I live among them and I try and provide that level of information to them.

I would like to brief you today as well on summary results from a study of thyroid disease that we have been conducting—when I say we, I mean the Nationwide Radiological Study. That study was a study commissioned by the Marshall Islands Government in 1989, funded under the Compact of Free Association, and this is in evidence of their attempt to take responsibility and control for understanding what exactly has happened to them.

I have provided you with some background information and a map that I think will be useful as you review my testimony and you review other people's testimony, and you will see that in Figure 1. [See page 229.]

I live in Majuro, the capital city, and we have established there as part of the program under the Marshall Islands Government a radiation laboratory, a permanent laboratory in the sense that it has been an institution for several years now and has all capabilities of doing the kind of credible work that you might do at another more established institution. This laboratory uses assistance from the Marshall Islands, and we have attempted by this kind of mechanism to communicate what we are finding out.

Now probably what may be of interest to you today I can't provide in its entirety, and that would be what exactly is the overall picture of contamination on all 29 atolls and 5 reef islands. That is information that we hope to finish this calendar year and release in peer-reviewed publications. At the appropriate time I would be glad to share it with this committee just as I will share it with the Marshall Islands Government.

Similarly, as part of the background information I have provided you with Figure 2. Just so you will know what size of tests were actually conducted there, there are a lot of numbers bantered around about kilotons and megatons, and I have actually plotted for you all 66 tests so you can just see what size they were, and that is Figure 2. [See page 230.]

Each one of those dots represents one test. If you will just look straight down to the horizontal line, it will tell you in kilotons what size that test was, and you will see on the right-hand side the very

largest one was 15 megatons. That was the BRAVO, and they extended over quite a range in sizes.

Half of the tests, I might add, in the Marshall Islands were larger than the largest test at the Nevada test site. That is provided to you just to give you a frame of reference in which to judge things, not for me to make any preliminary conclusions about the degree of damages there.

I will say that what I have learned about working with Marshallese in my laboratory is, they have a very high level of concern about what has happened to them over the past years, and that is very understandable. We have seen tremendous interest by the American public in the past two months, and their interest is exactly the same. They want to know about their lives and exactly what happened. I applaud the recent efforts to release that kind of information, and as that information is released, I hope it will be kept in mind that the real audience for that and the real receptors should be the Marshall Islands. It is not just to be placed on a bookshelf in an archive library, but I believe furnishing this level of information to them. Even if it is technical, it is about their lives, and that is what is just.

Now in the nationwide radiological study, just to brief you on what we hope to be able to report on in this next year, we have physically gone to every single atoll in the Marshall Islands and virtually every island of any size and made radiation measurements as well as taken samples of soil, coconuts, and other kinds of foods that are traditionally consumed. We have taken these back to our laboratory and made radioactivity measurements. Now this information can be used to supplement historical data to try and reconstruct not only what has happened in the past but to project what might be expected in terms of committed dose to people in the future.

This will not be an easy thing for me ever to say to you, however, to definitively say which islands received fallout and which did not. There is this phenomenon of the large weapons that were tested in the world, that they have thrown fallout virtually around the world. Scientists call that global fallout, and so in the Marshall Islands it makes my job complicated. We have fallout there from China and from Russia and from the Nevada test site and from everywhere else, and likewise all over the world they have some fallout from the Marshall Islands.

So the job of definitively telling you what islands were contaminated by the tests there will be difficult. And I have discussed this on pages 4 and 5 of my testimony, exactly how one can best attempt to do that. To do that I have tried to estimate just what the radioactivity would be there in the absence of the tests at Bikini and Enewetak, and there is a scientific and objective process for doing that. It is not precise, I will tell you that, but there is an objective process for doing that.

So our objective for our nationwide studies is to determine the geographical extent and the levels of fallout in the Marshall Islands from the tests in the Marshall Islands.

Now health studies are somewhat of a different matter. They are not made by radiation measurements. They involve people, and

they involve their lives, and they involve a different kind of work, and I will report on some of that as well.

Let me move on to talk about some historical data that was made available from the worldwide monitoring program that was established by the HASL laboratory under the direction of Professor Eisenbud, and I have provided you in Figure 3 a graphic—a very telling graphic, incidentally—of measurements that were made at Kwajelein Atoll. [See page 231.]

What I do not want to attach to this at this moment is any definitive interpretation. I am not claiming high levels of radiation; I am not claiming a terrible atrocity here; I am just showing you data that was collected. What it shows from early in 1954 through the end of 1959 is a very telling series of peaks, and these points are simply the amount of fallout collected on an instrument the size of a piece of paper, what fell out of the sky and then was measured.

Now what is interesting to me is that this location was Kwajelein, and if you will look at my Figure 1, you will see that Kwajelein is virtually in the middle of the Marshall Islands. To me, it also says that it is on a line from the test sites to many other islands.

Now without trying to understand exactly what these levels mean, what I see is that for every test of one megaton size or larger, it was detected by this relatively simple instrument at Kwajelein.

The foresight to have built this program was incredible to me, and it is very, very important for us in understanding just what were the geographical boundaries of the fallout. So I hope you can appreciate the significance of this. The interpretation of it is something that scientists, myself and others, could argue about, and this is not the forum to do that, but it is a kind of documentary evidence which I think you might be interested in.

I would like to move on, in the interests of time, to tell you very briefly of preliminary studies that we have done in investigating thyroid disease in the Marshall Islands. Virtually all adults in the Marshall Islands know that thyroid disease can be radiogenic. It can be linked to radiation exposure. The problem of that kind of information really is that most people believe that that is the only cause, and science knows that cancer and even benign thyroid disease is caused by other factors.

As Dr. Hamilton testified, the evidence appeared to him that it looked like it was in a pattern that suggested the pattern of radioactivity—that is, the further you went from the test site, the lower the disease rate became.

Now the one basic premise that scientists have to guide their actions is that you are always able to question another hypothesis, someone else's hypothesis, and retest it. When I and the scientific advisory group, which is five international scientists at the Marshall Islands Government, assembled, when we reviewed Dr. Hamilton's paper in 1990, we found it very interesting to our situation in trying to understand. We were rather new to this situation, and we felt it very important for us to look into this and try and confirm it.

We have many anecdotal stories, and I don't suggest that his investigation is that at all. It is quite objective actually. But we have

various kinds of evidence, and the further that we can go to confirm these kinds of evidence, the closer we may be to the truth possibly. That was the rationale partly as well as was the rationale for designing this study the expression that we received locally about people's concern about thyroid disease.

To make this short, we have conducted a first phase of examinations of Marshallese people. This was conducted in Ebeye. Ebeye is the second largest population center in the Marshall Islands. It is located in Kwajalein Atoll. There are about 20,000 persons there, I believe, or perhaps 10,000.

It was the location that was selected not because of the data that I showed you on Figure 3, but interestingly enough, I can look at this in a preliminary way and say, gee, we found some results there that seemed to be very correlated with other kinds of evidence. To be short on this, we have found a disease rate which leads us to the conclusion that we should investigate further.

Objectivity here, in my mind, is a very crucial step to maintain. As we have collected this data, it is very important that I emphasize to you that we exercised caution in interpreting it because what I don't want to do is make statements before this committee or in the public literature that are unsubstantiated. However, we have found a higher than expected incidence of benign disease and, as well, a higher than expected incidence of thyroid cancer.

Now I have provided to you in Figure 4 birth dates and locations about where the people lived and what years they were born that we feel have a high likelihood of having thyroid cancer. [See page 232.]

I will tell you those are unconfirmed at the moment except for five which are confirmed. So out of 23 persons which the examining physicians felt were very high risk for cancer, five of those are actually confirmed.

We know from many other studies that children are at the highest risk—that is, if they are exposed as children—at the highest risk for eventually development of thyroid disease. As you will see from Figure 4 there was quite a number of this group that were young children at the time of the BRAVO test.

Now I didn't plot the other tests on here in terms of when they occurred because you have that on other information, so the BRAVO test was just simply a focal point. But in 1952 and on through 1958 you have seen some of the data that I have presented from Kwajalein. This is information enough for us to want to examine this further, and I think it is very telling of possible relationship.

Currently, I am seeking funding from the Centers for Disease Control and Prevention to continue this kind of thyroid investigation in the Marshall Islands, and I have received a very strong expression of interest.

I would like to say that this study will have one additional strength over any previous study in that we will not have to speculate about the relationship of these cases to their radiation exposure. I have actually been to every atoll and measured it. Every other study has used a surrogate for exposure such as distance from Bikini, and I am not putting this kind of analysis down what-

soever, but I am telling you that we hope within the coming months to do a more definitive kind of analysis.

I would like to conclude and certainly welcome any questions and tell you that I have noted on the part of the Marshallese a very keen interest to know what has happened, and there is a very deep sadness on many people's part about the degree that their life has changed from traditional lifestyles that they knew.

Just in this past week, I was at two different meetings with the Rongelap community. I traveled eight hours by boat with two of the visitors here today. I want to again emphasize that release of information to the appropriate audience for that is the Republic of the Marshall Islands Government, and I will be glad to assist them in that interpretation. I would like to thank you today for allowing me to testify and allowing our Marshallese visitors here who have actually lived through these.

So thank you.

[Prepared statement of Dr. Simon follows:]



NATIONWIDE RADIOLOGICAL STUDY

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STATEMENT OF STEVEN L. SIMON, PhD
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Submitted to the
United States House of Representatives
Committee on Natural Resources
Subcommittee on Oversight and Investigations
in respect to
United States Nuclear Weapons Testing in the Marshall Islands

February 24, 1994

EXECUTIVE SUMMARY

A great deal of interest exists among the citizens of the Republic of the Marshall Islands concerning the possibility of radioactive contamination outside of the northern atolls. Questions are constantly raised about health effects which may have been caused by the atomic tests at Bikini and Enewetak Atolls. Undoubtedly, many cases of disease or personal or land damage are the result of other causes. Yet, until sufficient information is available to determine the past and present radiation levels, it will be hard to separate fact from fiction. To better understand the true extent of damage, the Government of the Marshall Islands commissioned its own radiological evaluation of its nation in late 1989. The results from that study will be forthcoming in 1994. That information will likely be of interest to this committee and can be made available following a presentation to the leaders of the Republic of the Marshall Islands. Today's presentation will discuss the type of data that is now being collected and analyzed.

The second topic of discussion will be a limited amount of historical data which indicates that some degree of contamination did occur beyond the atolls of Bikini, Enewetak, Rongelap and Utirik. Similarly, there is some evidence that tests other than BRAVO also spread contamination to islands within the Republic. During most of the years of the testing program, there was little or no radiological monitoring on the atolls except at islands near the test sites, or at atolls immediately adjacent to the test sites. Even then, the monitoring activities were sparse. The exception to this was a single passive monitoring device at Kwajalein which was part of a worldwide network of surveillance devices. Although the data from that monitoring station has been available since 1960, it is not clear why it has never been analyzed and the results discussed with government leaders of the Marshall Islands. The clear indication from the monitoring station was that deposition of fresh fallout occurred at Kwajalein Atoll within a single day following every one of the detonations over 1 megaton explosive yield.

The implications of this data are now being examined. For a number of years, the U.S. Department of Energy has implied that contamination did not occur at atolls outside of the northern group. Evidence for this is usually stated to be the low levels of 137-cesium at most atolls. The historical data at Kwajalein Atoll contradicts the assertion that there was no contamination. It is actually quite possible to have had measurable levels of fresh fallout and moderately high air concentrations of radioiodine and still show little or no trace of cesium today. The dynamics of deposition mechanisms, such as rainfall, played a role in determining whether measurable quantities of cesium were left behind as a tracer of the fallout.

Finally, a summary of the findings of a study of thyroid disease among 1400 Marshallese citizens will be presented. A surprisingly high rate of benign thyroid nodular disease was found, as well as a number of thyroid cancers. Although it is premature to interpret these findings as having been caused by radiation exposure, the prevalence rate suggests that more people should be examined.

INTRODUCTION

I would like to introduce myself. My name is Dr. Steven L. Simon. I work for the Government of the Republic of the Marshall Islands (RMI) and have done so for nearly 4 1/2 years. I reside in Majuro, the capital city of the Marshall Islands. My areas of expertise are in measurement of radiation, radiation risk assessment and, in general, radiation protection. I was hired by the Marshall Islands to conduct and direct studies to determine the geographical extent and degree of radioactive contamination on the atolls of the Marshall Islands from atomic weapons tests conducted by the United States at Bikini and Enewetak Atolls.

The financial resources to conduct these studies have been provided by Section 177 of the Compact of Free Association. The funds designated for scientific studies allowed the Government of the Marshall Islands to begin to take responsibility for assessing possible damages to the land of their nation or to their people from the atomic weapons testing program. In late 1989 the Government of the Republic of the Marshall Islands commissioned the independent scientific studies which I direct today. An international body of scientific advisors was assembled at that time to provide advice and guidance. The scientific advisors and I planned a nationwide monitoring program, thereby initiating the Marshall Islands Nationwide Radiological Study (NWRS). Although the U.S. Department of Energy has conducted extensive monitoring at Bikini and Enewetak Atolls and at a number of atolls near to the test sites, 70% of the land area of the over 1200 islands in the Marshall Islands was never monitored prior to the NWRS.

OBJECTIVES OF THIS PRESENTATION

The objectives of this testimony are several-fold. First, I would like to make it known to this Committee and others that the Republic of the Marshall Islands is conducting its own thorough and credible radiological evaluation, one that is peer reviewed by an international body of scientists and one that is winning a level of acceptance among the citizens of the Marshall Islands. This substantial body of work will not be reported on in detail today. However, I would like to brief you on the kinds of radiation related information that will be forthcoming this calendar year.

Second, I would like to discuss two other specific topics which I believe are of interest to this Committee. It is my understanding that this committee is specifically interested in evidence of contamination of islands of the Marshall Islands other than those in the atolls of Enewetak, Bikini, Rongelap and Utrik. The two topics that I will present here both relate to this matter. One is a summary of historical data from the years of the weapons testing program. This data shows conclusively that radioactive fallout on the atoll of Kwajalein was routinely detected during the years that the tests were conducted. Secondly, I would like to brief this committee on preliminary results from a screening program for thyroid disease conducted this past year at the nation's second largest population center, Ebeye Island within Kwajalein Atoll.

BACKGROUND INFORMATION

The Republic of the Marshall Islands is a small Pacific nation comprised of 29 atolls and 5 separate reef islands (see Figure 1 enclosed) with the total number of islands exceeding 1200 and a total land mass of approximately 180 km² (70 sq. miles). The nation's capital is located on Majuro Atoll in the southeast part of the nation, approximately 3800 km west of Honolulu, HI and 2700 km north of Fiji. The atolls are arranged in two island chains running roughly NNW to SSE: the western Ralik ("sunset") Chain and the eastern Ratak ("sunrise") Chain. The atolls are located within the latitude band extending from 4.5° to 14.5° N.

The land area of the various atolls cover a wide range of sizes from about 0.5 km² to 16.4 km². The lagoon areas also vary significantly, from 8.4 km² to over 2500 km², the latter belonging to Kwajalein Atoll, the world's largest lagoon.

The total population today numbers close to 50,000 and is one of the fastest growing in the world. There are numerous public health problems as there are in any country, particularly those which have incorporated western lifestyles and dietary habits within a few short generations. Almost every adult citizen of the Marshall Islands knows of the atomic weapons testing program conducted four decades ago. Most citizens, as well, believe that a variety of ailments, in particular, thyroid disease, are a result of that testing program.

The NWRS was designed to fill a need for information on the radiological conditions at all atolls within the Marshall Islands and at all islands of any significant size. Early in the planning of this study, it was decided that to prevent a lack of trust in the participating scientists, the staff must be resident fulltime in Majuro and be in full view of the local population. Over three years ago, we built a radiological laboratory in Majuro to support the field studies and sample analysis programs. This laboratory currently employs six full-time Marshallese assistants, three of whom represent the community of Rongelap.

The results of the NWRS are to be filed with the Government and the Nuclear Claims Tribunal and presented in an understandable fashion to the people of the Marshall Islands. Thus, there are educational and advising roles the NWRS provides the Republic.

Much has been written about the weapons testing period. However, in December of 1993, previously classified explosive yields for 48 of the 66 tests in the Marshall Islands were declassified and released to the public. The release of this data was in response to a request from the Government of the Marshall Islands which had been submitted about two years earlier. The test yield information is useful for constructing a perspective to show the sizes of the test in the Pacific compared with the Nevada Test Site.

The largest test at the Nevada Test Site was 74 kt (74 thousand tons) equivalent TNT. The largest test in the Marshall Islands was 15 MT (15 million tons) equivalent TNT. Fifty percent of the tests in the Marshall Islands were larger than the largest test in Nevada. A plot showing the distribution of the sizes of the tests in the Marshalls is shown in Figure 2.

I. THE NATIONWIDE RADIOLOGICAL STUDY

The need for radiological information that could be both trusted and understood was translated into three closely related programs.

- (1) An international scientific advisory body was formed following a lengthy search for qualified and unbiased advisors. Late in the selection process, the selection was limited to non-Americans. The RMI Scientific Advisory Panel was formed in 1989 drawing on expertise of five individuals.¹
- (2) A diagnostic medical program was initiated with the purpose of providing evidence for personal injury claims.
- (3) A comprehensive study was initiated to determine the radiological conditions at all locations in the nation with a reassessment of the conditions at Bikini, Enewetak, Rongelap and Utrik Atolls.

Over the past three years, all atolls of the Republic have been monitored, including the most southern atolls as well as the northern test site atolls. Environmental measurements over the entire country have varied tremendously. Any pattern of contamination will be apparent from these measurements. State-of-the-art gamma spectrometry instruments have been used in an environmental monitoring program which emphasizes the evaluation of 137-cesium (¹³⁷Cs) in the soil of the islands. The radiation monitoring instrument measures the rate at which energy is deposited in its detector crystal. Physicists refer to this measurement simply as a "count-rate". These count-rates will be used in a lengthy calculation to estimate the amount of radioactivity in the soil, what I call the "inventory of soil cesium." The end product of collecting and analyzing the environmental radiation data will be the capability to compare the soil cesium inventory at each atoll, island or location of interest.

Hundreds of samples have also been acquired for laboratory analysis including soil, coconuts, a variety of native fruits and animal life. In the Majuro laboratory, all samples are measured to determine the concentration of 137-cesium, 241-ameridium, and 239+240-plutonium.

Any locally grown food crop containing radioactive cesium must be obtaining its nutrients from contaminated soil. Similarly, when crabs, pigs and other animals show radioactivity in their bodies, it is a direct indication of the radioactivity in the soil. Thus, soil measurements are specially informative and contamination levels in plants and animals can be readily predicted from the soil measurements themselves.

Sampling and radiological analysis of certain native vegetation species used in traditional Marshallese medicine are also being carried out by the NWRS to complement the assessment of potential exposure via ingestion of foods. The uptake potential of these plants has not been

¹Dr. Keith Baverstock, of the WHO European Center for Environment and Health (Rome, Italy), Dr. Herwig Paretzke of the GSF Institut für Strahlenschutz (Munich, Germany), Dr. Andrew McEwan of the National Radiation Laboratory of New Zealand (Christchurch, NZ), Dr. Klaus Trott of the Medical College of St. Bartholomew's Hospital, University of London (U.K.), and Dr. Krishna Sankaranarayanan of the Department of Radiation Genetics and Chemical Mutagenesis, University of Leiden (Netherlands).

extensively studied in the past and, although they likely constitute a small part of the plant material and radioactivity consumed by Marshallese, the dose contribution of this pathway is yet unexplored.

The environmental measurement data can be used in a variety of ways. For example, the soil inventory values can be used to determine the radiation dose to people living at a specific location. The dose is normally composed of two components, external exposure and internal exposure. External exposure refers the process of energy absorption in the human (or animal) body from gamma-ray emissions from radioactivity in the soil or environment outside of the body. Internal exposure is a measure of the radiation dose received from radioactivity within the body. Foods that are contaminated with radioactivity can contribute the internal dose. Other small contributors to internal dose are breathing radioactive dust particles and drinking contaminated water. These sorts of environmental radiation data can be used to predict the dose to inhabitants now and in the future.

Measurements made today can also be used to some degree to estimate exposures that have taken place in the past. The process of historical dose reconstruction is a very active research area today. An example of this is the study of the dose to Utah residents from fallout originating at the Nevada Test Site. I was an investigator on that project from 1986 to its completion in 1993. There are, however, numerous problems and uncertainties in trying to estimate past exposures. With the obvious level of concern expressed by the American people over the past few months on the subject of exposure of the public, this area of research will surely continue.

The interest of the American people is no different from the interest of Marshallese citizens. There is, however, differences in the cultural and educational background that are needed to understand the difficult and abstract concepts of radiation physics. For those concerned about bringing truth and understanding about radiation to the Marshallese people, it is important to communicate radiological concepts without causing undue alarm.

The results of the Nationwide Radiological Study are expected to be released and published in the open scientific literature this year. The environmental monitoring has been completed for approximately 99% of the Marshall Islands. The only islands remaining to be monitored are those used by the military at the U.S. Army at Kwajalein Atoll. Almost every island 0.5 km in length or larger has been monitored. Thus far, the overall average spatial density of gamma measurements in the environment is approximately ten per square kilometer.

Distinguishing Fallout From Other Nations

It is widely known by scientists that there are low levels of fallout radioactivity at all locations worldwide as a result of over 800 nuclear detonations conducted by the United States, the former Soviet Union, the United Kingdom, Republic of France, the People's Republic of China and India. Radioactivity from large weapons is known to enter the stratosphere where it can circulate around the globe for a number of years before falling to the earth's surface. This phenomenon is termed "global fallout" by scientists. It is important for this study to determine the portion of

the fallout radioactivity measured at each island that can be attributed only to the weapons testing program conducted in the Marshall Islands. Not only is that quantity relevant for the determination of land damage from the testing program in the Republic, but it will also serve to delineate those islands which did not receive any measurable fallout from Bikini and Enewetak.

To determine the global fallout at each atoll, I have estimated the level of ^{137}Cs from world wide events using a mathematical predictive model. This type of model is a tool commonly used by physicists. Every model requires data for calibration purposes. In this case, $^{137}\text{cesium}$ data collected by other scientists at a number of locations in the Pacific outside of the Marshall Islands has been used. These locations include Pohnpei (Federated States of Micronesia), Guam, Hawaii and others. The model specifically uses the latitude of the island and annual rainfall rate to predict the deposition. Although these predictions are still under refinement, I have estimated an average value of 500 Bq/m^2 of ^{137}Cs from global sources for the atolls of the Marshall Islands.² This value will be used as a baseline above which the contamination will be assumed to have originated locally.

III. HISTORICAL CONTAMINATION DATA

The responsibility of the NWRS is to not only measure current levels of residual radioactivity but to also attempt to understand what level of exposure might have taken place in the past. Any radioactivity measured today can be precisely predicted at any other point in time whether it be in the future or the past. This is true because the rate of decay of most radioactive elements is known fairly precisely.

There is, however, a significant difficulty in estimating radiation dose from radioactivity which does not exist any longer. There are numerous radioactive elements created by atomic weapons that are relatively short-lived. In fact, there are more than 300 different forms (isotopes) of 36 elements created as fission products. Most of these radioactive byproducts emit what scientists call as "beta particles." The largest amount of radioactivity present immediately after the blast decays quickly.

Because some radioactive species cannot be measured today, the value of historical measurements is immense. Although historical measurements may suffer from a lack of precision when compared to modern measurements, they still can play a very important role in retrospective dose estimation. I have conducted several literature searches in an attempt to find historical radiation monitoring data in the Marshall Islands. The paucity of this kind of data is surprising. One very illuminating piece of information has been reconstructed, however.

The Health and Safety Laboratory (HASL) in New York City under the direction of Merrill Eisenbud during the 1950's made some of the most valuable measurements available today. This laboratory eventually became part of the Atomic Energy Commission and was later renamed the

² Bq/m^2 is an abbreviation meaning Bequerels per square meter. A Bequerel of cesium is equal to one disintegration per second.

Environmental Measurements Laboratory. Today it is part of the U.S. Department of Energy system and is world known for excellence in radiation measurements and associated research.

HASL developed a simple but effective monitoring instrument to detect fresh fallout. Using pieces of sticky or "gummed" paper as a collection device, HASL placed monitors at over 100 locations worldwide. The gummed film effectively collected fallout for 24 hours, after which the film was changed, and the used sheet mailed to HASL for measurement. The gummed film data represents the best available information on the quantity of early beta-activity deposition. The data were published over a number of years by Eisenbud and his collaborators in respected scientific journals. Since then, the gummed film data has been used extensively in the U.S. to assist in the reconstruction of doses to residents of Nevada and Utah and other states.

Several gummed-film stations were established in the Pacific area and the data from them may be of interest to this Committee. These locations include Hawaii, the Philippines, several locations in Micronesia and a single station in the Marshall Islands at Kwajalein Atoll. Although it seems a pity now that there were not additional monitoring stations in the Marshall Islands, the foresight to have started this very valuable program is to be applauded. I have used the data from a 1960 report to produce a plot of the deposition over the years 1954 through 1958. As can be seen in Figure 3, there were at least three periods during which significant deposition occurred. I have also noted in this graph the months in which the major bomb tests took place. The high level of agreement of the data peaks and the test dates is quite revealing. All seventeen of the tests of a size of one-megaton explosive yield or larger were detected on the gummed film at Kwajalein. Please note that the data in this figure is currently being examined in detail. Several analytical correction factors have been proposed by scientists since this data was collected. The data as shown is taken directly from a 1960 report and does not include any of the correction terms.

The implications of detectable radioactivity in Kwajalein immediately following the large tests is relatively profound and deserves greater attention. First, it is important to note that Kwajalein has been a site of a sizeable population for many years. The 1958 census of the Marshall Islands indicates that 9% of the Marshallese population lived there then, nearly 1300 persons. Second, the early fallout is in many ways the most dangerous to human and animal health. The mixture of radionuclides is quite complex; in particular, the fallout contains significant amounts of radioactive iodine. It is possible that barely measurable amounts of ^{137}Cs now may have been accompanied by levels of radioiodine sufficiently high to give thyroid doses which are great enough to cause the onset of disease many years later.

Calculations of fission yields taken from the scientific literature indicate that the amount of ^{131}I -iodine (^{131}I) produced is about 700 times the amount of ^{137}Cs . Whether any of the short-lived radioiodine (^{131}I has a half-life of only eight days) existed at locations of interest depends entirely on the time interval between the explosion and the deposition at a location. Global fallout, because of its long residence time in the atmosphere is normally completely depleted of the short-lived radioiodines. However, any location in the Marshall Islands that received local fallout could not have been more than a few days transit time from the test sites. Thus, fallout from Bikini or Enewetok deposited at any of the atolls could have likely contained significant

amounts of short-lived radioiodines. It is easy to see that a line drawn to Kwajalein from either Bikini or Enewetak intersects a number of other populated atolls. The implication here is that if early fallout radioactivity was in the air at Kwajalein, it could have also touched other atolls and exposed the residents of those islands.

Finally, I would like to take note of at least one other mention of early radioactivity at Kwajalein. Merrill Eisenbud in his autobiography vividly tells of the efforts of HASL to monitor the Pacific tests. He mentions that the flash from the first thermonuclear test (MIKE) in the spring of 1952 was visible at Kwajalein. Eisenbud goes on to state that in the early hours of the day following the test, environmental radiation levels were about 10 times higher than normal. The MIKE test took place before the gummed film station was operational at Kwajalein. However, the personal records of Eisenbud confirm that shot MIKE behaved similarly to the other large events in spreading early fallout to Kwajalein.

III. THYROID STUDY

Introduction

It is generally perceived in the Marshall Islands that the major health damage as a result of the testing are various forms of thyroid disease. The NWRS initiated a study of thyroid disease in the Marshall Islands to answer lingering questions about previous contamination by radioactive iodine and its effects on Marshallese citizens.

Previous investigations mainly concentrated on the the the populations from Rongelap and Utirik which were known to have been exposed. Repeated surveys by medical teams from Brookhaven National Laboratory have maintained this surveillance. The last detailed and comprehensive report was published in 1989 as Brookhaven National Laboratory Report BNL-52192 by W.H. Adams, P.M. Heotis and W.A. Scott: *Medical Status of Marshallese Accidentally Exposed to 1954 BRAVO Fallout Radiation: January 1985 to December 1987*. The findings presented in this report can be summarized as follows: In the heavily exposed Rongelap and Ailinginae population totalling 86 people, 23 thyroids developed benign nodules and 5 developed cancer. The majority of nodules and all cancers occurred in women. All cases were operated on in the United States, usually by total thyroidectomy. More than 50% of the people operated on developed hypothyroidism as a consequence of the treatment, thus requiring life-long supplementation with thyroid hormone pills. In the much less exposed Utirik population which totalled 167 people, 15 thyroids developed palpable (i.e., those capable of being felt by an examining physician) benign nodules, 5 others developed cancer. Between the two groups of people, there was a pronounced difference in latency time for manifestation of these nodules. In Rongelap, the first nodules were found 9 years after BRAVO; the incidence rose quickly and reached a plateau after about 30 years. In Utirik, the first nodules were found after 15 years; the incidence rose more slowly and in 1987 had not yet reached a plateau. Moreover, there was a

pronounced difference in the incidence of thyroid nodules between age groups: In Rongelap, 59% of those who were children under ten years at the time of the BRAVO test developed nodules; 25% of those who were 10-18 years old also developed nodules as well as 14% of those who were adults. The comparison group which was used for the last BNL report consisted of 227 people. Among these, 5 developed benign nodules and 2 developed cancer.

Between June 1983 and March 1985, Dr. Thomas E. Hamilton examined 2,273 people from different atolls for the presence of palpable thyroid nodules. All of this group was alive in 1954 and most of these individuals were from locations north of Majuro. Hamilton found 87 new nodular thyroids in addition to 55 others previously identified and surgically corrected. Twenty-three of the cases lived in Rongelap or Utirik at the time of the BRAVO test. The remaining 119 cases of thyroid nodules suggest an overall incidence of thyroid nodules in the portion of the Marshallese population which was not exposed to the heavy fallout of the BRAVO test of 119/2162 or 5.5%. This value is similar to the comparison group in the Brookhaven study where the rate was 7/227 or 3.1%. Yet, there was a striking difference of prevalence among the different atolls with four groups apparent:

- Very high prevalence: 38% - Rongelap
- High prevalence: 8-10% - Utirik, Likiep, Wotje, Lae, Ujae, Wotho
- Average prevalence: 4-6% - Ailuk, Maloelap, Kwajalein, Jaluit
- Low prevalence: < 4 % - Mejit, Ebon, Mili

The Hamilton study clearly suggests that thyroid disease might also be a problem in many Marshallese who were not in Rongelap or Utirik at the time of the BRAVO test. As a consequence of Hamilton's findings and the concern of the Marshall Island's government and citizens about radiation induced thyroid disease, the international Scientific Advisory Panel and the Nationwide Radiological Study recommended that a comprehensive nationwide survey of the prevalence of thyroid disease in the Marshall Islands should be performed.

The study proposed 2 years ago was planned to build on Dr. Hamilton's investigations but also to collect new information. In particular, nearly ten years have passed since Dr. Hamilton's study. As the experience in Utirik has shown, latency to the development of radiation-induced thyroid nodules becomes longer if radiation doses are small, thus many cases with nodules might be found. Another area in which this study hopes to improve is in using all locations of residence which an individual might have had. Dr. Hamilton related his findings to the place of residence at the time of the BRAVO test. Yet there is evidence that other nuclear tests that were conducted before and after BRAVO deposited radioactive contamination on other atolls. Therefore, a comprehensive residence history of every participant will be examined. Both benign and malignant thyroid

disease is also being studied, thus building on Hamilton's study which only reported the prevalence of nodules. Progress in the development of ultrasound imaging has made it possible to objectively measure, document and record characteristics of the thyroid pathology.

The Thyroid Disease Study in Ebeye, 1993

With the agreement of the Ministry of Health and the cooperation of the Ebeye Hospital, the Ebeye examination phase was begun early in 1993. Administration and financing was provided by the the Nationwide Radiological Study. Protocol development and general planning was assisted by Dr. Klaus Trott of St. Bartholomew's Hospital in London and medical examinations were conducted by three endocrinology surgeons from the Second Department of Surgery of Tohoku University in Sendai Japan. From January 15 to March 7, 1993, screening for thyroid disease was offered to all adult residents of Ebeye. Every participants received a physical and ultrasound examination of the thyroid. A blood sample was taken from most participants to study TSH (thyroid stimulating hormone) levels as a test for hypothyroidism. In addition, basic health data was recorded as well as information on past health conditions, diet, and residence history.

A main objective of the medical screening program was to examine persons alive at the time of the nuclear testing or those born a few years after it ended. Thus the study intended to concentrate on persons who are now 35 years or older with those between 28 and 35 also of interest for comparison purposes. However, no younger person was refused an examination if he/she wished it. Altogether, 1368 Marshallese residents of Kwajalein atoll were examined. Their ages ranged from 16 to 90 years. Of this group, 817 were female, 535 were male. Of the 817 women, 145 were younger than 28 years. In the younger group were 2 cases with palpable nodules and 3 with non-palpable nodules. There were 75 men examined who were younger than 28 years. In that group, no palpable nodules were found but two cases were identified with non-palpable nodules.

There were several strong points to the study design. Each patient was examined by two different medical doctors and received both a standard palpation exam and an ultrasound exam. Through the use of high-resolution ultrasound, the examining physician could visually examine the thyroid using sound waves displayed on a special video screen. The ultrasound machine can measure the size of abnormalities (nodules) and generate a paper copy reproductions of the image. In the Ebeye study, a photograph of the ultrasound image was given to each participant and added to the patient's medical chart with a written record of the sizes of any nodules detected.

Palpable nodules are nodules which can be felt by the examining physician. Palpable nodules were on average larger than nodules which were not-palpable. The median size of nodules which were not-palpable was 7.5 mm (about 1/4 inch), the median size of palpable nodules was 16mm (about 3/4 inch) although there was considerable overlap between both distributions. The smallest

palpable nodule was 7 mm diameter, the largest nodule not-palpable was 20 mm diameter. Nearly 20% of the palpable nodules were smaller than 10 mm and nearly 20% of the nodules not-palpable were larger than 10 mm. It is reasonable to assume that the size of a nodule is more strongly related to the potential impact on a person's health than the ease at which it can be palpated. Systematic studies on this question have not been published; however, in view of these data, the requirement of palpability for determining the presence or absence of thyroid disease should be reconsidered. That is an issue that the medical community worldwide must eventually address.

In the 128 patients with palpable nodules, a fine needle aspiration biopsy was performed. This is a procedure in which a very minute amount of thyroid tissue sample is removed for microscopic examination. The tissue sample was stained in Ebeye, sent to Japan and examined in the Second Department of Pathology of Tohoku University, Sendai. The percentage of biopsies which yielded sufficient material to permit an unequivocal diagnosis was about 60%. However, the experience of the surgeons who performed the ultrasound examination allowed them to make a probable histological classification of the nodule. In 16 patients, thyroid cancer is the most likely diagnosis. Five of this group had sufficient evidence to diagnose papillary cancer. Large follicular adenomas have a high tendency to contain malignant foci; there were another 6 of this diagnosis. Thus, there were 23 persons found with a high likelihood of thyroid cancer.

In agreement with most other studies, the prevalence of thyroid nodules was higher in females than in males. Also in agreement with other studies was a pronounced dependence of prevalence on age: nearly 50% of women over 60 have nodular thyroid disease. From the data as they are presented here, one should not make premature conclusions as to the probable causes of these benign or malignant nodules. It has to be stressed, however, that the total incidence of palpable thyroid nodules is rather high in the population of Ebeye: 13.5% of women over 30 years and 6.7% of men over thirty years have palpable thyroid nodules. The results from the Ebeye study are much higher than those which have been found elsewhere in the world except in the areas with significant iodine deficiency.

Preliminary Observations

The interpretation of disease-rate data to determine causal relationships requires considerable expertise and care in analysis. Thus caution is being exercised in interpreting the thyroid disease prevalence data from the Ebeye study. The number of persons examined is still somewhat small for proper interpretation. However, there is at least one pattern which is striking and deserves mention. Figure 4 of this briefing material shows the distribution of birth years for the 23 possible cancer cases and the atoll of residence in 1954 at the time of the BRAVO test. Forty

percent of these cases were children less than eight years old at the time of the BRAVO test. That young children exposed to external radiation or radioiodines are at higher risk is consistent with all studies. Fifty-five percent of the children under eight years of age during the testing years were born and raised on Ebeye in Kwajalein Atoll. The high number of the Kwajalein residents may only reflect the greater number of people living there. However, because the gummed film data indicates the presence of fresh fallout at Kwajalein on numerous occasions, these results require further careful examination.

Six of the persons in the group of possible cancers were born after the testing ended and their locations of residence as children is also shown. It is curious that two of the five younger subjects were born and raised on Rongelap. It is relatively well accepted in the scientific community that only the short-lived radioiodines are responsible for thyroid cancer. Since exposure to short-lived iodines is impossible in this case, alternative explanations will be required.

Consequences of the Findings

In the compensation scheme implemented by the Nuclear Claims Tribunals, Marshallese citizens are eligible to receive payments from \$12,500 for non-malignant palpable nodules to \$50,000 for nodules requiring thyroidectomy. Thus, to prevent unneeded and possibly dangerous surgery, the Thyroid Study has had the responsibility of recommending surgical intervention only when the ethics of proper medical care demanded it. The possibility of unneeded surgeries is a frightening scenario for an already overworked health care system. Therefore, careful but specific recommendations were made for the care of all patients. In particular, for those persons with nodules that are not-palpable and for all people with palpable adenomatous goiter which does not cause any difficulty with swallowing or compression of the trachea, no treatment is needed. No surgery should be performed on these cases. A follow-up examination has been scheduled for the spring 1995 for these persons to determine if any significant change in their condition has occurred. Surgery should only be performed on those people for whom ultrasound and/or fine needle biopsy examinations suggest either cancer or a large follicular adenoma. In a few patients, advanced age or other serious disease has suggested that thyroid surgery would not be in the best interest of the patient. After consultation with the doctors at the Ebeye Hospital, 14 patients have been selected for thyroid surgery because of suspected malignant thyroid nodules.

The possibility of 16 cancers out of 1368 persons is a prevalence rate of 1.2%. Thyroid cancer is rare in the world, normally ranging from 1 to 10 per 100,000 people depending on ethnic group, sex and age. This figure, if proven right deserves concern. Simple extrapolation to the total population alive at the time of the atomic testing yields an estimate of 80 to 100 thyroid cancers in the adult Marshallese population.

Plans for Further Study of Thyroid Disease

Overall, the Ebeye phase of the Thyroid Disease Study was successful. The local population accepted the offer of a thyroid examination to dispel or confirm their individual fears concerning thyroid disease. The results of the study confirmed the suspected high prevalence of palpable nodules in the population and a possible higher than expected incidence of cancer.

At a meeting with President Kabua and the Nitijela on August 30 1993, the leaders of the nation recommended an extension of the study to other atolls. Such a study would initially be based in Majuro and later extended to outer atolls. Currently, I am seeking support from the Centers for Disease Control and Prevention in Atlanta to continue this investigation.

The close association of the Thyroid Study and the Nationwide Radiological Study will provide an important analytical tool not previously available. Recently collected environmental radiation data at all the atolls can be extrapolated backward to estimate the likely exposure at the time of the testing for persons at locations throughout the Marshall Islands. Though this process is difficult and somewhat uncertain, it will be possible to compare the geographic pattern of thyroid disease with either the geographic pattern of present day residual contamination or with the geographic pattern of the exposure at the time of the bomb tests. The possibility of making these comparisons will improve the ability of this study to draw convincing conclusions over any other previous investigation. By using the largest database possible, the Nationwide Radiological Study and the Scientific Advisory Panel will be able to provide the most credible interpretation possible to date. Regardless of the outcome of scientific analyses which are intended to examine the relationship of thyroid disease and radiation exposure, many Marshallese citizens with heretofore unknown thyroid disease will be identified and provided the appropriate level of medical care.

CONCLUDING REMARKS

The United States atomic weapons testing program in the Pacific is now a part of the history of the Marshall Islands. Part of its legacy has been fear, misunderstanding, and, in some cases, true damage to persons or property. The passage of 40 years since the BRAVO test has not reduced the level of concern about radiation among adult Marshallese citizens. Even to trained scientists, it has never been apparent why the BRAVO incident was never openly investigated.

Today, there are still three communities of islanders displaced from their traditional home islands. Any hesitation of the islanders not to return to their homelands must be viewed with an understanding of the difficult concepts which they are being asked to understand. There are also numerous opinions as to the safety of these islands, and the differences of opinion only compound the difficult decisions for islanders considering whether they should return to their land. The hearing today is one further step to healing some long lasting scars. Openness and freedom of information can only serve to improve a situation in which misunderstanding and, in some cases, true damage, have obscured an understanding of the situation. Where real health effects are obvious, we hope they will be acknowledged and cared for. Where remediation activities are

necessary to return island land to a hospitable condition, we hope that this need will be acknowledged and satisfied.

On behalf of the Nationwide Radiological Study and the citizens and the Government of the Republic of the Marshall Islands, I express my thanks to this Committee for their openness and inquiry into these issues.

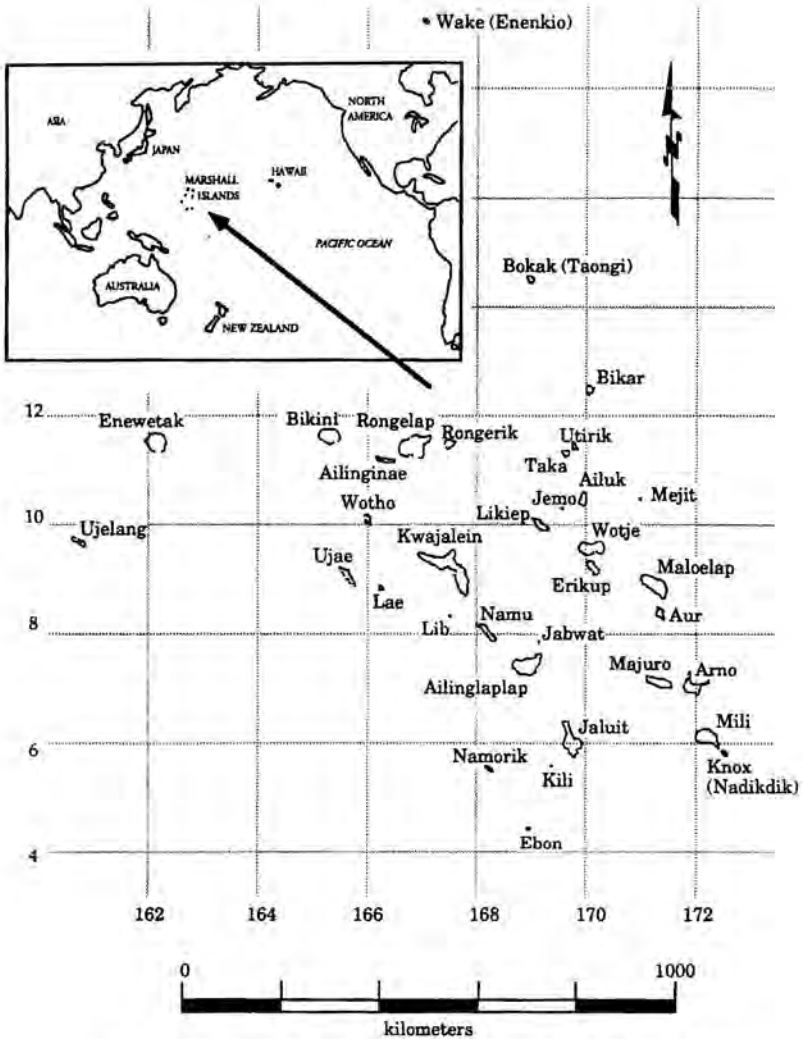


Fig. 1 Map of the Republic of the Marshall Islands

Fig. 2 Cumulative Distribution of Test Yields (kt)
in Republic of the Marshall Islands

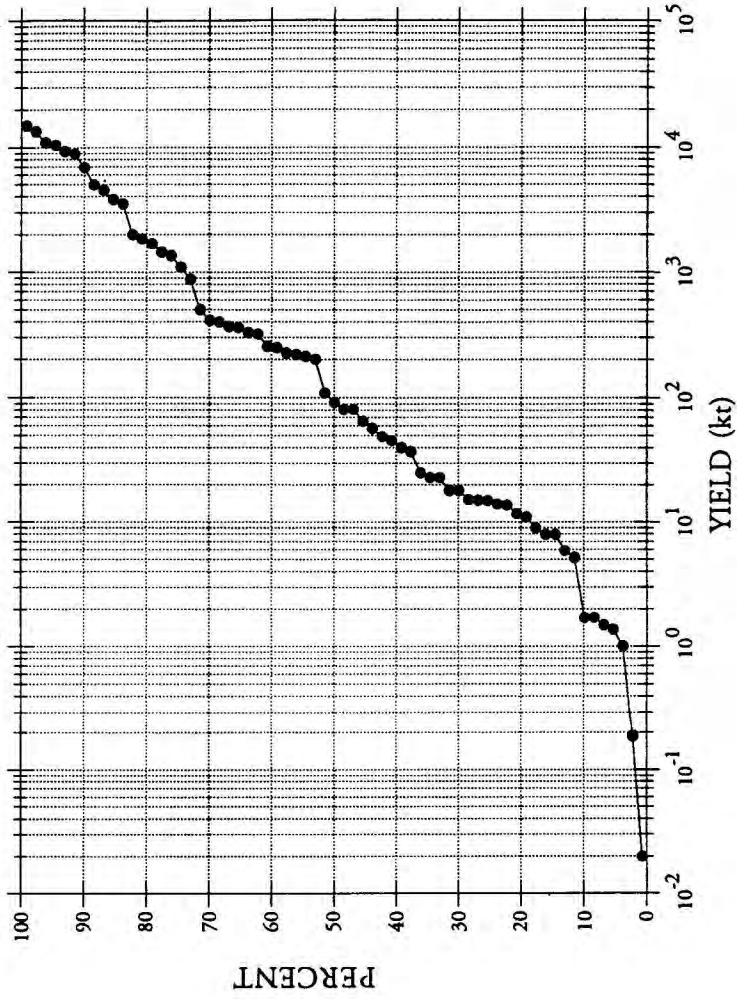
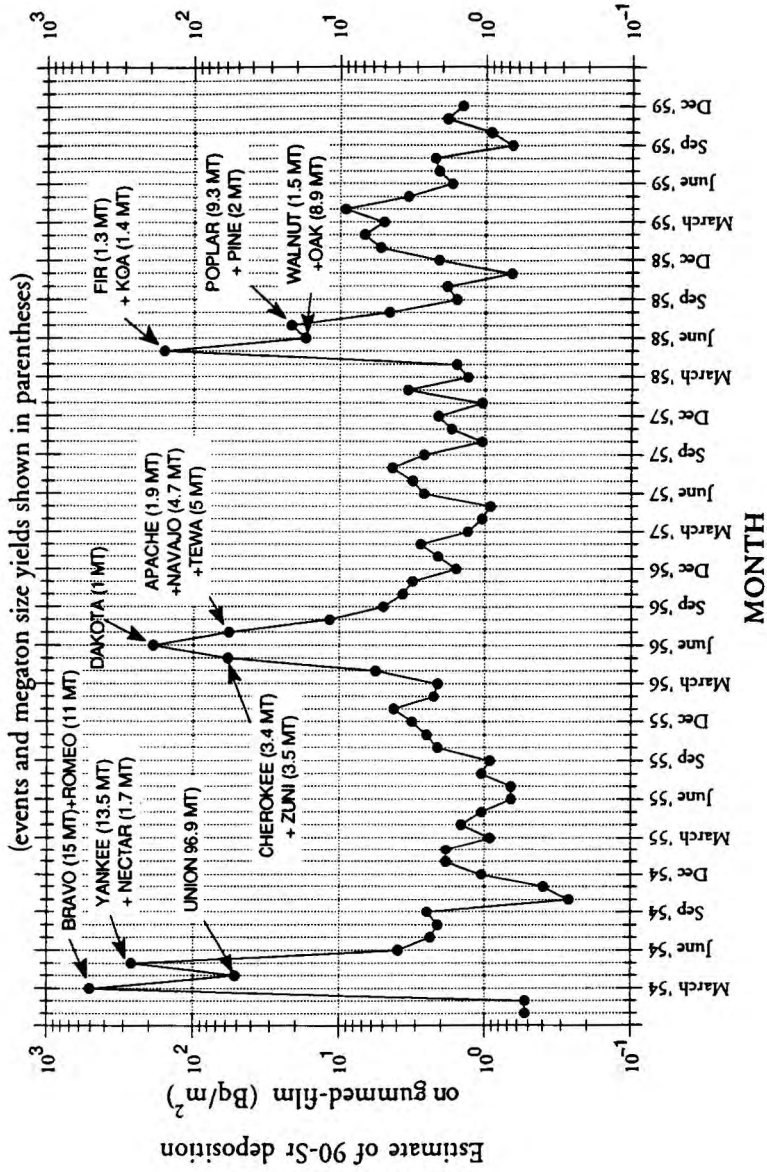
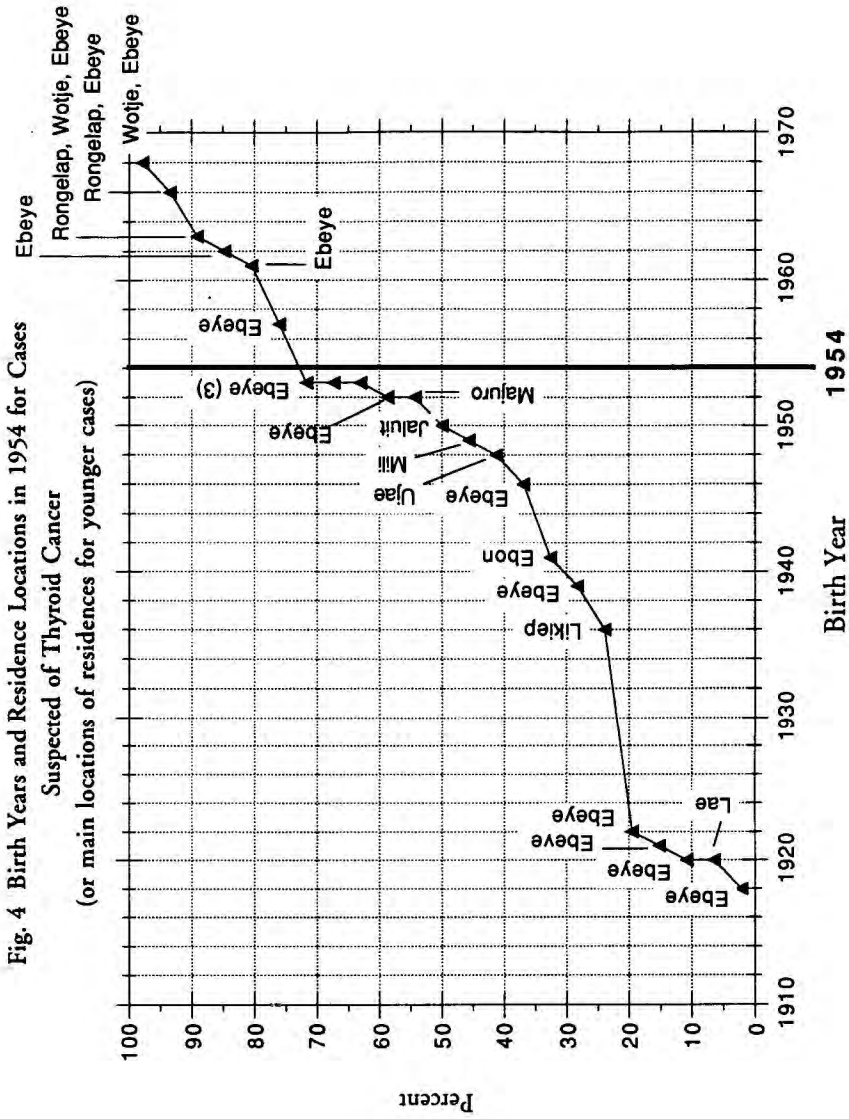


Fig. 3 Monitoring results at Kwajalein Atoll from gummed film network of HASL lab (1954-1959)





Mr. MILLER. Thank you.
Dr. Radford.

STATEMENT OF EDWARD RADFORD, M.D.

Dr. RADFORD. Thank you, Mr. Chairman. I am pleased to see you back.

Nothing exemplifies more the status of the Marshall Islanders than the situation on Ebeye. Dr. Simon has indicated that he thought there were 20,000; there were actually 10,000 people living on it. That is a 78-acre island which was uninhabited when I first went to the Marshall Islands as a radiological protection officer in 1947. Now it has 10,000 people. I have been on it.

Kwajelein Island, which is four miles away and to which the Marshallese commute in order to carry out many of the functions on the Kwajelein test base, is a picture of a tropical isle with manicured lawns, very nice houses, and on which no Marshallese are permitted to live unless they are married to an American. So I just point that out for openers.

I am a physician, and I graduated from Harvard Medical School in 1946. I have detailed some of my past experience, but I want to emphasize my experience on the BEIR committees—B-E-I-R stands for Biological Effects of Ionizing Radiation—and these committees were established by the National Academy of Sciences to investigate all of the world literature on what the effects of radiation were, and the first such committee was the BEIR I Committee, on which I served, which issued its report in 1972.

I was chairman of BEIR III, which issued its report in 1980, and that report was a controversial one, sufficiently that I submitted as part of the report as chairman a dissenting statement on the issue of cancer risks from radiation. This was an absolute bombshell to the National Academy of Sciences because it never happened before that a chairman dissented from his own committee. Well, the point is that BEIR III was what was available at the time of the signing of the compact as far as what risks of radiation are.

Now the issue of changed circumstances is that we now have BEIR V, which was published in 1990. BEIR V essentially confirmed the position that I had taken in BEIR III, that the radiation risks were a lot higher. Subsequent data from the Radiation Effects Research Foundation in Japan have further buttressed the position that I expressed in 1980. So there is a changed circumstance which is of considerable significance to this committee.

Now I received training in the military as a radiation protection officer, and I was detailed to Kwajelein in 1978 for Operation Sandstone, and I only want to make a few comments about that series of three tests. One was that we had meteorologic briefings every day or evening before the tests were carried out. The meteorologist would tell us, "Well, the winds are going to blow this way and that way."

Now it is important for this committee to realize that there are winds and winds. The winds up to, say, 10,000 feet can be very different from the winds above 10,000 feet. The winds aloft in general in the Pacific area, I think, at this time of year at least, are prevailing westerlies, due east from west, exactly the pattern that ex-

isted at the time of BRAVO. So there is nothing mysterious about the fact that the winds aloft are going to go from west to east.

Now the lower level winds might very well go south and various other places, and some of those could have changed. So that the idea that there was a change in the wind pattern at least has some possibility of support, but in terms of the winds aloft, it is quite likely they didn't. Indeed, as I have indicated, the chief of the weather group on Rongerik is now quoted as saying, at least in 1983, that they had been measuring the winds, and they were steadily from the east, they did not change before the test, they did not change during the test, and they did not change after the test, there was no wind change. Now that may apply only to certain levels of the winds, but the point is that you have to take all of these into account.

Now, I point out in my written testimony, and I won't go into details here, that there was a report written by Science Applications International Corporation in 1983 which went over the question of how much exposure did the servicemen—specifically the Navy which had the largest number of servicemen in Operation Sandstone—how much dose did they actually get. It turns out that the dose that they calculate—which takes account only of gamma radiation and does not consider the possibility of intake of any radio-nuclides, etc.—was higher on Kwajelein than on Enewetak.

Now let me be clear. The amount of radioactivity on Enewetak was undoubtedly higher in the crater area where the bomb tests had gone off, but when you got outside of that where the personnel were, the actual fallout exposure was less on Enewetak itself than it was 400 miles away on Kwajelein. Obviously there is no information in that report about what happened on any other islands because nobody measured it. That has been the pattern through most of the bomb tests, even including BRAVO; despite the efforts of the HASL lab to carry out monitoring, and it is still pretty much a mystery.

Now I recently returned to Majuro in connection with my position as a consultant to the public advocate from whom you will hear later on today. I have picked up a lot of new information that I did not know until I went back over the records, and I would just like to stress a few of that.

The first thing, of course, is that there have been actually 67 tests, but one of them was a fizzle, so I guess they don't count that. The total, as Dr. Simon says, is a big number. It comes to 107,000 kilotons, kilotons of TNT, and that is equal to over 7,000 Hiroshima bombs, that have been detonated in the Marshall Islands.

I would just like to close my brief comments here by pointing out some of the facts that came to light when I reviewed documents on the Marshall Islands themselves. The first, of course, is that the Marshallese knew that a lot of islands beside the four—Rongelap, Ailinginae, Rongerik, and Utirik—had fallout from test BRAVO. You have already heard about that from others. But I have listed at least another seven atolls and islands on which fallout was known to have occurred by the Marshallese, and now I would like to tell you a couple of anecdotes to close.

One of them is a story told me by Marshall Island Senator Tony de Brum who is in this room and he can confirm or deny whatever I say, but I will take his part here.

He was nine years old at the time of BRAVO, living on Likiep, which is supposed to be one of the non-impacted islands, okay? He lived in a thatched house. Now they noticed the snow-like dust falling on their island too, not anywhere near as much as the 1.5-2 inches that fell on Rongelap, but still detectable, and the water in the reservoirs turned yellow there too, as it did in some of the other atolls.

Soon afterwards, after the bomb, he noticed that there were gecko droppings falling on his head. Geckos are little lizards and are supposed to be a good luck charm in the Marshall Islands. But then more and more gecko droppings came around, and finally a dead gecko fell out of the roof and then another and then several more.

Now I don't know what he interpreted that to be, but my interpretation is that the beta radiation from the screened-out radioactivity in the roof of that thatched house was sufficient to kill the geckos from acute radiation problems.

The next point is that Mr. de Brum reported that a Navy ship stopped at Likiep and took a boy and a woman aboard apparently for whole-body counting. This at least is the inference at this time. This was, I guess, a few days after the bomb. The ship sailed away after depositing the people back onshore without telling the Marshall Islanders anything, and subsequently the U.S. Navy has denied that any ship stopped at Likiep for years and years and years. Only recently they finally admitted it. Talk about covered-up knowledge.

Finally, I would like to point out that it is known that fallout occurred on other islands such as Ujelang, and I have referred to that briefly. This is part of the documentation.

I also point out that the whole question of abnormal pregnancy outcomes has not really been addressed in the Marshall Islands partly because the statistics are poor. The reason for this is that the birth of a deformed child is considered a terrible stigma for the family, and therefore no mention is made of it socially. So that in order to do a proper follow-up study, I think it would be necessary now to question the older women who no longer have the commitment, let's say, to keeping the subject covered up, and it might be possible to get adequate information on this important question, which, incidentally is one of the more sensitive indicators of radiation exposure.

Finally, the anecdote that I heard about contamination of Kosrae. Now Kosrae is an island to the southwest of Majuro. It is actually just south of Enewetak, just below that blue map, and Kosrae isn't even part of the Marshall Islands. It is actually, I think, a separate country in its own right. But at some point—and I was unable to get accurate information—the U.S. Navy unit on that island came to the people living on it and said, "You can't eat your food or drink your water any more. You had better let us provide you with water and food," which they did for some time, I believe on the order of weeks. Then they finally came back, the U.S.

Navy personnel, and said, "Now you can eat your food—eat your food and drink your water."

Kosrae is 600 miles south of Enewetak, and it certainly is at the limit of any island you would expect could have been affected by fallout. Now this is hearsay evidence and I don't put it forward as any scientific truth, but the fact is that the U.S. Navy could tell us: Did they have fallout on Kosrae, was it measured, how much, and did they tell the natives not to eat the food? It should not be a difficult problem, but it is obviously apparent from today's discussions that it is a difficult problem. The Navy won't tell us, and I just reiterate what others have said. I believe that the fallout that occurred on the Marshall Islands was widespread and it is going to be very difficult to establish evidence of this in spite of Dr. Simon's efforts. I am not denigrating what he is doing; I am merely saying it is not going to be easy.

Then I have to say as my closing statement what I have written about this document, Operation Sandstone. This was given to all members of the task force after Operation Sandstone because of course we weren't allowed to have cameras. So they did a very complete photographic record of Operation Sandstone, and I find it interesting even today to recall memories of what actually happened at the test.

But I call your attention to the last page of the report which says, "The atomic energy proving ground at Enewetak lies ready and waiting for man's next adventure in atomic wonderland." That was the attitude of the leaders of the Operation Sandstone, and as I have indicated in my written testimony, it may have been a wonderland for nuclear physicists, but for the Marshall Islanders it was part of their home, and the bomb test islands were not a wonderland but became a place of fear and danger.

[Prepared statement of Dr. Radford follows:]

**Testimony prepared for the
Subcommittee on Oversight and Investigations
Committee on Natural Resources
U.S. House of Representatives**

February 24, 1994

**by Edward P. Radford, M.D.
Consultant to the Public Advocate
Nuclear Claims Tribunal
Republic of the Marshall Islands**

Testimony of Edward P. Radford, M.D.

I am a physician who graduated from Harvard Medical School in 1946. My career has been in research and teaching, most recently in the field of environmental public health. I am now retired from my academic position, although I continue to do consulting work, particularly on the health effects of ionizing radiation. I am presently a consultant to the Public Advocate of the Nuclear Claims Tribunal in the Marshall Islands.

In my academic career I was involved with teaching and research on the effects of ionizing radiation, and developed the first courses offered in this field at the Harvard School of Public Health in the 1950s. In 1969 I was made a member of the U.S. National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR). This committee issued its report in 1972; the report is now known as BEIR I. In 1977, a similar committee was appointed by the Academy to review new evidence, and I was made Chairman of the full committee, as well as of the subcommittee on somatic effects (cancer or other effects on the person irradiated). Its report (BEIR III) was issued in 1980. I submitted a dissenting statement in that report because I thought the evidence indicated significantly greater risks of cancer from radiation than was presented in the main report. The BEIR V report published in 1990 has vindicated my position in BEIR III.

In 1983-84 I was a Visiting Scientist at the Radiation Effects Research Foundation in Hiroshima, Japan, the organization supported by the Japanese and the U.S. governments to investigate the long-term effects of the Hiroshima and Nagasaki atomic bombs. At

that time I assisted in the epidemiological study of radiation-induced effects on the A-bomb survivors. The most recent evidence in 1993 from these follow-up studies has also supported my position in the BEIR III report.

My interest in radiation and its effects began in 1947 when, as a new flight surgeon in the U.S. Air Force, I was sent to the military Radiological Health School at Edgewood Arsenal in Maryland. After completing that course I was ordered in 1948 to join Joint Task Force Seven to participate in the second series of atomic bomb tests in the Marshall Islands, Operation Sandstone (the first was Crossroads at Bikini atoll). These three tests were carried out on Enewetak atoll. Most members of the Army and Air Force staff were based on Kwajalein atoll, 400 miles south-east of Enewetak. I was a radiological safety officer attached to a B29 crew, whose responsibility it was to photograph from 30,000 feet the evolution of the fireball and the mushroom cloud as it rose from the detonation site on a 200ft. tower. The tests were exploded just before dawn.

The night before each test we had meteorological briefings explaining the winds aloft to be expected at the next dawn's test. Meteorological conditions had to be such that there would be no likelihood of radioactive fallout on the American personnel in the area. No mention was made about Marshall Islanders, nor was any information then given to us as to where in the vast expanse of these islands the Marshallese were living. The impression I have now was that the Marshall Islanders, a few of whom were then living on Kwajalein, were not considered to be important in the minds of the test organizers.

Despite the meteorologists' assertions, we did have fallout on Kwajalein after the second (and largest) of the three tests. About 14 hours after the test, rain began falling on Kwajalein, and our unit of radiation safety officers, about 25 men, was ordered to take our Geiger counters and measure the radioactivity coming down in the rain. We were assigned different areas to monitor, and proceeded for the next two or three hours to take readings in the rain on the ground, on tent surfaces, and on any other surfaces present. My experience was that the count rates were high, much greater than background. Both gamma and beta radiation was measured; the beta radiation showed it was fresh fallout. We turned in our results to our commander, but at that time there was no further comment that I can recall about the significance of this "rainout", certainly not about any possible health implications of it.

In 1983 a report prepared by Science Applications International Corporation reviewed the radiation exposures of the 7,000 Naval personnel taking part in Operation Sandstone in 1948. A single measurement of gamma radiation (only) from fallout recorded for Kwajalein (presumably from our survey) at about midnight on May 1, the date of the second (YOKE) test, was higher than any of the greater number of measurements made at Enewetak during the tests. There is little comment in the report about beta radiation, which evidently was much higher than the gamma measurements. The highest integrated gamma dose measurements to personnel through May 31 were recorded for Kwajalein residents. These were higher than the Enewetak values, and those for people on ships which remained in the Enewetak lagoon during all the tests. No comment is made about the fact that the fallout on Kwajalein was 400 miles away from the test, and that fallout on other islands could have been higher than on Kwajalein. The distinct impression is

that radiation exposure estimates in this report were determined solely by where measurements were available. The conclusion of their report is that "film badge" doses of gamma radiation were less than 0.1 rad to all Sandstone personnel.

Retrospective reconstruction of doses in this fashion 35 years later depended critically on two reports and one memorandum compiled at the time of Sandstone and apparently all unpublished. One of the reports was stated to be a draft. Questions of inhalation or ingestion of fission products, the variability of ground measurements (noted by me during my monitoring), or other details about possible exposures were not discussed. For example, on Kwajalein tent roofs and walls gave the highest readings, but these were dismissed as not pertinent to human exposure. It is likely that some of these issues will never be resolved, especially as there is no way to check the basic data. In any case, I do not have much confidence in the results presented in this report, unsettling to me as one of those exposed.

Recently I have returned twice to Majuro in the Marshall Islands to meet with the Nuclear Claims Tribunal, with one return visit to Kwajalein. In this period I have learned about the later tests up to 1958 and their consequences. It is significant that the Marshall Islanders did not know radioactive fallout had occurred on Kwajalein in 1948 until I told them of my experience in Operation Sandstone. We now know that 67 bomb tests were carried out on Eniwetok and Bikini from 1946 to 1958, of which at least 17 were thermonuclear devices. The total kilotons of nitroglycerine equivalent explosive power of all these tests was 107,000 kilotons, or equal to over 7,000 Hiroshima type bombs.

Although the Bravo test was the largest U.S. bomb detonated, there have been many other large thermonuclear tests, and in any case the amount of radioactive fallout depends not only on the bomb energy but also on how close it was to the ground or lagoon floor at detonation. The Bravo tests in May 1954 was noteworthy because it was the first test whose fallout was recognized as hazardous to Marshall Islanders and the Japanese crew of the "Lucky Dragon", as well as to Americans. American military meteorological staff on Rongerik were evacuated to Kwajalein two days after the bomb. The Marshall Islanders on Rongelap, Rongerik and Utirik atolls were evacuated to Kwajalein three to four days after the test. Both Americans and Marshallese suffered from skin burns (presumably primarily from energetic beta radiation exposure) as well as nausea, vomiting, diarrhea and hair loss. The press release by the Atomic Energy Commission at the time stated that the evacuation was "precautionary", no burns were present, and all evacuees were reported well.

Fallout on these atolls was attributed by the test staff as due to "sudden wind shifts" before the test, but in 1982 the senior weather technician, who had been stationed on Rongerik in 1954 at the time of the test, said that the wind was blowing straight at Rongerik from Bikini before, during and after the test. There was no wind shift. This is not surprising in view of the prevailing westerlies at this latitude, particularly at upper altitudes. Neither the Marshallese nor the U.S. Air Force and Army men on Rongerik knew when the test would take place. On Rongelap the white dust-like fallout (including vaporized coral from Bikini) accumulated to two inches thick.

Although the test authorities and the Brookhaven Laboratory medical teams that subsequently studied those exposed Marshall Islanders have emphasized that fallout only affected Rongelap, Ailinginai, Rongerik and Utirik atolls, the Marshallese know that many more areas received substantial fallout from test Bravo. These include Ailuk, Bika, Likiep, Taka and Wotho atolls, and Jemi and Mejit islands. (Wotho atoll is 400 miles from Bikini). Let me tell a story told to me by Marshall Islands Senator Tony de Brum, who may be present in this room. He was 9 years old at the time of Bravo, living on Likiep atoll in a thatched house. He and the other residents noted a snow-like dust falling after the test, turning the water reservoirs a yellow color. Soon afterwards he noticed that gecko droppings were falling on him and other members of his family. (Geckos are small lizards.) then a dead gecko fell out of the roof thatch. Then another gecko fell dead, and finally a whole rain of dead geckos fell from the thatch, something unique in his experience. My interpretation of this phenomenon is that the thatched roof filtered out much of the fallout particles, and the high radiation doses in the thatch, especially from beta radiation energetic enough to pass through a small animal, was enough to kill the geckos. Mr. de Brum also reported that a Navy ship stopped at Likiep and took a boy and a woman on board, evidently for whole body counting. The two were returned, but nothing was said about this to the Marshallese, and the ship sailed away. For many years the U.S. Navy denied that any ship visited Likiep, although recently they have finally admitted it.

Undoubtedly there was radioactive fallout on many of the inhabited islands, for example, on Ujelang atoll after test King in 1952, and test Magnolia in 1958. You will hear from Dr. Thomas Hamilton about his thyroid study, a biological indicator of thyroid adenomas

as a radiation dosimeter showing contamination of many of the islands south of Rongelap from Bravo and other tests. I also heard in Majuro that at the time of the bomb tests a number of abnormal babies were born. When asked about pregnancy outcomes at the time, the mothers affected denied that there had been any problems because of the stigma in the Marshallese culture attached to a family when an abnormal baby is born. Now as older and wiser mothers and grandmothers they are prepared to discuss the problems they had.

Finally I would like to share another anecdote I heard in Majuro. During the bomb testing period, exact date unknown, the people living on Kosrae island were told one day by men from the U.S. Navy unit on the island not to eat the local food nor drink the water. For a substantial period of time, many days or weeks, the Navy provided food and water to the people from their own (presumably covered) stores. Finally the islanders were told that it was once again all right to take their food and water from local supplies. Now Kosrae is not even a Marshall island, and lies slightly south and about 600 miles west of Majuro. It is also about 600 miles due south of Enewetak. Certainly this episode sounds as though radioactive fallout had occurred on this relatively remote island, far from the test site. I realize that this hearsay evidence, but there is no question that the facts can be provided by the U.S. Navy if they choose to do so. If they state that no such episode occurred, they will not be believed by the Marshall Islanders.

In conclusion I strongly suspect that radioactive fallout from the many American atomic and thermonuclear bombs detonated at Enewetak and Bikini atolls up to 1958 had caused exposure of many Marshallese to significant radiation doses. It will be difficult to

establish objective evidence of this exposure, though Dr. Simon's survey will help. At the very least the U.S. government owes compassion and attention to the Marshallese people for the way that the use of their islands to advance the military purposes of the U.S.A. has disrupted the lives of many of the people of the Republic.

When Operation Sandstone of Joint Task Force Seven left the Pacific and returned home, eventually all members of the Task Force were sent a book containing a photographic history of the bomb tests. This book still brings back many memories to me. On the last page of the book, opposite a color picture of a fireball rising above an Eniwetok island, is the following text: "The atomic energy Proving Ground at Eniwetok lies ready and waiting for man's next adventure in atomic wonderland." It may have been a wonderland for nuclear physicists, but for the Marshall Islanders it was part of their home, and the bomb test islands were not a wonderland but became a place of fear and danger.

Mr. MILLER. Thank you very much.

Dr. Simon, on page 6 of your statement, in the middle there, you talk about the gummed film stations that were established in the Pacific area and data that was collected in a 1960 report. You say at one point that all 17 of the tests of the size of one megaton explosive yield or larger were detected on the gummed film on Kwajelejin.

Dr. SIMON. Yes, sir.

Mr. MILLER. That was part of the HASL data collection?

Dr. SIMON. Yes, it was. That a worldwide program of well over 100 stations.

Mr. MILLER. Are we to draw from that statement that the detection on the film is related to each of those explosives? It wasn't testing in general atmospheric radiation; it was testing the relationship to those—

Dr. SIMON. I can tell you how it was conducted, and I think it will be clear, although Professor Eisenbud is the expert on this, it was his program. But let me just briefly tell you, it was a piece of gummed paper as you understand, but it was changed every day. It was put out into the environment, a new piece everyday, and yesterday's piece was collected and sent to the HASL laboratory.

Mr. MILLER. So the 1960 report says, if you look at the evidence, what you are saying is, there was an explosion and there was radioactive material following that explosion on Kwajelejin.

Dr. SIMON. The station was located on Kawjelejin, sir, and I have made this photograph myself, and I have interpreted it. I have notated on the peaks, which is peaks, which is the data. I have notated that the test occurred during that month. These round circles are a sum of all the monthly measurements.

So during July they would add up all the measurements on those gummed film, and that represents one data point here, and as I began to look at when the test occurred and when these points are above the background, they all fell into place.

Now this is my interpretation. It is fairly simple at this point in time, but there could be no other source that I can think of for that contamination on the gummed film than those local tests.

Mr. MILLER. I understand, and I am not going into whether there is or not, but what you are relating to us is your belief that that was the source and, in fact, that happened even with relatively low yield weapons compared to the BRAVO?

Dr. SIMON. Well, yes sir, I am saying that, but I don't consider one megaton to be a low yield weapon.

Mr. MILLER. Compared to BRAVO, where there is some question what happened there.

Dr. SIMON. Yes, sir.

Mr. MILLER. Thank you.

Dr. Hamilton, you discussed the procedure that you went through with your study and that it was peer reviewed, and you presented it at some local conferences, and later it was published in the *Journal of the American Medical Association* in 1987. What reaction was there to that study by anybody at that time?

Dr. HAMILTON. That study was published in an annual issue that is put out by the *Journal of the American Medical Association* which had a number of interesting articles. I think my article was

the second one. The first article got most of the press. But for the next probably four to eight weeks, I was interviewed extensively by the press.

Mr. MILLER. What about your peers or the people who said you did the study the wrong way? Was there a critical analysis of it—you did it the wrong way, you did it the right way?

Dr. HAMILTON. Usually what happens in that situation is that, you know, when an article is published, then people who have expertise in that area will look at it and will write in criticisms in the form of letters to the editor.

I have to say that I was surprised that I never saw any such letters submitted to *JAMA* or in any other journals such as *Health Physics*, for instance, and presumably the individuals that would most likely have expertise in this area would be, you know, people that are within either the Department of Energy or Brookhaven who have extensively evaluated and followed the Rongelap and Utirik people.

Mr. MILLER. You didn't hear from Brookhaven at that point or the Department of Energy or Department of Defense?

Dr. HAMILTON. No, I have never heard from Brookhaven or the Department of Energy or Defense and have never seen actually until today any written commentary about this study, and the only information I have received today and in the last week has been correspondence from your committee.

Mr. MILLER. Thank you.

I am unfortunately going to have to abbreviate my questions a little bit because I have an amendment on the Floor, but just a couple of points.

Mr. Hills, you construct a scenario which would lead us to believe that the Marshallese people, in their quest for independence or decolonization or drive to start the process of decolonization, leveraged this agreement into compensation benefits, however people want to describe it, far in excess of what had been possible the previous 30 years. Is that fair?

Mr. HILLS. That is an element of my view of how it went down, yes.

Mr. MILLER. Did you ever give any thought to the fact that maybe the Federal Government was leveraging the Marshallese people's interest in independence and not to be a colony into compensation far less than they would have otherwise had to pay?

Mr. HILLS. Yes, I have thought about that, and that was very much part of the debate that took place. I think, as I look back on it, it was kind of a very, very difficult and agonizing process whereby this committee and this Congress became sort of the crucible in which you forged a way of moving forward. I think what happened is, all the various interests, the competing interests, the compatible interests, came here, and we moved the process to its next stage. I see this committee as poised at this time to now take it and move it to its next stage.

But I will just say in response to that, that the situation that would have occurred when you talk about leveraging their desire for independence in a way that caused them to give up the potential of a great deal for more compensation—for example, I presume you are alluding to the possibility of them having gone to court—

I think that what you would have had there, Mr. Chairman, if the matter had been dealt with in litigation—I think Mr. Weiman referred to it—you couldn't get any answers out of anybody because as soon as you tried to ask the question, the answer was, "Well, that is in litigation, we can't talk about it."

Now the fact that the litigation was dismissed has not produced a satisfactory result in that you still are not getting the documents you want, it is just that the litigation is not being used as the excuse not to give you the documents.

But I will say this, Mr. Chairman, if they had gone into court, it would have reinforced the reluctance and it would have given a legal basis for refusing to turn over information. We would have gone in and it would have been an entirely adversary process, and you would have increased the Federal Government's tendency not to disclose information, and the desire would have been at that point to defeat their claims.

Now I will agree with you, you know, the question of what would have happened in the court is an interesting one, but I think the process produced an outcome where it is not going to be decided in court, and they may have been thrown out of court and not collected a dime on jurisdictional grounds.

Mr. MILLER. I think you are misunderstanding my question. The question isn't whether or not, had they chosen to go to court, something different would have happened. The question is, they had even the information that we have this morning whether something different would have happened in the context of that agreement and/or the Congress of the United States. Clearly if they would have had available to them all of the information that we suspect is out there, would something differently have happened, not would they would have gone to court. I think the suggestion that there is a confluence here to the best of intentions theoretically by this committee to decolonize the Marshall Islands and the desire of the Marshallese people to be decolonized, and therefore somehow we got a settlement that is both fair and in excess of anything that they could have expected in court, is not the test. That cannot be the test.

Mr. HILLS. I agree with your analysis.

Mr. MILLER. Okay. I am a little worried about the suggestion that somehow this all worked out because they got something more than they could get when the entire Federal Government was in motion against them for the previous 30 years.

Mr. HILLS. No, I think it is not a matter of being in motion against them. I think what happened represented what was doable at the time when you take into account the allocation of interest, and I am not saying that the outcome was a perfect outcome. I think the compact and the 177 agreement fall far short of perfection.

Mr. MILLER. With all due respect, you are acting like everybody is playing like it is on the level. One party has all of the information, and they are in no way prepared to share that information with the other party. That is not an allocation of whatever you just said.

Mr. HILLS. Well, no, but I think that the good news—and I think there is good news here—is that because of the very point that you

just made, we knew all of the information that was of concern to people—and the Government of the Marshall Islands was very, very adamant about this in its negotiating position. They said, "Look we are not satisfied. We are not going to be able to close this deal if it means that we are not going to be able to seek additional remedies if it turns out that we are not getting all the information."

That is why article 9 went into the agreement, and I agree with you, Mr. Chairman, and what I am saying is, the good news here is that article 9 puts this committee and this Congress in a position, as the information flow gets better. And the point is, Is this Administration and this Department of Energy and this Department of the Interior going to do perhaps a better job getting the information out than they did in the past? And if it does, and if it turns out that there is a basis for concluding that what was done in the 177 agreement was inadequate, then it is within your power to redress that. I think that when you compare that to a lot of things that go on where the Department of Justice leverages people into settlements, in most cases the door is closed.

I think what article 9 represents is that this committee and Chairman de Lugo did a very, very good job in trying to deal with the competing interests of preserving the possibility of further measures if it turns out that further measures are required to achieve something more nearly resembling American justice and fairness.

Mr. MILLER. It is always troublesome, obviously, when you go back with new evidence in hindsight, and you have to attribute motives and knowledge and everything to people who were there at that time. I am just not quite sure that is the way this was presented to this committee at that moment because I don't know how you would construct it in that fashion if you didn't know the extent to which other evidence was available about the activities. I don't know how you could leap forward in that time frame to tell the committee there is all this out here that we can't get our hands on, so this is the best evidence we can get. In fact, most people didn't know what was out there.

Mr. HILLS. I agree with you, and in constructing the scenario that I did, I did not mean to imply that everybody felt good or was happy about the situation. In fact, I think it is a tribute to this committee, to the Government of the Marshall Islands, and to people like Mr. Weisgall and others who said, "Look, this thing is not going to close; we are not going to be able to achieve closure." Either there was going to be termination of the trusteeship or there wasn't going to be. Either there was going to be a settlement or there wasn't going to be a settlement, and the effort was to produce a settlement. Either information was going to come out or it wasn't going to come out.

The point is that the people involved in this process were vigilant enough about the very concerns that you are expressing that article 9 was put into this agreement. Article 9 empowers this Congress and it empowers the people of the Marshall Islands through their Government to say: Okay, it is 1994 now, Bill Clinton is the President of the United States, Hazel O'Leary is the Secretary of Energy, Bruce Babbitt is the Secretary of the Interior, and we are

going to get this information out, and we are going to respond to what we now have in the way of control over information.

I can tell you as somebody that was involved in the section 177 negotiations, every time I ever asked anybody from the Department of Energy a question to try to satisfy myself intellectually more than I had been about what the radiological conditions were in the Marshall Islands, I ended up almost regretting that I asked the question because it just was extremely byzantine and an inordinately complicated dilemma that they were in trying to assess. Every time they made an assessment, it was proved wrong and they got embarrassed, and every time they did it again. It was a very difficult and intractable problem.

That is why, Mr. Chairman, the United States Government would never have paid \$150 million in a settlement and put article 9 in if it did not recognize that there was a problem of certitude about injuries to people as a result of radiological conditions in the Marshall Islands. Article 9 did not go in there as a throw-away. It went in there because there was a recognition that additional information could come out in the future.

Now as to what information people had at that time and what they were withholding or not withholding, those were matters that weren't debated in the negotiations. The question was: How do we move the process forward?

Mr. MILLER. They probably would have never put it in if they had known Hazel O'Leary was going to be the Secretary of Energy. But thank God they didn't.

Well, let me thank you.

Mr. Weiman, let me thank you. I know how many years you have dedicated to this issue, and I think it is fair to say as the Chair of this committee that this hearing would not have taken place without your efforts and your countless hours on behalf of these victims, and we appreciate that.

I am going to have to run over to the Floor to take care of an amendment on the education bill, and I hope to return right away. I would ask if Chairman de Lugo could take over the committee.

Bob, it is your turn for questions.

Mr. UNDERWOOD. Thank you very much, and similarly, I would like to congratulate and thank Mr. Weiman for his efforts on this particular issue and also the remaining members of the panel on their contributions to our understanding of this issue.

Actually, my interest is a line of questioning which the chairman was pursuing with Mr. Hills. I think somewhere along the line what is trying to be expressed here is the sentiment for more than requesting an answer from Mr. Hills.

In your testimony you seem to indicate kind of a justification for article 9, and you dealt with a series of perspectives about article 9 and section 177 which I think are really not the issue here. The issue here is, no one is questioning whether it would unravel the compact or whether it is useful at this particular time. The real question is whether the U.S. Government side to the negotiation knowingly withheld information or knew something about the testing which would have either led to a great deal of embarrassment at the time or would have threatened the negotiations from their point of view or would have, in fact, led to the arrangement of a

whole different series of compensation packages and issues pertaining to the testing. I think the question is not whether this is useful at this particular time.

I wasn't here, of course, at the time that was dealt with, so I am not sure about the exact origin of article 9 and section 177, but I rather doubt that that was an initial position of the U.S. Government side. I would like to point out that our responsibility here in the committee is in a sense, to look into this issue, but also examine the U.S. Government side and whether they, in fact, were taking an appropriate position.

You indicated that you have a client relationship now with some people from Rongelap, and I know in your testimony you referred to an exquisite dilemma. I don't know whether you are in this exquisite dilemma because you personally now seemingly are on the other side of the fence, so to speak, but at least for my understanding of the issue and in terms of your own participation in that process at the time, did people know more or did they suspect that there was more to it? Did they deliberately avoid finding out more about it, or did they ignore this information, or did they withhold this information in the process of negotiations?

Mr. HILLS. Congressman, my response is that I can't think of anything more embarrassing to the United States than that which is known. In other words, it may be that there are documents, that there is information, that there are scientific findings or knowledge or data that are classified that would be very, very inflammatory or very provocative if it were revealed, but I know of nothing that I have ever seen. There may be. Jonathan Weisgall has done some great research out at Suitland Parkway, and I have spent some time out at Suitland Parkway myself going through the old boxes of records and whatnot, and many times you find documents that shed light on who did what.

I mean I think Mr. Weisgall's analysis that the high commissioner sitting up there, you know, writing that letter about whether or not people ought to be evacuated, is very interesting and illuminating. But in terms of knowledge that people had, I think for those of us who were on the negotiating team, that which was open and notoriously done in the Marshall Island was, whether you think of it as a shame or embarrassment or whether you feel that the United States failed to live up to its duties and responsibilities to the people, you know, what was done speaks for itself. As we approached the negotiations, we weren't given information about radiological conditions out there that we knew about and held secretly and didn't talk to the other side about.

Basically, it was pretty much all out on the table that we had gone out there and detonated 66 nuclear devices in their islands. They were powerless; they had no legal rights; they had no legal standing; they had no remedies; they were not in a position to protect themselves or to seek protection from any legal or political institution. They were completely disempowered people who had been dislocated. Their islands had been contaminated and some of them had been returned when they shouldn't have been. I mean, the saga of the people and what the United States did in its most negative and unpleasant and brutal reality was a matter of public record. So we didn't, in conducting the negotiations—

Mr. UNDERWOOD. I have to disagree with you on that because I think the implication of almost all these testimonies is that something more was known, as if indeed what was already known was not already embarrassing enough. It would, I guess, be left to the imagination how much more embarrassing and how much perhaps more from the U.S. Government side their position would have had to shift had more information been released.

So you have, in a sense, danced around the issue except to say that what you were dealing with was already public information.

Was your side trying to find out more about what was going on? Was it actively looking for more information? There must have been people from Defense and Energy who were sitting on your team who had more information. You must have had some kind of discussions about this.

Mr. HILLS. I think that the answer to that question is that our experience in that regard was probably fairly similar to anybody else's experience.

We sat down and said, "What is the story here? How do we proceed?" The Department of Justice was responsible for preparing the legal cases. We were responsible for the negotiations. The Department of Energy was responsible for management of its information.

The answer to your question—not to dance around it—is that no, I was not at any point given information about radiological conditions and told, don't tell anybody about this, or this is just for us to know, or let's keep this from the other side.

In fact, I think that, when we went out to the Marshall Islands, it was a very painful experience going out to the Marshall Island and spending day after day after day negotiating with the Government and talking to the claimant groups. We were learning more, frankly, from Jonathan Weisgall than we were learning from the Department of Energy.

Mr. UNDERWOOD. That in itself is a major indictment of how you guys were proceeding with the process, is it not?

Mr. HILLS. No. I think, Congressman, you have to look at how the U.S. Government operates, how the executive branch operates, and I think that is what you are doing.

The answer is that the people in the Department of the Interior responsible for running programs to assist the people—compensation programs if you will—the people in the Department—these are the realities of the way the executive branch works—do not become experts in everything that the people in the Department of Energy are experts in. A lawyer working in the Micronesian Status Negotiations Office becomes an expert on the status negotiations, does not deal with the Department of Energy. Within the executive branch, there are arm's-length negotiations.

Let me answer you this way, Congressman. Everybody likes to beat up on the Department of the Interior. It has become very popular these days. But the Department of the Interior during these negotiations, I think you have to understand, was avidly opposed to trying to settle these claims. Let me read you a letter that Undersecretary of the Interior Joseph wrote to the Micronesian Political Status Negotiator during the Carter Administration. It was the Carter Administration that put the section 177 in the compact. He said, "This Department remains opposed to an attempt by the

United States to negotiate a settlement on nuclear claims. In our view, this subject should be carved out from the negotiations."

And then, referring to the repeated embarrassments to the U.S. when DOE assessments and predictions regarding contamination and health effects were proven wrong, the undersecretary went on to say that:

Because of this dismal record of miscalculation on a subject that remains rife with uncertainty, we should not today assume that we can responsibly know now or predict for the future the fate of the damaged Marshallese, their offspring for generations to come, or their land. If that is so, then we believe that the United States should continue to remain responsible and should treat the damage problem on an ad hoc basis, obtaining legislation and appropriations to meet such needs when they arise. I recognize this is untidy, but so is the problem of nuclear damage.

So, you know, there you have a situation where, within the inter-agency process, there was a debate going on.

So you may say that every single official of any department in the executive branch is responsible for knowing what every other official of any other department in the executive branch knows, but that is not the way it works. There was a debate going on. The Department of the Interior opposed even trying to settle these claims.

The Department of Energy, I can't speak for them. I don't know what they were thinking about at the time. Maybe they would prefer not to have settled. There were people in the Department of Justice who were arguing, "Let's take this to court; we can beat these cases in court; we are going to knock these cases out on jurisdictional grounds." So there were competing interests, and you have to have a more complicated understanding of how things transpired.

There were people in the Department of Justice who told us—so you talk about what we as negotiators know—there were people in the Department of Justice who told us, "These cases will be dismissed on jurisdictional grounds, let's go to court." There were other people who said if we did that and these cases were thrown out on jurisdictional grounds, that would be politically unacceptable because then we would deny any recovery and any compensation to the people.

You know, I don't think I am dancing around your question. I think I am going right to the heart of your question.

Mr. UNDERWOOD. No. I understand the issue of division of labor and the responsibility for the negotiations, and I understand the issue of how complex some of this scientific data is, but I don't think any of us up here are scientists. I don't think it takes a great deal of scientific knowledge to know that something was amiss in the process, and we are not talking about having the scientific data to understand whether something was amiss or not. I think we are talking about having enough moral sense to do the right thing, and that is, I think, the crux of the issue. Certainly I think, knowing some of the Marshallese negotiators, they must have pointed out the inconsistencies along the process, and I think the response was not adequate.

In any event, I just want to make a brief comment because I was struck by something. Dr. Simon, you went to great pains in presenting your data, and I know having some familiarity with people who present information and research, that you went to great pains to talk about factual information and presentation in an ob-

jective manner, and not wishing to sensationalize, you characterize your whole presentation in that manner.

Just to elicit a brief comment from you, do you sense that there is some effort by others to sensationalize data? I mean that seems to be the flip side of your remarks. And why would they want to do that? I mean this is pretty sensational stuff.

Dr. SIMON. That is a difficult question, Congressman. I am not sure I could comment on why someone else might want to sensationalize.

I don't know that anyone sensationalized data. I wanted to emphasize that I was going to present data as opposed to emotional arguments, and there were many emotional arguments here.

The Rongelap and other Marshallese people are very close friends of mine, and I feel very deeply for them for any damage that has been done to them. So there are emotional issues here, but it is not up to me to present that to this committee. There will be other presentations that, I guarantee you, will evoke emotion, and maybe that could be termed sensational. But I did want to present to you what level of objectivity is possible, and that was the source of my comment.

Mr. UNDERWOOD. Okay. Thank you very much.

Mr. DE LUGO [presiding]. I think we may be having a vote. It may be in the Committee of the Whole. We may have to recess in a few minutes.

Well, Mr. Hills, in your written testimony you state you were legal counsel and the Department of Defense advisor to the National Security Council. At that time you were a naval officer. Is that correct?

Mr. HILLS. Yes, sir.

Mr. DE LUGO. You were a naval officer. What level of security clearance did you have at that time?

Mr. HILLS. I had a top secret clearance at the time.

Mr. DE LUGO. You had top secret clearance, so you had access to classified information.

Mr. HILLS. Yes, I did.

Mr. DE LUGO. You made reference to article 9 many, many times today. You didn't make any reference to article 8. I am going to read you article 8 from the compact.

Section 177 agreement, Article 8. Northern Marshall Islands radiological survey. The Government of the United States has concluded that the northern Marshall Islands radiological survey and related environmental studies conducted by the Government of the United States represent the best effort of that Government accurately to evaluate and describe radiological conditions in the Marshall Islands.

What is your reaction to that statement?

Mr. HILLS. I think it represents the expression by the U.S. Government of the understanding of the state of affairs that existed at the time by the people who were responsible for negotiating the 177 agreement.

Mr. DE LUGO. When the negotiations for the 177 agreement were going on, were the Marshall Island negotiators told time and time again that there had been no fallout in the four atolls? Were they assured time and time again by the American negotiating team that there had been no fallout beyond the four atolls?

When President Kabua asked whether there was any information and whether there had been any fallout beyond those four atolls, what was the answer of the American negotiating team?

Mr. HILLS. I never participated in a discussion between President Kabua and—

Mr. DE LUGO. You were not part of the negotiating team?

Mr. HILLS. Well, now, Congressman—

Mr. DE LUGO. You have no idea what was discussed in these negotiations?

Mr. HILLS. I think that there was a lot of discussion about what measures were going to be taken to deal with the effects of the testing program in the Marshall Islands, and one of the questions was, Were you going to continue the four-atoll health care program that was created by statute? You know, did the four-atoll health care program define the scope and the extent of the problem?

Mr. DE LUGO. The point is that this committee is to believe that a naval officer with the highest security clearance had no knowledge that there were questions of additional fallout beyond the four atolls?

Mr. HILLS. No, no. Congressman, please, you know, I want to be responsive, but the fact of the matter is that that is not how the issues were framed.

We were very well aware of the fact that the Marshallese position was that they have never gotten the truth about the scope of the problem, and please, you know, I am here as a friendly witness. I understand your concern.

Mr. DE LUGO. You know, every time there has been a question asked of you, you have had all day to answer it. Now I am asking you some specific questions.

Mr. HILLS. Yes, I know. What I am telling you is, the answer is yes to your question. The answer is yes, that we were well aware of the fact that it was the Marshall Islands Government's position in the negotiations—and these don't come down to discussions between people sitting in a room.

Mr. DE LUGO. Mr. Hills, you know, this committee has some knowledge of how these things are worked out. We have some knowledge of how the Administration works. I have served in the House for 20 years, so I have some knowledge of these things. So I don't need to be lectured, nor does this committee need to be lectured, on how the Federal Government works. What we want to find out is how the Federal Government worked in this instance.

Mr. HILLS. Okay, and the answer is this. The Government of the Marshall Islands took the position that they did not know all of the truth about what had happened in their island. We as negotiators at that point said we are not ourselves satisfied that we are not going to find ourselves in a situation where 5 years from now, 10 years from now, 15 years from now, it turns out that a lot of information—

Mr. DE LUGO. Mr. Hills, let me read to you again from article 8 since you say that you yourself had questions. What is said in article 8 is that this represents the best effort of the Government of the United States and that the Government accurately evaluates and describes the radiological conditions in the Marshall Islands.

Is that truthful?

Mr. HILLS. I think that the way you develop a document like that is, you have an agency of the Government, and it is going to be the same thing that is going to happen right now—

Mr. DE LUGO. I understand how we develop these things, and I understand that there was a court case going on. What I asked was, Is this a truthful statement—not whether it was going to jeopardize your court case or anything else—but was this a truthful statement?

Mr. HILLS. You mean article 8?

Mr. DE LUGO. Article 8. It comes just before article 9 that you have been referring to.

Mr. HILLS. Yes. Well I think that the answer is that article 9 is in there as, in essence, an admission on the part of the United States Government that if the situation arises where the assertion or the certification made in article 8 turns out to have been inadequate, then that is when article 9 kicks in.

Mr. DE LUGO. Well, let me put it another way, Howard. I'll take the same statement you have made, and I will phrase it a little differently. Article 9 is in there just in case we find out that article 8 is not truthful and that there is a problem.

Mr. HILLS. I accept that characterization, and I am not here to defend what any particular person at the Department of Energy was saying at any particular time. What I am saying is this. Article 9 is something that is important and good and valuable. Article 8 represents what the position of the United States Government was at the time the agreement was signed but that included—

Mr. DE LUGO. Mr. Hills, Mr. Hills, we agree that article 9 is a good provision. Thank God it is in there.

Dr. Radford cited a study that was done.

Dr. Radford, what study was that you cited that you felt was a changed circumstance clause?

Dr. RADFORD. The report of the BEIR III committee came out in 1980, so that as of the time of the negotiations which I believe started in 1983, that was the prevailing wisdom on the risk of cancer induction by radiation. What has occurred since then of course is, in the first place, the Japanese A-bomb survivor study has gone on further and has become improved by better dosimetry and so on. But, more important, another committee of the National Academy of Sciences, now known as BEIR V, issued its report in 1990.

Now BEIR V indicated that the risks of cancer induction by radiation were indeed substantially higher than the BEIR III report had said and relatively close to what I had said in BEIR III. So that the current view—indeed even more so since 1990—the current view is that the radiation risks are substantially higher than was known in 1983 or at least believed in 1983 and on which these negotiations were made.

Mr. DE LUGO. All right. We are up against time here because there is a vote on the Floor and we have got to go over and vote.

And then we had Dr. Hamilton's study that was brought to the attention of the committee, and the committee sent back to the Interior Department for its comment very troubling findings that were provided to the committee by Dr. Hamilton.

The Interior Department said that it could not comment because there was a lawsuit. All of this brings us to article 9 in that provi-

sion, article 9 which is the changed circumstances clause. But at the time that section 177 in the compact was presented to the Congress, it was presented to the Congress as a full and final settlement thereof.

Isn't that correct, Mr. Hills?

Mr. HILLS. It is a full and final settlement of legal claims, and I think that—

Mr. DE LUGO. Let me interrupt you right there. In the compact, the Government of the Marshall Islands espoused its claims; isn't that correct?

Mr. HILLS. The Government, under article 10—

Mr. DE LUGO. The claims of its citizens. So they espoused the claims of their citizens under article 10?

Mr. HILLS. Yes, the legal claims.

Mr. DE LUGO. All right. So as a result of that, as a result of that, the claims of the citizens, the court threw the case out and said they had been espoused by the Government of the Marshall Islands; is that correct?

Mr. HILLS. Yes. They had been settled under the agreement that was approved by the U.S. Government and the Government of the Marshall Islands.

Mr. DE LUGO. All right. Would you agree that there appear to be very changed circumstances here, that it would seem to be that article 9 should certainly be looked at very carefully?

Mr. HILLS. Mr. Chairman, I know you have got to go. I just want to take one minute to answer that. Article 8, article 9, and article 10 go together; they work together. It actually is a good arrangement if you look at it because at this point the Cold War is over. We have got a Secretary of the Interior who wants to release information.

We are now going to be free to know of the contents of litigation where people are denying things and trying to defeat each other through litigation tactics—not through leveraging everything into the negotiations on the political status, but just looking at it based on the information we are going to get now. Because of the work that these people are doing and because of the information that is going to come out, we are going to be able to look at it not from the standpoint of the legal liability, but of moral responsibility.

And that is where we are, and we are here because of the work you did and because of the work that this committee did and it is because of what the Marshall Islands Government did.

So there is a lot of good news here. The Marshall Islands Government did a good job of preserving this ability, working with you so that you could address it with a question of moral responsibility, not legal liability, and my hat is off to you because I think it is a good provision.

Mr. DE LUGO. Thank you very much. We are going to have to recess for—

Mr. FALEOMAVEGA. Mr. Chairman, I have purposely skipped my vote because I do want to ask some questions.

Mr. DE LUGO. Well, let me have you take over the Chair, will you.

Mr. FALEOMAVEGA. That is fine. Thank you.

Mr. DE LUGO. I have got to go vote.

Mr. FALCOMAEGA [presiding]. Mr. Hills, you had indicated earlier that we are being somewhat unfair to the Department of the Interior, that we are beating them on the head.

Mr. HILLS. They deserve it sometimes.

Mr. FALCOMAEGA. I think that is an unfair characterization of certainly some of us here on the committee. I think in fairness to the Department of the Interior, my understanding, at least my recollection was the fact you may have been housed physically in the Department of the Interior, but the negotiations were done exclusively under the auspices of the White House.

Am I correct on that?

Mr. HILLS. The Office for Micronesian Status Negotiations was an interagency office that was instituted or established under the National Security Council system, which is obviously a White House organization. The President's personal representative for Micronesian status negotiations was somebody who was an ambassador-rank appointee, who was technically in the executive office of the President, so the answer to your question is, yes.

Mr. FALCOMAEGA. In your capacity, I think you have answered earlier that you were at that time an officer in the Navy.

Mr. HILLS. Yes. I had been a Peace Corps volunteer and served in Micronesia as a Peace Corps volunteer. After I left the Peace Corps and completed my Peace Corps service, I then became a naval officer and through the process of personnel assignment by the Department of the Navy, I ended up working on these issues as well.

Mr. FALCOMAEGA. You were a member of the negotiation team in that capacity. What exactly were your duties and responsibilities?

Mr. HILLS. Well, they were to help finalize negotiations on the Compact of Free Association that had been initiated by Ambassador Rosenblatt on behalf of the Carter Administration.

In 1980, the Carter Administration signed the compact with the three Governments that were emerging from the trust territory, but they didn't finalize the negotiations and there were a lot of separate agreements to be negotiated. The section 177 agreement was one of those agreements, so I guess—

Mr. FALCOMAEGA. You were directly involved in the section 177 negotiations?

Mr. HILLS. What is that?

Mr. FALCOMAEGA. You were directly involved in the section 177 negotiations?

Mr. HILLS. I was a junior staff lawyer in the process. I am not trying to disclaim anything. I am just saying that I wasn't, you know, driving the process, but my job was to help finalize the terms of the compact and the various separate agreements negotiated pursuant to it.

Mr. FALCOMAEGA. You were a member of the negotiating team during the entire Carter Administration?

Mr. HILLS. No, no, no. I came in in 1982, after the Reagan Administration had conducted a policy review on the compact and decided to go forward with it. You may remember at that time the Reagan Administration came in and they did a policy review on everything that the Carter Administration had done, and for exam-

ple, they decided not to sign the law-of-the-sea agreement and they decided not to do a number of things, but in the case of the compact that is one of the things that they decided to move forward with.

Mr. FALEOMAVAEGA. You feel that the provisions that were discussed by Chairman de Lugo will definitely have a bearing on future hearings and issues affecting the republic of the Marshallese and I want to make that a question.

What will be the year that we will initiate renegotiations after the 15-year period?

Mr. HILLS. The compact calls to begin a dialogue in the thirteenth year, which I think would be 1999, on the overall political status relationship. With respect to the section 177 agreement, article 9, really the Government of the Marshall Islands is empowered by that provision. They could initiate discussions under that at any time.

It would really be a matter of that Government determining that sufficient new information had been discovered that would provide the basis for a request—

Mr. FALEOMAVAEGA. So under the current provisions of the compact, the Marshallese Government can reinstitute another round of discussions based on any new findings concerning this very issue?

Mr. HILLS. The procedure that is prescribed in article 9 is for the Government of the Marshall Islands to make a request to the Congress—

Mr. FALEOMAVAEGA. I understand, but they can make the request?

Mr. HILLS. Yes.

Mr. FALEOMAVAEGA. Dr. Hamilton, you raised a question about the fact that you did examine over 7,000 Marshallese as part of your study and that the Department of Energy has somewhat questioned the fact that you are the only one conducting the study.

Do you care to comment about the Department of Energy reaction in your response questioning the integrity of your findings?

Dr. HAMILTON. It is a reasonable concern in any scientific investigation, particularly the evaluation of thyroid disease, whether one or more individuals are doing the physical examinations.

And that was something that I acknowledged and realized early on, which was the basis for an in-depth validation study that was part of that whole effort and was published in the 1987 article which showed that there was excellent agreement between myself and the thyroid specialists from the University of Washington, so that issue in my mind has been dealt with completely.

Mr. FALEOMAVAEGA. How many other thyroid studies have been done? How many other studies have been done besides yours? Have there been several other studies conducted on this?

Dr. HAMILTON. In the Marshall Islands?

Mr. FALEOMAVAEGA. Yes.

Dr. HAMILTON. Of course, the major studies are from Brookhaven National Laboratory. I don't believe there was any other major study before the current one that has been done out there in the Marshall Islands other than mine.

Mr. FALEOMAVAEGA. Okay. Mr. Weiman, I also would like to echo my sentiments in expressing my appreciation for your patience and

your efforts in bringing this issue now to the forefront. I want to ask you now that we are where we are, and you probably know more than anyone to my knowledge, understanding the whole sad legacy of what has happened with the residents of Rongelap specifically to the situation that we are discussing.

Where do we go from here in your opinion? What should we do? The committee and the Congress, the Federal Government, what should be our responsibility now that more and more information is going to be bearing on this kind of thing? And it seems to me that the only reason that there is . . . national attention is because many Americans were affected unknowingly.

We have been talking about this for the last 15 years—about the Marshallese having been affected by nuclear testing all this time. What should our responsibility be now that this is coming to the forefront?

Mr. WEIMAN. Thank you. The discussion in the last hour has been fascinating, and science and politics have sort of crisscrossed one another. This committee has accomplished something this morning that is extraordinary.

It is not what do we do about article 9. The first thing we have to do is recognize that article 8, the statement that, "we have told you everything," is in fact wrong. And they knew it was wrong. They had to have known it was wrong. Dr. Simon has gone out and looked at some of the film badges and some of the other things that were available.

You have file material that shows where Kwajalein was hit, Majuro was hit. Dr. Radford brought up some of these things.

Well, if people 40 years later can find these things, people with top security clearances at the time can find the same things. There was a decision—I don't know who made it—not to allow this information to come out.

What is significant about Kwajalein is, Kwajalein is expressly considered outside the zone considered to have received fallout. That attacks the very premise that is in the compact.

What we also know is almost every aspect of this program has doubts, whether you start with the planning for the BRAVO tests and some of the other tests, you know, the weather reports, the bomb itself, how it was detonated, who was told, how the evacuation was done.

Professor Eisenbud pointed something out, and he educated me three years ago to a very simple question. There has never been an inquiry, not just into BRAVO, but into the totality of the program.

You get into Brookhaven. Dr. Simon said something that is powerfully important this morning, and I think we rushed by it. He talked about an audience, the audience being the Marshallese people. I don't know how many studies Brookhaven has published over the year. If you stack them all up, they would probably be measured in feet. It is a huge pile. In 40 years, there is not a single Brookhaven report published in Marshallese, not one.

Now, Mr. Miller, when you go home to Martinez and go to your family doctor, your doctor doesn't race out and publish a study about the findings about you and the Miller family. But that is what happened at Brookhaven.

And yet, if our audience is in fact the victims' community, why is it that to the best of my knowledge in the 40-year program there are four bilingual reports that were produced and they happen to deal with the environmental problems and radiological characterizations, not one on the medical.

That brings me to, what should we do. Mr. Chairman, in this very room in 1977, you put together some legislation looking at another issue, but one that had an equal number of complexities, the San Luis unit, the Westlands Water District. I spent a lot of time looking through those files, too. But one of the things that came up was, as much as we knew, there is so much we don't know.

Mr. Chairman, I guess my one recommendation to you is not to squeeze this issue into the Executive order. The Department of Energy is overwhelmed with their existing plan that has already been put together. I think a formal review, whether it is negotiated with the Secretary or something that this committee legislates, that is for you and the members of this committee and the leadership of the administration to resolve.

But I think that formal review needs to take place. I think there is so much we don't know. If there is a class of people in the Marshall Islands who have not been told that they have been irradiated, albeit at lower levels than those who have received acute doses, there is an attention distortion. We have distorted attention towards the acute doses. Three days of doses have gotten 99 percent of the attention in this debate for 40 years.

What we are now learning, and the significance of the fact is that the cloud may have gone further on one or more tests. If that is true, and in fact people are getting radiation-related cancers and health-related problems from that at the lower levels, then the implications for what is happening today and the information that is coming out, then A, it goes to the Marshall Islands people; and B, it goes to everybody else, because this is not restricted to the Marshalls. We need to know the answers to that. Those are profound questions.

And I think that, Mr. Chairman, maybe the San Luis task force legislation can be dusted off, looked at in a different light, do a little cut and paste, substitute some—instead of the delta and excess lands, we can talk about radiation and cloud formations and some other things and put together the same kind of prestigious, independent panel. Do it in cooperation with the Marshall Islands Government, and do all of the things that protocol requires. You have asked how do you do it. It has got to be in an organized way. Most importantly, it has got to be an inclusive way. Almost every study that has taken place up to now has had some form of exclusion to it.

Mr. FALEOMAVAEGA. Thank you, Mr. Weiman. I am afraid my time is running out. I just have one quick question for my friend Professor Eisenbud.

I understand there were about 7,000 military involved in the whole Sandstone operation. How were our fellow Americans treated during the time when these tests took place? Were there elaborate records kept of these American soldiers and sailors who were involved? Do we have that?

Mr. MILLER [presiding]. Dr. Radford or Professor Eisenbud?

Mr. FALCOMA. Dr. Radford and Professor Eisenbud.

Dr. RADFORD. With regard to Sandstone, no accurate records were kept. The basis of the SAIC report were two unpublished documents that had been prepared by RadSafe people at the time of the Sandstone tests.

Mr. FALCOMA. Those are probably shredded by now.

Dr. RADFORD. For all I know they don't exist any more, and one memorandum which really added very little. And all those were unpublished, so there is no real record, certainly no record that anyone could review. And, of course, it was very incomplete at that time.

Mr. FALCOMA. One real quick question to Dr. Simon. I am sorry, Professor Eisenbud.

Professor EISENBUD. Would it be improper to add something?

Mr. FALCOMA. Yes. You were there at the flagship, Dr. Eisenbud. I think according to the record, there were 7,000 military people involved.

Professor EISENBUD. I think what the tests themselves show in round numbers—I wasn't on Sandstone, but in the subsequent test—it was around 10,000. Altogether there were about 220,000 military personnel involved in tests in some way or the other.

And several years ago, I think it must be five or six years ago, the DNA, Defense Nuclear Agency, completed a dose reconstruction project. Now, some of the personnel, not all of them, but many of them did have film badges. Others worked in groups where maybe one had a film badge and the others didn't. And in various ways they reconstructed the doses.

And I chaired a National Academy of Sciences Committee that was asked to look at the methods used by DNA in that dose reconstruction, and our report is available. We concluded that the methods were quite sufficient, quite adequate.

Mr. FALCOMA. Just one more question, Dr. Simon. I am sorry, Mr. Chairman, just very quickly. I am somewhat puzzled by your referring constantly to let's not sensationalize the issue. I am not one to sensationalize, but I think you and I can really appreciate the fact that we have been to these islands, we met some of these people. I don't know how you can think otherwise, not only expressing a sense of outrage and emotion on my part, it almost seems to speak—my friend, Henry Kissinger, says of Micronesia, "There are only 90,000 people on there. Who gives a damn?" This is the kind of thing that kind of burns inside me and to think that perhaps we should have some sense of emotion involved here so we can be more committed to really getting to the bottom line and get some solutions to this very problem we are discussing.

The bottom line I want to ask you, Dr. Simon, does your study bear out the fact that the thyroid studies you have done are quite prevalent in the Marshalls as it is contrasted to other areas of the Pacific?

Dr. SIMON. I was going to comment on your first comments, but let me answer your question because it is a very difficult question. In most of the Pacific nations, there are not long-standing health records to establish the—

Mr. FALEOMAVAEGA. So, in other words, your study is very difficult to put together because you weren't there in 1954, so obviously—

Dr. SIMON. Yes, sir.

Mr. FALEOMAVAEGA [continuing]. 25, 30 years later there is not much left to study on.

Dr. SIMON. Well, there is plenty to study, but it is very difficult to know what are the causes of the disease that you are finding. It can be argued that it is natural disease in that population anyway. And that is why it is very important to have available some other measure and that measure will be the radiological measurements. If those two things correlate together, then you have a very powerful argument that it doesn't matter what the baseline disease is.

Mr. FALEOMAVAEGA. Thank you, Dr. Simon. Thank you, Mr. Chairman.

Mr. MILLER. Thank you. Thank you very much to the entire panel. Again, I would make the same request that we have the opportunity to continue to work with you as we continue to work our way through this issue. Thank you very much for your time and all of your effort.

The next panel, representing the Republic of the Marshall Islands will be made up of Mr. Wilfred I. Kendall, who is the Republic of the Marshall Islands Ambassador to the United States, and those individuals accompanying him: Peter Oliver, William C. Graham, Johnsay Riklon, Billiet Edmond, Henchi Balas, Tomaki Juda, Hiroshi Yamamura, Ismael John, and Toko Henry.

If there are not enough seats at the table, some of the witnesses can certainly come around and sit at the committee dais here.

Ambassador Kendall, welcome to the committee. Do we have your entire panel here yet?

Ambassador KENDALL. I believe so, Mr. Chairman.

Mr. MILLER. Welcome. Any introductions you would like to make, certainly feel free to do so. We look forward to your testimony.

PANEL CONSISTING OF HIS EXCELLENCY WILFRED I. KENDALL, REPUBLIC OF THE MARSHALL ISLANDS, AMBASSADOR TO THE UNITED STATES, ACCOMPANIED BY PETER N. OLIVER, UNDER SECRETARY FOR COMPACT IMPLEMENTATION; WILLIAM C. GRAHAM, PUBLIC ADVOCATE, NUCLEAR CLAIMS TRIBUNAL; HON. JOHNSAY RIKLON, SENATOR FROM RONGELAP TO THE NITIJELA OF THE MARSHALL ISLANDS; HON. HENCHI BALOS, SENATOR FROM BIKINI TO THE NITIJELA OF THE MARSHALL ISLANDS; HON. HIROSHI V. YAMAMURA, SENATOR FROM UTIRIK TO THE NITIJELA OF THE MARSHALL ISLANDS; HON. ISHMAEL JOHN, SENATOR FROM ENEWETAK, ACCOMPANIED BY HON. AND MRS. NEPTALI PETER, MAYOR OF THE ENEWETAK, UJELANG LOCAL GOVERNMENT COUNCIL, JOHNSON HERNEST, COUNCIL MEMBER, AND DAVOR PEVEC, ESQ., LEGAL COUNSEL; AND HARRY J. PETTENGILL, DEPUTY ASSISTANT SECRETARY FOR HEALTH, DEPARTMENT OF ENERGY, ACCOMPANIED BY JOHN E. RUDOLPH, DIRECTOR, OFFICE OF TRANSPORTATION, SAFEGUARDS AND ENERGY MANAGEMENT, DEPARTMENT OF ENERGY

STATEMENT OF HIS EXCELLENCY WILFRED I. KENDALL

Ambassador KENDALL. Thank you, Mr. Chairman. I just want to take one minute of your time to express my Government's condolences to the professional staff of yours for the loss of Pat Krause. We want the record to reflect our sincere appreciation for the help she has given us. We surely will miss her. Thank you, Mr. Chairman.

Mr. MILLER. Thank you. That is very kind of you and we all grieve Pat's loss and recognize her contribution not only to this issue, but to the overall policy of this committee with respect to the Pacific territories. Thank you very much for those remarks, Mr. Ambassador.

Ambassador KENDALL. Thank you, Mr. Chairman, and Members of the subcommittee. On behalf of the government and people of the Marshall Islands, I would like to express our gratitude to you for investigating the effects of the United States nuclear testing program that was conducted in our country for a 12-year period during the height of the Cold War.

I know that you, Mr. Chairman, and many members of the Committee on Natural Resources have long been concerned about the harm that was caused to the Marshallese people. We very deeply appreciate your concern, and we thank you for holding the hearing today and inviting our participation. We strongly urge this committee to continue regulating the disturbing questions that have been raised in testimony today and we will encourage the subcommittee to reconvene in the months ahead to consider the response of the Department of Energy to these questions.

The legacy of the nuclear testing program is a central feature of the relationship between the United States and the Marshall Islands. The two nations are alike in the Compact of Free Association, which came into effect in October 1986. Section 177 of this compact and the related subsidiary agreements established a mechanism for compensating the people of the Marshall Islands who

suffer physical injury or loss of property from the nuclear testing program.

The compensatory programs administered by my Government included payments to the communities affected, tribunal adjudicated disputes and makes awards to claimants, continuation of the health care program originally established by U.S. law and a Nationwide Radiological Study, as Steven Simon discussed in his testimony. The Marshall Islands Government also administers supplemental health and food programs for the nuclear victims and assisted people in administering the Rongelap Resettlement Project.

Mr. Chairman, the many nuclear programs administered by the Marshall Islands Government are further described in a July 8, 1993, letter to you from my Minister of Foreign Affairs, and I request that this letter be included in the record of this hearing.

I would like to provide for the record a report on implementation of the section 177 agreement during fiscal year 1993. Finally, I ask to be included in the record of this hearing a recent letter from my Government to the Department of Energy requesting additional information about the nuclear testing program.

[The information follows:]



MINISTRY OF FOREIGN AFFAIRS
 REPUBLIC OF THE MARSHALL ISLANDS
 MAJURO, MARSHALL ISLANDS

July 8, 1993

Congressman George Miller
 Chairman
 Committee on Natural Resources
 Longworth House Office Building, Room 1324
 United States House of Representatives
 Washington, D.C. 20515

Dear Congressman Miller:

The Embassy of the Republic of the Marshall Islands in Washington, D.C., has provided me with a copy of the May 10 news release from the Committee on Natural Resources announcing that it would be investigating the effects of American nuclear tests on the people of the Marshall Islands and other indigenous peoples. The Government of the Republic of the Marshall Islands (RMI) welcomes such a review by the United States Congress of the harm that was caused to citizens of our country and the environment of our islands by the sixty-six nuclear detonations conducted by the U.S. Government in our nation between 1946 and 1958. If the Committee on Natural Resources intends a comprehensive review of the aftereffects of the U.S. Nuclear Testing Program in the Marshall Islands, I request that the RMI Government be invited to contribute to the review process.

I believe the Committee will find it especially helpful to consult with officials of the RMI Government who work with these matters. In accordance with certain provisions of the Compact of Free Association (U.S. Public Law 99-239), the RMI Government is now directly involved in evaluating the personal injury and environmental degradation caused by the nuclear tests and in administering compensatory services to people who were either forcibly removed from their ancestral homes at Bikini and Eniwetok Atolls, which became nuclear test sites, or injured by radioactive fallout. Many of these services are undertaken in fulfillment of the subsidiary Agreement Between the Government of the United States and the Government of the Marshall Islands for the Implementation of Section 177 of the Compact of Free Association ("the Section 177 Agreement"). Provision for additional services to the nuclear victims is made in other sections of the Compact legislation. Certain of these programs are administered by U.S. federal agencies, principally the U.S. Department of Energy. A succinct summary of these compensatory programs is set forth in the September 1992 report of the U.S. General Accounting Office on "Marshall Islands: Status of the

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Nuclear Claims Trust Fund" (GAO/NSIAD-92-229), which was prepared at your request.

In accordance with the Compact legislation, the RMI Government is responsible for administering the following programs and services:

- * investment and administration of the RMI Nuclear Claims Fund, capitalized at \$150 million by the U.S. Government in 1986, which generates the income disbursed quarterly to the four Marshallese communities most severely harmed by the U.S. Nuclear Testing Program and expended on other compensatory programs as specified in the Section 177 Agreement;
- * operation of a Nuclear Claims Tribunal having jurisdiction to render final determination upon claims of the Government and citizens of the Marshall Islands related to the U.S. Nuclear Testing Program and disputes arising from the distributions of the proceeds of the Nuclear Claims Fund;
- * the scientific work of the Nationwide Radiological Study, which is nearing completion of a characterization of radiological conditions throughout the Marshall Islands;
- * the scientific studies of the Rongelap Resettlement Project, which will help determine the habitability of Rongelap Atoll and assist the people of Rongelap in decisions about rehabilitation and resettlement of their traditional homeland;
- * the Section 177 Health Care Program, which, as a successor to the Four Atoll Health Care Program established by the U.S. Department of the Interior, provides special medical services to RMI citizens who are shown to have been affected by the consequences of the U.S. Nuclear Testing Program;
- * administration of a USDA Special Food Assistance Program for the four communities most directly affected by the nuclear tests; and
- * administrative support to the Enewetak Agricultural and Food Program, which is now operated directly by the Enewetak Local Government Council.

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To bring the Committee up-to-date on the progress of the RMI Government in implementing these programs, I am pleased to send you two recent reports: first, the Fiscal Year 1992 Report to the Nitijela of the Republic of the Marshall Islands by the Nuclear Claims Tribunal and, second, the narration pertaining to implementation of the Section 177 Agreement from the 1992 Annual Report of the Republic of the Marshall Islands, which earlier this year was presented to the President of the United States and the United States Congress in accordance with the report requirements of Title I, Section 103(e)(5), and Title II, Section 211(c), of the Compact of Free Association.

The RMI Government would be prepared to assist the Committee on Natural Resources in reviewing the adequacy of the framework established by the Compact of Free Association for resolving the legacy of the U.S. Nuclear Testing Program. As requested by the staff of the Committee, I would like to draw the attention of the Committee to several specific concerns that have come to light through the work of my government.

- * It has become increasingly apparent that the Section 177 Agreement did not provide sufficient funding to compensate citizens of the Marshall Islands afflicted with radiogenic medical conditions and Marshallese communities that were denied access to their land or had land contaminated by fallout. (A discussion of this situation is set forth on pages 43-45 of the Nuclear Claims Tribunal report.)
- * In the Marshall Islands and elsewhere in the world, the most widespread medical effect of exposure to radioactive fallout has been development of thyroid nodules, including cancerous nodules. Regrettably, the U.S. Government did not conduct thyroid examinations of the Marshallese people aside from the residents of Rongelap and Utrik Atolls where the fallout from the March 1954 Bravo test was heaviest. A recent medical survey by the RMI Nationwide Radiological Study of the thyroid glands of the residents of Ebeye Island who were alive at the time of the nuclear tests may provide additional evidence regarding the extent of the medical harm caused to the Marshallese people. These findings will be shared with the Committee when they become available within the next few months. It is the intention of the RMI Government to expand the program of thyroid examinations so that every Marshallese person who may have been exposed to radiation from the nuclear tests will have access to a thyroid examination.

Congressman George Miller
July 8, 1993
Page 4

- * In conjunction with the thyroid examinations, the RMI Government has sought financial assistance from the U.S. Government to determine the presence a rare isotope of the element iodine in the environment. In this study, samples of soil that have been gathered by the RMI Nationwide Radiological Study at all of the inhabited atolls and islands of the nation will be subjected to a complex chemical analysis to determine the quantities of 129-iodine that remain in the environment. The U.S. Department of Energy has long acknowledged that the high incidence of thyroid nodules and thyroid cancers in the communities of Rongelap and Utrik could be attributed to their exposure to radioactive iodines contained in the fallout of the 1954 Bravo test. However, it has not been established that radioactive iodine in the fallout was a factor in the development of thyroid disease at other locations in the nation. The proposed measurement of 129-iodine will help resolve this question. While the Nationwide Radiological Study will provide detailed information about residual levels of radiation in the Marshall Islands environment and, by extrapolation, the quantities of fallout that were deposited in the past, it has recently been postulated by scientists that the dispersion of radioiodines in nuclear fallout may not have coincided with the distribution of other radioactive elements. In the proposed project, the Nationwide Radiological Study will determine whether the deposition of radioiodines corresponded to that of other radionuclides, thereby gaining a better understanding as to whether past exposures are related to present-day thyroid disease.
- * From the extensive environmental monitoring that has been conducted by the Nationwide Radiological Study, it is shown that certain areas in the northern region of the Marshall Islands remain severely contaminated from the American nuclear tests. The three locations most severely contaminated are the test sites at Bikini and Enewetak Atolls and certain portions of Rongelap Atoll that were contaminated by the fallout of the 1954 Bravo blast. Steps have been taken to rehabilitate all three locations: In accordance with the Compact legislation, the U.S. Government has provided funding for the cleanup of Bikini Atoll and the Bikini community is currently planning and implementing this project; the Rongelap Resettlement Project, also provided for in the Compact legislation, is well underway; and in 1977-1980 the Defense Nuclear Agency conducted a cleanup of sorts at Enewetak Atoll that allowed the exiled community to return to certain portions of the atoll. It is not

Congressman George Miller
 July 8, 1993
 Page 5

apparent that the environment at any of these locations can be decontaminated to U.S. standards. Even after the extensive cleanup at Enewetak Atoll, 73% of the land mass is still too heavily contaminated to be used for the production of food crops.

- * Runit Island in Enewetak Atoll is the disposal site for plutonium-contaminated soil collected from throughout the atoll. This radioactive material was plowed into a crater left by a nuclear explosion, mixed in a cement slurry, and covered with a concrete dome. The disposal of radioactive waste in this manner would not be permitted in the United States. Furthermore, the Defense Nuclear Agency did not complete the cleanup of Runit Island, leaving chunks of deadly plutonium metal in the surface soil of the island instead of plowing the contaminated soil into the crater. Despite this hazard, the island is readily accessible to the residents of Enewetak. There are no fences to keep them away, the few warning signs have faded or toppled over, and, since the island has become a nesting place for birds, there is evidence that birds and eggs are being harvested from this dangerously contaminated site. In addition, we are greatly concerned by a recent (unconfirmed) report that the Defense Nuclear Agency has decided to discontinue its annual safety inspections of the Runit disposal site.
- * There are shortcomings to the USDA Special Food Assistance Program for the nuclear victims. These have to do with (1) the considerable length of time it takes for the commodity foods to be shipped from America to Majuro and then transshipped to the beneficiary communities and (2) the short-term authorization of the program (the current authorization extends only through Fiscal Year 1996), which requires a specific congressional appropriation each year and results in an interruption in the provision of commodity foods at the beginning of each program year. The Committee is encouraged to explore with USDA practical improvements that could be brought to the program.

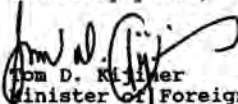
These are the present concerns of the RMI Government regarding the legacy of the U.S. Nuclear Testing Program in the Marshall Islands. In addition to the practical experience that our governments have gained in working to resolve this legacy, the officials of the U.S. Government and the RMI Government who framed the Section 177 Agreement prudently recognized that the full effect of the nuclear tests might not become apparent until

Congressman George Miller
July 8, 1993
Page 6

after the Agreement had come into effect. For this reason, Article IX of the Section 177 Agreement makes provision for changed circumstances that would "render the provisions of this Agreement manifestly inadequate". Among the concerns that I sought to highlight in this letter are changed circumstances which I believe should be of concern to both of our governments.

I hope that information set forth in this letter and the enclosures will be of assistance to the Committee in its deliberations. The RMI Government would be pleased to work with the Committee in devising ways to improve services to the nuclear victims and ensure that they receive a full measure of justice.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Tom D. Miller", is written over the typed name and title.

Tom D. Miller
Minister of Foreign Affairs



MINISTRY OF FOREIGN AFFAIRS
 REPUBLIC OF THE MARSHALL ISLANDS
 MAJURO, MARSHALL ISLANDS 96961

February 14, 1994

Dr. Harry J. Pettengill
 Deputy Assistant Secretary for Health
 United States Department of Energy
 Washington, D.C. 20585

Dear Dr. Pettengill:

I regret that I was unable to meet with you and other officials of the Department of Energy in Hawaii in December. In my absence, I was ably represented by Chief Secretary Phillip Kabua. I am told that the discussions were very productive for the many participants from the U.S. Government and the Marshall Islands. I was especially pleased that you were able to release to officials of the RMI Government information on the yields of nuclear tests conducted in the Marshall Islands that previously had been classified.

The declassification of Marshall Islands test yields coincided with a broader declassification by the Department of Energy of information about medical tests that the Atomic Energy Commission conducted on human subjects in the United States. These revelations are of grave concern to the leadership and general public of the Marshall Islands. To address some of the issues that have been raised in recent weeks, I request your assistance in providing the RMI Government with additional information about the tests in the Marshall Islands.

First, my government requests confirmation of the actual number of nuclear weapons tests conducted in the Marshall Islands. It is commonly understood that there were a total of sixty-seven such tests, with twenty-three at Bikini Atoll, forty-three at Enewetak Atoll, and the April 28, 1958, "Yucca" device that was detonated from a high-altitude balloon northeast of Enewetak Atoll. Please provide confirmation as to whether these totals are complete and accurate and whether any additional tests were planned or implemented at Bikini, Enewetak, or any other locations, whether on land, on water, or in the atmosphere within the currently recognized international boundaries of the Republic of the Marshall Islands. In the December 7, 1993, news release that you provided to Chief Secretary Kabua with the declassified test yields, it was announced that one-fifth of all United States nuclear tests had previously been kept secret; this

Dr. Harry J. Pettengill
February 14, 1994
Page 2

news has been received with considerable alarm in the Marshall Islands and is the basis of this first request.

Second, it is requested that the Department of Energy provide information on the fission yields of the thermonuclear tests conducted in the Marshall Islands. It is my understanding that this information may be readily available from the Department of Energy or its contractors and may not have to go through the process of declassification. This information will be of importance to the RMI Nationwide Radiological Study as it completes its work in the months ahead.

Third, the RMI Government requests that it be provided with copies of all information, including newly declassified documents, that the Department of Energy presents to the U.S. House of Representatives Committee on Natural Resources in reply to the January 3, 1994, letter to President Clinton from Chairman George Miller in which the Committee requested documents from the Department of Energy and other agencies giving information on the true scope and full effects of United States nuclear testing in the Marshall Islands.

Fourth, my government requests all documents, including weather reports and any subsequent summaries or investigations, pertaining to the decision by the U.S. Government to proceed with the March 1, 1954, Bravo test.

Fifth, the RMI Government requests all reports pertaining to the radiological condition of Runit Island in Enewetak Atoll. In particular, my government would like all documentation on the discontinuation by the Defense Nuclear Agency of the 1977-1980 Enewetak cleanup without Runit Island having been completely decontaminated.

Sixth, my government requests that it be provided with all documents relating to fallout from the "Mike" test that was detonated at Enewetak Atoll on October 31, 1952. My government is especially interested in obtaining information about fallout from this test that was deposited at Ujelang Atoll.

Seventh, please provide a complete listing of all islands used at any time during the testing program as monitoring stations, including information as to how much land on each island was used for such stations and for support of monitoring personnel, for what periods of time, and to what extent trees or vegetation were removed from the land used for these stations.

Eighth, the Department of Energy is asked to provide any and all data relating to fallout and other radiation exposure measured at monitoring stations within the Marshall Islands during the testing program.

Dr. Harry J. Pettengill
February 14, 1994
Page 3

Ninth, the RMI Government requests a complete and detailed accounting of any and all monitoring visits to islands and atolls throughout the Marshall Islands, including the dates of such monitoring, the fallout and exposure data measured, and the means of transportation for monitoring personnel (such as the names of the vessels that carried them to and from the monitoring sites).

Tenth, the Department of Energy is asked to provide a complete and specific listing of all instances in which any people of the Marshall Islands were relocated in connection with the U.S. Nuclear Testing Program. This information should include the number of people removed from each location, the destination and duration of each relocation, and the physical condition of each individual prior to and at the conclusion of the relocation.

In light of the very strong concerns of my countrymen about the medical and environmental effects of the U.S. Nuclear Testing Program in our country, I hope that responses can be provided to these inquiries on an expedited basis. This information is requested in accordance with Article XIII, Section 3(a) of the Agreement Between the Government of the United States and the Government of the Marshall Islands for the Implementation of Section 177 of the Compact of Free Association.

I remain most grateful to you for arranging the declassification of the yield data. I expect that the additional information requested in this letter can be made available on the same cooperative basis that has characterized the working relationship between the Department of Energy and the RMI Government during the past several years.

Sincerely yours,



Tom D. Kistner
Minister of Foreign Affairs



REPUBLIC OF THE MARSHALL ISLANDS

1993 ANNUAL REPORT

REPUBLIC OF THE MARSHALL ISLANDS

Report on Implementation of the Agreement Between
the Government of the United States and
the Government of the Marshall Islands for
the Implementation of Section 177 of the
Compact of Free Association

Fiscal Year 1993

Presented to the President of the United States and the Congress of the United States in partial fulfillment of the report requirements of Title I, Section 103(a)(5), and Title II, Section 211(c), of the Compact of Free Association as ratified by United States Public Law 99-239 and Marshall Islands Nitijela Resolution Number 62 of 1986.

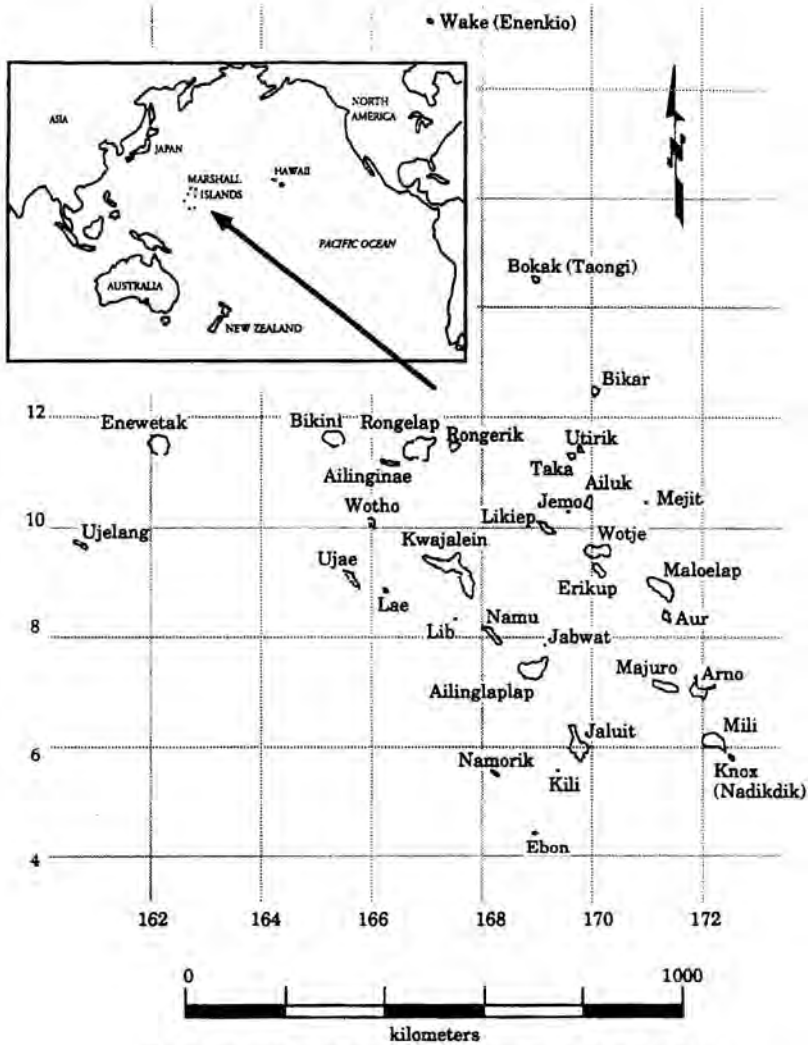
REPUBLIC OF THE MARSHALL ISLANDS

REPORT ON IMPLEMENTATION OF THE AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES AND
THE GOVERNMENT OF THE MARSHALL ISLANDS FOR
THE IMPLEMENTATION OF SECTION 177 OF THE
COMPACT OF FREE ASSOCIATION

FISCAL YEAR 1993

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REPUBLIC OF THE MARSHALL ISLANDS

Section 177 Implementation

1. Nuclear Claims Fund

Attached to this report is the annual report for Fiscal Year 1993 prepared by the Bank of New York, Fund Manager of the Republic of the Marshall Islands Nuclear Claims Fund. Section 103(e)(5) of U.S. Public Law 99-239 requires that the RMI Government transmit annually to the U.S. Congress such a report detailing disbursements from the annual proceeds of the Fund. In accordance with Section 177 of the Compact of Free Association, the Fund was capitalized by the U.S. Government in the amount of \$150.0 million when the Compact came into effect in October 1986.

The RMI Government is pleased to report that all of the required quarterly disbursements from the Nuclear Claims Fund were made to the four beneficiary communities. In accordance with Article II of the Section 177 Agreement, during Fiscal Year 1993 a total of \$5.0 million was disbursed to the Bikini Distribution Authority, \$3.25 million to the Enewetak Distribution Authority, \$2.5 million to the Rongelap Distribution Authority, and \$1.5 million to the Utrik Distribution Authority. In addition to the disbursements to the four beneficiary communities, regular quarterly disbursements have been made to Mercy International Health Services to continue the special medical support of the Four Atoll Health Care Program in accordance with Title I, Section 103(j), of the Compact of Free Association; a total of \$2.0 million was disbursed for the medical program in Fiscal Year 1993. Additional disbursements have been used to pay for the operation of the Nuclear Claims Tribunal from the proceeds available for this purpose pursuant to Article II, Section 6, of the Section 177 Agreement and for the extensive radiological monitoring activities carried out by the RMI Government pursuant to Article II, Section 1(e), of the Section 177 Agreement.

To date, the moneys generated pursuant to Article II, Section 6(c), for the payment of monetary awards made by the Nuclear Claims Tribunal have not been disbursed in the maximum amounts available. In Fiscal Year 1993, a total of \$4.7 million was transferred to the Tribunal for disbursement to successful claimants. At the close of the year, an additional amount of \$9,050,000 remained available in the Fund from previous years for awards payments.

At the end of Fiscal Year 1993, the value of the Nuclear Claims Fund stood at \$128,787,000. This figure represents a decline of \$2,482,000 in the value of the Fund over the course of the year. During this twelve-month period, the Fund earned an 18.54% rate of return on its investments. (For the same twelve-month period, this investment income may be compared to an increase in the Consumer Price Index of 2.96% and an increase in the Standard and Poor's 500 index of 13.00%.) The above average

performance of the Fund may be attributed to excellent returns from the U.S. bond market and strong earnings from interest rate sensitive cyclical sectors of the U.S. equity market, such as capital goods--let by technology--and consumer durables, and from special niche stocks. (The Section 177 Agreement permits the RMI Nuclear Claims Fund to be invested only in instruments of United States nationality.) Nevertheless, the 18.54% rate of return was not sufficient to maintain the previous value of the principal and meet the disbursement schedule required by the Section 177 Agreement. During Fiscal Year 1993, a total of \$19,650,000 in beneficiary payments was disbursed from the Fund in accordance with the Section 177 Agreement. The 1993 disbursements included some of the moneys that had remained in the Fund from previous years for the awards by the Nuclear Claims Tribunal and for scientific studies. The attached report from Smith Barney Shearson, the investment advisor to the RMI Government, provides a summary of the investment holdings of the Nuclear Claims Fund at the end of Fiscal Year 1993.

THE
BANK OF
NEW
YORK

ONE WALL STREET
NEW YORK, N.Y. 10038

101101

JUN-19-'94 MON 18:00 ID:W95 TST CUS TELECOM TEL NO:212 635-8779

MARSHALL ISLANDS NUCLEAR CLAIMS FUND
SCHEDULE OF MISCELLANEOUS PAYMENTS

OCTOBER 1, 1992
THROUGH
SEPTEMBER 30, 1993

| | AMOUNT |
|---|----------------|
| 4. PAYMENT TO VARIOUS BANKS | |
| a. GOVT. OF MARSHALL ISLANDS BANK OF HAWAII | 200,000.00 |
| b. MERCY INT'L HEALTH SERVICES COMERICA BANK | 2,000,000.00 |
| c. ENWETAK FLEET BANK | 3,250,000.00 |
| d. NUCLEAR CLAIMS TRIBUNAL BANK OF HAWAII | 500,000.00 |
| e. BILIMI AMERICAN SECURITY TRUST | 5,000,000.00 |
| f. UTRIK BANK OF HAWAII | 720,000.00 |
| g. RONGELAP FLEET BANK OF MAINE | 2,500,000.00 |
| h. COMPENSATION BANK OF HAWAII | 4,700,000.00 |
| BEGINNING FUND BALANCE AT MARKET (9/30/92) | 131,269,163.06 |
| ENDING FUND BALANCE AT MARKET (9/30/93) | 128,786,936.96 |

THE
BANK OF
NEW
YORK

CHEWALL STREET
NEW YORK, N.Y. 10036

#101 P02

MARSHALL ISLANDS NUCLEAR CLAIMS FUND
SCHEDULE OF MISCELLANEOUS PAYMENTS

OCTOBER 1, 1992
THROUGH
SEPTEMBER 30, 1993

| | |
|--|------------|
| 1. ACTIVITY FEE | AMOUNT |
| 2. CUSTODY FEE | 13,780.00 |
| 3. INVESTMENT MANAGERS FEES | 12,596.88 |
| a. NEW SOUTH CAPITAL MANAGEMENT | 192,197.00 |
| b. PROVIDENT INVESTMENT COUNSEL INC. FIXED INCOME CUSTODY | 84,429.00 |
| c. GARDNER & PRESTON MOSS FIXED INCOME CUSTODY | 88,194.00 |
| d. NEWBOLD ASSET MANAGEMENT | 93,708.21 |
| e. SHEARSON LEHMAN HUTTON CHEMICAL BANK | 13,500.00 |
| f. BOSTON REAL ESTATE | 2,606.00 |
| g. NWO INVESTMENT MANAGEMENT | 102,021.82 |
| h. NAVELLIER & ASSOCIATES | 52,403.86 |

**SMITH BARNEY SHEARSON
CONSULTING GROUP
MARSHALL ISLANDS
NUCLEAR CLAIMS FUND
INVESTMENT PERFORMANCE REVIEW
September 30, 1993**

Daniel A. Roland
Vice President/Financial Consultant
Smith Barney Shearson
Suite 701, Bank of Guam Building
111 Chalan Santo Papa
Agaña, Guam 96910



**CONSULTING
GROUP**

A division of Smith Barney Shearson

MARSHALL ISLANDS NUCLEAR CLAIMS FUND

September 30, 1993

This investment evaluation is directed only to the client for whose account the evaluation was created. The underlying data has been obtained from sources considered to be reliable: the information is believed to be accurate, but there is no assurance that it is so. This evaluation is for informational purposes only and is not intended to be an offer, solicitation, or recommendation with respect to the purchase or sale of any security or a recommendation of the services supplied by any money management organization.

**CONSULTING
GROUP**A division of Smith Barney Securities

NUCLEAR CLAIMS - SUMMARY OF ENTIRE MANAGED FUND

In Percent

Periods Greater Than One Year Are Annualized

Time Periods

| | 06/93 | 09/92 | 12/86 |
|--------------------|---------|----------|-----------|
| | 09/93 | 09/93 | 09/93 |
| | Current | Trailing | Inception |
| | Quarter | 12 Mos. | To Date |
| ENTIRE FUND | 4.43 | 18.54 | 11.58 |
| TOTAL FUND | | | |
| ENTIRE FUND | 2.65 | 11.44 | 11.73 |
| COMPOSITE | | | |
| MEDIAN BALANCED FD | 3.20 | 12.37 | 11.33 |
| 90-DAY T-BILLS | 0.72 | 2.94 | 5.64 |
| CPI | 0.49 | 2.69 | 4.09 |



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NUCLEAR CLAIMS - SUMMARY OF EQUITY FUNDS

In Percent

Periods Greater Than One Year Are Annualized

| Time Periods | 06/93 | 09/92 | 10/86 |
|--------------------------------|---------|----------|-----------|
| | 09/93 | 09/93 | 09/93 |
| | Current | Trailing | Inception |
| | Quarter | 12 Mos. | To Date |
| ENTIRE FUND EQUITIES | 5.88 | 24.44 | 12.83 |
| NWQ INVESTMENT MGT EQUITIES | 0.68 | 17.50 | N/A |
| NEWBOLD'S EQUITIES | 4.08 | 11.69 | 13.89 |
| NEWSOUTH CAPITAL EQUITIES | 6.15 | 33.94 | 14.43 |
| NAVELLIER EQUITIES | 19.83 | 49.15 | N/A |
| S&P 500 INDEX | 2.59 | 13.00 | 13.23 |
| RUSSELL 2000 | 8.74 | 33.14 | 11.07 |
| S & P MIDCAP | 5.03 | 24.04 | 15.98 |
| LARGE CO. VALUE | 5.32 | 23.98 | 14.06 |
| SMALL CO. GROWTH | 9.80 | 36.03 | 11.34 |
| SMALL CO. VALUE | 6.87 | 28.38 | 13.99 |



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NUCLEAR CLAIMS - SUMMARY OF FIXED INCOME FUNDS

In Percent

Periods Greater Than One Year Are Annualized

| Time Periods | 06/93 | 09/92 | 10/86 |
|-----------------------|---------|----------|-----------|
| | 09/93 | 09/93 | 09/93 |
| | Current | Trailing | Inception |
| | Quarter | 12 Mo. | To Date |
| ENTIRE FUND | 2.52 | 12.37 | 9.96 |
| FIXED INCOME | | | |
| INVESCO | 1.56 | 9.88 | 9.99 |
| FIXED INCOME | | | |
| PROVIDENT | 3.66 | 15.12 | 10.02 |
| FIXED INCOME | | | |
| LB GOVT/CORP BONDS | 3.32 | 11.46 | 9.93 |
| LB AGGREGATE BOND | 2.61 | 9.98 | 9.93 |
| LEHMAN BROS. - MBS BD | 0.96 | 6.64 | 10.08 |
| LB TREASURY BONDS | 3.23 | 11.08 | 9.60 |



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PERFORMANCE MEASUREMENT SUMMARY FOR ENTIRE FUND

From December 31, 1986 To September 30, 1993

Time-Weighted Rates of Return

| | Current Quarter | Trailing 12 Months | Since 12/31/86 |
|--------------------------------------|--------------------|-----------------------|-------------------|
| <u>Investment Objective Progress</u> | | | |
| ENTIRE FUND | 4.43 | 18.54 | 11.58 |
| Consumer Price Index (CPI) | 0.49 | 2.69 | 4.09 |
| Objective 1: 12.00% Annualized | 2.87 | 12.00 | 12.00 |
| Objective 2: CPI + 4.00% | 1.48 | 6.69 | 8.09 |

Manager Asset Allocation Evaluation

| | | | |
|--|------|-------|-------|
| Manager's Composite Index ¹ | 2.65 | 11.44 | 11.73 |
| Maximum Equity Exposure ² | 2.88 | 12.44 | 12.48 |
| Maximum Fixed Income Exposure ³ | 3.10 | 11.98 | 11.32 |
| Preferred Asset Mix Composite ⁴ | 2.79 | 11.92 | 12.08 |
| Equity Index: S&P 500 | 2.59 | 13.00 | 13.60 |
| Fixed Income: Lehman Brothers Govt/Corporate | 3.32 | 11.46 | 9.93 |
| Cash & Equiv. Index: 90-Day T-Bills | 0.72 | 2.94 | 5.64 |

Manager Security Selection Evaluation

| | | | |
|--|------|-------|-------|
| Manager's Total Fund | 4.43 | 18.54 | 11.58 |
| Manager's Composite Index ¹ | 2.65 | 11.44 | 11.73 |
| Manager's Equities | 5.88 | 24.44 | 13.43 |
| S&P 500 | 2.59 | 13.00 | 13.60 |
| Dow Jones Industrial Average | 1.82 | 11.95 | 13.56 |
| Manager's Fixed Income | 2.52 | 12.37 | 9.84 |
| Salomon Brothers | 4.35 | 15.58 | 11.21 |
| Lehman Brothers Govt/Corporate | 3.32 | 11.46 | 9.93 |
| Manager's Cash & Equivalents | 0.79 | 3.22 | 6.62 |
| 90-Day T-Bills | 0.72 | 2.94 | 5.64 |

¹ A combination of the S&P 500 INDEX, LB GOVT/CORP BONDS, 90-DAY T-BILLS and CDA BANK RE in the same asset mix as the client portfolio. This mix changes with changes in the portfolio.

² MEE is comprised of 60.00% of the S&P 500 and 40.00% of the LB Govt/Corp Bond Index.

³ MFI is comprised of 70.00% of the LB Govt/Corp Bond Index and 30.00% of the S&P 500.

⁴ Index comprised of 55.00% of the S&P 500, 40.00% of the LB Govt/Corp Bond Index and 5.00% of the 90-Day T-Bill Index.



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MARSHALL ISLANDS NUCLEAR CLAIMS FUND

SUMMARY RATES OF RETURN (%) FOR ENTIRE FUND

as of September 30, 1993

| | Current Quarter | Trailing 12 Mos. | Fiscal Y-T-D | Annualized Since 12/86 |
|------------------|--------------------|---------------------|-----------------|---------------------------|
| TOTAL FUND | 4.43 | 18.54 | 18.54 | 11.58 |
| EQUITIES | 5.88 | 24.44 | 24.44 | 13.43 |
| FIXED INCOME | 2.52 | 12.37 | 12.37 | 9.84 |
| CASH & EQUIVS | 0.79 | 3.22 | 3.22 | 6.62 |
| REAL ESTATE | 0.45 | -9.82 | -9.82 | N/A |
| COMPOSITE | 2.65 | 11.44 | 11.44 | 11.73 |
| S&P 500 INDEX | 2.59 | 13.00 | 13.00 | 13.60 |
| LARGE CO. VALUE | 5.32 | 23.98 | 23.98 | 14.39 |
| SMALL CO. GROWTH | 9.80 | 36.03 | 36.03 | 12.01 |
| LB G/C INT BONDS | 2.25 | 8.21 | 8.21 | 9.24 |
| CDA BANK RE | 1.04 | -0.01 | -0.01 | 1.00 |
| 90-DAY T-BILLS | 0.72 | 2.94 | 2.94 | 5.64 |
| CPI | 0.49 | 2.69 | 2.69 | 4.09 |

Annualized Return Components 12/31/86-09/30/93

| | Principal | Income | Total |
|---------------|-----------|--------|-------|
| TOTAL FUND | 5.74 | 5.52 | 11.58 |
| EQUITIES | 9.68 | 3.42 | 13.43 |
| FIXED INCOME | 1.23 | 8.51 | 9.84 |
| CASH & EQUIVS | 0.00 | 6.62 | 6.62 |
| REAL ESTATE | N/A | N/A | N/A |

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MARSHALL ISLANDS NUCLEAR CLAIMS FUND

QUARTERLY PERFORMANCE REPORT FOR ENTIRE FUND

Unannualized Time-Weighted Rates in Percent

Quarterly Periods

| | 09/30/92 | 12/31/92 | 03/31/93 | 06/30/93 |
|------------------|----------|----------|----------|----------|
| | 12/31/92 | 03/31/93 | 06/30/93 | 09/30/93 |
| TOTAL FUND | 3.65 | 6.04 | 3.28 | 4.43 |
| EQUITIES | 5.94 | 7.09 | 3.60 | 5.88 |
| FIXED INCOME | 0.25 | 5.31 | 3.82 | 2.52 |
| CASH & EQUIVS | 0.85 | 0.74 | 0.81 | 0.79 |
| REAL ESTATE | -8.48 | 1.89 | -3.73 | 0.45 |
| COMPOSITE | 3.04 | 4.09 | 1.21 | 2.65 |
| S&P 500 INDEX | 5.03 | 4.37 | 0.48 | 2.59 |
| LARGE CO. VALUE | 5.70 | 9.17 | 2.02 | 5.32 |
| SMALL CO. GROWTH | 18.53 | 0.89 | 3.60 | 9.80 |
| LB G/C INT BONDS | -0.36 | 3.96 | 2.16 | 2.25 |
| CDA BANK RE | 0.31 | -0.55 | -0.80 | 1.04 |
| 90-DAY T-BILLS | 0.74 | 0.71 | 0.73 | 0.72 |
| CPI | 0.42 | 1.19 | 0.56 | 0.49 |

Cumulative Periods

| | 09/30/92 | 12/31/92 | 03/31/93 |
|------------------|----------|----------|----------|
| | 09/30/93 | 09/30/93 | 09/30/93 |
| TOTAL FUND | 18.54 | 14.37 | 7.85 |
| EQUITIES | 24.44 | 17.46 | 9.69 |
| FIXED INCOME | 12.37 | 12.09 | 6.44 |
| CASH & EQUIVS | 3.22 | 2.35 | 1.60 |
| REAL ESTATE | -9.82 | -1.46 | -3.29 |
| COMPOSITE | 11.44 | 8.15 | 3.90 |
| S&P 500 INDEX | 13.00 | 7.58 | 3.08 |
| LARGE CO. VALUE | 23.98 | 17.30 | 7.45 |
| SMALL CO. GROWTH | 36.03 | 14.76 | 13.75 |
| LB G/C INT BONDS | 8.21 | 8.60 | 4.46 |
| CDA BANK RE | -0.01 | -0.32 | 0.24 |
| 90-DAY T-BILLS | 2.94 | 2.18 | 1.46 |
| CPI | 2.69 | 2.26 | 1.05 |

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MARSHALL ISLANDS NUCLEAR CLAIMS FUND

QUARTERLY ASSET ALLOCATION (%) FOR ENTIRE FUND

| Quarter Ending | EQUITIES | FIXED INCOME | CASH & EQUIVS | REAL ESTATE |
|----------------|----------|--------------|---------------|-------------|
| 12/86 | 51.49 | 39.96 | 8.64 | 0.00 |
| 03/87 | 56.49 | 32.96 | 10.54 | 0.00 |
| 06/87 | 56.18 | 27.34 | 16.52 | 0.00 |
| 09/87 | 54.64 | 24.15 | 21.21 | 0.00 |
| 12/87 | 47.52 | 30.82 | 21.66 | 0.00 |
| 03/88 | 51.77 | 31.45 | 17.11 | 0.00 |
| 06/88 | 52.98 | 31.58 | 15.44 | 0.00 |
| 09/88 | 54.51 | 31.84 | 13.65 | 0.00 |
| 12/88 | 55.36 | 33.53 | 11.12 | 0.00 |
| 03/89 | 56.75 | 27.16 | 16.09 | 0.00 |
| 06/89 | 55.50 | 24.83 | 19.67 | 0.00 |
| 09/89 | 57.35 | 28.76 | 11.58 | 2.31 |
| 12/89 | 58.06 | 33.14 | 5.96 | 2.83 |
| 03/90 | 56.94 | 30.42 | 9.68 | 2.96 |
| 06/90 | 57.62 | 30.48 | 8.97 | 2.93 |
| 09/90 | 53.16 | 34.47 | 9.03 | 3.34 |
| 12/90 | 44.71 | 41.94 | 10.37 | 3.21 |
| 03/91 | 56.41 | 36.28 | 4.34 | 2.96 |
| 06/91 | 56.25 | 33.18 | 7.59 | 3.01 |
| 09/91 | 57.86 | 35.56 | 3.64 | 2.93 |
| 12/91 | 57.27 | 37.48 | 2.44 | 2.82 |
| 03/92 | 56.89 | 34.37 | 5.79 | 2.70 |
| 06/92 | 58.87 | 33.69 | 4.70 | 2.64 |
| 09/92 | 57.79 | 34.62 | 4.95 | 2.64 |
| 12/92 | 60.10 | 31.91 | 5.51 | 2.48 |
| 03/93 | 61.05 | 28.76 | 7.92 | 2.27 |
| 06/93 | 61.68 | 30.21 | 5.95 | 2.16 |
| 09/93 | 61.88 | 29.26 | 6.73 | 2.12 |

MARSHALL ISLANDS NUCLEAR CLAIMS FUND

QUARTERLY ASSET ALLOCATION (%) FOR ENTIRE FUND

| Quarter Ending | | | | |
|-----------------------------|----------|-----------------|------------------|----------------|
| | EQUITIES | FIXED INCOME | CASH & EQUIVS | REAL ESTATE |
| AVERAGE ASSET ALLOCATION | 56.14 | 31.76 | 9.26 | 0.93 |



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MARSHALL ISLANDS NUCLEAR CLAIMS FUND

BREAKDOWN OF CHANGE IN VALUE (\$) FOR ENTIRE FUND

as of September 30, 1993

| | Fiscal Year Ending 09/91 | Fiscal Year Ending 09/92 | Fiscal Y-T-D | 12/31/86 To Date |
|--|-----------------------------|-----------------------------|-----------------|---------------------|
| TOTAL FUND | | | | |
| Beginning Mkt. Value | 128,086,400 | 137,309,100 | 130,443,200 | 130,860,000 |
| + Sponsors Net Contr | -19,038,000 | -18,478,000 | -20,621,884 | -98,537,670 |
| + Income Received | 7,214,900 | 6,292,900 | 5,678,847 | 48,462,410 |
| + Realized/Unrealized Capital Gain/(Loss) | 21,045,800 | 5,319,200 | 15,439,665 | 50,155,088 |
| = Ending Mkt. Value | 137,309,100 | 130,443,200 | 130,939,828 | 130,939,828 |
| EQUITIES | | | | |
| Beginning Mkt. Value | 68,089,504 | 79,452,300 | 75,381,400 | 67,384,096 |
| + Net Flow | -8,922,600 | -9,894,500 | -11,125,203 | -50,479,903 |
| + Income Received | 2,467,600 | 2,296,500 | 1,961,992 | 17,372,292 |
| + Realized/Unrealized Capital Gain/(Loss) | 17,817,796 | 3,527,100 | 14,812,124 | 46,753,828 |
| = Ending Mkt. Value | 79,452,300 | 75,381,400 | 81,030,313 | 81,030,313 |
| FIXED INCOME | | | | |
| Beginning Mkt. Value | 44,149,600 | 48,831,800 | 45,159,600 | 52,287,700 |
| + Net Flow | -2,839,500 | -9,778,000 | -11,374,322 | -42,850,622 |
| + Income Received | 4,046,300 | 3,716,200 | 3,461,027 | 24,419,727 |
| + Realized/Unrealized Capital Gain/(Loss) | 3,475,400 | 2,389,600 | 1,071,894 | 4,461,394 |
| = Ending Mkt. Value | 48,831,800 | 45,159,600 | 38,318,199 | 38,318,199 |
| CASH & EQUIVS | | | | |
| Beginning Mkt. Value | 11,571,800 | 4,996,600 | 6,460,000 | 11,307,800 |
| + Net Flow | -7,188,600 | 1,236,900 | 2,115,342 | -8,862,658 |
| + Income Received | 613,400 | 226,500 | 235,675 | 6,365,875 |
| + Realized/Unrealized Capital Gain/(Loss) | 0 | 0 | 0 | 0 |
| = Ending Mkt. Value | 4,996,600 | 6,460,000 | 8,811,017 | 8,811,017 |


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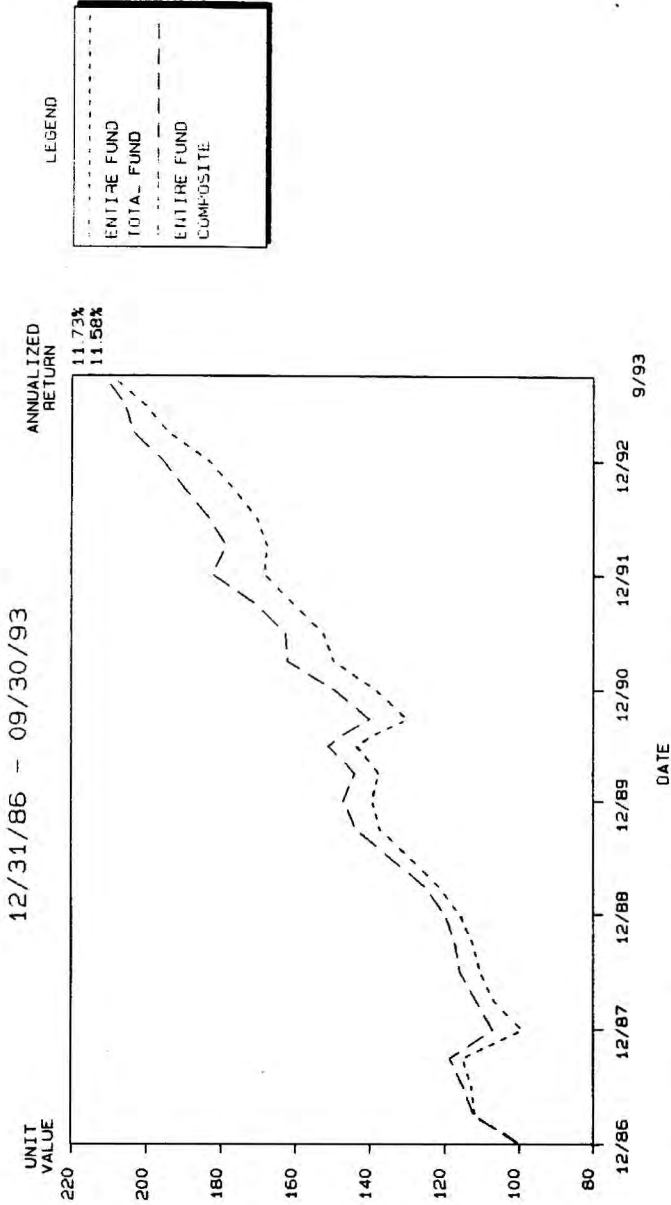
MARSHALL ISLANDS NUCLEAR CLAIMS FUND

BREAKDOWN OF CHANGE IN VALUE (\$) FOR ENTIRE FUND

as of September 30, 1993

| | <u>Fiscal</u> | <u>Year</u> | <u>Ending</u> | <u>Fiscal</u> | <u>12/31/86</u> |
|-----------------------|---------------|-------------|---------------|---------------|-----------------|
| | <u>09/91</u> | | <u>09/92</u> | <u>Y-T-D</u> | <u>To Date</u> |
| REAL ESTATE | | | | | |
| Beginning Mkt. Value | 4,275,600 | | 4,028,200 | 3,442,200 | N/A |
| + Net Flow | -87,500 | | -92,200 | -331,900 | N/A |
| + Income Received | 87,500 | | 92,200 | 114,200 | N/A |
| + Realized/Unrealized | | | | | |
| Capital Gain/(Loss) | -247,400 | | -586,000 | -444,200 | N/A |
| = Ending Mkt. Value | 4,028,200 | | 3,442,200 | 2,780,300 | N/A |

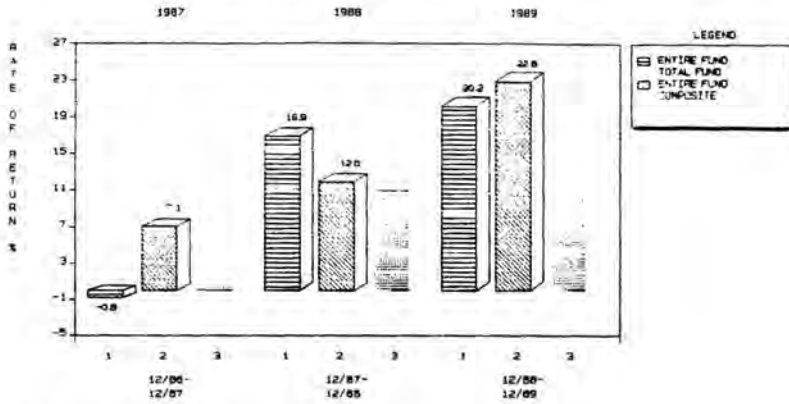
NUCLEAR CLAIMS - REVIEW OF ENTIRE MANAGED FUND



The Unit Value Graph depicts the cumulative growth of \$100 invested with the investment advisor vs. the same \$100 invested in appropriate capital market indices. Annualized rates of return since inception are depicted on the right hand axis.

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NUCLEAR CLAIMS - REVIEW OF ENTIRE MANAGED FUND

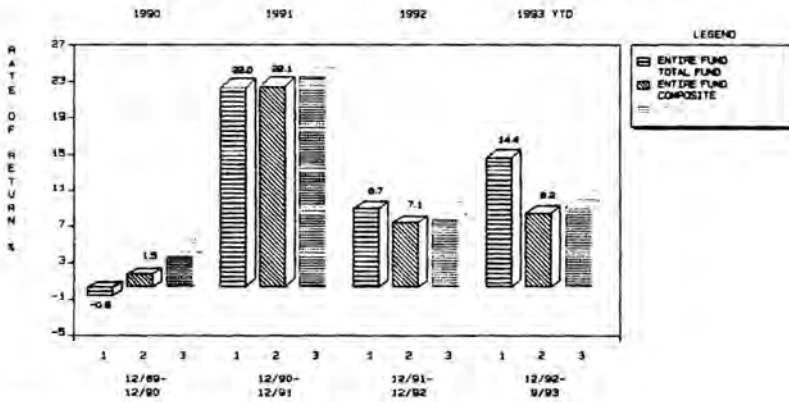


Rates annualized for periods greater than one year.

The Multiple Time Period Graph depicts the performance of the fund vs. appropriate market benchmarks for specified time periods.

SMITH BARNEY SHEARSON

NUCLEAR CLAIMS - REVIEW OF ENTIRE MANAGED FUND

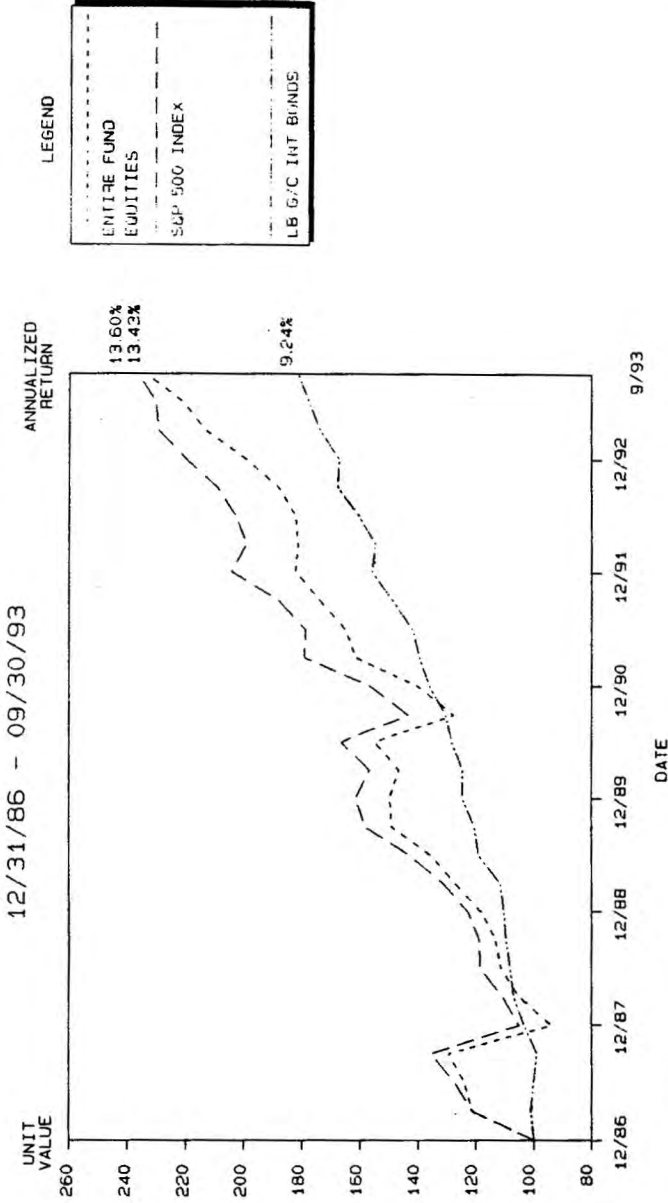


Rates annualized for periods greater than one year.

The Multiple Time Period Graph depicts the performance of the fund vs. appropriate market benchmarks for specified time periods.

SMITH BARNEY SHEARSON

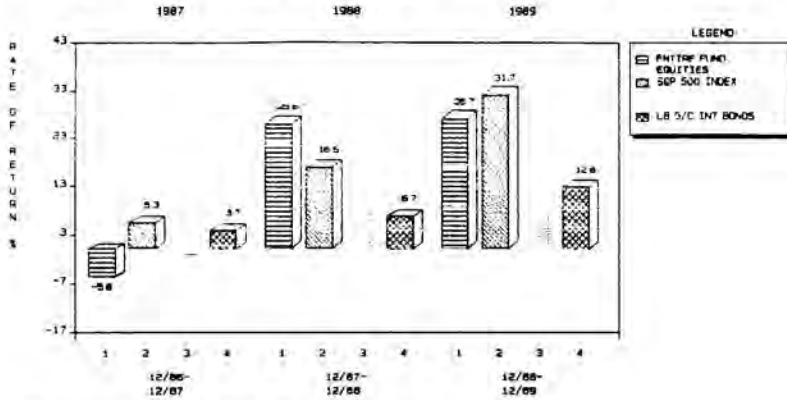
NUCLEAR CLAIMS - SECTIONALIZED REVIEW OF ENTIRE MANAGED FUND



The Unit Value Graph depicts the cumulative growth of \$100 invested with the investment advisor vs. the same \$100 invested in appropriate capital market indices. Annualized rates of return since inception are depicted on the right hand axis.

SMITH BARNEY SHEARSON

NUCLEAR CLAIMS - SECTIONALIZED REVIEW OF ENTIRE MANAGED FUND

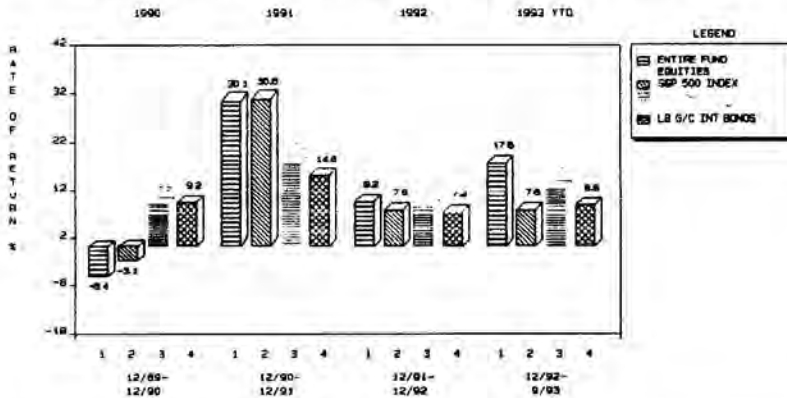


Rates annualized for periods greater than one year.

The Multiple Time Period Graph depicts the performance of the fund vs. appropriate market benchmarks for specified time periods.

SMITH BARNEY SHEARSON

NUCLEAR CLAIMS - SECTIONALIZED REVIEW OF ENTIRE MANAGED FUND



Rates annualized for periods greater than one year.

The Multiple Time Period Graph depicts the performance of the fund vs. appropriate market benchmarks for specified time periods.

SMITH BARNEY SHEARSON

**REPUBLIC OF MARSHALL ISLANDS
NUCLEAR CLAIMS FUND**

Account Value Summary
September 30, 1993

Equity Managers

| | | |
|-----------|----------------------|---------------|
| Newbolds | \$ 25,961,600 | |
| NewSouth | \$ 27,632,600 | |
| NWQ | \$ 19,874,900 | |
| Navellier | <u>\$ 12,218,000</u> | |
| TOTAL | | \$ 85,687,100 |

Fixed Income Managers

| | | |
|-----------|----------------------|---------------|
| Invesco | \$ 21,941,100 | |
| Provident | <u>\$ 20,531,500</u> | |
| | | \$ 42,472,600 |

Real Estate Managers

| | | |
|------------|-------------------|---------------------|
| AETNA | \$ 2,329,600 | |
| Boston Co. | <u>\$ 450,700</u> | |
| TOTAL | | <u>\$ 2,780,300</u> |

TOTAL MARKET VALUE **\$130,940,000**

| | | |
|----------------------------------|-----------------------|-----------------------------|
| ORIGINAL PRINCIPAL | \$ 150,000,000 | |
| BENEFICIARY DISTRIBUTIONS | <u>\$ 112,262,500</u> | |
| ADJUSTED ORIGINAL VALUE | | <u>\$ 37,737,500</u> |
| TOTAL EARNINGS INCEPTION TO DATE | | <u>\$ 93,202,500</u> |



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2. Nuclear Claims Tribunal

As had been the case three years earlier, 1993 was a year of extensive personnel change at the Nuclear Claims Tribunal. Nevertheless, progress occurred in numerous areas: appointment of two new Tribunal judges, including the first of Marshall Islands citizenship; expansion of the list of medical conditions administratively presumed to be the result of the nuclear testing program; acceptance of death certificates as *prima facie* evidence in the absence of any medical records to document conditions suffered; and completion of preliminary procedural matters necessary to prepare for the formal hearing of claims for damage to land.

Personnel Changes

In August James H. Plasman became the first Tribunal Judge to complete his three-year appointment. Judge Plasman and his family moved back to the mainland United States, but he will return to the Marshall Islands from time to time in connection with his appointment as Special Master for the Enewetak class action land compensation case.

In October the Cabinet appointed Ambassador Oscar de Brum and former RMI Attorney General and Cabinet Legal Advisor Gregory J. Danz as Tribunal Judges, replacing Judge Plasman and former Judge Peter Crane, whose position had been vacant since his resignation in April 1992. The appointments of Judge de Brum and Judge Danz, for statutory three-year terms, were confirmed by the *Nitijela* in its January 1994 session.

In December C. Sebastian Aloit became the first Tribunal Chairman to complete the statutory three-year term of appointment. Originally appointed as a Tribunal Judge in August 1990, Mr. Aloit was appointed as Chairman by the Cabinet in December 1990. Mr. Aloit was not reappointed by the Cabinet and has relocated to Hawaii. Efforts have commenced to recruit a third judge to serve on a full-time resident basis.

Defender of the Fund S. Joshua Berger resigned his position and departed from the Marshall Islands in early June to accept a position in a private law firm on Saipan. Subsequent to his departure, Mr. Berger was retained as a consultant to his former office. Kester Albert, who had been appointed Assistant Defender of the Fund in March 1993, served as Acting Defender from June 1993 through January 1994. In November 1993, Majuro-based attorney Philip Okney was retained as a part-time legal counsel to the Defender's office and effective February 1, 1994, he was appointed to a temporary three-month term as Defender. Efforts are underway to recruit a new full-time Defender of the Fund for the statutory two-year term.

In the office of the Public Advocate, Claims Officers Melissa Note resigned in April and moved to Honolulu. Claims Officer Thelita Juda resigned in October to accept a new position with

the Social Security Administration. In July Hackney Takju was appointed as Assistant Public Advocate, a position, formerly titled Claims Supervisor, which had been vacant since Dunstan Lokboj resigned in late 1992 to accept an appointment at Social Security. Also in July, Riten Batol was appointed to be a full-time Claims Officer in the Majuro office.

In October Gerald Smith was appointed as Assistant Financial Officer. Mr. Smith had previously served as a part-time consultant to the Tribunal Chairman in the areas of computerized financial tracking and reporting. The duties of this new position include assistance to the Financial Officer in the areas of accounting, disbursements and computer network management and financial analysis of both the Compensation Fund and the Operations Fund.

Compensation Program

Article IV of the Section 177 Agreement and Section 4 of the Marshall Islands Nuclear Claims Tribunal Act of 1987, as amended, give the Tribunal jurisdiction "to render final determination upon all claims past, present and future of the Government, the citizens and nationals of the Marshall Islands which are based on, arise out of, or are in any way related to the Nuclear Testing Program."

To date the Tribunal has awarded compensation only for certain medical conditions defined by regulation as "presumed" to be the result of radiation created by the testing program. However, progress was made during 1993 toward preparing for formal hearings focusing on claims seeking compensation for damage to property and for personal injuries consisting of non-presumed medical conditions.

Personal Injury Claims

Section 23(13) of the Nuclear Claims Tribunal Act authorizes the Tribunal to issue regulations establishing "a list of medical conditions which are irrebuttably presumed to be the result of the nuclear testing program." In accordance with Section 23(13), the Tribunal adopted regulations in July 1991 identifying twenty-five medical conditions that are presumed to be caused by exposure to radiation created by the testing program. For each of those conditions, there is credible medical and scientific evidence demonstrating a significant relationship between exposure to radiation and the subsequent development of the listed medical conditions, or statutory precedent in the United States, for providing compensation based on a presumption of causation.

Acting primarily on the basis of recent studies of Japanese atomic bomb survivors by the Radiation Effects Research Foundation (RERF) in Hiroshima and findings reported by the U.S. National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR V), in late 1993 the Tribunal amended

its regulations to include two additional conditions on the presumed list (see Attachment 1).

The medical and scientific evidence, or statutory precedents recognized by the Tribunal, provide a "presumption of causation" for each of the twenty-seven conditions. In addition, the regulations provide a "presumption of exposure" for all citizens who were physically present in the Marshall Islands during the testing period (1946-1958). The latter presumption recognizes the difficulties of proving exposure, a burden that most claimants would be unable to meet because of the limited monitoring of exposure carried out by the United States during its conduct of the testing program.

As 1993 began, compensation awards for presumed medical conditions had been made to 427 individuals for a total of 526 individual conditions. The net amount of compensation awarded the 427 individuals totaled over \$18.5 million, of which more than \$6.1 million (33%) had been paid.

During 1993 new awards of nearly \$4.3 million were made to, or on behalf of, an additional 145 individuals for 150 presumed conditions. As of December 31, 1993, compensation in a net amount of \$22.8 million had been awarded to or on behalf of 572 individuals for 676 conditions (see Attachment 2) and a total of \$9.1 million in compensation payments had been distributed. As shown in Attachment 3, compensation awards have been made to people from every atoll in the Marshall Islands.

Most of the new awards were for benign thyroid nodules diagnosed during a thyroid disease survey conducted on Ebeye by the RMI Nationwide Radiological Study. Some of the new awards were made on behalf of deceased individuals for whom no medical records could be found and for whom a certificate of death was the only evidence to indicate the medical condition(s) suffered.

A determination was made by the full Tribunal in June providing that death certificates may be considered as admissible evidence and that, with certain restrictions, "any [death] certificate admitted for the purpose of showing that a decedent suffered from a compensable condition should constitute prima facie evidence of that issue." This decision limited to five days the acceptable period between time of death and signing of the certificate by the attending physician. Subsequently, the Tribunal determined that the weight to be accorded certificates signed more than five days but less than one year after death presented a question of law involving a matter of public importance and ordered the filing of written views and arguments on that question.

Additional briefs were filed by the Public Advocate and the Defender of the Fund in December 1993. In January 1994 the full Tribunal issued a decision stating that it "will admit death certificates which are signed up to one year after death as prima facie evidence of the existence or non-existence of a medical condition."

While all of the awards made to date by the Tribunal have been for presumed personal injuries (i.e., medical conditions listed in the regulations), the Nuclear Claims Tribunal Act also provides that compensation may be awarded for certain other medical conditions where the claimant can prove, by a preponderance of the evidence on record, that the condition was a result of the nuclear testing program. An example of such a condition is lung cancer, which is highly associated with radiation exposure but is not on the presumed list because of a strong causal link to smoking.

It is expected that resolution of claims for such "non-presumed personal injuries" will begin during the coming year through individual or group hearings conducted by the Tribunal. Before those hearings can be scheduled, however, radiation exposure dose estimates must be prepared on an individual basis for each claimant who suffered from a non-presumed medical condition that could have resulted from radiation. The need for dose estimates has been discussed with officials of the RMI Nationwide Radiological Study, but the Tribunal has not yet begun to work with the Radiological Study in developing this information.

Annual Pro Rata Payments

Under the Section 177 Agreement, funds for payment of compensation awards made by the Tribunal are disbursed annually each October. When the first awards were made in August and September 1991, initial payments were distributed to recipients in the amount of 20% of each award. Annual pro rata payments were made for 5% in October 1991 and for 8% in October 1992.

For 1993, annual payments were set at 7% of each award, bringing the cumulative payout to 40%. In determining the amount of the 1993 annual pro rata payment, the Tribunal reiterated its concern that there will not be sufficient funds available for full payment of the awards it has made. The Tribunal observed that the 7% rate for 1993 recognizes the need to balance two competing interests: the interest of existing recipients to receive full payment of their award as soon as possible and the interest of future recipients to receive payment in an amount equal to that received by individuals previously paid.

Property Damage Claims

During 1993 the Tribunal also made substantial progress in preparation for hearing of claims seeking compensation for damage to property resulting from the testing program. The first property damage claim to be heard will be the consolidated claim filed in the name of the People of Enewetak by the Enewetak/Ujelang Local Government Council. That claim will proceed before any other for several reasons: (1) as a claim on behalf of a large group, the final determination of the Tribunal will resolve the claims of many individuals; (2) at the request of

the Tribunal, the results of the Nationwide Radiological Study will be available for Enewetak before the results from other atolls; and (3) of the four atolls most clearly affected by the testing program, Enewetak was the first to file such a claim with the Tribunal.

The Enewetak claim has been certified as a class action and preliminary statements identifying the issues to be addressed in hearing the claim have been filed by counsel for claimants and by the Defender of the Fund. In addition, a memorandum of understanding was entered under which the Tribunal provided \$71,567.24 to assist the Enewetak Local Government in contracting for an appraisal study of the atoll to be used by claimants in pursuing the claim.

Similar class action claims for property damage have also been filed separately by the people of Rongelap and the people of Bikini. In addition, thousands of individual claims have been filed for damage to property, with claims arising from every atoll in the nation. Resolution of the Enewetak claim will provide an important precedent on which determination of other property damage claims will be based.

In addition, it should be noted that the Tribunal Act [Sec. 23(1)] specifically provides for filing of "claims by owners of lands used or conveyed by the United States in its program to relocate those made homeless by the nuclear testing program." To date, no such claims have been filed with the Tribunal.

Financial Expenditures for Operations and Proceedings

During the fiscal year ending September 30, 1993, the Tribunal expended a total of \$901,493 for its overall operations (see Attachment 4). Of this amount, \$544,588 was for the Tribunal's general administrative operations and \$356,905 was for the operation of the offices of the Defender of the Fund, the Public Advocate, and Medical Diagnostics. The expenses of these three offices are deemed by the Tribunal to be "costs of proceedings" and, as is typical in mass tort settlement programs, are charged against the funds available for payment of claims.

As in the previous two years, costs of proceedings for each fiscal year are charged against the Compensation Fund during the subsequent year. Combined with the \$346,475 charged for Fiscal Year 1991 and the \$328,344 charged for Fiscal Year 1992, a total of \$1,031,724 has been charged against the Compensation Fund for costs of proceedings.

Revenues for administrative operations during Fiscal Year 1993 included the \$500,000 provided annually under the Section 177 Agreement and an additional \$81,513 in interest income and miscellaneous receipts. As shown in Attachment 4, administrative revenues exceeded expenditures by \$8,364 during the year, increasing the Operations Fund surplus from \$503,397 to \$511,761. Due primarily to extended personnel vacancies, overall

Fiscal Year 1993 Tribunal expenditures decreased \$86,605 from the previous year, a reduction of 9.6%.

Marshall Islands Nuclear Claims Tribunal
Notice of Regulations: Compensation for Damage to Person

Pursuant to §23(13) of the Marshall Islands Nuclear Claims Tribunal Act 1987, as amended, the Tribunal adopted regulations in August 1991 establishing a list of 25 medical conditions which are irrebuttably presumed to be the result of the Nuclear Testing Program. Those regulations were amended by the Tribunal in January 1994 to add two additional conditions (numbers 26 and 27 below) to the presumed list.

For eligible claimants who were present in the Marshall Islands during the testing program period, the administratively presumed medical conditions and the amounts of compensation for each that will be paid in pro rata annual payments are as follows:

| | |
|---|-----------|
| 1. Leukemia (other than chronic lymphocytic leukemia) | \$125,000 |
| 2. Cancer of the thyroid | |
| a. if recurrent or requires multiple surgical and/or ablation | \$75,000 |
| b. if non-recurrent or does not require multiple treatment | \$50,000 |
| 3. Cancer of the breast | |
| a. if recurrent or requires mastectomy | \$100,000 |
| b. if not recurrent or requires lumpectomy | \$75,000 |
| 4. Cancer of the pharynx | \$100,000 |
| 5. Cancer of the esophagus | \$125,000 |
| 6. Cancer of the stomach | \$125,000 |
| 7. Cancer of the small intestine | \$125,000 |
| 8. Cancer of the pancreas | \$125,000 |
| 9. Multiple myeloma | \$125,000 |
| 10. Lymphomas (except Hodgkin's disease) | \$100,000 |
| 11. Cancer of the bile ducts | \$125,000 |
| 12. Cancer of the gall bladder | \$125,000 |
| 13. Cancer of the liver (except if cirrhosis or hepatitis B is indicated) | \$125,000 |
| 14. Cancer of the colon (but not cancer of the rectum) | \$75,000 |
| 15. Cancer of the urinary bladder | \$75,000 |
| 16. Tumors of the salivary gland | |
| a. if malignant | \$50,000 |
| b. if benign and requiring surgery | \$37,500 |
| c. if benign and not requiring surgery | \$12,500 |
| 17. Non-malignant thyroid nodular disease (unless limited to occult nodules) | |
| a. if requiring total thyroidectomy | \$50,000 |
| b. if requiring partial thyroidectomy | \$37,500 |
| c. if not requiring thyroidectomy | \$12,500 |
| 18. Cancer of the ovary | \$125,000 |
| 19. Unexplained hypothyroidism (unless thyroiditis indicated) | \$37,500 |
| 20. Severe growth retardation due to thyroid damage | \$100,000 |
| 21. Unexplained bone marrow failure | \$125,000 |
| 22. Meningioma | \$100,000 |
| 23. Radiation sickness diagnosed between June 30, 1946 and August 18, 1958, inclusive | \$12,500 |
| 24. Beta burns diagnosed between June 30, 1946 and August 18, 1958, inclusive | \$12,500 |
| 25. Severe mental retardation (provided born between May and September 1954, inclusive, and mother was present on Rongelap or Utrik Atolls at any time in March 1954) | \$100,000 |
| 26. Unexplained hyperparathyroidism | \$12,500 |
| 27. Tumors of the parathyroid gland | |
| a. if malignant | \$50,000 |
| b. if benign and requiring surgery | \$37,500 |
| c. if benign and not requiring surgery | \$12,500 |

The regulations adopted by the Tribunal also provide a mechanism and set out applicable standards for (1) the consideration of non-presumed conditions for compensation in individual cases; (2) the periodic evaluation of possible modifications to the list of presumed conditions; (3) the assignment of compensation levels to non-presumed or future presumed medical conditions; and (4) adjustments to the amounts of compensation based on age and prognosis.

To review or obtain copies of the regulations, contact Cathlina J. deBrum, Clerk of the Tribunal, P. O. Box 702, Majuro, MH 96960; telephone (692) 625-3396; facsimile (692) 625-3389.

MARSHALL ISLANDS NUCLEAR CLAIMS TRIBUNAL
ADMITTED CLAIMS BY CONDITION AND AMOUNTS AWARDED (AS OF DECEMBER 31, 1993)

| | COMPENSATION | # ADMITTED | TOTAL COMP. | DEDUCTIONS* | NET DUE |
|---|--------------|--------------|---------------------|--------------------|---------------------|
| Acute radiation sickness | \$12,500 | 64 | \$800,000 | 0 | \$800,000 |
| Benign salivary gland tumor requiring surgery | \$37,500 | 12 | \$450,000 | 0 | \$450,000 |
| Benign salivary gland tumor without surgery | \$12,500 | 3 | \$37,500 | 0 | \$37,500 |
| Beta burns | \$12,500 | 61 | \$762,500 | 0 | \$762,500 |
| Breast cancer - lumpectomy or no surgery | \$75,000 | 5 | \$375,000 | 0 | \$375,000 |
| Breast cancer - mastectomy | \$100,000 | 14 | \$1,400,000 | \$25,000 | \$1,375,000 |
| Breast cancer - end stage or cause of death | \$125,000 | 14 | \$1,750,000 | \$159,000 | \$1,591,000 |
| Cancer of the colon | \$75,000 | 2 | \$150,000 | \$25,000 | \$125,000 |
| Cancer of the colon - cause of death | \$125,000 | 1 | \$125,000 | \$25,000 | \$100,000 |
| Cancer of the liver | \$125,000 | 3 | \$375,000 | \$36,000 | \$339,000 |
| Cancer of the ovary | \$125,000 | 11 | \$1,375,000 | \$86,000 | \$1,289,000 |
| Cancer of the pancreas | \$125,000 | 5 | \$625,000 | \$81,000 | \$544,000 |
| Cancer of the pharynx | \$100,000 | 4 | \$400,000 | 0 | \$400,000 |
| Cancer of pharynx - end stage or cause of death | \$125,000 | 8 | \$1,000,000 | \$82,000 | \$918,000 |
| Cancer of the stomach | \$125,000 | 4 | \$500,000 | \$106,000 | \$394,000 |
| Cancer of the urinary bladder | \$75,000 | 2 | \$150,000 | 0 | \$150,000 |
| Hypothyroidism | \$37,500 | 13 | \$487,500 | \$175,000 | \$312,500 |
| Leukemia | \$125,000 | 7 | \$875,000 | \$125,000 | \$750,000 |
| Lymphoma | \$100,000 | 7 | \$700,000 | 0 | \$700,000 |
| Lymphoma - end stage or cause of death | \$125,000 | 6 | \$750,000 | \$34,000 | \$716,000 |
| Malignant salivary gland tumor | \$50,000 | 2 | \$100,000 | 0 | \$100,000 |
| Meningioma | \$100,000 | 3 | \$300,000 | 0 | \$300,000 |
| Meningioma - end stage | \$125,000 | 1 | \$125,000 | \$8,000 | \$117,000 |
| Multiple myeloma | \$125,000 | 1 | \$125,000 | \$25,000 | \$100,000 |
| Severe growth retardation | \$100,000 | 2 | \$200,000 | \$75,000 | \$125,000 |
| Thyroid cancer | \$50,000 | 37 | \$1,850,000 | \$300,000 | \$1,550,000 |
| Thyroid cancer - multiple surgeries | \$75,000 | 15 | \$1,125,000 | \$100,000 | \$1,025,000 |
| Thyroid nodule - partial thyroidectomy | \$37,500 | 136 | \$5,100,000 | \$862,500 | \$4,237,500 |
| Thyroid nodule - total thyroidectomy | \$50,000 | 8 | \$400,000 | \$75,000 | \$325,000 |
| Thyroid nodule without surgery | \$12,500 | 225 | \$2,812,500 | 0 | \$2,812,500 |
| TOTALS | | 676** | \$25,225,000 | \$2,404,500 | \$22,820,500 |

* Deductions include both prior compensation for the same medical condition and adjustments in the amount of compensation due to age.

** The 676 admitted claims involve 572 individuals (many of whom had more than one admitted condition). Of these totals, 72 of the individuals (totaling 87 of the conditions) died without having submitted a claim and have been claimed by one or more relatives.

ADMITTED CLAIMS BY ATOLL OF BIRTH AND RESIDENCE
(AS OF DECEMBER 31, 1993)

| <u>ATOLL</u> | <u>BY BIRTHPLACE</u> | | <u>BY 1993 RESIDENCE</u> | |
|--------------------------------|-----------------------------|--------------------------|---------------------------------|--------------------------|
| | <u>People</u> | <u>Conditions</u> | <u>People</u> | <u>Conditions</u> |
| Ailinglaplap | 33 | 35 | 13 | 14 |
| Ailuk | 20 | 20 | 3 | 3 |
| Arno | 11 | 11 | 0 | 0 |
| Aur | 6 | 6 | 3 | 3 |
| Bikini/Kili | 6 | 10 | 1 | 1 |
| Ebon | 23 | 24 | 0 | 0 |
| Enewetak/Ujelang | 9 | 9 | 5 | 5 |
| Jaluit | 71 | 72 | 11 | 11 |
| Jebat | 2 | 2 | 1 | 1 |
| Kwajalein (excluding Mejjatto) | 75 | 90 | 184 | 227 |
| Lae | 17 | 19 | 4 | 4 |
| Lib | 2 | 2 | 0 | 0 |
| Likiep | 29 | 31 | 5 | 5 |
| Majuro | 51 | 51 | 166 | 186 |
| Maloelap | 17 | 17 | 5 | 5 |
| Mejit | 21 | 22 | 3 | 5 |
| Mili | 9 | 9 | 2 | 2 |
| Namodik | 22 | 22 | 5 | 5 |
| Namu | 11 | 12 | 4 | 5 |
| Rongelap/Rongerik/Mejjatto | 59 | 131 | 16 | 28 |
| Ujae | 19 | 22 | 2 | 2 |
| Utrik | 28 | 28 | 12 | 12 |
| Wotje | 19 | 19 | 12 | 12 |
| Wotto | 5 | 5 | 4 | 4 |
| Other (outside RMI) | 7 | 7 | 12 | 15 |
| Deceased | <u>0</u> | <u>0</u> | <u>99</u> | <u>121</u> |
| TOTALS | 572 | 676 | 572 | 676 |

NOTE: Many individuals have been awarded compensation by the Tribunal for more than one medical condition. In most of these cases, the awards have been made to people who were on Rongelap on March 1, 1954 and who suffered the conditions of acute radiation sickness, beta burns and some thyroid abnormality.

FY 1993 REVENUES AND EXPENDITURES

NUCLEAR CLAIMS TRIBUNAL
 UNAUDITED STATEMENT OF REVENUES AND EXPENDITURES
 OPERATION FUND
 FISCAL YEAR ENDED SEPTEMBER 30, 1993

| | |
|--------------------------|------------------|
| REVENUES FY 93: | |
| COMPACT FUND | \$500,000 |
| INTEREST & MISC. RECEIPT | \$81,513 |
| TOTAL REVENUES FY 93 | <u>\$581,513</u> |

| | ADMIN. | P.A. | DOF | MED. | TOTAL |
|---|------------------|------------------|-----------------|-----------------|-------------------------|
| EXPENDITURES FY 93 | | | | | |
| WAGES AND SALARIES | \$143,866 | \$103,577 | \$49,024 | \$25,948 | \$322,416 |
| OTHER PERSONNEL BENEFITS | \$79,156 | \$27,567 | \$18,259 | \$1,065 | \$126,047 |
| OFFICE RENTAL | \$46,198 | \$8,000 | \$0 | \$5,760 | \$67,968 |
| OFFICE EQUIPMENT | \$15,430 | \$0 | \$0 | \$0 | \$15,430 |
| OFFICE SUPPLIES | \$13,913 | \$1,668 | \$265 | \$310 | \$16,167 |
| TRAVEL | \$60,330 | \$20,439 | \$4,529 | \$12,722 | \$98,021 |
| VEHICLE | \$1,757 | \$500 | \$0 | \$116 | \$2,372 |
| CONTRACTUAL SERVICES | \$65,000 | \$38,957 | \$24,609 | \$1,708 | \$130,274 |
| ADVERTISING | \$960 | \$0 | \$0 | \$0 | \$960 |
| TRAINING | \$695 | \$0 | \$0 | \$0 | \$695 |
| LIBRARY BOOKS | \$12,780 | \$0 | \$0 | \$0 | \$12,780 |
| TELEPHONE | \$35,000 | \$1,000 | \$0 | \$3,261 | \$39,261 |
| MEDICAL AND LABORATORY | \$0 | \$0 | \$0 | \$7,620 | \$7,620 |
| ADMINISTRATION/MISC | \$2,219 | \$0 | \$0 | \$0 | \$2,219 |
| HEARING | \$42,283 | \$0 | \$0 | \$0 | \$42,283 |
| EBEYE OFFICE SUPPORT | \$0 | \$2,000 | \$0 | \$0 | \$2,000 |
| ASSISTANCE GRANT | \$25,000 | \$0 | \$0 | \$0 | \$25,000 |
| TOTAL EXPENDITURES | <u>\$544,586</u> | <u>\$201,708</u> | <u>\$96,687</u> | <u>\$58,510</u> | <u>\$901,493</u> |
| REVENUES OVER EXPENDITURES | | | | | <u>(\$319,980)</u> |
| OPERATING TRANSFERS | | | | | <u>\$328,344</u> |
| EXCESS OF REVENUES AND OTHER SOURCES OVER EXPENDITURES AND OTHER USES | | | | | <u>\$8,364</u> |
| FUND BALANCE, BEGINNING OF YEAR | | | | | <u>\$503,397</u> |
| FUND BALANCE, END OF YEAR | | | | | <u><u>\$511,761</u></u> |

3. Nationwide Radiological Study

This report describes the progress and activities of the Nationwide Radiological Study over the time period from October 1, 1992, to September 30, 1993. The RMI Government has undertaken the scientific investigations of the Nationwide Radiological Study in accordance with the provisions of Article II, Section 1(e) of the Section 177 Agreement. The activities of the Nationwide Radiological Study described in this report pertain mainly to (1) the collection of further radiological data from field survey expeditions, (2) a continuing program of refinements to the laboratory facility in Majuro, (3) activities associated with the laboratory staff and Scientific Advisory Panel, (4) a continuing contribution to the scientific studies of the Rongelap Resettlement Project, and (5) the first phase of a nationwide survey to determine the prevalence of thyroid disease in the Republic of the Marshall Islands.

Collection of Radiological Data from Field Surveys

In the past year a significant amount of new environmental radiological data was gathered from atolls and islands of the Marshall Islands by the Nationwide Radiological Study, despite the lack of a dedicated ocean-going vessel to support the study. As in the previous year, field surveys mainly used the locally chartered fishing vessel M/V Charlie's Angel, although work at Rongelap Atoll was supported by the M/V Offshore Venture, a ship contracted by the U.S. Department of Energy.

In the time period October 1, 1992, through September 30, 1993, field survey expeditions were made to ten atolls and one reef island (Lib):

| | |
|---------------------------|-------------------------------|
| October 22-29, 1992 | Ujelang |
| November 19-24, 1992 | Namu |
| December 12-20, 1992 | Kwajalein and Lib |
| February 23-March 6, 1993 | Kwajalein and Namu |
| March 23-April 6, 1993 | Utrik, Taka, Bikar, and Bokak |
| April 14-27, 1993 | Rongelap |
| May 12-19, 1993 | Bikini. |

On all atolls and islands, in-situ gamma spectrometric measurements were made and soil and plant samples were collected. In addition to the soil samples, at certain locations the samples collected included coconut milk and coconut meat, breadfruit, pandanus, banana, pumpkin, arrowroot, clam, coconut crab, and wild pig. Also, the leaves of eight medicinal plant species and the fruit of one medicinal plant were collected.

All field survey work in the nation is completed except for about one-third of the islands of Kwajalein Atoll, including the USAKA-held islands, and Wake Island (Enenkio). The survey of both of these locations is planned for early 1994.

During the reporting period, the following numbers of soil samples were prepared at the Majuro laboratory and measured for gamma emitting radionuclides (e.g., 137-cesium, 241-amerium, and 60-cobalt):

- 16 deep soil profiles from Enewetak (a total of 80 samples)
- 112 surface soil samples from Enewetak
- 42 deep soil profiles from Rongelap (a total of 210 samples)
- 311 surface soil samples from Rongelap.

During the reporting period, the following numbers of samples were prepared in the wet sample facility at the Majuro laboratory and measured for gamma emitting radionuclides (e.g., 137-cesium, 241-amerium, and 60-cobalt):

- 154 coconut juice samples
- 141 coconut meat samples
- 181 leaf samples (medicinal plants)
- 52 other samples
(including other fruits, crab, and pig meat).

The table on the next page shows the total number of samples under study by the Nationwide Radiological Study as of December 1993.

Environmental Radiation Laboratory

Personnel

As various milestones have been met, a number of changes have been made within the Nationwide Radiological Study organization and laboratory. With the field survey work neared completion, two junior scientists employed by the laboratory returned to the United States. Both Dr. Steven L. Simon, the Director of the Study, and Mr. Jim Graham have remained on staff, as have Mr. Alexander Noah and Mr. Dante Demanarig. Several new Marshallese staff have been added to assist with the high workload of sample preparation and processing. The new employees added to the Nationwide Radiological Study staff were Mr. Renny Ohwiler, Mr. Alee Jonas, Mr. Tom Schmidt, Mr. Ransey Larrone, and Mr. Randy Thomas. Ms. Shiela Como also returned to the United States after serving as laboratory radiochemist for a year. She was replaced by Mr. Andy Borchert.

Mr. Alee Jonas is a citizen of the Federated States of Micronesia (Chuuk) and Mr. Renny Ohwiler is a Marshallese citizen; both are members of the Rongelap community by either marriage or birth. The hiring of these two employees was made possible by the separate funding of the Rongelap Resettlement Project.

December 1993

Number of Measurements and Samples Now Under Study by
RMI Nationwide Radiological Study

| Atoll Reference Number | Atoll or Island Name | Area in km ² | No. of <i>In-Situ</i> Gamma measurements | No. of Gamma measurements per km ² | No. of Soil Profiles ¹ | No. of Gamma Profiles ¹ | No. of Coconut ² and Matched Soil Samples | Plants (Medicinal and Fruit) and Matched Soil Samples | Surface Soil Samples for [27] for Transuranics measurement | Surface Soil Samples for Transuranics and ²³⁵ U | Well Water for ¹³⁷ Cs analysis |
|------------------------|------------------------|-------------------------|--|---|-----------------------------------|------------------------------------|--|---|--|--|---|
| 1 | Alinginas | 2.8 | 64 | 22.86 | 12 | 5.33 | 6 | 3 | 2 | 64 | 0 |
| 2 | Alingilap | 14.7 | 36 | 2.45 | 4 | 9.00 | 4 | 0 | 0 | 4 | 0 |
| 3 | Aluk | 5.4 | 38 | 7.04 | 3 | 12.67 | 7 | 21 | 3 | 3 | 0 |
| 4 | Arad | 13.0 | 31 | 2.31 | 5 | 6.20 | 4 | 2 | 3 | 5 | 0 |
| 5 | Aur | 5.6 | 17 | 3.04 | 4 | 4.25 | 0 | 0 | 0 | 0 | 0 |
| 6 | Bakar | 0.5 | 5 | 10.00 | 1 | 5.00 | 1 | 1 | 1 | 2 | 0 |
| 7 | Bikini | 6.0 | 99 | 16.50 | 17 | 5.82 | 20 | 9 | 0 | 98 | 4 |
| 8 | Ebon | 5.8 | 21 | 3.62 | 3 | 7.00 | 5 | 19 | 3 | 3 | 0 |
| 9 | Banwak | 5.9 | 168 | 28.47 | 27 | 6.22 | 33 | 32 | 3 | 168 | 1 |
| 10 | Erikub | 1.5 | 7 | 4.67 | 2 | 3.50 | 0 | 0 | 0 | 2 | 0 |
| 11 | Jabst Island | 0.57 | 2 | 3.51 | 1 | 2.00 | 0 | 0 | 0 | 1 | 0 |
| 12 | Jaluit | 11.3 | 36 | 3.19 | 4 | 9.00 | 5 | 24 | 3 | 4 | 0 |
| 13 | Jemo Island | 0.16 | 4 | 25.00 | 1 | 4.00 | 2 | 0 | 2 | 1 | 0 |
| 14 | Kili Island | 0.93 | 4 | 4.30 | 1 | 4.00 | 3 | 0 | 3 | 1 | 0 |
| 15 | Kwajalein ³ | 16.4 | 56 | 3.41 | 6 | 9.33 | 10 | 0 | 9 | 6 | 0 |
| 16 | Lik | 1.5 | 10 | 6.67 | 3 | 3.33 | 4 | 3 | 3 | 3 | 2 |
| 17 | Lik Island | 0.93 | 5 | 5.38 | 2 | 2.50 | 3 | 1 | 2 | 2 | 1 |
| 18 | Likiep | 10.3 | 55 | 5.34 | 6 | 9.17 | 9 | 43 | 2 | 6 | 0 |
| 19 | Knos | 1.0 | 4 | 4.00 | 1 | 4.00 | 0 | 0 | 0 | 1 | 0 |
| 20 | Majuro | 9.2 | 44 | 4.78 | 13 | 3.38 | 9 | 23 | 1 | 13 | 0 |
| 21 | Makalap | 9.8 | 27 | 2.76 | 4 | 6.75 | 0 | 0 | 0 | 4 | 0 |
| 22 | Mejit Island | 3.5 | 25 | 7.14 | 2 | 12.50 | 5 | 5 | 3 | 2 | 0 |
| 23 | Mili | 14.9 | 32 | 2.15 | 4 | 8.00 | 2 | 1 | 0 | 4 | 0 |
| 24 | Nemorik | 2.8 | 7 | 2.50 | 2 | 3.50 | 3 | 4 | 4 | 2 | 0 |
| 25 | Nemu | 6.3 | 43 | 6.83 | 4 | 10.75 | 10 | 3 | 5 | 4 | 2 |
| 26 | Rongelap | 8.0 | 285 | 35.63 | 42 | 6.79 | 44 | 76 | 4 | 311 | 0 |
| 27 | Rongerik | 1.7 | 40 | 23.53 | 9 | 4.44 | 8 | 9 | 3 | 33 | 0 |
| 28 | Tronak | 3.2 | 16 | 5.00 | 3 | 5.33 | 0 | 5 | 3 | 3 | 0 |
| 29 | Taka | 0.57 | 10 | 17.54 | 4 | 2.50 | 0 | 1 | 2 | 7 | 0 |
| 30 | Ujae | 1.9 | 13 | 6.84 | 3 | 4.33 | 4 | 6 | 3 | 3 | 3 |
| 31 | Ujelana | 1.7 | 36 | 21.18 | 7 | 5.14 | 8 | 9 | 3 | 12 | 3 |
| 32 | Utrik | 2.4 | 49 | 20.42 | 5 | 9.80 | 5 | 1 | 3 | 43 | 2 |
| 33 | Wotho | 4.3 | 17 | 3.95 | 3 | 5.67 | 4 | 1 | 3 | 3 | 1 |
| 34 | Wotho | 8.2 | 27 | 3.29 | 4 | 6.75 | 9 | 20 | 3 | 8 | 0 |
| Total = | | ~183 | 1333 | 9.57 | 212 | 6.12 | 227 | 322 | 86 | 822 | 19 |
| | | | | (avg.) | | (avg.) | | | | | |

¹ Each profile (0-30 cm) consists of 6 samples (5 cm increments)² Each coconut results in three samples: coconut milk, meat (soft meat), and root-cream soil.³ Kwajalein atoll survey is only ~65% complete at present time

Mr. Randy Thomas resides permanently with the Rongelap community now living on Mejetto Island in Kwajalein Atoll. He has worked in the laboratory since June 1993 to help improve communication between the laboratory and the Rongelap community. On previous occasions, he had assisted the Nationwide Radiological Study in field survey work.

Mr. Tom Schmidt and Mr. Ransey Larrone are both Marshallese citizens with homes in Majuro.

Mr. Andy Borchert was hired from Colorado. He had graduated with a degree in chemistry from Colorado State University where he was employed as a laboratory chemist in the Department of Radiological Health Sciences. Before relocating to the Marshall Islands, Mr. Borchert received specialized training at Colorado State University in plutonium chemistry, as had Ms. Como before him.

Laboratory Building

The laboratory itself has undergone some minor but important modifications over the past year to improve its efficiency. In particular, an enlargement of the soil preparation facilities was added to the building in November-December 1992. This additional space was added to accommodate a second soil drying room and a room for crushing rocks and sieving soil; this expansion opened extra space in the original soil preparation room for a second ball mill, which is used to crush soil samples into powder. This enlargement of facilities provides for more efficient operation of the soil preparation steps.

Additional seawall protection was also constructed in November and December 1992 on the west side of the laboratory. Although storms originating out of the west are somewhat unusual in Majuro, they are often the most damaging because waves can build to significant intensity along the length of the atoll. An additional 60 feet of seawall was added to ensure the protection of the laboratory.

The trailer acquired the previous year from USAKA was outfitted this past year with adequate work space for exposing soil samples collected on Rongelap to plastic track detectors. This project is a component of the Rongelap Resettlement Project scientific studies. Plastic track detectors are a specialized type of plastic that registers microscopic pits, or "tracks", after absorbing alpha particles emitted from certain radioactive elements, especially plutonium. Exposing the track detectors to soil is relatively simple, although it requires leaving batches of small containers of soil, into which the track detectors have been inserted, undisturbed continuously for a month.

Laboratory Operations

The plutonium wet chemistry laboratory under the operation of Mr. Andy Borchert significantly increased its throughput this year due to several changes in procedure. Around June 1, 1993, the Radiochemistry Laboratory responsibilities and management was transferred from Sheila Coma to Andy Borchert. The beginning of Mr. Borchert's radiochemical analysis of samples was delayed from June 1 to July 20, 1993, due to the inability of Hawaii Chemical Scientific and Fisher Scientific to deliver scientific supplies that had been ordered seven months previously.

During this lag time, the laboratory was reorganized into specific workstations including: a muffle furnace station, radioactive spiking area, leaching area, acid reduction, column extraction, and microprecipitation. The benefit of workstations was demonstrated when batch production went into effect. A new and more appropriate radioactive standard was made to better fit the geometry of the alpha detectors. During the first month, however, a vacuum problem was diagnosed with one of the alpha spectrometry chambers forcing the laboratory to return one of the chambers back to the manufacturer, Canberra Industries of Meriden, Connecticut.

Chemical analysis of plutonium resumed in August 1993 with the addition of Mr. Randy Thomas as a laboratory technician. After twelve plutonium samples had been processed, it was determined that the chemical procedures needed to be reviewed and streamlined. At this point, on the basis of information gained from previous mass spectroscopy measurements made on Marshall Islands soil and following a literature review, the procedure for calcium-oxalate co-precipitation was determined to be unnecessary. The same twelve samples were reprocessed without calcium-oxalate co-precipitation. The recovery of plutonium from the soil improved from approximately 50% to approximately 80%. The spectra showed no interfering peaks and, due to this higher chemical yield, the count time was decreased from twenty-four hours to a six- to eight-hour count time.

The processing of samples for plutonium analysis was also streamlined by organizing samples into batches. The benefit of the batch method allows for continuous processing of samples one after another. To assist in the new processing system, a seven outlet PVC manifold and clean box was constructed for the microprecipitation procedures. This equipment allowed for production of six times as many samples at a time in comparison to the former method. The extraction workstation was also modified by a stationary column apparatus that enabled better access and stabilization. The extraction columns were modified by the addition of a 50 mL reservoir that allowed for more freedom of the operator to proceed with other laboratory procedures at the same time.

The improvements made in the methodology have resulted in the production of thirty or more samples a week, a significant increase over the previous capacity of the laboratory of six to eight samples a week. Improvements were also made on the

computerized database to improve the clarity of the data reports. In December 1993 another delay was experienced as one of the alpha particle detectors proved to be defective.

Sample production for the first six months was approximately 300 samples. A 70% increase in sample output has been accomplished. Not only did the volume of samples increase, but also the quality and precision was stabilized.

Considerable difficulty was experienced this past year with all of the laboratory's radiation detection instrumentation. The laboratory instruments are operated in an air-conditioned environment, yet they have suffered more problems than the instruments used in the field survey. In late April 1992, one of the two laboratory high purity germanium (HPGe) detectors began to develop problems. After conferring for several months with the manufacturer, Canberra Industries, the detector was returned to the factory in Meriden, Connecticut, in late September 1992. It was back in operation in mid-December 1992, although about seven months had elapsed without its use. That detector was out of operation again for two weeks in January 1993 and one week in May 1993. The detector again went down in late August 1993 and was returned to Canberra in late September 1993. (It arrived back at the Majuro laboratory on January 31, 1994.)

This second laboratory detector began experiencing problems in mid-April 1993 and worked erratically for several months thereafter. In late August 1993, this machine also had to be returned to Canberra. Canberra determined that the germanium crystal of this unit could not be returned to its original operating condition, although the company agreed to replace it. Because these particular detectors have an enhanced low energy detection range to facilitate the measurement of 241-americiuim, a replacement detector had to be custom built. As of this writing, the new unit is still undergoing testing at the factory and is not yet back in service.

In order for the measurement of cesium in samples to continue during this past year, the laboratory's portable field HPGe detectors were installed into the lead shields in the measurement facility. These detectors, although similar to the laboratory units, possess different energy response characteristics and, for this reason, required separate calibrations.

The alpha spectrometry system for measurement of plutonium exhibited numerous problems during the entire year that Ms. Como worked in the laboratory. Canberra was consulted numerous times and replaced several components during 1992. In late spring of 1993, one of the alpha spectrometry vacuum chambers was sent back to Canberra and replaced with a new unit in July. The solid-state detectors which fit inside the vacuum chambers were also returned to Canberra for testing. On one occasion, in September 1993, Canberra sent the wrong machine back to Majuro. Even after the components were replaced, difficulties still plagued the system and in late November 1993, the full alpha

spectrometry system was disassembled and returned to Canberra for testing. As of this writing, the system is not yet back in service.

Despite numerous difficulties with instrumentation, the Nationwide Radiological Study laboratory continued its participation in international intercomparisons. In November 1992, the laboratory submitted its measurements of samples distributed by the International Atomic Energy Agency (IAEA) Laboratory of Marine Radioactivity in Monaco. These samples included sediments from the Irish Sea and marine cockle flesh. Additionally, the Nationwide Radiological Study continued its program of direct comparisons of samples with Lawrence Livermore National Laboratory, a U.S. Department of Energy contractor.

Activities of the Staff and the Scientific Advisory Panel

Through the Scientific Advisory Panel, the Nationwide Radiological Study is advised and monitored by an international oversight committee of five senior radiation scientists.

During Fiscal Year 1993 no meeting was held of the entire Scientific Advisory Panel. However, four members of the panel visited Majuro in work related to various projects of the Nationwide Radiological Study.

In mid-March 1993, Dr. Herwig Paretzke from the GSF Institut für Strahlenschutz (Institute for Radiation Protection) in Germany visited the Nationwide Radiological Study laboratory. During his visit, he reviewed the calibration procedures of the gamma spectrometry measurements being made in the laboratory.

In late March through early April, Dr. Andrew McEwan, Director of the National Radiation Laboratory of New Zealand, visited the Marshall Islands and participated in the radiological field survey of Utrik and Taka Atolls. The Utrik leadership had earlier voiced a desire for international participation and oversight of the monitoring project. Dr. McEwan's dedication of nearly two weeks of his time was a significant contribution.

Dr. Klauss Trott, a radiobiologist and physician on the faculty of St. Bartholomew's Hospital in London, has provided medical guidance to Dr. Simon in implementing the first phase of a thyroid disease screening study. Dr. Trott visited Ebeye in early January 1993 for about a week to assist in the first examinations. He next visited Ebeye and Majuro in late August and early September to report the clinical results to individuals who participated in the Ebeye study. Dr. Trott also travelled to Japan in late August 1993 on behalf of the Marshall Islands Thyroid Study to review all the patient charts and diagnoses.

Dr. Keith Baverstock, from the World Health Organization in Rome, visited the Marshall Islands twice during the reporting period. He visited in February 1993, at which time he accompanied Dr. Simon to Mejetto to brief the Rongelap community

on progress of the Rongelap Resettlement Project. Dr. Baverstock also visited the Marshall Islands in late August coincident with a visit by a team from the U.S. National Academy of Sciences. This visit also entailed travel to Rongelap and Mejetto.

Staff of the laboratory travelled several times in this period in support of the various laboratory projects. In late January 1993, the scientific staff of the Nationwide Radiological Study laboratory attended the 26th Midyear Topical Meeting of the Health Physics Society. The meeting focused on environmental health physics and was held in Coeur d'Alene, Idaho. Dr. Simon presented an overview of the Nationwide Radiological Study which was subsequently published in the proceedings. Dr. Simon and his colleagues also presented a poster display on the field survey of the Nationwide Radiological Study. Proceeding from Coeur d'Alene, Dr. Simon went on to meet with scientists at the U.S. Department of Energy Environmental Measurements Laboratory in New York City. The methods of in-situ gamma spectrometry used by the RMI Nationwide Radiological Study were pioneered by scientists at the Environmental Measurements Laboratory and they have been quite helpful with providing guidance and suggestions. Dr. Simon continued on to Amherst, Massachusetts, to meet with faculty of the School of Public Health at the University of Massachusetts (UMass) concerning the conduct of a soil ingestion study for the Rongelap Resettlement Project. While at UMass, Dr. Simon presented a guest lecture on the Nationwide Radiological Study to a graduate-level course in Risk Assessment at the School of Public Health. Two members of the Rongelap community, Ms. Abacca Anjain and Mr. Aisen Tima, accompanied Dr. Simon to UMass for these discussions.

In late February Dr. Simon, accompanied by Ms. Anjain, Mr. Tima and Dr. Keith Baverstock, went to Mejetto Island for discussions with the Rongelap community on the progress of the Rongelap Resettlement Project.

In late March and early April, Dr. Simon travelled to Albuquerque, New Mexico, to meet with officials of Scientific Instrument Company, Inc., developers of a specialized computer imaging system for performing analysis of plutonium tracks. This work has been funded by the Rongelap Resettlement Project. During this trip, upon request of the faculty at Colorado State University, Department of Radiological Health Sciences, Dr. Simon presented a lecture on the Nationwide Radiological Study. This lecture was videotaped and broadcast on the National Televised University as part of a graduate credit class in Radiation Public Health.

In early May, Dr. Simon accompanied a delegation from the Marshall Islands to annual budget hearings in Washington, D.C., where he provided testimony on the progress of the Rongelap Resettlement Project.

During late May Dr. Simon traveled to Washington State to participate as one of five invited peer reviewers for the Hanford Dose Reconstruction Study. That study is being conducted by Battelle Pacific Northwest Laboratory to assess the radiation exposure of residents of Washington State to radiiodine released during the 1940's and 1950's from the Hanford plutonium production facilities. The results of the peer review were published as a Battelle report. Dr. Simon also traveled on this trip to New Mexico State University in Las Cruces to meet with software developers for a computerized track imaging system being developed as part of the Rongelap Resettlement Project.

In early June, Dr. Simon again travelled to Ebeye and to Mejetto to accompany visitors from the U.S. Department of Interior, Department of Energy, and the Senate Energy Committee for meetings with the Rongelap communities living there.

Dr. Simon and Mr. Graham attended the annual Health Physics meeting in Atlanta in mid-June. This was a technical conference for radiation protection specialists. Dr. Simon also travelled to Las Cruces, New Mexico, for a second meeting with the software developers.

August 1993 was a busy month for the Nationwide Radiological Study with a total of sixteen visitors coming to the laboratory. In the second week of August, Dr. Russel Carey, a technical sales representative from Scientific Instruments, Inc., came to the Nationwide Radiological Study laboratory to install a computerized imaging system built specifically for the Rongelap Resettlement Project. From August 26 through September 5, Mr. Terry Jenner from the Medical Research Council in Didcot, United Kingdom, provided assistance to the Nationwide Radiological Study laboratory in acquiring the first alpha track data using the computerized imaging system. In late August, fourteen additional visitors came to the Nationwide Radiological Study laboratory, including Dr. Keith Baverstock, an advisor to the Nationwide Radiological Study and the Rongelap Resettlement Project, thirteen persons from the U.S. National Academy of Sciences (NAS), and an official of the U.S. Department of Energy. The NAS group is responsible for reviewing the Department of Energy's scientific programs in the Marshall Islands. The NAS team visited the Nationwide Radiological Study laboratory to gain insight into the various scientific questions and to better understand the difficulties in conducting research in the Marshall Islands. Dr. Simon and Randy Thomas then accompanied the group to Bikini, Rongelap, and Mejetto. Dr. Simon and Mr. Thomas provided the NAS group with a tour of Rongelap Island and substantial background information on the Rongelap Resettlement Project.

Rongelap Resettlement Project

The Rongelap Resettlement Project (RRP) encompasses a number of different scientific studies with the overall goal of determining the suitability of reinhabiting Rongelap Island and

the southern islands of Rongelap Atoll based on whether compliance is met with (1) a dose limit and (2) a soil contamination level. The dose limit of 100 mrem/y above background was agreed upon several years ago by the U.S. Department of Energy and representatives of the Rongelap community. Subsequently, the two compliance limits were written into the memorandum of agreement for the project between the U.S. Department of Energy, the U.S. Department of the Interior, the RMI national government, and the Rongelap Local Government. Both of the compliance limits must be satisfied. In addition to the dose limit, a maximum level of transuranic radionuclides (^{238}Pu , ^{239}Pu , ^{240}Pu , plutonium, as well as ^{241}Am , americium) in the soil of 0.2 uCi/m^2 was agreed upon. The progress of the past year in completing the scientific studies has been in keeping with the overall goal of determining compliance.

Radiological Monitoring. Possibly the largest component of the study has been an evaluation of the radiological conditions at Rongelap Island and the other southern islands of Rongelap Atoll. This study component is the responsibility of the RMI Nationwide Radiological Study. Three full field missions to Rongelap have been carried out for the purpose of making environmental measurements and collecting samples. On these trips, all of the islands were sampled using a systematic grid sampling program. To accomplish this, the thick underbrush was cut through to form a periodic array of sampling points. Over 165 high resolution gamma spectrometry measurements were made on Rongelap Island alone.

At each site, surface soil samples were collected for evaluating transuranic levels since these radionuclides cannot be measured by gamma emissions. These samples have been analyzed by a combination of wet chemistry and alpha spectrometry techniques. First, however, the soil is prepared by drying and crushing. Consequently, the total number of steps is fairly extensive. The analysis of these samples is nearly complete. Deep soil profiles were also acquired on the field trips; data from these are used to interpret all the other measurements.

In addition, coconuts, breadfruit, arrowroot, coconut crabs, and pig meat collected from Rongelap are also being analyzed. All sample analysis is nearly complete.

Compliance Evaluation. The methods used to evaluate compliance with dose limit and soil radioactivity limit prescribed in the four-party memorandum of agreement are relatively complex. The difficulty arises because the dose calculated is a projection, rather than a measured quantity. Extreme care is required to maintain scientific credibility; this projection, in particular, requires extensive documentation of the assumptions involved in the calculations and for the evidence supporting those assumptions. Methods which have been proposed are now being reviewed

internationally for credibility. Dose calculations are expected to be carried out early in 1994 using all of the available data from the studies.

Microdistribution of Plutonium in Soil. The object of this study is to evaluate the microscopic characteristics of plutonium in the soil. The results from this study do not directly factor into the compliance calculations, but rather will provide supplementary scientific data to better understand the health risks from plutonium in the environment of Rongelap. This study component is also the responsibility of the RMI Nationwide Radiological Study.

The study uses a special plastic detector material that registers microscopic pits or "tracks" from the alpha particles emitted by plutonium; the tracks can be made visible after a month-long exposure and after etching in a strong NaOH base solution. The pattern of the tracks mimics the pattern of the plutonium in the soil, i.e., it can show whether the plutonium is distributed evenly as very small particles or whether larger granules of plutonium are present. The risk from plutonium depends in a complex way on the size of these particles and, for this reason, learning about the particle size is of fundamental interest. During the year, a research grade computerized microscope and imaging system were developed in conjunction with an American microscope supplier and several subcontractors. This system enables data to be collected from the plastic track detectors indicating the size and quantity of plutonium granules in the soil. A collaborator from the Medical Research Council in Didcot, United Kingdom, spent two weeks in Majuro helping collect the first set of data in August 1993. Analysis of this data is proceeding under the guidance of a statistical collaborator at the University of Lancaster in the United Kingdom. Analysis of the track images produces tremendous volumes of data because of the microscopic scale being examined. Data collection from the many soil samples will continue over a period of many months.

Trace Element Intake Study. One possible contributor to internal dose, particularly from plutonium, is the direct ingestion of soil into the body. This seemingly unlikely occurrence is documented to be a worldwide phenomenon--sometimes accidental and sometimes intentional--by both children and adults. This study component, also the responsibility of the Nationwide Radiological Study, is designed to directly measure the amount of soil being ingested by children on Mejetto by analyzing feces for trace elements found in the soil. This study has a number of relatively difficult logistical problems to accommodate and, for these and other reasons, has not yet taken place. Nevertheless, considerable time this year was devoted to literature review, community meetings on Mejetto, preliminary data collection, and outside contractor negotiations. Part of the difficulty lies in the collection of fecal samples

from children over a one-week period, which must proceed without any contamination by dust or dirt. At the same time, a carefully controlled selection of food must be supplied to the children for all meals in order to eliminate the possibility of eating the same trace elements that are found in the soil. With this study design, samples can be collected at one time from only about 25% of the 120 children residing at Mejetto. Complete sample collection for the children of Mejetto will take about a month. During this time, samples require freezing and, therefore, electricity and reliable freezer storage will be required.

During the past year, extensive negotiations were undertaken with the University of Massachusetts to assist in the sample analysis. Sample analysis requires a mass spectrometry laboratory, a facility available at only a few major research institutions. UMass backed out of the project and currently a new contractor is being sought.

Other progress included the conduct of a food inventory survey at every household on Mejetto from which a list of all available foods was compiled. From this list, suitable dietary choices can be made to design the "tracer suppression" diet. During the course of the study, the foods will be analyzed to find the optimal diet for dwellers of the rural areas of the Marshall Islands.

The completion of this study cannot be foreseen before mid-1994. However, the conclusions of this study will not be needed to determine compliance with the established dose limitations. Plutonium normally contributes very little of the total dose; it is likely that the cesium exposure alone will determine if compliance is possible.

In early November 1993, Dr. Simon attended the second Technical Oversight Group meeting of the Rongelap Resettlement Project. This meeting was held in New Orleans, Louisiana, and was attended by a delegation of the Rongelap leadership and scientists from Europe, Japan, and New Zealand. At the New Orleans meeting, Dr. Simon presented a substantial document on progress of the four scientific studies for which the Nationwide Radiological Study is responsible.

Thyroid Study

Although this study had been long delayed, several important steps were made in late 1992 to prepare for a nationwide study of the prevalence of thyroid disease. In November 1992, Dr. Simon was visited by two Japanese physicians from Tohoku University who were invited to participate in a first phase of the thyroid study. Dr. Simon and the physicians held a successful meeting with the medical staff of the Ebeye Hospital for purposes of planning the study proposed to begin in Ebeye.

The study on the prevalence of thyroid diseases in Marshallese had been formally proposed to the Ministry of Health in 1992 by the Nationwide Radiological Study and the Scientific Advisory Panel. With the agreement of the Ministry of Health and Environment and the cooperation of the Ebeye Hospital, the Ebeye examination phase, funded by the Nationwide Radiological Study, commenced early in 1993. Protocol development and general planning was assisted by Dr. Klauss Trott and medical examinations were conducted by three endocrinology surgeons from the Second Department of Surgery of Tohoku University: Dr. Keisei Fujimori, Dr. Tatsuya Takahashi, and Dr. Hiroshi Ohtomo. From January 15 to March 7, 1993, screening for thyroid disease was offered to all adult residents of Ebeye. Every participant received a physical examination of the thyroid. A blood sample was taken from most participants to evaluate TSH (thyroid stimulating hormone) levels as a test for hypothyroidism. In addition, basic health data was recorded as well as information on past health conditions, diet, and residence history.

A main objective of the study was to examine persons alive at the time of the nuclear testing or those born a few years after it ended. Thus, the study intended to concentrate on persons who are now thirty-five years of age or older, with those between twenty-eight and thirty-five years of age also of interest for comparison purposes. No younger person was refused an examination if requested. Altogether, 1,368 Marshallese residents of Kwajalein Atoll were examined. Their ages ranged from sixteen to ninety years.

There were at least two very strong points to the study design. First, high-resolution ultrasound was used in order that the physician could visually examine the thyroid using sound waves displayed on a special video screen. Second, each patient was separately examined by two different medical doctors, one giving a standard palpation examination and the second administering an ultrasound examination. The ultrasound machine was used to measure the size of abnormalities (nodules) and generate paper copy reproductions of the image. A photograph of the ultrasound image was given to each participant and added to the patient's medical chart and the sizes of any nodules were recorded. The smallest nodule found by ultrasound was 2 mm and the largest was 60 mm diameter.

Palpable nodules were on average larger than nodules that were non-palpable. The median size of nodules which were non-palpable was 7.5 mm (about 1/4 inch), while the median size of palpable nodules was 16 mm (about 3/4 inch), although there was considerable overlap between both distributions. The smallest palpable nodule was 7 mm in diameter, while the largest nodule non-palpable was 20 mm in diameter. Nearly 20% of the palpable nodules were smaller than 10 mm and nearly 20% of the non-palpable nodules were larger than 10 mm.

A fine needle aspiration biopsy was performed for each of the 128 patients with palpable nodules. This is a procedure by which a very minute amount of thyroid tissue sample is removed. The tissue sample was stained in Ebeye, sent to Japan, and examined by Dr. Norioko Kimura in the Second Department of Pathology of Tohoku University in Sendai. The percentage of biopsies yielding sufficient material to permit an unequivocal diagnosis was about 60%. In twenty-three patients, thyroid cancer is the most likely diagnosis; this diagnosis will only be confirmed at the time of surgery. Results of the biopsies, however, did indicate papillary thyroid cancer in five patients.

In agreement with most other studies, the prevalence of thyroid nodules was higher in females than in males. Also in agreement with other studies was a pronounced dependence of prevalence on age: nearly 50% of women over sixty years of age were found to have nodular thyroid disease. The total incidence of thyroid nodules appears relatively high in the population of Ebeye: 13.5% of women over thirty years of age and 6.7% of men over thirty years of age have palpable thyroid nodules. The results from the Ebeye study are generally higher than those found elsewhere in the world except in the areas with significant iodine deficiency. However, it is also known that sensitive screening methods can yield higher nodule prevalence rates. The Nationwide Radiological Study is proceeding cautiously in drawing conclusions as to the probable causes of these benign and malignant nodules. Of most immediate concern is the rate of occurrence of the thyroid cancers and providing the appropriate medical care.

Medical reports on all 1,368 people have been filed at the Ebeye Hospital with the patients' medical charts. In addition, letters have been distributed to all participants. For those persons found to have nodules, the letters were delivered directly to them by Dr. Trott during his visit to Ebeye early in September 1993 or were sent by mail to those who did not attend any of the announced meetings.

Recommendations for treatment are as follows. For those persons with nodules that are non-palpable and for all people with palpable adenomatous goiter which does not cause any difficulty with swallowing or compression of the trachea, no treatment is needed. No surgery should be performed on these cases. A follow-up examination has been scheduled for Spring 1995 for these individuals to determine if any significant change in their condition has occurred. Surgery should only be performed on those people for whom ultrasound or fine needle biopsy examinations suggest either cancer or a large follicular adenoma. In a few patients, advanced age or other serious disease suggests that thyroid surgery would not be in their best interest. After consultation with the doctors at the Ebeye Hospital, fourteen patients have been selected for thyroid surgery because of suspected malignant thyroid nodules.

Overall, the Ebeye phase of the Thyroid Disease Study was successful. The local population accepted the offer of a thyroid examination to dispel or confirm their individual fears concerning thyroid disease. The Japanese doctors were very popular and the cooperation and communication with the physicians and medical staff in the hospital were excellent. The results of the study confirmed the suspected high prevalence of thyroid disease in the population, which indeed was higher than predicted.

At a meeting with President Kabua and the Nititiela on August 30, 1993, the leaders of the nation recommended an extension of the study to other atolls. Such a study would initially be based in Majuro and later extended to outer atolls.

The data from the Ebeye study were transferred to computer disk using a program supplied by the Department of Preventive Medicine at St. Bartholomew's Medical College, London. In the analysis of this data, the following three hypotheses, as stated in the original proposal, will be studied:

1. People who were children between 1946 and 1958 and who lived close to Bikini and Enewetak during those years have a higher risk of thyroid disease than those who lived further away.
2. After 1958, the atoll of residence during childhood had no influence on the risk of thyroid disease.
3. For persons who became an adult from 1946 to 1958 or who were older, the atoll where they resided at the time of the nuclear testing had less influence on the risk of thyroid disease than for those who were children at the time.

The close association between the Thyroid Disease Study and the Nationwide Radiological Study also provides an important analytical tool not previously available. Recently collected environmental radiation data from all atolls can be extrapolated backward to estimate the likely exposure at the time of the testing for persons at locations throughout the Marshall Islands. Although this process is difficult and somewhat uncertain, it will be possible to compare the geographic pattern of thyroid disease with either the geographic pattern of present-day residual contamination or the geographic pattern of exposure at the time of the bomb tests. The possibility of making these comparisons will improve the ability of this study to draw convincing conclusions over previous investigation.

Other hypotheses may be suggested from closer analysis of the information collected during the Ebeye phase of the Thyroid Study. However, because more than 6,000 Marshallese who were alive at the time of the bomb tests have yet to be examined, other hypotheses will be explored only after the next phase of medical examinations and the collection of similar information about more participants. By using the largest database possible,

the Nationwide Radiological Study and the Scientific Advisory Panel will be able to provide the most authoritative interpretation. Regardless of the outcome of scientific analyses examining the relationship of thyroid disease and radiation exposure, many Marshallese citizens with heretofore unknown thyroid disease will be identified and provided with appropriate medical care.

Summary

Fiscal Year 1993 was one of significant progress toward completion of the radiological field survey of the atolls of the Marshall Islands. The size of the laboratory staff remained relatively stable, although there was significant change in personnel. The plutonium chemistry laboratory and soil sample preparation facilities both greatly increased their throughput. Despite numerous difficulties with equipment, a significant number of samples were measured for radioactivity in the laboratory.

The Nationwide Radiological Study was successful in conducting the first phase of a Nationwide Thyroid Study, screening nearly 1,400 Marshallese residing at Kwajalein Atoll.

Significant progress was also accomplished in the scientific studies of the Rongelap Resettlement Project.

4. Section 177 Health Care Program

In accordance with Section 103(j) of U.S. Public Law 99-239, since April 1987 the Government of the Republic of the Marshall Islands has operated the Section 177 Health Care Program as a successor to the Four Atoll Health Care Program that had been established and administered by the United States Government. Following the precedent established by the Four Atoll Health Care Program, the present program serves the Marshallese people with ancestral ties to Bikini, Rongelap, Utrik, or Enewetak Atolls. These people may live in one of the four principal communities or elsewhere in the Republic. In addition to these enrollees of long-standing, the Nuclear Claims Tribunal has assigned to the program those citizens of the Marshall Islands who have been awarded compensation for physical injury that may have been caused by the U.S. Nuclear Testing Program.

Program Overview

The Section 177 Health Care Program succeeded in providing primary, secondary, and tertiary care during 1993, limited only by the constraints of a fixed annual budget. Solutions continued to be developed to overcome the principal challenge facing the program: to provide comprehensive medical services to the large number of people enrolled in the program, while accommodating the increasing costs of health care services within the \$2.0 million annual ceiling established for the program by Article II, Section

1 of the Agreement Between the Government of the United States and the Government of the Marshall Islands for the Implementation of Section 177 of the Compact of Free Association.

The program emphasized decentralized treatment at primary care dispensary sites, with a clinic in Majuro. Central support was provided from Majuro to the health assistants who man the dispensaries. Patient referral to secondary treatment facilities (the hospitals in Majuro and Ebeye) was arranged and coordinated by the administration and medical staff in Majuro. Tertiary care for procedures not available within the Marshall Islands was also coordinated by the program staff in Majuro and provided under contract at the Queen's Medical Center in Honolulu.

The program continued to evolve to meet the needs of its beneficiaries and to adapt to the changing health care environment in the Marshall Islands. Because of a continuing urban migration of people from the outer atolls to Majuro, the primary care patient load in Majuro continued to increase. Additional primary care resources are now being provided in the Majuro clinic, in addition to those in place in the outer atoll dispensaries.

The program had an enrollment of 6,773 at the close of Fiscal Year 1993. (It is important to note that this figure is significantly smaller than the 9,907 enrollees at the close of Fiscal Year 1992, and even smaller than the approximately 7,300 enrollees who belonged to the Four Atoll Health Care Program when the RMI Government assumed responsibility for the program in early 1987. The leaders of the beneficiary communities, especially Utrik were able to accomplish this reduction by revising the enrollment lists.) The six operating dispensaries and one clinic saw an average of 798 patients per month, a rate that approximated nearly one-and-a-half visits per year by individuals enrolled in the program.

In accordance with the Compact legislation, funding for the medical program is fixed at \$2.0 million per year. The fluctuation in the number of people to be served, compounded by increases in health care service costs, has often exhausted the available funds before the end of the program quarter or year. This shortage of funding has caused suspensions in key elements of the program for significant periods of time. During Fiscal Year 1993 travel support for inter-island referrals was suspended from February 22 through April 21 and again from August 2 through the end of the fiscal year. Tertiary care was suspended in January 1993 for the remainder of the fiscal year. The program previously provided enrollees residing in Honolulu with the opportunity to make a quarterly walk-in visit to the outpatient clinic of the Queen's Medical Center; this feature of the program was suspended in Fiscal Year 1992 and remains suspended.

For most of the first seven years of the Section 177 Health Care Program, it has been a policy that referrals for tertiary care were to be made by the Medical Referral Committee of the RMI

Government, with the decisions of the Committee subject to a veto by the senators from the four atolls. The exercise of this privilege by the senators was often described as a "political"---as opposed to "medical"---referral. Starting with Fiscal Year 1994, all referrals will be based solely on medical considerations.

A new Health Care Information System was institutionalized during the year. This project was supported by a grant and technical assistance from the Office of Territorial and International Affairs of the U.S. Department of the Interior. The system has made possible improved patient referral and tracking, recording of medical information, control of expenses, and provision of data on patient load and utilization planning.

During the year, the Section 177 Health Care Program aggressively pursued provider discounts for medical services and supplies. Discounts were granted by the major tertiary care provider, Queen's Medical Center of Honolulu, and also by ophthalmological and pharmaceutical suppliers.

Improvements were made in outer island dispensary equipment as a result of equipment donations obtained from member hospitals of Mercy International Health Services. More can and will be done to improve the conditions of some of the outer island dispensaries in Fiscal Year 1994.

The RMI Government's Nationwide Radiological Study commissioned a group of Japanese thyroid doctors to screen the adult population of Ebeye for the prevalence of thyroid disease. The study had two aims. The first was to provide baseline information on the prevalence of thyroid disease in the general population of the Marshall Islands. The second aim was to determine the correlation of the prevalence of thyroid disease with suspected causes, such as dietary factors and exposure to radioactive iodine during childhood. Of the 1,368 people screened, 128 patients were diagnosed with palpable thyroid nodules, among whom were twenty-three patients with suspected cancers. Most suspected cancers and several cases of large non-malignant nodules will require surgery during Fiscal Year 1994. While this survey is planned to be expanded to other locations throughout the nation, the Section 177 Health Care Program will have to bear the expenses for treatment of those people found to have thyroid nodules.

The Section 177 Health Care Program continued its emphasis on primary care by sending medical teams to the outer atolls to provide on-site medical care. Patients who could not be treated at their home atoll were referred to Majuro or Ebeye for further evaluation and treatment. Patients requiring procedures that are not available at Majuro or Ebeye can be referred to Honolulu for medical care. In addition to these services, the Section 177 Health Program operates an outpatient clinic in Majuro.

The program is changing in many respects. There is a greater need for outpatient ambulatory care in Majuro, as many residents of the outer islands continue to migrate to this urban center. The 177 Health Care Program is feeling the effect of this trend every day as patients fill the clinic. The RMI National Health Plan began operation in October 1991; this plan has a subrogation clause which makes the Section 177 Health Care Program the primary insurer for all medical expenses of its beneficiaries. Improvements were made in the Health Information Systems, which will provide more accurate and detailed information for better operational planning. The Honolulu referral program was expanded to include the Tripler Army Medical Center as a tertiary health care provider. The administrative operation of the Section 177 Health Care Program was adjusted to accommodate these and other dynamics.

5. Enewetak Agricultural and Food Programs

Background

Title I, Section 103(h)(2) of the Compact of Free Association (U.S. Public Law 99-239) makes provision for a supplemental food program for the resettled community at Enewetak Atoll, which had been the site of forty-three American atomic and nuclear tests. (This section of the Compact also assures that USDA commodity foods will be provided to the people of Enewetak and the three other communities in the Marshall Islands that were most directly affected by the U.S. Nuclear Testing Program. These programs have been extended by law through Fiscal Year 1996.)

Beginning in Fiscal Year 1988 the Government of the Marshall Islands assumed responsibility for those components of the agricultural and food program at Enewetak that had formerly been administered by TTPI Headquarters:

- a. the Government of the Marshall Islands entered into contract with the incumbent captain and engineer of the Wetak II motor sailer for a continuation of their services;
- b. beginning with calendar year 1988, the Government of the Marshall Islands paid the annual insurance premium for the Wetak II; and
- c. a nutritionist employed by the RMI Ministry of Social Services was made available for quarterly trips to Enewetak to review the nutritional needs of the community and make recommendations regarding the supplemental foods ordered for the community.

The costs for services administered by the Government of the Marshall Islands were covered by a grant from the Office of Territorial and International Affairs. Other aspects of the rehabilitative work, agricultural maintenance, and food support at Enewetak were performed by the U.S. Department of Energy

through its contractors, Holmes and Narver and Raytheon Services Nevada.

The Government of the Marshall Islands and the Office of Territorial and International Affairs established similar administrative arrangements for the Enewetak Agricultural and Food Program in Fiscal Years 1989, 1990, and 1991.

Throughout this period, management of the program was progressively transferred to the people of Enewetak. To provide training in several areas of expertise, especially for the senior managerial positions, the program continued to be administered by the U.S. Department of Energy contractors through Fiscal Year 1991. With the exception of the indirect support administered by the RMI Government, the Enewetak Council assumed full responsibility for the program in the second quarter of Fiscal Year 1992, with technical advice provided by the DOE support services contractor and the captain of Wetak II employed by the RMI Government. For several years previously, management decisions regarding the Wetak II motor sailer had been made by the Enewetak Local Government Council, which owns the vessel.

Program Highlights -- Fiscal Year 1993

The budget for Fiscal Year 1993 was devised by the Enewetak Local Government Council with the assistance of the DOE management advisor and RMI Government officials.

The DOE/Raytheon Services Nevada advisor ended his work at the project site on January 31, 1993. The buildings and equipment of the field station were transferred by DOE to the Enewetak Local Government Council in February 1993.

The new community pier, which had been completed the previous year, facilitated the off-loading of supplies, including the supplemental food, delivered by ship.

With the financial support of the supplemental food program, the Enewetak Local Government engaged the services of an American health and nutrition consultant to conduct training in nutrition for the women of Enewetak.

Procurement of Supplemental Food and Kerosene

The procurement of food was coordinated by the Enewetak Field Station and the Majuro Support Office. The ordering, procurement, shipping, and payment were administered by project personnel. The quantities of food brought to Enewetak by the program were increased to better meet the nutritional needs of the community; a total of 3,023 cases of food were shipped to Enewetak during the year. In addition, the program shipped 10,000 gallons of kerosene to Enewetak, the same volume provided by the program in Fiscal Year 1992. The schooner Wetak II continued to transport most of the supplemental food and kerosene.

Agricultural Activities

The principal objective of the agricultural program has been to re-establish and maintain the traditional food crops of coconut, pandanus, breadfruit, taro, lime, and banana. Food crops have been cultivated on the inhabited islands of Enewetak, Medren, Japtan, and Ananij. An annual program of brushing and weeding is undertaken at each of these four islands. The number of food bearing plants at each island are summarized in the table below.

| LIVE PLANT STATUS AS OF OCTOBER 1993 | | | | | | | | | |
|--------------------------------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| ISLAND | COCONUTS | | PANDANUS | | BREADFRUIT | | BANANAS | | LIMES |
| | Present Numbers | Numbers Bearing | Present Number | Number Bearing | Present Number | Number Bearing | Present Number | Number Bearing | Present Number |
| Enewetak | 4726 | 2861 | 1896 | 629 | 182 | 97 | 59 | 59 | 39 |
| Medren | 8435 | 5630 | 1550 | 73 | 45 | 22 | 15 | 15 | 18 |
| Japtan | 3555 | 3505 | 282 | 197 | 21 | 17 | 2 | 2 | 1 |
| Anani | 572 | 566 | 128 | 100 | 0 | 0 | 0 | 0 | 0 |
| TOTALS: | 17288 | 12562 | 3856 | 999 | 248 | 136 | 76 | 76 | 58 |

The agricultural field crew performed crop maintenance, as well as replanting, constructing windbreaks, cleaning taro pits, and watering. The agricultural crew enlarged six of the fifteen taro pits adjacent to the Enewetak runway. It is planned that other taro pits will be expanded in Fiscal Year 1994.

In November 1992 Typhoon Gay passed just south of Enewetak Atoll. The typhoon brought winds of 60 knots, gusting to 80 knots, with seas of 15 to 20 feet. The storm caused extensive damage to crops, windbreaks, and taro pits. The windbreak vegetation was completely swept away at the shoreline. In the recovery effort, the agricultural crew replanted the seashore windbreak on Enewetak Island with Casuarina seedlings.

The Enewetak Local Government Council established an ordinance requiring pigs to be penned. The ordinance was enforced by the local constables. It is reported that the enforcement succeeded in keeping the swine out of the food crop areas.

Plans and a budget were developed for Fiscal Year 1994 with strong emphasis on the planting of food crops, reestablishment of nurseries on Enewetak and Medren, and expansion of the planting areas along the Enewetak runway. The plans make provision for

the involvement of landowners in the agricultural program, including the establishment of a garden area on each Weto (communally owned parcel of land), in addition to enlargement of the taro pits. The agricultural program will be aided with the technical assistance of consultants sponsored, in part, by the USDA Land Grant program, the United Nations Development Program, and the University of the South Pacific.

Motor Sailer Wetak II

During Fiscal Year 1993 the trading schooner Wetak II completed eighteen voyages, with trips to Kwajalein, Pohnpei, Kosrae, and Ujelang. These trips were made for the purpose of transshipping to Enewetak supplemental foods, kerosene, and other supplies. Two inter-atoll charters were contracted to transport to Ujelang Atoll (temporary home of the Enewetak community during the period of the U.S. Nuclear Testing Program) members of the Enewetak Local Government Council and a survey team from the RMI Nationwide Radiological Study.

The vessel is now crewed entirely by men from the Enewetak community. All except two of the voyages during the past year--to such destinations at Ujelang, Pohnpei, Kosrae, and Kwajalein--were made without the presence of the American training captain who had previously directed the Wetak II. For each of these voyages, the training captain remained available at Enewetak to provide assistance via radio communication. In February 1993 the training captain relinquished to his Marshallese counterpart responsibility for operation and maintenance of the vessel, but remained at Enewetak as a management advisor for the program.

In the transportation of supplemental food and kerosene the Wetak II made more voyages and spent more time at sea than in previous years. This was due, in part, to the increase in the quantities of the quarterly food shipments. The vessel motorsailed more than 13,000 nautical miles during the program year and transported more than 300,000 pounds of cargo to Enewetak. Further increases are anticipated in Fiscal Year 1994.

Responsibility for planning the voyages remained with the Enewetak Local Government Council.

The high turnover of crew members continued to detract from efforts at seamanship training. It has been a policy of the Local Government Council that all sailors on the vessel must be members of the Enewetak community, by either birth or marriage. Consequently, there are very few individuals who are eligible to be crew members and are otherwise suitable.

A priority of the program has been a maintenance program to ensure the safety of the ship and her crew. A special emphasis of the program has been to motivate the performance of routine ship maintenance and the application of new skills.

In March 1993 the trading schooner Wetak II came to the aid of a Japanese longline fishing vessel that had lost her way and was low on fuel. The Wetak II transferred fuel at sea, but the fishing boat was still unable to make way. The Wetak II then proceeded to tow the fishing vessel sixty nautical miles into the calm waters of Enewetak lagoon. There she made repairs with the assistance of field station personnel and proceeded to Majuro to commence commercial fishing.

Operation and Maintenance of Field Station

The personnel of the Enewetak Field Station were responsible for procuring and shipping the supplemental food and kerosene from Kwajalein, Majuro, Kosrae, and Pohnpei and making payment for these supplies. The shipments were coordinated with the help of the logistics coordinator in Majuro. The supplies from Ebeye, Kosrae, and Pohnpei were shipped on board the Wetak II, while the shipments from Majuro were transported on inter-island vessels operated by the RMI Government.

The Enewetak Field Station contributed to a number of community support projects, including school rehabilitation, road repair, and dock rebuilding. In the aftermath of Typhoon Gay, the personnel of the Field Station engaged in cleanup and reconstruction, including the clearing of debris from the roads and wetos and the rehabilitation of a house trailer and the carpentry shop at the Field Station.

Among the construction projects completed at the Field Station during the year were a new storage building, a toilet facility, and a shallow groundwater well to supply saltwater for the sewage system.

Thirty-nine people were employed at the Enewetak Field Station.

Majuro Support Office

From its office in Majuro, the Food and Agricultural Logistics Officer supported the Enewetak Agricultural and Food Program on a day-to-day basis. He coordinated the procurement and transportation of supplemental food, kerosene, and project supplies. He was also responsible for personnel data records, travel arrangements, facsimile communications, and other support services.

Once the program began operating independently of the U.S. Department of Energy in February 1993, the Majuro Support Office has had sole responsibility for liaison of the program with suppliers and other organizations.

6. Rongelap Resettlement Project

Background

The residents of Rongelap Atoll were exposed to intensive radioactive fallout from the March 1, 1954, Bravo thermonuclear test 105 miles upwind at Bikini. Although the fallout was visible on Rongelap--some witnesses described it as snow-like--the residents, not expecting such a disturbance and not being familiar with the substance, did not take precautions to minimize their levels of exposure. The sixty-four Rongelap residents were exposed to about half of a lethal dose of radiation during a fifty-hour period before the U.S. Navy evacuated them to a medical base at Kwajalein. Also removed to Kwajalein were eighteen Rongelapese who had been gathering food and copra on nearby Ailinginae Atoll and the 157 residents of Utrik Atoll who had been exposed to less severe levels of radiation. In June 1954 the U.S. Government authorized the construction of a temporary village for the Rongelapese on Ejit Island in Majuro Atoll, District Center for the Marshall Islands District of the U.S. Trust Territory of the Pacific Islands.

It was later determined that Rongelap Atoll was so heavily contaminated that the islanders would not be able to return for an extended period. In February 1957, on the basis of field data and dose calculations, the U.S. Atomic Energy Commission (AEC), with the concurrence of the High Commissioner of the Trust Territory of the Pacific Islands, announced that Rongelap Atoll had become safe for rehabilitation. Soon thereafter a repatriation program was begun with the reconstruction of the village. In late June 1957 approximately 250 Rongelapese who had been living in Majuro or Ebeye return home after nearly forty months of exile. Since then, the AEC and its successor agency, the U.S. Department of Energy (DOE), have provided environmental radiation monitoring and a radiological health care program for the fallout victims of Rongelap and Utrik. The continuation of medical care and its accompanying logistical support are assured through Fiscal Year 1997 by Section 103(h)(1) of the Compact of Free Association (U.S. Public Law 99-239).

By the mid-1960s, damage to the thyroid gland made its appearance in persons in the Rongelap community who were under ten years of age at the time of the Bravo blast. Of the nineteen persons examined in this age group, seventeen tumors appeared, including one cancer. Of three persons who were exposed in utero, two have developed benign thyroid tumors. Several children became hypothyroidal, and growth was stunted in two boys who received very high doses of radiation at about one year of age.

During the first four years following exposure, the frequency of miscarriages and stillbirths was higher among exposed women than it was among women who were away from Rongelap when the Bravo fallout occurred, but no difference has been observed since that time.

Low-level residual radioactivity remained on Rongelap at the time of the 1957 resettlement. It was found that the coconut crab, a much-favored food among Marshallese, tended to concentrate strontium-90 and consumption of local crabs was forbidden. Following resettlement of Rongelap, it was apparent from the DOE measurements that persons who were not living on Rongelap at the time of the Bravo accident were absorbing radioactivity through locally-grown food at the same rate as the exposed population.

Through the 1970s more thyroid nodules appeared. Spokespersons for the Rongelap community, expressing grave concern for the health status of their people, requested an independent health review, which was not granted.

Fearful of their continued exposure to radiation, all 295 residents voluntarily abandoned Rongelap in May 1985, with the assistance of Greenpeace. The community now resides at Mejetto Island in the remote northwest quadrant of Kwajalein Atoll.

Although DOE scientists agree that the northern islands in Rongelap Atoll are still too dangerous for habitation, they believe that the southern islands are safe. Uncertainties over this question prompted the U.S. Congress to insert Section 103(i) in the Compact of Free Association, requiring the Government of the Republic of the Marshall Islands (RMI) to undertake a scientific project to review the sufficiency of the DOE data and conclusions. This study, known as the Rongelap Reassessment Project, concluded that: (1) adults may reside on Rongelap Island under ordinary conditions with no significant danger from radiation, (2) the northern islands of Rongelap Atoll should remain off-limits for food gathering until measures have been taken to limit the uptake of cesium into the food crops, (3) before Rongelap is resettled, the U.S. Department of Energy should resume the whole-body counting program for the protection of the settlers, and (4) further scientific inquiry was needed on several important questions. The report of this project was completed and submitted to Congress in 1988 and served as the basis for the petition to Congress by the Rongelap community and the RMI Government for an appropriation, authorized by the Compact of Free Association, for the recommended scientific studies and the beginning of a resettlement trust fund, which has begun to be funded by Congress.

With a \$1.6 million grant from the U.S. Government, the RMI Government and the Rongelap Local Government jointly established a scientific project to examine the technical issues identified by the Rongelap Reassessment Project as requiring further study, including (1) the levels of residual radiation remaining at Rongelap Atoll, (2) the possible danger of Rongelap residents absorbing plutonium through oral intake, and (3) the dosage of radioactivity that infants and small children would receive from local foods.

The Rongelap Resettlement Project consists of several different scientific studies with the overall objective of determining the suitability of resettling Rongelap Island and the other southern islands of Rongelap Atoll. The determination of suitability will be based upon compliance with a dose limit and a soil contamination level. The dose limit of 100 mrem/year above background radiation was agreed upon in negotiations between the U.S. Department of Energy and representatives of the Rongelap community. The two compliance limits, both of which must be satisfied, were written into the agreements governing the project. In addition to the dose limit, a maximum level of transuranic radionuclides (^{238}Pu , ^{239}Pu , and ^{240}Pu -plutonium and ^{241}Am -americium) in the soil of 0.2 uCi/m^2 was agreed upon.

Radiological Monitoring

The largest study component has been the evaluation of the radiological conditions on Rongelap Island and the other southern islands of Rongelap Atoll. This study component is the responsibility of the RMI Nationwide Radiological Study. Three full field missions to Rongelap have been carried out for the purpose of making environmental measurements and collecting samples. On these trips, all of the southern islands were examined using a systematic grid sampling program in which the thick underbrush was cut through to gain access to a regular array of sampling locations. Over 165 high resolution gamma spectrometry measurements were made on Rongelap Island alone. These measurements require very sophisticated electronic measuring instruments as well as a supply of liquid nitrogen. The result is a complete evaluation of gamma emissions from any radionuclide which might be present. The data collected in the field is analyzed in the Majuro laboratory of the RMI Nationwide Radiological Study. All of these spectral measurements have now been analyzed and are being used to predict the whole-body gamma exposure to which a future inhabitant of Rongelap would be exposed.

At each site, surface soil samples were collected for evaluating transuranic levels since these radionuclides cannot be measured by gamma emissions. These samples are analyzed by a combination of wet chemistry and alpha spectrometry techniques. First, however, the soil is prepared by drying and crushing, in a process of many steps. Typically, no more than ten soil samples can be analyzed in a week. The analysis of these samples will be completed in mid-November 1993.

Deep soil profiles were also acquired on the field trips. Data from the soil profiles are used in interpreting all the other measurements.

In addition, samples of coconuts, breadfruit, arrowroot, coconut crabs and pig meat collected from Rongelap are also being analyzed. All sample analysis is nearly complete.

A number of samples have been divided ("split") with scientists from the Lawrence Livermore National Laboratory, the prime contractor for the U.S. Department of Energy, to evaluate the radiological conditions of Rongelap. The split sample analysis from Rongelap Island is now complete and a comparison is underway. Following confirmation of DOE data, additional measurements from Lawrence Livermore will be made available to the Rongelap Resettlement Project scientists as a supplement to their own data for use in the project assessment.

Diet Study

The evaluation of gamma exposure described above is only one component of the information that will be needed to determine compliance with the dose limit. Another major contributor to dose is the internal dose received from foods which contain ¹³⁷-cesium. The foods are being analyzed as described above. However, it is important to know the quantities of food typically consumed. The Memorandum of Understanding governing the project requires that exposure be evaluated on the basis of both a "local food" only diet and a mixed diet of local and imported foods. A study to determine a suitable diet for compliance calculation purposes is the responsibility of Mr. Bernd Franke. Mr. Franke has used the expertise of a professional dietician from the South Pacific Commission, with guidance from a diet expert on the project Oversight Group. A diet survey was conducted on Mejetto in May 1993 using about a dozen volunteers from the community who were trained in a workshop in Majuro early that month. Data analysis of the results of the diet survey are proceeding and should be available soon for external review and eventual use in the dose compliance calculations.

Compliance Evaluation

The methods used to evaluate compliance, particularly for the dose limit, are relatively complex. This is because the dose calculated is a projection, as opposed to a measured quantity. Consequently, extreme care will be taken to maintain scientific credibility. This activity, in particular, requires extensive documentation of the assumptions involved and the evidence in support of those assumptions. A method developed by Dr. Steven L. Simon, Director of the RMI Nationwide Radiological Study, from his previous work in dosimetric evaluation was presented to the Rongelap Oversight Group in August 1992 and was subsequently evaluated in England by a statistical consultant. This subject will be reviewed again by the Oversight Group at the scheduled meeting in New Orleans in early November 1993. Dose calculations are expected to be carried out early in 1994 using all of the available data from the studies.

Microdistribution of Plutonium in Soil

The objective of this study is to evaluate the microscopic characteristics of plutonium in the soil. The results from this study do not directly factor into the compliance calculations,

but rather will provide supplementary scientific data to better understand the risks from plutonium in the environment of Rongelap. This study component is also the responsibility of the RMI Nationwide Radiological Study.

The study uses a special plastic detector material which registers microscopic "tracks" from the alpha particles emitted by plutonium; after being exposed for a month to soil samples taken from Rongelap, the tracks can be made visible by developing in a strong base solution. The pattern of the tracks mimics the pattern of the plutonium in the soil, i.e., it can show whether the plutonium is distributed evenly as very small particles or whether there are larger granules of plutonium present. The risk from plutonium depends in a complex way on the size of these particles and, hence, learning about the particle size is of fundamental interest. The past year has seen the development of a research grade computerized microscope-imaging system to record and analyze the track data from the plastic detectors. The system was developed by a contractor from specific requirements written for the needs of the study. In August 1993 a collaborator from the Medical Research Council in Didcot, United Kingdom, spent two weeks in Majuro helping to collect the first set of data. Analysis of this data is proceeding under the guidance of a statistical collaborator at the University of Lancaster in the United Kingdom. Analysis of the track images produces tremendous volumes of data because of the microscopic scale being examined. Data collection from the many soil samples will continue over a period of many months.

Trace Element Intake Study

One possible contributor to internal dose, particularly from plutonium, is the ingestion of soil directly into the body. This seemingly unlikely occurrence is documented to be a worldwide phenomenon--sometimes accidental and sometimes intentional--in both children and adults. This study component, also the responsibility of the RMI Nationwide Radiological Study, is designed to directly measure the amount of soil being ingested by children on Mejetto Island by analyzing their feces for trace elements found in the soil. This study has had to overcome relatively difficult logistical problems and, for this and other reasons, the field work for this study has not yet been accomplished. Nevertheless, considerable time has been devoted to literature review, community meetings on Mejetto, preliminary data collection, and negotiations with an outside contractor. Part of the difficulty lies in the collection of fecal samples over the course of a one-week period without any contamination by dust or dirt. During this week-long period, the project will have to supply food for all meals in order to eliminate the possibility of the children eating the same trace elements, which might be present in their food. With the present study design, samples can be collected at one time from only about one-fourth of the 120 children residing at Mejetto. Therefore, sample collection at Mejetto will take about a month. During this time, samples will have to be frozen, thus electricity and reliable freezer storage will be required.

During the past year, extensive contract negotiations were undertaken with the School of Public Health at the University of Massachusetts to assist in the sample analysis. Sample analysis requires a mass spectrometry laboratory, a facility which is available at many institutions. This analysis cannot be performed in Majuro. Currently, a new contractor is being sought as the University of Massachusetts recently backed out of the project. Securing a new contractor should not be difficult.

For this component of the project, a food inventory survey was conducted at every household on Mejetto. From this survey a list was compiled of all foods normally consumed by the residents of Mejetto. From this list, suitable dietary choices can be made to design the "tracer suppression" diet. During the course of the study, analysis will be conducted on the foods to find the optimal diet.

The completion of this study cannot be foreseen before mid-1994. However, the overall issue of compliance can be judged without this component of the study. Plutonium normally contributes very little of the total dose, and it is likely that the cesium exposure alone will determine whether compliance is possible.

Plutonium in Bone Study

Long unanswered has been the question of how much plutonium is absorbed by the human body following exposure. Previous scientific data indicates that only a small fraction is absorbed, the remainder being relatively quickly eliminated. That fraction of the plutonium absorbed, however, becomes nearly permanently resident in the skeleton. There the risk arises from the blood-forming cells and the bone tissue being continuously exposed to the alpha particle emissions of the plutonium. A study of the plutonium in deceased Rongelap residents was contracted to Mr. Bernd Franke. In January 1993 bone samples were acquired from seven exhumed bodies that had been buried on Mejetto Island. Of the seven subjects, one was exposed to Bravo fallout, six others were exposed to only residual contamination on Rongelap after 1957 and one was a control subject from Majuro. Analysis of the samples is proceeding at a laboratory in Germany; some split samples are being analyzed elsewhere for comparison.

Ambassador KENDALL. In addition, we understand that the preserved thyroid glands removed from approximately 77 Marshallese patients who were exposed to radioactive fallout from the U.S. bomb tests are in storage at the Brookhaven National Laboratory Medical Program. We respectfully request that the orders be returned to the Republic of the Marshall Islands as they are the personal property of the Marshallese.

Article 9 of the section 177 agreement has particular bearing on this hearing and at the risk of being redundant, I would like to quote that in full.

If loss or damage to property and person of the citizens of Marshall Islands, resulting from the Nuclear Testing Program, arises or is discovered after the effective date of this agreement, and said injuries were not and could not have reasonably been identified as of the effective date of this agreement and if said injuries rendered the provision of this agreement manifestly inadequate, the Government of the Marshall Islands may request that the Government of the United States provide for such injuries by submitting such a request to the Congress of the United States for its consideration.

We note that article 9 of the section 177 agreement, Mr. Chairman, also provides that Congress is not committed by the changed-circumstances provision to authorize or appropriate funds to additional compensation. Nonetheless, it is the view of my Government that the United States Government continue responsibilities arising from the effects of the nuclear testing program on our people and our islands and the environment. We believe that the United States carries the responsibility to compensate our people.

The information which has been developed since 1983 when the section 177 compact agreement was negotiated, some of which we have heard about today and the nearly eight years of experience of the Marshall Islands Government in implementing the Compact of Free Association have made it abundantly clear that the state of our knowledge about the effects of the nuclear tests on our island and our people have changed in a material way since the compact was negotiated.

The section 177 settlement is a significant and important measure taken by the U.S. Government and my Government which addresses the effects of testing, but it is incomplete and additional claims are existing at the time.

Day by day, we are developing compelling evidence that the fallout from the detonation at Bikini and Enewetak was more widespread than previously disclosed, and that many more Marshallese people were exposed to higher levels of radiation than previously discovered.

Acting on the basis of this mounting evidence the Government of the Republic of the Marshall Islands soon will determine if there are grounds to invoke article 9 of the section 177 agreement. Based on the new information already before us which did not exist in 1983, it is hard to avoid the conclusion that the section 177 agreement is manifestly inadequate. Because the evidence upon which a formal request under article 9 will be based is being developed, we will continue to gather evidence and information before coming to Congress with an official proposal.

Our request will be formulated as we make final determinations based on the facts, and we look forward to working with the subcommittee in particular on this important matter. Mr. Chairman,

as you are aware, the people of my country were greatly harmed by the nuclear testing program.

The physical harm to the people of Rongelap and Utirik is well-documented, and we know of the deprivations endured by the communities of Bikini and Enewetak as a result of their compulsory relocation.

In addition to these wrongs which have long been acknowledged by the United States Government, it is the conviction of my Government that many more Marshallese people were harmed than have been recognized throughout the prolonged negotiation of the compact. This was always our position.

At that time, our evidence was anecdotal. It had arisen from daily life in the Marshall Islands during the testing era and now it depends on the government radio station, passed along by word of mouth, told people to cover their fresh-water systems or wrap their heads in arms if outside during a test. The Marshallese witnessed the glow of the blast. Many Marshallese people attribute their illnesses from the radiation from these tests. The Marshallese people are still haunted by uncertainty and fear about radiation. We are now assembling documentation to enable Congress to fully appreciate the impact of the testing on our people.

It is important that the record of this hearing reflect the fact that radioactive contamination from the nuclear testing program remains a serious threat to human health and safety and to the environment. There are islands that continue to be severely contaminated. Indeed they remain off-limits to the people of the Marshall Islands. Other islands have various levels of residual radioactive contamination.

Equally important, it must be recognized, that previous cleanup efforts failed to conform with standards that prevail today. It is obvious that the American public will never accept in the United States the kind of conditions that exist in the Marshall Islands. Under such circumstances, it is critically important that our two Governments work together to find a prompt, permanent and responsible solution to this problem.

Mr. Chairman this concludes my remarks. Sitting with me this afternoon are other witnesses from the Marshall Islands whom I would like to introduce now.

With me at the table I would like to address Mr. Peter Oliver to my right, Mr. Bill Graham, Senator Johnsay Riklon from Rongelap, Mayor Billiet Edmond of Bikini and Henchi Balas, Senator from Bikini, Ismael John, Senator for Enewetak, and Toko Henry, a citizen of Enewetak.

Also in the audience is one of our negotiators who did a lot of work on the Compact of Free Association. I would like to introduce him. Also he is part of the delegation. I believe he will have something to say if the committee so desires. Thank you, Mr. Chairman.

[Prepared statement of Ambassador Kendall follows:]

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STATEMENT OF WILFRED I. KENDALL
AMBASSADOR FROM
THE REPUBLIC OF THE MARSHALL ISLANDS
TO THE UNITED STATES OF AMERICA

BEFORE

THE SUBCOMMITTEE ON
OVERSIGHT INVESTIGATIONS

COMMITTEE ON NATURAL RESOURCES

U.S. HOUSE OF REPRESENTATIVES

February 24, 1994

Mr. Chairman and members of the Subcommittee,

On behalf of the Government and people of the Marshall Islands, I would like to express our gratitude to you for investigating the effects of the United States Nuclear Testing Program that was conducted in our country for a twelve-year period during the height of the Cold War. I know that you, Mr. Chairman, and many members of the Committee on Natural Resources have long been concerned about the harm that was caused to the Marshallese people. We very deeply appreciate your concern, and we thank you for holding the hearing today and inviting our participation. We strongly urge the Subcommittee to continue investigating the disturbing questions that have been raised in testimony today, and we would encourage the Subcommittee to reconvene in the months ahead to consider the response of the Department of Energy to these questions.

The legacy of the Nuclear Testing Program is a central feature of the present relationship between the United States and the Marshall Islands. The two nations are allied in the Compact of Free Association, which came into effect in October 1986. Section 177 of this Compact and the related subsidiary agreement established a mechanism for compensating the people of the Marshall Islands who suffered physical injury or loss of property from the Nuclear Testing Program. The compensatory programs administered by my government include direct payments each quarter to four communities affected by the nuclear tests, a Claims Tribunal that adjudicates disputes and makes awards to claimants, a continuation of the Four Atoll Health Care Program originally established by U.S. law, and the Nationwide Radiological Study that Dr. Simon discussed in his testimony. The Marshall Islands Government also administers supplemental food programs for the nuclear victims and assists the people of Rongelap in administering the Rongelap Resettlement Project.

Mr. Chairman, the many nuclear-related programs administered by the Marshall Islands Government are further described in a July 8, 1993, letter to you from Foreign Minister Tom Kijiner, and I request that this letter be included in the record of this hearing.

I would also like to provide for the record a report on implementation of the Section 177 Agreement during Fiscal Year 1993.

Finally, I ask to be included in the record of this hearing a recent letter from my government to the Department of Energy requesting additional information about the Nuclear Testing Program.

In addition, we understand that the preserved thyroid glands, removed from approximately 77 Marshallese patients who were exposed to radioactive fallout from the U.S. bomb tests, are in storage at the Brookhaven National Laboratory Medical Program. We respectfully request that the preserved organs be returned to the Republic of the Marshall Islands as they are the personal property of the Marshallese citizens.

Article IX of the Section 177 Agreement has particular bearing on this hearing. This article provides as follows:

"If loss or damage to property and person of the citizens of the Marshall Islands, resulting from the Nuclear Testing Program, arises or is discovered after the effective date of this Agreement, and such injuries were not and could not reasonably have been identified as of the effective date of this Agreement, and if such injuries render the provisions of this Agreement manifestly inadequate, the Government of the Marshall Islands may request that the Government of the United States provide for such injuries by submitting such a request to the Congress of the United States for its consideration..."

We note that Article IX of the Section 177 Agreement also provides that Congress is not committed by the changed circumstances provision to authorize or appropriate funds for additional compensation. Nonetheless, it is the view of my government that the United States government has significant continuing responsibilities arising from the effects of the nuclear testing program on our people and our islands, and the responsibility of the U.S. includes as yet uncompensated injuries and other damages resulting from its nuclear testing program which are still being discovered.

The information which has been developed since 1983 when the Compact Section 177 Agreement was negotiated, some of which we have heard about today, and the nearly 8 years of experience of the Marshall Islands Government in implementing the Compact of Free Association -- have made it abundantly clear that the state of our knowledge about the effects of the nuclear tests on our land and our people has changed in a material way since the Compact was negotiated. The Section 177 settlement is a significant and important measure taken by the U.S. and my government which addresses the effects on testing, but it is incomplete and based only on claims existing at the time.

Day-by-day, we are developing compelling evidence that the fallout from the detonations at Bikini and Enewetak was more widespread than previously disclosed, and that many more Marshallese people were exposed to higher levels of radiation than previously discovered. Acting on the basis of this mounting evidence, the Government of the Republic of the Marshall Islands soon will determine if there is grounds to invoke Article IX of the Section 177 Agreement. Based on the new information already before us which did not exist in 1983, it is hard to avoid the conclusion that the Section 177 Agreement is manifestly inadequate.

Because the evidence upon which a formal request under Article IX will be based is being developed, we will continue to gather evidence and information before coming to Congress with an official proposal. Our request will be formulated as we make final determinations based on the facts, and we will look forward to working with the Subcommittee in particular, on this matter.

Mr. Chairman, as you are aware, the people of my country were greatly harmed by the "nuclear testing program". The physical harm to the people of Rongelap and Utrik is well documented, and we know of the deprivations endured by the communities of Bikini and Enewetak as a result of their

compulsory relocation. But in addition to these wrongs, which have long been acknowledged by the United States Government, it is the conviction of my government that the many more Marshallese people were harmed than had been recognized. Throughout the prolonged negotiation of the Compact, this was always our position.

At that time, our evidence was anecdotal. It had arisen from daily life in the Marshall Islands during the testing era. Announcements on the government radio station, passed along by word of mouth told people to cover their fresh water cisterns or wrap their heads and arms, if they ventured outside when a test was scheduled. Many Marshallese people witnessed the glow of the Bravo blast on their northern horizon. Many Marshallese people attribute their illnesses to the radiation from these tests. And the Marshallese people are still haunted by uncertainty and fear about radiation. We are now assembling documentation to enable Congress to fully appreciate the impact of the testing on our people.

It is important that the record of this hearing reflect the fact that radioactive contamination from the Nuclear Testing Program remains a serious threat to human health and safety and to the environment. There are islands that continue to be severely contaminated, indeed, they remain off-limits to the people of the Marshall Islands. Other islands

have varying levels of residual radioactive contamination. Equally important, it must be recognized that previous cleanup efforts fail to conform with standards that prevail today. It is obvious that the American public would never accept in the United States the kind of conditions that exist in the Marshall Islands. Under such circumstances, it is critically important that our two governments work together to find a prompt, permanent, and responsible solution to this problem.

Mr. Chairman, this concludes my remarks. Sitting with me this afternoon are other witnesses from the Marshall Islands. I would like to introduce them as they offer their testimony.

Once again, I thank the Subcommittee for its interest in this vitally important matter.

Mr. MILLER. Are there other members of the panel who have statements to make or comments?

STATEMENT OF WILLIAM C. GRAHAM

Mr. GRAHAM. Mr. Chairman, I am Bill Graham, the public advocate at the Nuclear Claims Tribunal. We have the statutory responsibility for advising, assisting and representing claimants before the tribunal. I think that my statement encapsulates the compensation program that the tribunal has been able to put in place since its establishment in mid-1988. I believe that speaks for itself.

I would just like to state that I think that the testimony that has been made before the committee already today clearly documents the changed circumstances in the medical and scientific knowledge. I believe there are many changed circumstances in other areas as well, but I would like to note that the medical and scientific knowledge of the effects of radiation, which I think has been sufficiently documented as having changed since the date the 177 agreement was signed is not based on studies that have been done in the Marshall Islands of effects of the radiation on humans, but it is more based on the effects that have been done by the Radiation Effects Research Foundation in Hiroshima and other groups. In fact, there have not been the studies conducted on the effects of radiation on the people of the Marshall Islands that were envisioned in Public Law 96-205, which required, and I quote, "comprehensive periodic survey and analysis of the radiological status of the atolls, development of updated radiation dose assessments, and risk estimates of residing on the atolls."

As the public advocate, I have had opportunities to talk with Dr. Radford and Dr. Hamilton about this and many others of the doctors who have been involved, they are always looking at the reports and the studies that have been generated on other people and not on the people of the Marshall Islands, per se. These studies have not been done that would enable us to state with any certainty what the real effects of the testing program and the radiation created by it were and have been and will be on the people of the Marshall Islands.

In addition, although it may not be my place to do so, I don't know that anyone else will do so. I would like to introduce into the record of this hearing a resolution that was adopted by the Nitijela of the Marshall Islands earlier this month. I am inserting a certified copy.

In accordance with the statement at the end, the resolution will be provided to President Clinton, to Secretary O'Leary, to Senator Johnston, as well as to yourself, Chairman Miller, but their resolution deals with the issue that I was just speaking to and it respectfully requests the Government of the United States to provide for the construction and operation, maintenance and staffing of a specialized hospital in the Republic of the Marshall Islands to diagnose and treat patients with thyroid cancers and other related medical conditions resulting from the nuclear testing program and to further provide funding for medical and radiological studies with respect thereto.

As much as the declassification of past information is important, this, I believe, is as important, if not more so, that we begin to deal

with those effects and begin to really assess and analyze what those effects are and will be in the future on the people of the Marshall Islands. Thank you.

[Prepared statement of Mr. Graham follows:]

**BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS**

**STATEMENT OF BILL GRAHAM, PUBLIC ADVOCATE
MARSHALL ISLANDS NUCLEAR CLAIMS TRIBUNAL
FEBRUARY 24, 1994**

Mr. Chairman and distinguished members of the Subcommittee,

The Agreement for the Implementation of Section 177 of the Compact of Free Association, signed by Marshall Islands President Amata Kabua and United States Ambassador Fred Zeder in Majuro in June 1983, formally recognized as yet unspecified "contributions and sacrifices made by the people of the Marshall Islands in regard to the Nuclear Testing Program."

In Article VIII of that Agreement, the Government of the United States concluded that the Northern Marshall Islands Radiological Survey and related environmental studies conducted by it represented "the best effort ... to evaluate and describe radiological conditions in the Marshall Islands" and that those studies "can be used for the evaluation of the food chain and environment and estimating radiation-related health consequences of residing in the Northern Marshall Islands."

The state of the art scientific reference available at the time for estimating such radiation-related health consequences was the report "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation" issued in July 1980 by the National Academy of Sciences/National Research Council's Committee on the Biological Effects of Ionizing Radiation.

That report, commonly known as BEIR III, acknowledged that there were unresolvable differences among committee members concerning the methods of extrapolating to the most probable effects of low doses of radiation. Because of those differences, the somatic effects section of the initial final draft report that had been approved by the Academy in 1979 was modified by a subgroup of the committee, resulting in the writing of a strong dissenting statement to the report by Dr. Edward P. Radford, Chairman of the overall BEIR III Committee and of the Subcommittee on Somatic Effects.

Dr. Radford stated his support for the linear no-threshold model originally adopted by the subcommittee for estimating cancer induction by radiation, as opposed to the linear-quadratic model frequently employed in the final version of the report. He observed that the approach used "has the effect of reducing the cancer risk estimates ..." and that this conclusion "ignores the considerable body of supportive data ... which indicate that as the follow-up of human study populations has been extended, evidence of cancer risk is increasing, the doses at which effects have been observed have progressively decreased, and the number of different human cancers in which radiation exposure has shown an effect has been extended." [BEIR III, page 250]

In 1990, the National Research Council and National Academy of Sciences issued a new report entitled "Health Effects of Exposure to Low Levels of Ionizing Radiation—BEIR V." Citing "significant developments in our knowledge" and "new data on the late health effects of radiation in humans," the Executive Summary section of the BEIR V report states (at page 6): "The cancer risk estimates derived with the preferred models used in this report are about 3 times larger for solid cancers (relative risk projection) and about 4 times larger for leukemia than the risk estimates presented in the BEIR III report."

Clearly, circumstances had changed with regard to accepted medical and scientific knowledge about the effects on humans of exposure to radiation since the 1983 consummation of the Section 177 Agreement.

In the meantime, in accordance with Article IV of the Agreement, the Government of the Republic of the Marshall Islands had established the Nuclear Claims Tribunal in mid-1988, giving it statutory jurisdiction "to render final determination upon all claims past, present and future of the Government, the citizens and nationals of the Marshall Islands which are based on, arise out of, or are in any way related to the Nuclear Testing Program."

During the first year of its existence, the Tribunal received thousands of claims for an extensive variety of personal injuries, land damage and loss of personal property from and on behalf of individuals from every atoll in the Marshall Islands. In addition, the Tribunal had:

Reviewed the reported results of the 1978 Northern Marshall Islands Radiological Survey, noting that the survey had been conducted strictly on an aerial basis and that Kwajalein and all atolls to the south had been excluded from the survey;

Analyzed both the BEIR III report and the history of medical findings of Brookhaven National Laboratory visits to the Marshall Islands, and observed that the focus of the latter's examinations had been limited largely to the people of Rongelap and Utirik;

Apprised itself of the programs established by Congress for the benefit of those people of the Marshall Islands deemed to have been affected by the testing program¹ and ascertained what had been done to provide compensation and medical care and treatment;

Sought information on the monitoring for illnesses, the comprehensive periodic survey and analysis of radiological status, and the development of updated radiation dose assessments and risk estimates mandated by Congress in 1980², and found no evidence of any such efforts beyond Bikini, Enewetak, Rongelap and Utirik; and

¹ For example: U.S. Public Laws 88-485 (1964) and 95-134 (1977), which provided compensation to the peoples of Bikini, Enewetak, Rongelap and Utirik "in full settlement and discharge of all claims against the United States arising out of the thermonuclear detonation on March 1, 1954" and P.L. 96-205 (1980), which was intended to "provide for the people of the atolls of Bikini, Enewetak, Rongelap, and Utirik and for the people of such other atolls as may be found to be or to have been exposed to radiation from the nuclear weapons testing program, a program of medical care and treatment..." (italics added)

² Also provided for under U.S. Public Law 96-205.

Taken notice of U. S. Public Law 100-321 (the Radiation-Exposed Veterans Compensation Act of 1988), which provided a "presumption of service connection" to veterans who participated in the testing program for 13 specified medical conditions.

By mid-1989, the Tribunal had realized that it could not effectively carry out its mandate based on the limited information available to it. Most of the personal injury claims before it were not supported by a documented medical diagnoses and so could not be adjudicated in a fair manner. And without radiological survey results for half of the nation's atolls and islands, many of the land claims could never be heard. Accordingly, the Tribunal requested the Government of the Republic to utilize the \$3 million available to it under Article II, Section 1(e) of the Section 177 Agreement to conduct medical surveillance and radiological monitoring activities on a nationwide basis.

A medical diagnostics program, directed by expatriate M.D.s, was established by the Republic in early 1990 and was continued by the Tribunal, at its own expense, for an additional six months when the allocated 177 funds had been exhausted in late 1992. During the three years of its existence, the program's doctors examined and/or reviewed medical records of nearly 3,500 personal injury claimants and filed with the Tribunal individual diagnostic reports on each.

In addition, in late 1989, a nationwide radiological study was initiated by the Republic under the direction of a resident scientist working with an international scientific advisory panel. The activities of that study continue and will be reported on today by Dr. Steven Simon.

With documented medical diagnoses of personal injury claimants beginning to come before the Tribunal and the release of the BEIR V report, the Tribunal was finally able to begin, in early 1991, the actual process of establishing a compensation program for personal injury. In carrying out this task, an important guideline was provided by the United States Radiation Exposure Compensation Act of 1990 (P.L. 100-406). Under that law, Congress found that "fallout emitted during the Government's atmospheric nuclear tests exposed individuals to radiation that is *presumed* to have generated an excess of cancers among these individuals." (italics added) The law provides for "partial restitution" in the form of payments of \$50,000 for any of 13 specified diseases suffered by people meeting certain physical presence requirements.

Before, during, and after the testing program, the U.S. had failed to compile exposure data on the people of the Marshall Islands, had failed to investigate thoroughly the existing health and non-radiation risk factors of the population, and had largely provided medical diagnostic services only to the people of Rongelap and Utirik, whose radiation exposure levels it could only estimate.

In light of the presumptions of service connection and causation extended by the United States to its own citizens, the Tribunal determined that it could do no less than provide for similar presumptions on behalf of the people of the Marshall Islands. Therefore, after much deliberation and review, the Tribunal adopted regulations in August 1991 identifying 25 medical conditions which it would administratively presume were caused by exposure to radiation created by the testing for those who were physically present in the Marshalls Islands during the period of testing. In late 1993, the Tribunal amended its regulations to include two additional conditions on the presumed list, bringing the current total to 27 (see Attachment I).

The first 13 of the Tribunal's presumed conditions are the same as in the Radiation-Exposed Veterans Compensation Act and the Radiation Exposure Compensation Act. The additional 14 were adopted based on research finding of the Radiation Effects Research Foundation in Japan and its Life Span Study of atomic bomb survivors, the conclusions contained in BEIR V, and on consultation with and recommendations of Dr. Robert Miller, a recognized expert in the area of radiation health effects who is the Chief of Clinical Epidemiology at the National Cancer Institute.

Once the original list of 25 presumed conditions had been finalized, the Tribunal's attention was directed to setting amounts of compensation for each condition. With substantial input from a variety of medical professionals, a rating system was developed taking into account three distinct matrices: typical prognosis, general amount of pain and suffering, and level of treatment usually involved for each condition. This led to an overall ranking of the original 25 conditions with a wide range of impact between the top and bottom.

The Tribunal then re-examined the provisions of the U.S. Radiation Exposure Compensation Act. Of the 13 conditions compensated equally at \$50,000 under that law, it was clear that thyroid cancer ranked well below the other 12 on the Tribunal's ranking of overall impact. Based on this, the Tribunal determined that the \$50,000 RECA payment for thyroid cancer should be viewed as a benchmark and that compensation levels for the other 24 conditions should be established based on their relative impact and severity (again, see Attachment 1).

To date, the only compensation awards made by the Tribunal have been for those 27 presumed medical conditions, as suffered by individuals who were physically present in the Marshall Islands during the testing program.

Only a few awards have been made for presumed medical conditions suffered by deceased individuals for whom the only documented diagnosis is that contained on a certificate of death.³

No awards have been made for any personal injuries suffered by individuals who had not been born (or were not *in utero*) by the conclusion of the testing program.

No awards have been made for other accepted radiogenic conditions such as lung cancer which may be proven by an individual to have resulted from the testing program but which are not on the presumed list because of other risk factors.⁴

³ A decision issued by the Tribunal in June 1993 provided that, with certain restrictions, "any certificate admitted for the purpose of showing that a decedent suffered from a compensable condition should constitute prima facie evidence of that issue." That decision limited the acceptable period between time of death and signing of the certificate by the physician to five days. In January 1994, based on briefs filed before it, the Tribunal issued a decision stating that it "will admit death certificates which are signed up to one year after death as prima facie evidence of the existence or non-existence of a medical condition." Resolution of over 20 such claims is pending.

⁴ It is expected that resolution of claims for such "non-presumed personal injuries" will begin during this year through formal individual and/or group hearings conducted by the Tribunal. Before those hearings can be scheduled, however, radiation exposure dose estimates must be prepared on an individual basis for each claimant who suffered from a non-presumed medical condition that could have resulted from radiation. The need for these dose estimates has been communicated to the nationwide radiological study but it is uncertain when or if the study will be able to provide the requested information.

No awards have been made for any of the genetic effects which have been diagnosed and which may be linked to parental exposure.

No awards have been made for the many documented birth abnormalities or anomalies that have been observed since the testing program began.

No awards have been made for the side effects, intrusions on lifestyles, or inconveniences experienced by the people of the Marshall Islands. For example, Atomic Energy Commission doctors prescribed, on a preventive basis in the 1960s, daily thyroid medication for many of the people of Rongelap and Utirik for the rest of their lives.

No awards have been made for exposure *per se* or for any other emerging effects of radiation that may be found.

And no awards have been made for damage to, loss of, or loss of use of any land or property.

Despite having made no awards in any of these areas, over half of the \$45.75 million available to the Tribunal over the period of the Compact for payment of all types of damage has already been awarded⁵ since the first claims were approved and initial payments were made by the Tribunal in August 1991. Annual pro-rata payments, made every October since 1991, have resulted in actual distributions of \$9.1 million, representing a current cumulative payment of 40% of each award.

Current information leads one to conclude that the extent of the damage caused by exposure to radiation from the testing program, although presumably greater on Bikini, Enewetak, Rongelap and Utirik, was by no means limited to those atolls. The fact is that compensation has been awarded to people from every atoll in the nation (see Attachment 3), suggesting that, as a biological indicator, there was widespread fallout throughout the Marshall Islands.

In summary, the truth about the damaging effects of the United States nuclear testing program on the people and lands of the Marshall Islands will never be fully known. Nevertheless, any assistance which this Committee can provide in obtaining the release of presently declassified information about the testing program or in generating new and additional information through further study of its effects will be greatly appreciated by the Tribunal and the claimants before it.

However, if the experiences of the Nuclear Claims Tribunal in attempting to establish and administer a fair and reasonable program of compensation for damages is an accurate indicator, I believe that it can safely be said that the information already known about the extent of those damages is sufficient to render the provisions of the Section 177 Agreement manifestly inadequate.

⁵ As shown in Attachment 2, compensation in the net amount of \$22.8 million had been awarded to or on behalf of 572 individuals for a total of 676 presumed conditions as of December 31, 1993. A number of individuals have been awarded compensation for more than one presumed condition; most such individuals were on Rongelap or Ailingnae atolls at the time of the Bravo event on March 1, 1954, and have been awarded compensation for the conditions of beta burns, acute radiation sickness and some type of thyroid disorder.

Marshall Islands Nuclear Claims Tribunal Notice of Regulations: Compensation for Damage to Person

Pursuant to §23(13) of the Marshall Islands Nuclear Claims Tribunal Act 1987, as amended, the Tribunal adopted regulations in August 1991 establishing a list of 25 medical conditions which are irrebuttably presumed to be the result of the Nuclear Testing Program. Those regulations were amended by the Tribunal in January 1994 to add two additional conditions (numbers 26 and 27 below) to the presumed list.

For eligible claimants who were present in the Marshall Islands during the testing program period, the administratively presumed medical conditions and the amounts of compensation for each that will be paid in pro rata annual payments are as follows:

| | |
|---|-----------|
| 1. Leukemia (other than chronic lymphocytic leukemia) | \$125,000 |
| 2. Cancer of the thyroid | |
| a. if recurrent or requires multiple surgical and/or ablation | \$75,000 |
| b. if non-recurrent or does not require multiple treatment | \$50,000 |
| 3. Cancer of the breast | |
| a. if recurrent or requires mastectomy | \$100,000 |
| b. if not recurrent or requires lumpectomy | \$75,000 |
| 4. Cancer of the pharynx | \$100,000 |
| 5. Cancer of the esophagus | \$125,000 |
| 6. Cancer of the stomach | \$125,000 |
| 7. Cancer of the small intestine | \$125,000 |
| 8. Cancer of the pancreas | \$125,000 |
| 9. Multiple myeloma | \$125,000 |
| 10. Lymphomas (except Hodgkin's disease) | \$100,000 |
| 11. Cancer of the bile ducts | \$125,000 |
| 12. Cancer of the gall bladder | \$125,000 |
| 13. Cancer of the liver (except if cirrhosis or hepatitis B is indicated) | \$125,000 |
| 14. Cancer of the colon (but not cancer of the rectum) | \$75,000 |
| 15. Cancer of the urinary bladder | \$75,000 |
| 16. Tumors of the salivary gland | |
| a. if malignant | \$50,000 |
| b. if benign and requiring surgery | \$37,500 |
| c. if benign and not requiring surgery | \$12,500 |
| 17. Non-malignant thyroid nodular disease (unless limited to occult nodules) | |
| a. if requiring total thyroidectomy | \$50,000 |
| b. if requiring partial thyroidectomy | \$37,500 |
| c. if not requiring thyroidectomy | \$12,500 |
| 18. Cancer of the ovary | \$125,000 |
| 19. Unexplained hypothyroidism (unless thyroiditis indicated) | \$37,500 |
| 20. Severe growth retardation due to thyroid damage | \$100,000 |
| 21. Unexplained bone marrow failure | \$125,000 |
| 22. Meningioma | \$100,000 |
| 23. Radiation sickness diagnosed between June 30, 1946 and August 18, 1958, inclusive | \$12,500 |
| 24. Beta burns diagnosed between June 30, 1946 and August 18, 1958, inclusive | \$12,500 |
| 25. Severe mental retardation (provided born between May and September 1954, inclusive, and mother was present on Rongelap or Utrik Atolls at any time in March 1954) | \$100,000 |
| 26. Unexplained hyperparathyroidism | \$12,500 |
| 27. Tumors of the parathyroid gland | |
| a. if malignant | \$50,000 |
| b. if benign and requiring surgery | \$37,500 |
| c. if benign and not requiring surgery | \$12,500 |

The regulations adopted by the Tribunal also provide a mechanism and set out applicable standards for (1) the consideration of non-presumed conditions for compensation in individual cases; (2) the periodic evaluation of possible modifications to the list of presumed conditions; (3) the assignment of compensation levels to non-presumed or future presumed medical conditions; and (4) adjustments to the amounts of compensation based on age and prognosis.

To review or obtain copies of the regulations, contact Cathlina J. deBrum, Clerk of the Tribunal, P. O. Box 702, Majuro, MH 96960; telephone (692) 625-3396; facsimile (692) 625-3389.

MARSHALL ISLANDS NUCLEAR CLAIMS TRIBUNAL
ADMITTED CLAIMS BY CONDITION AND AMOUNTS AWARDED (AS OF DECEMBER 31, 1993)

| | COMPENSATION | # ADMITTED | TOTAL COMP. | DEDUCTIONS* | NET DUE |
|---|--------------|--------------|---------------------|--------------------|---------------------|
| Acute radiation sickness | \$12,500 | 64 | \$800,000 | 0 | \$800,000 |
| Benign salivary gland tumor requiring surgery | \$37,500 | 12 | \$450,000 | 0 | \$450,000 |
| Benign salivary gland tumor without surgery | \$12,500 | 3 | \$37,500 | 0 | \$37,500 |
| Beta burns | \$12,500 | 61 | \$762,500 | 0 | \$762,500 |
| Breast cancer - lumpectomy or no surgery | \$75,000 | 5 | \$375,000 | 0 | \$375,000 |
| Breast cancer - mastectomy | \$100,000 | 14 | \$1,400,000 | \$25,000 | \$1,375,000 |
| Breast cancer - end stage or cause of death | \$125,000 | 14 | \$1,750,000 | \$159,000 | \$1,591,000 |
| Cancer of the colon | \$75,000 | 2 | \$150,000 | \$25,000 | \$125,000 |
| Cancer of the colon - cause of death | \$125,000 | 1 | \$125,000 | \$25,000 | \$100,000 |
| Cancer of the liver | \$125,000 | 3 | \$375,000 | \$36,000 | \$339,000 |
| Cancer of the ovary | \$125,000 | 11 | \$1,375,000 | \$86,000 | \$1,289,000 |
| Cancer of the pancreas | \$125,000 | 5 | \$625,000 | \$81,000 | \$544,000 |
| Cancer of the pharynx | \$100,000 | 4 | \$400,000 | 0 | \$400,000 |
| Cancer of pharynx - end stage or cause of death | \$125,000 | 8 | \$1,000,000 | \$82,000 | \$918,000 |
| Cancer of the stomach | \$125,000 | 4 | \$500,000 | \$106,000 | \$394,000 |
| Cancer of the urinary bladder | \$75,000 | 2 | \$150,000 | 0 | \$150,000 |
| Hypothyroidism | \$37,500 | 13 | \$487,500 | \$175,000 | \$312,500 |
| Leukemia | \$125,000 | 7 | \$875,000 | \$125,000 | \$750,000 |
| Lymphoma | \$100,000 | 7 | \$700,000 | 0 | \$700,000 |
| Lymphoma - end stage or cause of death | \$125,000 | 6 | \$750,000 | \$34,000 | \$716,000 |
| Malignant salivary gland tumor | \$50,000 | 2 | \$100,000 | 0 | \$100,000 |
| Meningioma | \$100,000 | 3 | \$300,000 | 0 | \$300,000 |
| Meningioma - end stage | \$125,000 | 1 | \$125,000 | \$8,000 | \$117,000 |
| Multiple myeloma | \$125,000 | 1 | \$125,000 | 25,000 | \$100,000 |
| Severe growth retardation | \$100,000 | 2 | \$200,000 | \$75,000 | \$125,000 |
| Thyroid cancer | \$50,000 | 37 | \$1,850,000 | \$300,000 | \$1,550,000 |
| Thyroid cancer - multiple surgeries | \$75,000 | 15 | \$1,125,000 | \$100,000 | \$1,025,000 |
| Thyroid nodule - partial thyroidectomy | \$37,500 | 136 | \$5,100,000 | \$862,500 | \$4,237,500 |
| Thyroid nodule - total thyroidectomy | \$50,000 | 8 | \$400,000 | \$75,000 | \$325,000 |
| Thyroid nodule without surgery | \$12,500 | 225 | \$2,812,500 | 0 | \$2,812,500 |
| TOTALS | | 676** | \$25,225,000 | \$2,404,500 | \$22,820,500 |

* Deductions include both prior compensation for the same medical condition and adjustments in the amount of compensation due to age.

** The 676 admitted claims involve 572 individuals (many of whom had more than one admitted condition). Of these totals, 72 of the individuals (totaling 87 of the conditions) died without having submitted a claim and have been claimed by one or more relatives.

ADMITTED CLAIMS BY ATOLL OF BIRTH AND RESIDENCE
(AS OF DECEMBER 31, 1993)

| ATOLL | <u>BY BIRTHPLACE</u> | | <u>BY 1993 RESIDENCE</u> | |
|--------------------------------|-----------------------------|--------------------------|---------------------------------|--------------------------|
| | <u>People</u> | <u>Conditions</u> | <u>People</u> | <u>Conditions</u> |
| Ailinglaplap | 33 | 35 | 13 | 14 |
| Ailuk | 20 | 20 | 3 | 3 |
| Arno | 11 | 11 | 0 | 0 |
| Aur | 6 | 6 | 3 | 3 |
| Bikini/Kili | 6 | 10 | 1 | 1 |
| Ebon | 23 | 24 | 0 | 0 |
| Enewetak/Ujelang | 9 | 9 | 5 | 5 |
| Jaluit | 71 | 72 | 11 | 11 |
| Jebat | 2 | 2 | 1 | 1 |
| Kwajalein (excluding Mejjatto) | 75 | 90 | 184 | 227 |
| Lae | 17 | 19 | 4 | 4 |
| Lib | 2 | 2 | 0 | 0 |
| Likiep | 29 | 31 | 5 | 5 |
| Majuro | 51 | 51 | 166 | 186 |
| Maloelap | 17 | 17 | 5 | 5 |
| Mejit | 21 | 22 | 3 | 5 |
| Mili | 9 | 9 | 2 | 2 |
| Namodik | 22 | 22 | 5 | 5 |
| Namu | 11 | 12 | 4 | 5 |
| Rongelap/Rongerik/Mejjatto | 59 | 131 | 16 | 28 |
| Ujae | 19 | 22 | 2 | 2 |
| Utrik | 28 | 28 | 12 | 12 |
| Wotje | 19 | 19 | 12 | 12 |
| Wotto | 5 | 5 | 4 | 4 |
| Other (outside RMI) | 7 | 7 | 12 | 15 |
| Deceased | <u>0</u> | <u>0</u> | <u>99</u> | <u>121</u> |
| TOTALS | 572 | 676 | 572 | 676 |

NOTE: Many individuals have been awarded compensation by the Tribunal for more than one medical condition. In most of these cases, the awards have been made to people who were on Rongelap on March 1, 1954 and who suffered the conditions of acute radiation sickness, beta burns and some thyroid abnormality.

Mr. MILLER. Thank you very much. Are there any other statements or comments that people wish to make?

STATEMENT OF HON. JOHNSAY RIKLON

Mr. RIKLON. Thank you, Mr. Chairman. First of all, I would like to say that I endorse all these statements that were earlier made by the ambassador, our Ambassador Kendall. And the public has heard Mr. Graham.

I had a prepared statement, but I think most of what I was going to say has basically been stated today. The fact that there needs to be a further investigation, as far as the evidence to be able to expose or know more about what really took place during tests and starting from 1946 up to 1956, so I am not going to really state anything here formally, but I think on the part of the Rongelap, we would request the committee or the Congress of the U.S. to immediately take the necessary steps to remedy our situation.

I think it is time to use the article 9 provision and also to use the section 13(i) immediately, and Rongelap is prepared to start the process as soon as possible.

It is clear that Rongelap has been a victim for a long time, and it is time to move to remedy our situation. The former Senator Ajain, who I believe most of the members of this committee knew him, would be very happy today if he was alive, and I myself have to show my respect for the work that he has done.

With all the statement that I prepared, I would ask the committee to please have it as part of the record and I also had a letter that I sent to you, Mr. Chairman, on behalf of the people of Rongelap to thank you for initiating the process of opening or disclosing the records that had been closed for years and I would also ask that this particular piece of letter be also included in the record.

So with all this statement made, I have no further comments. Thank you.

[Prepared statement of Mr. Riklon and February 17, 1994 letter follow:]

**STATEMENT OF SENATOR JOHNSAY RIKLON
MEMBER — MARSHALL ISLANDS NITIJELA
BEFORE THE COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
U.S. HOUSE OF REPRESENTATIVES**

February 24, 1994

The calendar measures the passage of time. Human experience is measured by our feelings and ideas about events in our lives. As we approach the beginning of a new century as measured by the calendar, the people of the world also are entering into a new era of human experience. The super power dominated world order that was imposed at the end of World War II shaped human experience for the second half of this century more than any other political force. That order and the ethos of the Cold War is passing, but it will be replaced in the future by a better and higher order only if we take responsibility for making that happen.

To do so we must look back over the last fifty years and understand better the events that have constituted our human experience and brought us to where we now stand. We owe it to those who did not survive the Cold War, we owe it to ourselves, and, most importantly, we owe it to our children, to examine the events and experiences of the last five decades to see if we can improve the quality of life for our people by changing the way we manage our affairs.

This is a time of change for the Rongelap people. We are changing the way we manage our affairs because we have learned from our experience, and we are dedicated to improving the quality of life for our community. Mayor Edmond, who is here with me today, is dedicated to promoting greater unity among our people and improving the administrative operations of our local government. We also are dedicated to coordinating our local policies and programs with those of our national government, and our views on U.S. obligations to Rongelap must be understood in light of our status as patriotic citizens of the Republic of the Marshall Islands who are represented diplomatically and officially by our constitutional government. Finally, we are dedicated to doing a better job of telling our story to you here in the United States, so that in making decisions that affect us this Congress can act in a manner that more truly reflects the values of the American people and the principles on which their government is founded.

We view this hearing as part of the process through which the United States also is examining its actions and experience during the Cold War era to determine if it too should change the way it manages its affairs — including its policies relating to the people of Rongelap. Specifically, we hope this hearing will help determine if this Congress has had sufficient information in the past to make appropriate decisions about how the U.S. should meet its continuing obligations arising from the nuclear testing program in the Marshall Islands.

It says a great deal about the character of the American people and their government that we are here today to determine if U.S. policies and measures with respect to the effects of the nuclear tests in our islands should be changed to reflect new knowledge being developed about radiological conditions in our homeland and among our people. Mr. Chairman, we believe your leadership in holding this hearing reflects the faith and confidence you have that the United States is a nation great enough to correct and improve upon the measures it takes to meet its obligations -- even to the least powerful of those to whom its moral duties run. We share your expectation that the U.S. will take further action as necessary to provide full and fair remedies for past injuries and injustices once it has more accurate and complete information about the problems the nuclear testing created for our people.

We too need more information, not only in order to know what will be required on the part of the U.S. in the context of the Rongelap rehabilitation and resettlement process, but perhaps more importantly to know what our real options are and what will be required of us as a community in order for us to take control once again of our own destiny. The greatest obstacle to our empowerment as a people and our ability to become more self-reliant and self-sufficient is the lack of accurate, complete and reliable information about radiological conditions at Rongelap and the physical condition of our people. If you, Mr. Chairman, can bring about the disclosure of any information on these matters which is not yet public you will be doing a great service for the Marshall Islands and Rongelap, as well as the United States.

Of course, even if there were no secret information or significant data that has been withheld with respect to Rongelap, that in itself would tell an entire story. For what was done openly and notoriously to our people was quite enough. The fact that more of what happened to us was not kept secret demonstrates more than anything else our lack of legal standing, rights or access to remedies.

We literally have been victims for four decades, and we have been victimized repeatedly over the years every time DOE revised upward its dose assessments in order to explain some new test-related illness which has appeared in the community. We were victimized by not being evacuated with other islanders before the tests, we were victimized by the decision to go ahead with nuclear test code-named "BRAVO" under conditions which put us at risk, we were victimized by the acute 190 rem exposure we suffered during the Bravo incident, we were victimized by being returned to Rongelap in 1957, and we were victimized by being allowed to sustain additional external and internal doses of radiation poisoning at Rongelap from 1957 to 1985 (when we finally took a measure of control and went into self-imposed exile).

We voted against the Compact and the Section 177 Agreement because important requirements for our recovery from victimization were not addressed. In a sense we've been victimized by scientists, medical personnel, lawyers, and a whole host of

others, most well-intentioned but some not, who used our suffering to advance interests in addition to the well-being of our people, and whose personal and professional loyalties did not always run to the individuals or the community they ethically were obligated to serve. We are optimistic but not assured that the current process to enable us to resettle our community based upon a conservative risk assessment will not leave us once again in the status of victims.

Mr. Chairman, I am here today to state for the record that the people of Rongelap are tired of being victims. We are taking control of our own future and we are going to commit ourselves to a resettlement program that we determine. The 40th anniversary of the Bravo test also will be the beginning of a new program for the recovery of Rongelap from the effects — physical, cultural and economic — of the testing program.

In describing our new strategy for recovery of the Rongelap people from the nuclear testing program, rather than starting with measures we seek from the U.S. — that will come later — let me begin by taking the time to share with you the evolving understanding we have of our relationship to the U.S. and the events that have connected your people and mine.

Instead of basing our thinking about recovery on the same old political clichés, we are coming around to the view that Rongelap and the U.S. actually may have more in common than previously has been considered. For fifty years ago both the people of Rongelap and the people of your nation were caught up in events that were beyond our control and left us with few choices. Let me explain how I see things.

UNDERSTANDING THE U.S. EXPERIENCE

Although the calendar measures the second half of this century beginning in 1950, from the standpoint of human experience it can be said that the second half of this century began for America nine years earlier, on December 7, 1941. That is when the U.S. was required by its will to survive, its moral character and heritage as the cradle of democracy, and ultimately by its very destiny, to become the nation primarily responsible — during the next five decades — for survival of liberty and international law and order.

But the difficulty, hardship and sacrifice that the U.S. would face in the years ahead was beyond human comprehension in 1941. For throughout history wars had sparked human ingenuity to produce technological breakthroughs, and the U.S. knew it would have to invent and produce a massive modern arsenal to defeat the Axis powers. But the people of the U.S. and their leaders had no way of knowing that the struggle which began at Pearl Harbor eventually would produce a technological breakthrough that not only could enable the Allies to prevail in that conflict, but which could lead to destruction of the planet.

Thus, the leadership role the U.S. assumed after Pearl Harbor became more than your brave people could have imagined as they rallied to defeat the Axis powers. Ultimately, once weapons of mass destruction became a reality, the U.S. was responsible for the survival of civilization. The most critical strategic objective of the post- Hiroshima and Nagasaki era was to harness the "doomsday" weapons technology in service to international peace in a manner that prevented the use of those very weapons. In order for the U.S. to meet this most awesome and dreadful responsibility, the weapons development program that ultimately brought atmospheric nuclear testing to our islands was initiated. That fateful moment in history is what began the series of events that led us to this hearing room today.

We recognize that the absolute necessity during World War II of producing a deliverable "atomic bomb" before Hitler could do so involved an unprecedented effort in which people were expected to make sacrifices for what was seen as no less than a struggle for the survival of humanity. In order to prevent a great and ultimate evil that could have brought an end to human liberty and possibly civilization itself, it apparently came to be accepted that many lesser evils would have to be tolerated to achieve victory. Brave men and women gave their lives, and others suffered greatly, to preserve secrecy and produce a weapon for military use.

The crisis mentality of the World War II atomic weapons race transformed itself into the nuclear siege mentality of the Cold War, and it came to be accepted that even greater sacrifices would have to be made in order to ensure survival in the nuclear age. The notion of a world in which the totalitarian regime of the Soviet Union would be able to issue a nuclear ultimatum to the rest of the world was simply unacceptable, and was seen as being as bad or worse than living in the world which would have existed if the Axis powers had acquired the atomic bomb and been able to dictate terms of a WWII surrender to the Allies.

Thus, the dark side of the 1950's for your country was a period of super-high tech weapons science and the politics of nuclear annihilation. A new tolerance for hazards associated with our own nuclear program seems to have been deemed necessary in order to defend against the greater threat posed by the enemy. It apparently was accepted that the imperatives of nuclear weapons testing and production would mean that people and the environment would be put at risk — sometimes calculated, sometimes not, sometimes with the knowledge of the people at risk, sometimes not.

This is how, increasingly, we understand your experience. Recent revelations about contamination of your own lands and injuries inflicted on your own people, though not on the order of our experience, help us see that desperate times produced desperate behavior. We think we are beginning to see how you, as civilized people, but subjected to the extreme "future-shock" stress of the atomic age, and possessed by a sense of mission arising from what was seen as the real and present danger

posed by the Soviet nuclear weapons development program, came to view it as appropriate to select our islands as a test site. Our anger and despair about what was done still haunt us, but we are trying to understand better your experience. We hope you can begin to understand better our experience.

UNDERSTANDING RONGELAP'S EXPERIENCE

Measured, again, by the calendar, the second half of this century began on January 1, 1950. But in the experience of the Rongelap people, the second half of this century began a little more than four years later, on March 1, 1954. It is one of the ironies, and for us the great tragedy, of the Cold War era that the nuclear arms race between the U.S. and the Soviet Union resulted in a decision to test weapons in the Marshall Islands. Were it not for the very nature of the task — testing nuclear weapons — Rongelap would have been literally one of the last places on earth the U.S. ever would have come.

Before World War II Rongelap had been a place where human experience varied only somewhat, and our lives and our culture were sustained by the sea and the life in it, by the land and the plants that grew in our soil. The ocean and our islands were the one constant in our lives to which all else was related.

Our people had no way of knowing that the events of March 1954 would lead to four decades of hardship and sacrifice. There could be no people on earth more completely removed from the events which made the nuclear testing program necessary for you. Yours was the most complex set of requirements for living, ours was the most simple. Having been ruled by the Japanese under League of Nations system and during the war, we expected a better life under the Americans. But what we really expected was basically to be left alone.

The people of Rongelap fall into a small and highly unique class of Cold War casualties. We were not drawn into the arms race out of nationalism, self-interest or for profit. We gained nothing and lost almost everything that gave our lives meaning. We had no legal standing or political rights except those granted unilaterally by the U.S. in the exercise of the absolute authority and discretion granted to the U.S. by the United Nations. In the name of the U.N. and international security the U.S. took complete control of our islands and our people, and in so doing assumed complete responsibility for the effects of the nuclear testing program upon our people.

The people of Rongelap were exposed to risks far greater, and we sustained injuries far more severe, than any other population except your enemy's population at Hiroshima and Nagasaki. Indeed, the weapons used over those Japanese cities involved high air-bursts that did not produce the much more severe radiological contamination to the land that we faced in Rongelap due to the Bravo shot. This is because Bravo's enormous ground level energy yield at Bikini — 1,000 times more

powerful than the Hiroshima blast -- produced massive quantities of radioactive debris that was lifted in a cloud reaching 25 miles into the atmosphere. The fallout deposited at least 142 radionuclides on our islands.

Of course, the effect of Bravo's 17-megaton-yield thermonuclear blast on our people and islands already has been made a matter of record before this body. The purpose of the preceding discussion is to underscore the central theme of my message to you today: The United States and the Rongelap people are bound to one another by historical and moral forces that transcend the political, budgetary, legal, medical and scientific questions which are at issue in 1994. Clearly, all those issues must be addressed and we are ready to roll up our sleeves and work in partnership with DOI, DOE and the rest of the federal government and our own national government to manage and resolve those issues. But restoration of moral rectitude to the relationship between the U.S. and Rongelap will require more.

MEASURES NOW REQUIRED

The most immediate task before us is to take those measures in cooperation with the U.S. required to deal with effects of the nuclear testing program which have not been addressed under the terms of the settlement of prior legal claims pursuant to Section 177 of the Compact of Free Association. For Rongelap that means doing all that is necessary to ensure that Rongelap is habitable and enable our people to resettle in their homeland. In our view, the provisions of Section 103(i) of U.S. Public Law 99-239 provide a framework for the U.S. to fulfill significant obligations in this regard which are above and beyond the important measures which were taken in accordance with the Section 177 Agreement.

We note that there is considerable discussion about Article IX of the Section 177 Agreement. That is a government-to-government matter, but one in which we have a great deal of interest. For the record I want to note that there is no need for further study to determine if material changes in circumstances have come about with respect to Rongelap since the Section 177 Agreement was signed. The only question still to be debated by the scientists is the degree of changed circumstances, and under any of the assessments the discovery of plutonium contamination and repudiation of DOE findings in its 1982 report are grounds to invoke Article IX. Again, we are proceeding under Section 103(i) to work with DOI and DOE, but I wanted to state our view on Article IX for the benefit of the Subcommittee.

The people of Rongelap and their elected leaders understand that addressing outstanding requirements related to the nuclear testing program in the Marshall Islands is just part of a much larger and even more complicated set of requirements relating to the effects of almost fifty years of nuclear weapons testing and production. The U.S. and those nations which possess nuclear technology now must make the same total commitment to repairing damage done to lands, waters and people during the arms race as they once made to prevailing in the arms race

itself. The same unconditional dedication of ingenuity, energy and necessary resources that went into inventing and improving nuclear weapons must now be applied to cleaning up and storing nuclear waste, caring for people who were harmed and preventing repetition of past mistakes and abuses.

Engineering a new world order that will enable the people of all nations to thrive and prosper in political liberty and free enterprise will require that the U.S. provide leadership in a new approach to managing nuclear technology. Enabling those who were harmed during the first four decades of the nuclear age to recover is the first order of business in any rational plan to bring appropriate discipline and accountability to nuclear industries in the post-Cold War era. Thus, enabling the people of Rongelap safely to resettle is an imperative element of any U.S. program to repair the damage done in the name of U.S. national security and international peace during the Cold War.

The cost of meeting this obligation must be seen as part of the cost of the weapons program and the national security policy of the U.S. throughout the Cold War. Spread out over forty years, and considering its value to the U.S., the cost of winding up operations at Rongelap by meeting your remaining responsibilities to the indigenous people of the island is very reasonable. Resettlement of the Rongelap people probably will be one of the least costly projects which will be undertaken to deal with damage to lands and people related to your nuclear technology industries.

Mr. Chairman, we believe you realize that failure now to meet its outstanding obligations to Rongelap simply is not the way the U.S. can do business. We think you also realize that the Cold War will not be over for the U.S. until the dilemma which is the legacy of Rongelap and the nuclear testing program is resolved. For the people of Rongelap will not be able to end the hardship of our exile and have any sense of well-being as a people until we become a self-directed and self-reliant community that works with but does not unduly depend upon the federal government. We want to work with the Department of Energy to advance our common interests and solve problems, but we must do that from a position of strength rather than a position of weakness.

In order for Rongelap to take control of its own long-term planning and day-to-day decision-making, we need to secure a resource base that literally provides a substitute form of self-sufficiency to replace the self-sufficiency we had as a people prior to the nuclear testing program. The primary means by which this can be accomplished is for Congress to appropriate the funding authorized by Section 103(i) of P.L. 99-239 in an amount that ends the annual pilgrimage from Rongelap to Washington D.C. to beg for resources. There is limited efficacy for you and for us in continuing to appear here with tin cup in hand to seek only increments of the asset base we need to take responsibility for our own affairs. This obsolete model

for our relationship with the U.S. is actually contributing to the cultural deterioration and political disempowerment of our people.

Consequently, we will be working with the Clinton Administration and the Congress in the months ahead, and will be making our case to the Appropriations Committee this year, in order to determine the level of funding that would be required to put Rongelap in the position to organize and manage its resettlement. We point to the resettlement and rehabilitation measures already taken with respect to the Bikini and Enewetak communities as an example of the level of support we too require.

It is simply factual to note that above and beyond the payments made to Bikini and Enewetak under Article II of the nuclear claims settlement reached between the U.S. and the Republic of the Marshall Islands in implementation Compact Section 177, past and presently obligated U.S. expenditures to restore habitability at Bikini and Enewetak and support resettlement of those peoples now substantially exceed \$200 million. The Bikini resettlement and rehabilitation funds alone involve more than \$110 million.

Mr. Chairman, the primary difference between the nuclear test related experience of the people of Rongelap and those of the peoples of Bikini and Enewetak is that they were removed from their islands by the U.S. prior to the tests to prevent radiological poisoning of the local population, while the people of Rongelap were not evacuated to safety and were exposed. Then, in addition to being left in harm's way and receiving acute doses of radiation the catastrophic physical effects of which need not be recounted here, our experience contrasts with that of Enewetak and Bikini in that we were rescued after two days of 190 rem exposure only to be returned three years later even though DOE was not able to make any reliable determination about the radiological hazards. The people of Bikini and Enewetak were allowed to return to their islands only years later and then were removed once again for their safety when DOE's scientific assessment of hazards once again proved to be unreliable.

Apparently, because the U.S. was trying to move the Bikinians and Enewetakese back to their islands, there was an interest in keeping us at Rongelap. The U.S. clearly did not want to accept responsibility or admit the need for Rongelap resettlement. As a result, the people of Rongelap were not evacuated even though DOE never was able convincingly to certify that it was safe to remain. That is why we had to evacuate ourselves. We now share with the other two communities the experience of being exiled from our homeland and discovering that the information DOE previously had provided about radiological conditions in our homeland was not reliable. Like the Bikinians and the Enewetakese, only after we had been put at risk repeatedly did we realize that we had been expected to live with and accept radiological conditions that no one from the federal government with whom we dealt would have accepted for themselves or their own families.

Thus, this is not merely a matter of asking for funds. Rather, the support your government has given to those two communities on the very resettlement issues for which Rongelap now seeks support has a value that far exceeds the funding involved. The importance of the Bikini and Enewetak resettlement and rehabilitation process is that it provides that substitute resource base that represents a significant step toward making an exiled people masters once again of their own fate. We seek the same type of measures to promote our self-sufficiency and control over our own affairs. We seek empowerment as a people so that we can stop being victims.

The lessons of the last fifty years were not lost on the U.S. Congress in providing for resettlement of the people of Bikini and Enewetak, and there is no rational basis for treating the people of Rongelap differently. Ironically, it is because the Rongelap people had not been relocated on a long term basis like the other two communities that our more aggravated circumstances may not have been fully recognized or understood by the U.S. during the Section 177 negotiations. Resettlement was not provided for under the settlement and had to be addressed in the implementing legislation because we had not been evacuated. In this sense, compared to Bikini and Enewetak, we were victimized again for having been more severely victimized previously.

While we did receive medical treatment and nominal compensation to individuals whose thyroids or thyroid nodules were removed over the years, as a community we were never given the same protection from injury as Bikini and Enewetak, and in that neglect the seeds were sown for the neglect we now face. It has always been our view that the children of those who were exposed and those who suffered illness as a result of residence at Rongelap after 1957 should have received care, and we have always believed the Section 177 Agreement should have extended to other islands, including Rongerik and Ailingnae. The fallout did not discriminate between the islands in its path, and the Section 177 Agreement should not have discriminated against people whose islands were affected.

Notwithstanding our differences over some of these issues, DOI and DOE are working with us to acquire the information and develop the plans we need to manage our resettlement, but without knowing what resources will be available to us, without knowing what is ours, without having our own stake in the world, we continue to struggle to retain our identity as a people, and making long-term decisions as a community is almost impossible.

We know that the U.S. government budget deficit has created a fiscal crisis, and that discretionary spending accounts are under severe pressure due to interest on the national debt and the requirements to fund non-discretionary entitlement programs. However bad the fiscal crisis may be, the measures required to meet basic U.S. obligations to Rongelap are not ones which will decide the success or failure of your efforts to manage spending. The stakes are high in your battle of

the budget, but this is not another scenario like that which led to the testing program in our islands, where the survival of your nation means Rongelap must be sacrificed once again.

I am not dismissing the magnitude of the request we will be making to the Appropriations Committee this year, especially in relation to the amounts needed for important domestic programs that may go without the funding needed. But when the domestic well-being of the people of this country was at risk and Rongelap's sacrifice became part of the cost of meeting the threat of the Cold War there was no hesitation by the U.S. in funding and conducting its nuclear testing program.

Similarly, now that we as a people are ready to end our dependence on the U.S. and take control of our lives once again there can be no hesitation on the part of the U.S. in making us whole and empowering us to do so. For every dollar required to give us a resource base so we can be masters of our own fate again, the U.S. got full value in the testing program, and arguably a good deal more. We are not looking for a windfall, but rather the resources to enable us to manage our own recovery as a people from our unique role in one of history's most dramatic episodes.



NITIJELA OF THE MARSHALL ISLANDS

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MAJURO, REPUBLIC OF THE MARSHALL ISLANDS 96960

Telephone: 2679 or 3621 - CABLE: NITIJELA MAJURO

17 February 1994

The Honorable George Miller
Chairman
Committee on Natural Resources
U.S. House of Representatives

Dear Mr. Chairman:

The people of Rongelap realize that you probably never will win an election in the U.S. because you have supported our struggle as a community to recover from the devastating effects of the U.S. nuclear testing program in the Marshall Islands. Even with the current publicity about the impact of Cold War era nuclear weapons programs on your own people, the voters in your district cannot be expected to recognize fully the importance of your work on behalf of a relatively small number of Pacific Islanders whose actual story of irradiation and dislocation during nuclear test explosions is probably beyond comprehension to most Americans.

Thus, your work on our behalf must be understood not as politically beneficial to you, or even as simple human compassion for us. Rather, we believe your efforts represent a commitment on your part to ensuring that the U.S. Government acts in accordance with the values and principles that have caused the whole world to look to America as the champion of liberty and justice. By seeking to vindicate those principles in the case of the people of Rongelap, and others in the Marshall Islands, who were exposed to high level radiation and exiled from our homeland, you are representing all that is good and decent and strong about the United States.

Those who understand that America is strong and decent enough to face up to the frightening and bitter legacy of the Cold War nuclear arms race will recognize the important contribution you are making to your nation's ability to maintain its moral leadership as we enter the next century. Your call for full disclosure about the open-air nuclear testing in our islands and measures to enable our people to recover after forty years of real human suffering is the type of leadership the U.S. needs in order to complete the historic process that began when the Berlin Wall fell.

The Cold War will not be over until those who made sacrifices or


The Honorable George Miller
17 February 1994
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who were victimized in connection with U.S. national security programs are empowered to take control of their own lives, their own hands and their own destinies once again. We do not want to be victims any longer, we do not want to be known only for our unique radiation-related medical problems, or as exiles from our contaminated home islands.

We want to recover our lands and recover our way of life as a people with our own culture and heritage -- which now includes forty years of living daily with sickness and inability to settle down to a normal way of life. Even though very few human populations have ever experienced the type of radiation-related medical difficulties or prolonged dislocation we have, we do not want to focus only on recriminations or blame.

We want the truth and we want to be able to decide our own future. Your letter about the weapons development program in the Marshall Islands which was sent to President Clinton of January 3, 1994 encourages us to believe that the U.S. will meet its obligations to enable us to accomplish these goals, and on behalf of the Rongelap Community I want to express our profound gratitude to you for standing up for what is right.

Sincerely yours,



John Jay Riklon
Senator
Rongelap Atoll

Mr. MILLER. Anyone else? No comments.

Ambassador, thank you for your statement. Mr. Graham, let me ask you a question. On the back of your submission to the committee, there is a chart, attachment 2, Marshall Islands Nuclear Claims Tribunal admitted claims by conditions and amounts awarded as of December 1993. [See page 355.] That is for what period of time up to December 1993?

Mr. GRAHAM. From the inception of the tribunal in mid-1988, but it actually goes back only as far as August of 1991. That is when the very first award was made.

Mr. MILLER. From 1991, then. Am I to conclude from this that these compensations that were made in these admitted cases that the admission here is that these were caused from the radioactive activity by the nuclear blast during the tests?

Mr. GRAHAM. Yes, sir. As is the case with the radiation exposed veterans and the Radiation Exposed Compensation Act, there is a presumption of causation that the tribunal extends based largely on the fact that there were no film badges issued to the Marshallese and there was no real way of detecting who was exposed, or if they were exposed, at what level.

So there is a presumption of exposure that is involved in the tribunal's compensation program that effectively presumes that these admitted and awarded conditions were the result of radiation created by the testing program.

Mr. MILLER. So if I took this table and I took the testimony of the previous panel about the thyroid spikes and about the anecdotal evidence and Dr. Hamilton's study, as a lay person I don't want to make this a scientific conclusion because, obviously, it is not, but there is a fair amount of cancer activity going on in the Marshall Islands.

Mr. GRAHAM. I think that this grossly underestimates the amount of cancer activity because I would like to make the observation that these claims that have already received partial compensation at this point for whom an award has been made are today based only on, for the most part, pathological documentation that the cancer existed. There may be many, many other people who have already passed away for whom we don't have a pathological diagnosis and there may be many others living right now and dying these days from cancer that will not be pathologically diagnosed because of insufficient medical treatment available today.

Mr. MILLER. You are saying—

Mr. GRAHAM. Throughout the testing program as well.

Mr. MILLER. You are saying we don't know.

Mr. GRAHAM. We certainly don't know.

Mr. MILLER. What are the official studies that are ongoing outside of the Brookhaven study?

Mr. GRAHAM. There are none to my knowledge. There was a diagnostic program that was funded under some of the section 177 monies for medical surveillance. That involved primarily diagnosticians who visited various atolls or each of the atolls during the course of a three-year period, primarily to establish written diagnoses of conditions that personal injury claimants were suffering.

Unfortunately, when these medical diagnosticians visited the outer islands, they were able to only take minimal equipment with

them. Certainly they had no benefit of x-ray machines or more sophisticated diagnostic equipment, yet, nevertheless, with the limited equipment that was available to them in the outer islands during visits of perhaps as short as one day to as long as one week, they were able to make a number of diagnoses that have resulted in compensation being awarded to people. But there is no ongoing study that I am aware of, and this is what I think is desperately needed.

Mr. MILLER. So what we have really is, in the official capacity of the Government, what we have is a Brookhaven study.

Mr. GRAHAM. If there is such a study. It seems to me it is a periodic examination of the people primarily of Rongelap and Enewetak. Whether there is analysis of the results of those examinations is another issue altogether that I wouldn't be prepared to speak about knowledgeably.

Mr. MILLER. But however you characterize it, whether it is a study or monitoring or what have you, that is all we have from the U.S. Government side.

Mr. GRAHAM. To my knowledge, that is all that exists.

Mr. MILLER. The committee has received testimony that that study may have made some wrong assumptions about the control group; that somehow the control group may be subject to radioactivity as the study group and so when they find no variance, it may be because they are looking in the mirror.

Mr. GRAHAM. That certainly is the belief that my office has.

Mr. MILLER. I don't know if that is the case, but that has been the allegation more or less so we have one study that has some serious questions raised about how it was designed.

Mr. GRAHAM. I would concur in those reservations.

Mr. MILLER. Mr. Ambassador, on page 5 you talk about the issue of a formal request under article 9. Am I to understand from that statement that the Government is in the process of formulating a formal request, gathering information for the possibility of making a formal request under article 9 and the changed circumstances?

Ambassador KENDALL. Yes, sir, Mr. Chairman. At the moment we are gathering evidence and other data to put forward a formal request. We are doing that at the moment and upon finding and having gathered all this information, we will submit the proposal to you, Mr. Chairman.

Mr. MILLER. Okay. Thank you.

Ambassador KENDALL. Mr. Chairman, can I make one request of you? I believe other members of my delegation would like to have a chance to say a few words.

Mr. MILLER. Sure. Excuse me. I thought the others had decided not say anything.

Ambassador KENDALL. With your permission, sir, I would like to call on Senator Henchi Balos to either make a statement or put forward anything in writing.

STATEMENT OF HON. HENCHI BALOS

Mr. BALOS. Thank you, Mr. Chairman.

Mr. MILLER. Please.

Mr. BALOS. I thank Ambassador Kendall for extending the opportunity for me to say a few words. On behalf of my delegation from

Bikini Island and all the people of Bikini, I would like to, first of all, state for the record that we are very saddened to learn about the death of one of the resourceful staff of this Congress, Pat Krause.

Mr. MILLER. Thank you.

Mr. BALOS. She has been very helpful to the people of Bikini. And I would like to ask you, Mr. Chairman, to please convey our condolences to the family of Ms. Krause and also to her friends.

Mr. MILLER. Thank you.

Mr. BALOS. I would also like to take the opportunity to thank you, Mr. Chairman, for your interest and your colleagues, distinguished members of the committee. We would like to make one request to you, Mr. Chairman, that is please expedite the process so that the result of the purpose of this hearing can come out sooner.

Once again, thank you very much for your support and thank you for your interest in this matter. Having said that, thank you, Mr. Ambassador, for giving me the opportunity to speak.

On behalf of the delegation from Bikini Island I also would like to say that the statement presented to you by Mr. Weisgall earlier this morning was the views and feelings of the people of Bikini. Thank you very much.

Mr. MILLER. Thank you.

Ambassador KENDALL. Next to speak on my delegation is Senator Hiroshi Yamamura.

STATEMENT OF HON. HIROSHI V. YAMAMURA

Mr. YAMAMURA. Thank you, Mr. Chairman. Bear in mind, Mr. Chairman, I am here before your committee not to condemn the U.S. Government, but to seek your kind support in trying to discover at least the earnest disclosed information on the U.S. nuclear testing in the Marshall Islands.

I believe you have a copy of my written statement, but I just want to touch one point in that statement, Mr. Chairman, about what has been said by the Advisory Committee on the Biological and Medicine, stated January 14, 1956. I quote, "the statement was revealed that Utrik was by far the most contaminated place in the world." It further stated that people of Utrik do not live, I would say, as the Westerners do, civilized people. It is nevertheless also true that these people are more like us than the mice.

This, Mr. Chairman, causes a doubt in my mind. I don't know what is in the mind of the American who made this statement, but I was here this morning and I believe it was stated by Mr. Weiman. In the *Washington Times* I read also the statement that he made a comment on this issue because he was too tired, and at that time he also further made a comment that maybe it was stupid of him to say such a statement.

Mr. Chairman, I do not believe that anyone could have made a stupid statement like that and if that statement has been stated in that newspaper, it seems like those meetings were wasted in those two days. I believe he was aware of what he was stating. That is the only thing I would bring up, Mr. Chairman, and I wish to compliment you and your committee for bringing up these issues before the Congress. Thank you, Mr. Chairman.

[The prepared statement of Mr. Yamamura follows:]

REPUBLIC OF THE MARSHALL ISLANDS
MAJURO, MARSHALL ISLANDS 96960

STATEMENT OF THE HONORABLE HIROSHI V. YAMAMURA
MEMBERS OF THE "NITIJELA" OR THE NATIONAL PARLIAMENT
SENATOR REPRESENTING UTRIK ATOLL
REPUBLIC OF THE MARSHALL ISLANDS

SUBMITTED TO THE
UNITED STATES HOUSE OF REPRESENTATIVE
COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

FEBRUARY 24, 1994

Chairman and Distinguished members of the Subcommittee,

On behalf of the people of Utrik atoll, I wish to thank you and the members of your Subcommittee for granting me an opportunity to respectfully express and to unfold several genuine concerns of the people of Utrik who have been perpetually endured the ultimate aftermath of the United States Nuclear Testing from 1940's to 1950's in the Marshall Islands.

Bear in mind, Mr. Chairman, that I am here before your committee not to condemn the U.S. Government for such mishap, but primarily to seek your kind support in trying to discover at least the earnest disclosed information on the U.S. Nuclear Testing in the Marshall Islands.

Well to begin with, Mr. Chairman, I have several fundamental components which I will briefly address before your committee:

1. Activities of the U.S. Department of Energy on Utrik Atoll environment and its residents;
2. The validity of acquiring radiological information from the Republic of the Marshall Islands National Radiological study and the Scientific advisory panel; and

3. Disclosure of Republic of the Marshall Islands Nuclear Claims Tribunal Medical conditions affecting the people of Utrik Atoll.

I. U.S. Department of Energy

Although DOE claims to have been annually monitoring the radioactive level on Utrik Atoll as prescribed pursuant to Public Law 95-134 and 96-205, only one environmental radioactivity survey was made on April, 1993. The validity and the results of such measurement have not been available. In light of the limited restriction stated under the Public Law 99-239, out of 3,000 total population of Utrik Atoll, only about 98 remaining exposed individuals are medically or scientifically monitored by DOE twice a year. Since one group of Utrik Atoll has been monitored, thereafter, such restricted radiological bioassays can only signify inaccurate findings for the community. Unlike the restricted radiological monitoring of Utrik residents, I can only assume that the radiological bioassay on Rongelap residents is precisely valid since a controlled and an experimental groups are involved in such activities. Also, I can only predict that if DOE were eager to monitor a radiological bioassay on the 500 individuals who have been residing on Utrik atoll since 1956, thereafter, the prevalence of thyroid and other radiation related disease would have been higher than the expectation of many scientific findings. Mr. Chairman, please note that the Exhibit A disclosed an important message

addressed by a U.S. advisory committee on Biology and Medicine on January 14, 1956 revealing that Utrik Atoll "is by far most contaminated place in the World...." Exhibit A further stated that the people of Utrik atoll "... do not live, I would say, the way Westerners do, civilized people, it is nevertheless also true that these people are more like us than the mice."

II. RMI Nationwide Radiological Study

I wish I could offer you, Mr. Chairman, and the members of your Subcommittee an explicit information on Utrik atoll Radiological survey made last year by the RMI Nationwide Radiological Program; however, such information has not been available. I believe Dr. Steve Simon will explicitly enlightened you on the issue.

III. RMI Nuclear Claims Tribunal

Among many Utrik claimants, thirty-six cases of thyroid and other radiation related diseases from Utrik have been confirmed by the RMI Nuclear Claims Tribunal. In fact, ninety-eight percent of the thirty-six individuals from Utrik, who were easily identified of the radiation presumed medical conditions, did actually submit their medical documents from the U.S. Department of Energy. Unfortunately, many other claimants from Utrik who were not eligible for Nuclear Claims Tribunal award don't have the same

privilege as the ones monitored by the DOE program where the only radiological bioassay is made available in the Marshalls.

Mr. Chairman, I was informed that you have written a letter to the President of the United States requesting his benevolent support to impose on the Department of Energy to reveal all the classified informations in regard to the U.S. Nuclear Testing in the Marshall Islands. Up to this date, not a single DOE classified information has been revealed to my people and my government.

I wish, however, to compliment you, Mr. Chairman, and your Subcommittee members for your kind effort in trying to bring justice for us who can hardly be recognized. Thank you.

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ADVISORY COMMITTEE ON BIOLOGY
and MEDICINE

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January 13, 14, 1956

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CLASSIFICATION CANCELLED
BY AUTHORITY OF J. G. Hawthorn DATE 7-13-71
BY Mem 4/12/82

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U.S. ATOMIC ENERGY COMMISSION
NEW YORK OPERATIONS OFFICE
HEALTH and SAFETY LABORATORY
70 Columbus Avenue
New York, New York

EXHIBIT: A

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We have a few things that we are thinking about for the immediate future and I would like to mention a few of these.

We think that one very intriguing study can be made and plans are on the way to implement this -- "Uterik" Atoll is the atoll furthestest from the March 1st shot where people were exposed got initially about 15 roentgens and then they were evacuated and they returned.

They had been living on that Island; now that Island is safe to live on but is by far the most contaminated place in the world and it will be very interesting to go back and get good environmental data, how many per square mile; what isotopes are involved and a sample of food changes in many humans through their urines, so as to get a measure of the human uptake when people live in a contaminated environment.

Now, data of this type has never been available. While it is true that these people do not live, I would say, the way Westerners do, civilized people, it is nevertheless also true that these people are more like us than the mice. So that is something which will be done this winter.

Mr. MILLER. Thank you.

Ambassador KENDALL. Thank you, Mr. Chairman. I believe Mayor Billiet Edmond is submitting a paper for the record, Mr. Chairman. I believe we have all the speakers here and have all had a chance to put whatever they want in the hearing today, Mr. Chairman. Thank you.

[The prepared statement of Hon. Billiet Edmond follows:]

STATEMENT OF
THE HONORABLE BILLIET EDMOND
MAYOR OF RONGELAP

BEFORE THE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
COMMITTEE ON NATURAL RESOURCES
FEBRUARY 24, 1994

In five days we will observe the 40th anniversary of the nuclear test code-named "Bravo." This hearing is timely for that reason, and because the people of Rongelap are observing the 40th anniversary of the Bravo test by adopting a new strategy for recovery by our people from the effects of the U.S. nuclear testing program.

It is time for the Rongelap people to commit themselves to an organized recovery and resettlement program, and it is time for the U.S. to deliver on its commitments to support our recovery effort. As a community we need to make some decisions and commit ourselves to a resettlement program which includes support for those who are ready to accept the risks of living at Rongelap, and support for those who choose to resettle elsewhere in the Marshall Islands. In order to accomplish these goals we need two forms of assistance from the United States.

First, with respect to the subject of this hearing, we need better information so that our people can make informed decisions about returning to Rongelap. The scientific efforts being made to develop more precise and practical information in this regard are underway, and we believe real progress that is being made will soon produce the framework for resettlement planning decisions. Of course, if there is information about radioactivity or other hazardous conditions at Rongelap in the possession of the U.S. government which has not been made public it is imperative that it be released immediately.

In particular, I want to state for the record that if there is information relevant to the health of our community now or at any time since 1946 which has not been made public it should be released immediately. The Cold War is over, the veil of secrecy is being lifted on the U.S. nuclear program, and there is no apparent national security justification for anything but full disclosure.

As Senator Riklon has indicated in his statement to the Subcommittee today, we already know enough about what has happened to Rongelap over the years to know that we need to stop relying others to protect our interests. Thus, the second form of assistance we need is to have the Rongelap resettlement program fully funded in the FY 1995 budget which will be approved this year so that our people can know

the extent of the resources we can rely on and make a realistic assessment of options based on that knowledge.

While the Department of Energy, independent scientists, lawyers, medical experts and the Department of Interior continue to work on outstanding issues, we need to begin making the political decisions we must in order better to plan our own future. We need DOE and DOI and appreciate the assistance provided. When we note the unreliability of DOE scientific findings over the years we do so without rancor. But rather than expecting us to wait for all the technical and logistical questions to be answered before seeking the funding authorized by Section 103(i) of P.L. 99-239, we are asking the U.S. Congress to provide us with the resources needed to take greater control and responsibility for our own future now.

We are asking, in essence, for economic empowerment in the form of an adequate recovery and resettlement fund that will give us self-sufficiency which substitutes for the self-sufficiency taken from us forty years ago when the U.S. very nearly destroyed our people and our homeland. To understand our proposal to proceed with funding now you need to understand the way our people feel about their past and their future.

The people of Rongelap and the people of other islands throughout our nation must live every day with the anxiety and anger of not knowing if the insidious effects of undetected or unreported radiological poisoning are attacking us, and our children, from within.

We are told that it is probably safe to go home if we cooperate with DOE and follow dietary and other behavioral guidelines. But given the exasperating record of miscalculation by AEC and DOE scientists, including the frequent "surprises" we have come to expect like regular announcements that new levels of contamination and related health problems have been discovered, we must ask ourselves many questions about what life at Rongelap will be like in the future. Should our children be allowed to play in the sand? How many times a day should we wash their hands? How do we keep their hands out of their mouths? Is it safe for a baby to drink its mother's milk? How much local food can we eat?

We no longer are focusing on issues of blame and guilt about how and why the conditions were created that give rise to these questions. These are our problems, and we are ready to begin managing them. We have the courage and the resolve to move beyond recrimination and start controlling our own lives. But the U.S. must have the courage to tell us everything that is known so our decisions will be informed. The U.S. also must end the budgetary limbo that is preventing our community from dealing with the real issues. Help us unite behind a program that is real and that can be quantified so that sound judgments can be made.

It is not smart or even fair to require that we make the most important decisions of our lives when we do not really know yet what is possible. Just look at Bikini and Enewetak. Once the U.S. made a commitment to carry out a clean-up at Enewetak and fund rehabilitation and resettlement for Bikini important progress was made.

It is not good government or good program management to make plans and decisions in the abstract. When the decisions must be made by a community with our history, it is bad policy to frame the issues without establishing the resource base available to implement the decisions that ultimately are to be made. Approximately \$5 million is now available for resettlement, and there is the hope that more will be made available. But hope is not sufficient incentive to enable a victim population to rise above its fear, anger and frustration and unite behind an agenda and set of solutions that it may or may not be able to implement depending on the budget process in Washington.

Recognizing this, Congress provided the Bikini community with a \$20 million resettlement fund and a \$90 million rehabilitation fund. This was in addition to the \$75 million provided to settle previous legal claims of the Bikinians under the Section 177 Agreement. Again, as Senator Riklon points out in his testimony, that approach does much more than provide funding, it puts the community back in control of its destiny, and that is what we too must achieve.

The moral rectitude and practical logic of what we are proposing is compelling and is based on what the U.S. did in the case of Bikini and Enewetak. As the Mayor of Rongelap I am asking that this Congress do what only the Congress of the United States of America is capable of doing. Stop for just a moment in the middle of the debate over health care reform, welfare reform, and all the other vital issues before you, and recognize that there is a piece of unfinished business with the people of a tiny island in what in 1954 was the U.S. Atomic Weapons Proving Grounds. The surviving community remains in exile after enduring a brutal saga of grievous radiation induced illness and physical and psychological estrangement from their contaminated homeland, and Congress needs to act on the matter. We know you have more important things to do, but we hope you will decide that this is too important to be left undone.

Mr. Chairman, we are ready to seize the challenge of managing change for our people, but we are able to do so because the commitment the U.S. has made pursuant to Section 103(i) of P.L. 99-239 enabled us to turn our people from despair and outrage to a vision of being a self-reliant people again. It would be a dreadful thing for the U.S. now to convert them back into being victims all over again.

I do not believe that is going to happen. That is why I am here instead of at home with my family. I will be back this Spring to work with your Appropriations Committee to achieve the goal of a fully funded recovery and resettlement fund. We look forward to working with you, and hope we will have your support. I thank

you for your leadership and courage in bringing these matters to the attention of this Congress and the American people.

Mr. MILLER. Thank you. Chairman de Lugo.

Mr. DE LUGO. Thank you, Mr. Chairman. I would like to ask permission to submit some additional questions to the panel that preceded this one, Dr. Hamilton, Dr. Simon, Dr. Radford, Mr. Weiman, and some additional questions for Mr. Hills, if there is no objection.

Mr. MILLER. Without objection.

Mr. DE LUGO. Let me ask, Ambassador Kendall, when the compact was being considered, there was an obvious split between the Marshall Islands Government and the atolls. These are the atolls that were clearly affected by the U.S. nuclear testing.

Is the Marshall Islands speaking now with one voice? I know that officially the Marshall Islands always officially spoke with one voice, but it was clear to us that there was not unanimity in the past.

Are you speaking now with one voice?

Ambassador KENDALL. Well, I think the statements will speak for themselves, I am sure. There may be differences in the way we approach the problems, but I believe we are all as a delegation—granted everybody is free to say what they have to say. I think the statements that have been submitted here have varying degrees of disagreement and all that. What you are saying is whether what I have here is a consensus as a united delegation here?

Mr. DE LUGO. Well, there has been mention of the great work that was done by a great man who is not with us anymore. I guess the powers that be figured that if you can hold out long enough people will die and the problem may go away. And I couldn't help but think of that last year when Senator Ajain visited me for the last time and we met over in the Rayburn Room.

To me, he was one of the most courageous individuals that I have ever met in my life. He was a simple man, but he had a great love for his people and he had a great concern for what had happened out there and he was very fortunate in that he had a very able advocate for him that worked with him tirelessly, David Weiman, who appeared before this committee.

Mention has been made of the wonderful work of Pat Krause who spent countless hours working on this issue and making available records, going through the records, whatever could be found so that the truth could come out about this issue. It was always said that officially the Marshall Islands were speaking with one voice. The subcommittee, which I chair got the very clear distinction that Senator Ajain was not getting support in his efforts.

Is that changed or is everybody together on this now?

Ambassador KENDALL. Well, I said this much. As you know, we were not the only victims of this so-called seeking the truth. You have your own people, a lot of information was declassified. Now, we are not going to wait and tell everybody, oh, let's put everything on hold until the United States gives us access to these materials. Senator Ajain had the courage to go after the truth. He had the patience. We didn't have the patience, but he had the patience to go after the truth. And as always, in the nature of human events, truth reveals, and I am glad that what he did was not for nothing. So I would say that the Marshall Islands wasn't deserting Ajain and Ajain wasn't deserting the Marshall Islands. I think we are

working on two different tracks trying to arrive at the same destination and trying to go after the facts.

Mr. DE LUGO. Let me say, Mr. Ambassador, you and I know that to a large extent these hearings are being held today because of the work of Senator Ajain.

Ambassador KENDALL. I know that.

Mr. DE LUGO. He just would not give up and kept working on the issue and working on the issue with all of us. And you know in the past our mentor, the Chairman's mentor, my mentor, Phil Burton was one of the first and then there was John Seiberling. And I will be leaving this Congress at the end of this session and I am very grateful that we have a young, powerful, energetic Chairman who is taking over, taking over this issue.

To those that would hope it is just going to go away, at this time it is not going to go away. As you just said, the truth will always out and there are those in this Congress that will make sure that the truth will win out.

That is why I want to thank you, Mr. Chairman, for holding these hearings and it makes me feel better as I leave this House, because it has been a very frustrating experience to try to get the information from these various agencies and, of course, we will have the Department of Energy before us in a little while and I am sure they are looking forward to that.

Mr. MILLER. Thank you.

Mr. Underwood.

Mr. UNDERWOOD. Thank you, Mr. Chairman, and welcome to all of you from the Republic of the Marshall Islands. Just a comment on your testimony, Ambassador Kendall. I know you made mention of organs that are being kept in Brookhaven. We have a similar problem in Guam with respect to organs that have been kept for almost 40 years in Rochester, Minnesota, in the Mayo Clinic for investigation of Alzheimer's disease and Parkinson's disease and we seem to have the same problem in retrieving those organs.

It seems that some people can't resist the temptation to look at Pacific islanders as guinea pigs rather than as people with rights and privileges who are due a measure of dignity.

And perhaps I think Mr. Faleomavaega's earlier comment about Henry Kissinger has been changed. It is now, there are 180,000 people in Micronesia and who gives a damn. So the numbers have gone up, but I think to some extent the sentiments still remain the same.

I am happy to see Mr. Graham. At first I didn't recognize him. It has been a long time, and we go back many years together in a different setting.

The question I have, Ambassador, is in terms of your formal request that you are currently formulating. I know there has been a series of discussions about the data, the kinds of data which is collected and how useful this data is. I would be interested to know what are your sources of information. What are your sources of data in formulating this request and do you have an anticipated time line?

Ambassador KENDALL. Thank you, Mr. Chairman. May I give the further question to our technical people, Mr. Oliver?

Mr. OLIVER. Thank you, Mr. Underwood. My name is Pete Oliver. I am a long-time resident of the Marshalls, and I work on compact implementation. There is no timetable at this stage. I have got to say that when it was announced that the committee was going to hold a hearing today in Washington, those of us from the Marshalls basically dropped what we were doing and flew on over.

I would say an estimate might be eight or nine months. There are several important components that will be taken into consideration. Certainly the work and the findings that will lead to conclusions that will come out of the Nuclear Claims Tribunal will be a key factor. Other factors include different components of the work that Dr. Simon described.

The reason he came to the Marshalls was to do a Nationwide Radiological Study, and as he described this morning, he has visited every atoll inhabited or uninhabited in the Nation, and by the end of this year that will be wholly completed and there will be a characterization that will enable him to reconstruct information about doses that were actually received by people at the time of BRAVO and other nuclear tests.

When the Chairman asked the question about current studies, an important current study which Dr. Simon was also involved in is an expansion of thyroid study. The thyroid study has been completed at Ebeye where roughly 1,400 people who were alive at the time of the BRAVO or soon thereafter were examined.

The study is now being expanded nationwide. The physicians that will be doing this work will arrive in Majuro next week. They will be based in Majuro, and of course, Majuro is the capital and the center of population for the nation. But in addition to reaching the older residents of Majuro, they will be able to get to other island locations as well. And the findings of that work will also be an important part of any presentation that comes back to the United States Congress in accordance with article 9 of the 177 agreement.

President Kabua just in recent weeks has established a committee to begin to assemble this work, but at this stage we are at the very beginnings of the process.

Mr. UNDERWOOD. Okay. Thank you.

Mr. MILLER. Mr. Faleomavaega.

Mr. FALEOMAVAEGA. Thank you, Mr. Chairman. Maybe Mr. Oliver and Mr. Graham can answer this question. Where are we exactly with these \$150 million as far as this fund is concerned? Is that \$25 million given to these persons presently part of the allegations that is now being utilized?

Mr. OLIVER. The—

Mr. FALEOMAVAEGA. Who is using it? Are the people of these island groups? Are they getting the benefit of this \$150 million fund or is it somewhere else?

Mr. OLIVER. Mr. Faleomavaega, in the 1993 annual report that was submitted as part of the testimony for the Marshall Islands delegation, the first section of that report describes the current status of the fund.

The fund was provided to the Marshall Islands Government in October 1986 and capitalized at the amount of \$150 million. In accordance with the 177 agreement it has been invested in U.S. fi-

nancial instruments. The value of the fund now stands at approximately \$125,000. We have the year end—

Mr. FALEOMAVAEGA. \$125,000?

Mr. OLIVER. Sorry. Million, excuse me.

Mr. MILLER. I didn't know that instruments were that bad.

Mr. OLIVER. The fund is not holding intact. You can see at the bottom of page 1 it says at the end of fiscal year 1993 the value of the nuclear claims fund stood at \$127.787 million. Also in the early section of the report, there is a documentation from the trustee, which is the Bank of New York, the compact legislation, that is U.S. Public Law 99-239 requires that a report of this sort be submitted annually to the U.S. Congress. And it points out quite clearly where the monies are going.

Annually \$18 million are generated. Of that amount, roughly three-fourths of it goes directly to the four communities that are most directly impacted. A certain amount has been available, a total of \$3 million has been available for scientific work. Annually \$2 million is provided for a continuation of the four atoll health care programs that were established by this committee a good many years ago.

Mr. FALEOMAVAEGA. In my last discussion with Mr. Ajain, some time back prior to his passing away, there was some concern the residents of Rongelap have had over the years with the central Government. I don't know. I think Rongelap has their own city council and doesn't Bikini have their own city council?

Mr. OLIVER. Yes, sir.

Mr. FALEOMAVAEGA. There were some disagreements on how this money was to be funded in terms of whether or not the residents of Rongelap or Bikini are getting any direct benefit on this funding. Has this problem been corrected, these disagreements that the city councils of these different islands have had with the central Government?

Mr. OLIVER. The local Governments for each of the four communities have received the full amounts that are spelled out in the section 177 agreement. I think in some cases where disputes have risen within the communities, disbursements may have been administered by other authorities at the direction of the Nuclear Claims Tribunal for short periods of times. I think that is all behind us. But the short answer is that all required payments have been made to all four of those communities.

Mr. FALEOMAVAEGA. And you say that the payments that were made as of December 1993 to as many of the inhabitants that were affected directly by the testing, that they have been given proper compensation, the 676. Were there more than the 676, Mr. Graham? Are we still looking for more residents that were not duly compensated?

Mr. GRAHAM. We have thousands of uncompensated claimants for whom we still don't have accurate diagnoses or we have diagnoses of conditions that my office and many of the other medical and scientific experts believe are radiogenic and they are caused by the testing program, but these claimants have not been compensated as yet. I think that the compensation program that is in place right now is very limited relative to what should be compensated, what I think can be documented with proper study and

release of documents as related and resulting from the testing program.

Mr. FALCOMAVAEGA. What would be your recommendation so we could improve on this documentation and getting the proper claims for the residents of these islands that are still not compensated?

Mr. GRAHAM. Well, we need further diagnosis of individuals who are suffering from conditions right now. The medical facilities for diagnosis, much less for treatment, remain highly inadequate. The medical program envisioned under the 177 agreement is serving far too many people to do more than just be a Band-Aid on the treatment problem, and it doesn't have the resources to develop any kind of epidemiological studies.

Mr. FALCOMAVAEGA. Would you be making that kind of a recommendation to the Congress to improve the commission's work on this? I am surprised to learn that it is very inadequate.

Mr. GRAHAM. Well, I believe the tribunal having been created by the parliament of the Nitijela of the Marshall Islands to date has viewed—those negotiations need to be conducted on a Government-to-Government basis and the tribunal recommendations are made to various bodies in the Republic of the Marshall Islands.

Mr. FALCOMAVAEGA. So the Government is not at all—

Mr. GRAHAM. So it wouldn't be able to make such a recommendation directly, I would say.

Mr. FALCOMAVAEGA. You are saying that the Government is not involved at all at this time?

Mr. GRAHAM. I don't think, if the request has been formally transmitted in the proper form.

Mr. FALCOMAVAEGA. Thank you, Mr. Chairman.

Ambassador KENDALL. Mr. Chairman.

Mr. MILLER. Yes.

Ambassador KENDALL. One more individual, here, a member of my delegation, wishes to speak also at this time. Mr. John Ismael, Senator.

STATEMENT OF HON. ISHMAEL JOHN

Mr. JOHN. Thank you, Ambassador. Thank you, Mr. Chairman. I want to introduce my staff and myself. My name is Ismael John. I am the Senator from Enewetak. With me is Mr. Mayor and Mrs. Mayor and one of the council members, Ernest Johnson, and our legal counsel Davor Pevec. If you would, I want my statement to be in the record.

Mr. MILLER. Fine.

Mr. JOHN. Thank you, Mr. Chairman. I just want to say a few words, not much. I just want to talk about MIKE. MIKE test somebody in 1952. My people were evacuated from Enewetak and taken in a big boat. Ninety days, this means three months, and after the three months, we come back to Ujelang. And our waters, everything look like there is a shine on top of everything we have.

And because in all the discussion I heard today was mostly concern about the problem, but MIKE was the first atomic bomb in the world and it was tested in any weather in 1952, and it was the first hydrogen bomb dropped on place on the earth. That is what I understand. And look like nobody talks about MIKE. It is kind

of not powerful like BRAVO. MIKE was 10.4 megaton. It is not powerful like BRAVO.

And to prove that we have fallout from that MIKE, I bring with me a witness that have thyroid disease—I know that it is from MIKE. And we got fallout from the MIKE. It has been one of the victims of MIKE from Ujelang and Enewetak.

Thank you very much, Mr. Chairman.

[Prepared joint statement of Mr. John and Mr. Peter follows:]

STATEMENT OF THE ENEWETAK/UJELANG LOCAL GOVERNMENT COUNCIL
BEFORE THE
HOUSE COMMITTEE ON NATURAL RESOURCES

February 22, 1994

Submitted by
. The Honorable Ismael John
Senator, Nitijela of the Marshall Islands; and
The Honorable Neptali Peter
Mayor of the Enewetak/Ujelang Local Government Council

Mr. Chairman and distinguished members of this Committee:

Thank you for providing this opportunity to the people of Enewetak to discuss issues relating to radiation exposure from fallout and the resultant health effects on our population.

With us are Mrs. Tokko Henry Peter, Mr. Johnson Hernest, and Mr. Davor Pevec, our legal counsel.

Mrs. Tokko Henry Peter is Mayor Peter's wife. In 1947, Tokko along with the other Enewetak people, was moved from Enewetak Atoll to Ujelang Atoll by the United States because the United States wanted to use Enewetak Atoll as a nuclear test site. Ujelang is 120 miles southwest of Enewetak. Because of the prevailing trade winds, Ujelang is downwind of Enewetak.

Forty-three nuclear devices were exploded on Enewetak. The most powerful explosion was the "Mike" test which occurred on October 31, 1952. Mike was the world's first thermonuclear (hydrogen) bomb test. The yield was 10.4 megatons (750 times greater than the Hiroshima bomb), equivalent to 10.4 million tons of high explosives. The test was located on the island of Bokombako (sometimes referred to as Elugelab). Bokombako was vaporized by the Mike test and in its place was a crater more than a mile in

diameter and 200 feet deep. The United States' Defense Nuclear Agency described the test as follows:

"A large fireball, 1-1/2 miles in diameter and followed by a wave of water, swept across neighboring islands. Trees and shrubs facing the test site on the island of Biken were scorched and wilted, although they were located 14 miles southwest of the Mike shot site."

Prior to the Mike test, the United States came to Ujelang and placed the Enewetak people on a ship which sailed southwest from Ujelang towards an island named Kosrae. We were told we must go on the ship for our safety because a test was planned.

After a number of days of sailing, we were awakened just before dawn and told to look at a particular direction on the horizon. We then saw an enormous bright light in the direction of Enewetak. We were told that what had occurred was a test on Enewetak. We were terribly sad. Some of us cried because nothing could survive the enormity of such an explosion. We thought, surely Enewetak was no more; our ancestral homeland was gone to us forever.

After the explosion, we were returned to Ujelang. When we came ashore we noticed that virtually everything was covered by a fine dust. We noticed a whitish film on all of our individual and community water catchments.

The United States personnel from the ship came ashore and took away several instruments they had placed there when they came to pick us up. No one told us what the fine dust was or what the whitish film on our catchments was. We drank, cooked and washed with the catchment water. Within a few days our skin became

extremely itchy. Rashes and sores developed on skin. Some people had their hair fall out. We had no idea what afflicted us.

Several years later, we learned about fallout. It was then that we associated those ailments to the fallout from the Mike test.

We returned to Enewetak in 1980. We live on the four southern islands. The rest of the islands in the atoll are contaminated by radiation to one degree or another. We understand that there is radiation contamination in the silt of the lagoon.

We are told that living on the four southern islands is safe. We were told that living on Ujelang would be safe. Now we are not so sure. Over the years a number of our people have become afflicted with thyroid nodules, thyroid cancer and other types of cancers. Tokko herself is a victim of thyroid cancer. Nine other members of our community have developed thyroid problems and/or cancers.

That is why we are here today. We are here to lend support to your Committee's quest to find out what really happened in the Marshall Islands as a result of the nuclear testing program. We also would like to have all documents declassified so that the full record can be reviewed and analyzed.

In the meantime, it is imperative that Brookhaven National Laboratories, through funding provided to the Department of Energy, conduct thorough and adequate monitoring of our population. That monitoring includes whole body counting and urinalysis for plutonium detection. In recent meetings with Brookhaven and the

DOE, representatives of both organizations stated that each member of our population should undergo whole body counting every two years. Unfortunately, that frequency has yet to be achieved. In addition, we understand that cesium cannot be detected after one year. Accordingly; annual whole body counting may be more appropriate. We are willing to discuss with the DOE and other scientists the optimal frequency of such monitoring. We would be pleased to report to this committee the results of such discussions.

In addition to the whole body monitoring, our environment must be monitored to assure that our people are not adversely affected by the residual radiation contamination on our atoll. Runit island is a radiation waste storage site. It must be monitored as any storage site would be monitored in the United States. Unfortunately, monitoring over the past 14 years has been minimal and superficial. A plan, consistent with U.S. monitoring regulations of nuclear waste sites, should be implemented and carried out. Also, the remainder of Runit should be surveyed to determine its current status and to determine methods to render it less dangerous for our people.

We have for too long relied on the representations of others when it came to the effects of the testing program. It is time that we be provided all data so that we can have such data analyzed to our satisfaction. Only in this way will be able to determine

the origins of some of our afflictions and plan for a future free from the harm of the nuclear age.

We thank the Chairman and the Committee members for their interest in our welfare and their pursuit of truth on our behalf.

Mr. MILLER. Thank you.

Mr. FALEOMAVAEGA. Thank you, Mr. Chairman.

Mr. MILLER. Anyone else?

Mr. BALOS Mr. Chairman.

Mr. MILLER. Yes.

Mr. BALOS. May I make one more comment?

Mr. MILLER. Certainly.

Mr. BALOS. Word of advice, Mr. Chairman, if I were to give you advice, there was an individual from the U.S. Government that used to come to Bikini Island, more frequently to Bikini Island and told us that there is no problem on Bikini Island in terms of safety.

So based on his representation, my people went back to Bikini early 1970s, living there for almost ten years and then the same person advised the U.S. Government that there was a problem with the people residing on Bikini Island. This individual's name, Mr. Chairman, for what it is worth to your committee, is Roger Ray. And I hope your committee make an effort to locate him to bring to your committee to testify. He has been lying to us and he has been lying to the U.S. Government as well. Thank you.

Mr. MILLER. Thank you very much. Any other statements, or questions by members of the panel?

Mr. DE LUGO. Yes.

Mr. MILLER. Yes, sir.

Mr. DE LUGO. Mr. Chairman, I know it has been a long day, but these witnesses have traveled a great distance and this is not the subject of the hearing, but because of the long distance you have traveled, I would like to ask the elected representatives of the atolls if they have any brief comments that they would like to make about the programs that ensure health care and supplemental food to the victims of the nuclear testing.

Are there any comments that you want to make on those programs, if you would make them verbally or you can submit a statement for the record, whichever way you would like to approach that.

Mr. John.

Mr. JOHN. Thank you, Mr. Chairman.

Mr. DE LUGO. Which is your atoll?

Mr. JOHN. I am from Enewetak Atoll. Senator from Enewetak Atoll. Thank you. I just want to make an oral statement that I want the tomb on Enewetak and Ujelang to be monitored by the U.S. Government and I want my people to be monitored from those two agencies, like Brookhaven Laboratory and Lawrence Livermore, with DOE, if it is possible. I want them to be monitored every year.

Mr. DE LUGO. You need more monitoring.

Mr. JOHN. Yes, sir. Because of the tomb there, I don't know what inside this is. The tomb is too hot. We cannot go there. The island has been off limits for human beings. The population right now, they are on Enewetak. It is about eight miles from Rongelap—not eight, maybe seven. So close we can't use it, because that thing is round. You can lay down and you can touch it and so close and I want that thing to be monitored.

Thank you, Mr. Chairman.

Mr. DE LUGO. Anyone else? Yes. Your atoll?

Mr. YAMAMURA. My atoll, I am from Utirik Atoll. There are three programs that we are getting. I believe this program is a good program for the people of all four atolls that are affected from the nuclear testing. The money that has been given to us is \$2 million per year. And when it was started, there were only about 3,000 people for a total of those four atolls. Now the number has gone up to 10,000 people.

Mr. DE LUGO. From 2,000 to 10,000?

Mr. YAMAMURA. From 3,000 to 10,000.

Mr. DE LUGO. From 3,000 to 10,000 people?

Mr. YAMAMURA. Yes.

Mr. DE LUGO. What year was the program started that you refer to?

Mr. YAMAMURA. I believe it started in 1984.

Mr. DE LUGO. Has there been any increase from 1984?

Mr. YAMAMURA. Yes.

Mr. DE LUGO. In the funds? Not in the people, but in the amount of money.

Mr. YAMAMURA. We still have the same amount—\$2 million per year. And that will be going all away after the compact is ended, 15 years. The total is \$30 million.

Mr. DE LUGO. Thank you. That is helpful to us.

Mr. YAMAMURA. One other thing, Mr. Chairman. The DOE program, I believe the DOE has been helping most of the people on Utirik and also the people from Rongelap except DOE nowadays is only examining the 98 remaining exposed people on Utirik, but the total residents on Utirik is about 500 people. And I believe that DOE should expand the program because we want to make sure those 500 are also affected from the fallout.

I think DOE is, according to the Public Law 99-239, just to monitor all those remaining populations of the exposed. Thank you.

Mr. DE LUGO. Is that it? Yes, sir. Mr. Balos from Bikini.

Mr. BALOS. Thank you, Congressman de Lugo, Mr. Chairman, with regards to the health care, I would like to say that the funding under the compact under the section 177 agreement—first of all, let me state for the record that in the process of approving the Compact of Free Association, and I am not criticizing any individual or anybody here, but my people voted against the approval of the compact only for one reason: Because of the section 177 agreement. They were not satisfied with the arrangement in the agreement.

They believe the fundings were not sufficient. And one of the fundings was health care.

Today, Mr. Chairman, the population has increased, has doubled. The money has not been increased. The funding has not been increased. Also, Mr. Chairman, the USDA program for the people of Bikini has not increased since 12, 13 years ago. The population has tripled and we are still using the same amount that was given to us 13 years ago.

Mr. Chairman, one other concern we have is, the funding to clean up Bikini Atoll is not enough. Although we thank Congress for appropriating \$90 million, but as you know, Mr. Chairman, that funding is not sufficient to do the cleaning up of all atolls. So please consider these concerns of our people. Thank you very much.

Mr. DE LUGO. Thank you.

Mr. MILLER. Thank you. Mr. Abercrombie, did you have any questions or statements you wanted to make?

Mr. ABERCROMBIE. No, Mr. Chairman.

Mr. DE LUGO. Mr. Chairman.

Mr. MILLER. Yes.

Mr. DE LUGO. When we come back—I assume you are going to recess for this vote—when we come back, between panels, I would like to make a brief statement at that time.

Mr. MILLER. Are we finished with this panel?

Mr. DE LUGO. Yes.

Mr. MILLER. Thank you very much and let me just say on behalf of the committee and Members that it is hard to say we look forward to it, but we certainly want you to know that we do look forward to working with you both on the question of preparing your formal request for the Congress should you decide to do that and to helping you declassify the information. But I also think Mr. Graham makes a very important point that we need to expedite our obligations and the care that individuals in the Marshall Islands need as a result of this activity.

While we ferret out what went wrong, those people who have paid a very severe price for what went wrong should not continue to fail to be treated when necessary. Also the issue of trying to determine and acquire better knowledge about exactly what is the risk that those individuals face that were subject to this event, I think, is a very important point, Mr. Graham, and for that matter to be expedited is very important. It is really almost an incredible admission that what we are left with on behalf of the United States 40 years later is the Brookhaven study and that somehow, somewhere, somebody must feel that that discharges our obligation in this case or met our responsibilities prior to the compact and is sufficient enough to carry that on.

Obviously, the testimony received today and additional information we have been given just suggests that this in no way can be an acceptable outcome in terms of this Government's obligation. So I appreciate the great distance that you have come and the time you have spent on this matter. It is going to be very helpful to this committee and we do look forward to your help and to your counsel as we proceed on this matter.

We will recess to go make the vote and then when we come back we will hear from the individuals from the Department of Energy. Thank you, again, very much for your time and your effort.

[Recess.]

Mr. MILLER. Let me see if I get our bearings where we are here. Mr. Pettengill, you are in the middle of making a statement?

Dr. PETTENGILL. We are the last panel.

Mr. MILLER. You haven't started yet. My apologies for the disruptions. That is the Congress, unfortunately. Why don't we go ahead and begin. We have used most of your day as it is. I appreciate you sticking with us here.

STATEMENT OF HARRY J. PETTENGILL, DEPUTY ASSISTANT SECRETARY FOR HEALTH, DEPARTMENT OF ENERGY, ACCOMPANIED BY JOHN E. RUDOLPH, DIRECTOR, OFFICE OF TRANSPORTATION, SAFEGUARDS AND ENERGY MANAGEMENT, DEPARTMENT OF ENERGY

Dr. PETTENGILL. Let me say, Mr. Chairman, good afternoon. I am Harry J. Pettengill. I am the Deputy Assistant Secretary for Health at the Department of Energy. My role and my responsibility is I am the current manager for the Marshall Islands program for the past three-and-a-half years going on four years, and that is my reason to be here today to speak to you about our roles and activities in the Marshall Islands.

With me today I have Mr. John Rudolph. Mr. Rudolph was a past associate in the Marshall Islands program during the period when it was managed by the Office of Defense Programs from 1982 through essentially 1990. All individuals I could offer to you that could give you any more historical perspective on DOE's involvement have essentially since retired so we are the two individuals that can give you any perspective at this point in time in terms of DOE's involvements and activities.

We have entered a rather lengthy statement in the record and what I would prefer to do right now is just go through a more summarized statement that I have to offer.

Mr. MILLER. All right.

Dr. PETTENGILL. I am pleased to appear before you on behalf of Secretary O'Leary and Dr. Tara O'Toole, the Assistant Secretary for Environment Safety and Health. As you know, the Department of Energy is currently engaged in working with other Federal agencies such as the Department of the Interior, which has primary responsibilities, the Republic of the Marshall Islands directly and the numerous local Marshall Islands atoll Government representatives to provide our ongoing medical surveillance and radiological environmental monitoring on behalf of the Marshall Islands people that were exposed to radioactive fallout from atmospheric weapons testing in the South Pacific.

For the record, there were 66 atmosphere nuclear tests conducted in the Marshall Islands with one additional test termed YUCCA, which was detonated from a high-altitude balloon northeast of Enewetak Atoll. I add that because there has been some concern and confusion about whether there were additional unannounced tests in the South Pacific. And after further review we are declaring that that was the number and there are no other additional ones.

In 1954 one of the weapons tests conducted in the Pacific resulted in the deposition of fallout on inhabited islands. This test code name BRAVO was one of the tests in the operation castle series. In response to this unfortunate occurrence, the United States Congress has enacted several legislative initiatives to redress any harm or loss suffered by the Marshallese as a result of these weapons tests.

It is important to mention that those legislative mandates provide a basis, a number of them for DOE's programs. They are best described, I think, under Public Law 99-239 of January 14, 1986,

known as the Compact of Free Association, which requires in part that:

DOE continue to provide special medical care and logistical support to the remaining numbers of the population of Rongelap and Utrik who were exposed to radiation from the 1954 United States thermonuclear BRAVO tests.

Most funding to support Marshall Islands' general health and support program needs are appropriated and administered through the Department of the Interior under the Compact of Free Association. The Department of Energy receives its own separate appropriation for this very limited medical surveillance program and the environmental monitoring we do by its own separate appropriation.

There are also some additional prior laws which impact DOE's responsibilities and they are Public Laws 95-134 and 96-205, which, in essence, were carried on and require DOE to continue to provide environmental monitoring to characterize the radioactivity remaining at the four affected atolls of Bikini, Enewetak, Rongelap and Utrik.

DOE's current Marshall Islands program is conducted primarily through the utilization of resources that we have at the National Laboratories that possess the specific expertise to provide the necessary individual medical surveillance and radiological monitoring. The personnel and scientific expertise that is associated with these laboratories have generally had a very long association with the Marshall Islands and have developed a very unique and lasting working relationship with the Marshallese people.

Now, I will just briefly discuss the essential elements of DOE's Marshall Islands program. In terms of our medical program, the DOE conducts an ongoing field medical surveillance program that involves two medical missions into the field every year to evaluate those Marshallese that were exposed to fallout from test BRAVO.

There are now 147 individuals of this population that are still alive and requiring continuing clinical care and follow-up for possible radiogenic illnesses. In addition to the field visits, in our medical program, additional care as needed is provided to those individuals when it is required to send them outside of the Marshall Islands for secondary and tertiary care.

During the twice yearly surveillance visits the medical teams also as a humanitarian service do make themselves available to provide consultative medical services to the unexposed populations on the outer atolls after we have assured that we have attended to the needs of the exposed population that we are mandated to be there to look after.

The DOE program is, of course, limited by that congressional mandate to only the exposed population. Those that were resident during test BRAVO and section 177 of the compact also provides for a separate, as you are aware, Marshallese section 177 health care program, which is independent of the DOE program.

The section 177 health care program is funded under the compact and overseen by the U.S. Department of the Interior and provides additional health care for all the peoples of Bikini, Enewetak, Rongelap and Utrik. I think you have heard in testimony here today that the individuals involved in that program number somewhere around 10,000.

DOE physicians routinely refer all of our people that have been diagnosed as having medical problems that require referral care and that are in any way related to the radiogenic diseases referred to the 177 health care program. And recently in the past several years it has been my objective and we have had the physicians of the 177 health care program accompany our DOE medical missions.

This has provided a unique opportunity to share our clinical expertise between the two programs. In addition it provides for expedited referrals where they are necessary and allows us to provide consultative services from our specialists as needed and physicians for all the resettled populations.

In terms of our environmental monitoring program, the DOE's long-standing environmental monitoring programs are dedicated to the routine characterization of the residual levels of radionuclides on the four predominant and affected atolls, the ones that I had earlier mentioned. Currently, DOE conducts, again, two environmental missions a year where we send a large cadre of scientists into the field.

A primary goal of our environmental monitoring program is to complete and upgrade grid sampling of vegetation and soil so that we can be assured of what the base lines are prior to resettlement of each and every affected atoll. Then we follow up with routine characterizations of the environmental conditions.

In addition, because there is such an issue on mitigation prior to resettlement for many years, the program has devoted a significant amount of its effort to research on mitigation techniques that would help to reduce the consequences of exposure when populations do resettle.

In this regard in terms of environmental monitoring, in 1978, Lawrence Livermore, our primary environmental monitoring lab, and the DOE did conduct a Northern Marshall Islands Radiological Survey, which was a combination aerial, radiological, and photographic and ground sampling program of 11 atolls and 2 islands in the northern Marshalls.

The main purpose of this survey was to document the remaining external gamma levels for these atolls that may have received fallout from nuclear tests conducted at Enewetak and Bikini. The aerial portion of the survey was performed to quantify the levels of gamma-emitting radionuclides remaining on the ground, and the ground segment involved selective sampling to provide more accurate and comprehensive information.

In November of 1982, the DOE did publish the results of the Northern Marshall Islands Radiological Survey in the form of a bilingual report and in December of 1982 DOE introduced and presented in Majuro the report entitled, "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978."

In the spring of 1983, the report was further presented to each and every one of the populations in the four most affected atolls. DOE has continued its radiological monitoring activities between 1982 and 1985 and during this period of time I think it is fair to say that we placed the major emphasis on the collection of samples and the continuation of environmental studies at the most radio-

active contaminated atolls of Bikini and Enewetak, the site of the actual testing.

Since that time, however, since 1985, radiological evaluations have been expanded to include greatly increased monitoring of Rongelap and Utirik Atolls.

In addition to the primary environmental monitoring program and the medical program, DOE does carry on what I call a radiological assessment program. DOE provides continuing radiological monitoring of Marshallese people to determine and quantify the uptake and the presence of radioactive material which has been taken into their bodies.

The program includes basically two types of monitoring techniques. The first one quantifies the amount of gamma-emitting radioactive material located within the body by means of a technique known as a whole-body count. This method is typically used to measure the predominant long-lived gamma fallout radionuclides such as cesium-137.

The second monitoring technique involves the collection and analysis of urine samples to test for the presence of radionuclides which would emit alpha particles, such as plutonium being the predominant one, but since plutonium does not emit any gamma rays that can be readily detected using the whole-body counting technique, both techniques must be used together in order to get an accurate assessment of acquired radioactivity in the affected atolls.

Mr. Chairman, an important issue and one that has been mentioned and discussed here today is the issue that the committee has reported elevated incident rates of thyroid disease in populations from the northern Marshalls, as compared to populations in the southern portion of the Marshall Islands.

I would just attempt to provide you with the following DOE perspective on this subject. The Republic of the Marshall Islands, as provided for under section 177 is currently, as you are aware, completing a nationwide radiological study to establish residual environmental radiation levels throughout the entire Marshall Islands.

The nationwide survey is most timely since it will document what potential for radiation exposure still exists on all the atolls and will provide data to assist in an effective dose reconstruction. That is where we go back and attempt to reestablish the dose that would have occurred historically.

Clearly, the data from DOE's 1978 Northern Marshall Islands Survey will provide useful information for comparison to this new nationwide survey which is more extensive. However, such surveys do not answer the important questions about the short-lived nuclides such as iodine-131.

In this regard the Nationwide Radiological Survey, to our understanding, is conducting a comprehensive thyroid disease survey utilizing an independent institute in Japan. A phase one thyroid survey was done using current inhabitants at Ebeye on Kwajalein Atoll. After that data has been fully evaluated—and as of this time we have only been apprised of it in its essential initial form—it is expected that the study would be expanded to include surveillance of thyroid disease in other parts of the northern Marshall Islands.

The survey is noteworthy in that it utilizes an ultrasound imaging technique which provides for more resolution when defining

thyroid nodules. That is important to point out because I think if you look historically at other thyroid studies that have been done, a lot of those were done by physical palpation by clinicians and where the use of the ultrasound will allow you basically to detect a nodule with great accuracy essentially half the size that you could by physical palpation.

DOE supports the need for and the essential benefits of this activity. Arrangements have already been made to include these same physicians using their ultrasound technique to accompany a DOE-sponsored medical mission to the outer atolls in 1994.

Of unique interest in the survey is that it may add information of historic exposures to radioiodine which has since decayed. DOE and its predecessor agencies have conducted extensive environmental monitoring activities throughout the northern Marshall Islands even during the testing years.

Our review of historic data indicates that the atolls to the south and east of Rongelap and Utrik were several orders of magnitude less than those levels observed on Rongelap atoll, with the high point being shortly after test BRAVO. Because the primary fallout radioiodine decays away quickly because of its eight-day physical half-life, significant exposure to any mid-belt inhabitants would likely have been small when compared to the very large, and I emphasize that even I consider them very large thyroid doses received by inhabitants of Rongelap and Utrik.

Because of the low potential for exposure to thyroid in those individuals compared to those that we have seen on Rongelap and Utrik, any follow-up on the mid-belt atoll inhabitants we should understand may be somewhat inconclusive in those exposure levels and among a limited population.

When you look at it in terms of an epidemiologic study, it would make it extremely difficult to detect statistically significant increased traits of thyroid disease.

Such studies often require significant increases in levels. I think the point to make here in terms of DOE, because we have been mandated under law to deal with a very defined population, if we were to attempt to expand our study and our involvement, much larger populations that reside in the entire area of the northern Marshalls, it is something that we would find very difficult to do within the resources that we have available in terms of manpower and the appropriation that we get.

If this were a consideration for Congress then I would offer to the chairman of the committee this is something we would ask. You should require additional consideration to the fact that we simply don't have the resources to expand ourselves and not do harm to what we are already doing in terms of the quality.

Mr. MILLER. What is the value of doing that? What would be the expected value of doing that?

Dr. PETTENGILL. The value of doing the study is, I believe, is this: If we can assume that there may have been the possibility of significant exposure to those populations beyond the two atolls that we are actively involved in, then the value in doing the studies would be that you would have an opportunity to find the occurrence of lesions before they had turned cancerous, and you could provide better care for those individuals.

As you are aware, the last issue that I would like to address is the openness issue. On December 7 of last year, in 1993, Secretary O'Leary announced the Department of Energy openness initiative. As a result, the Department is undertaking the declassification of many weapons testing-related documents. I am currently unaware of any previously classified documents which would add significant value to the immense database on health effects or medical information that already exists on this topic related to the Marshall Islands. Much information has been already published in the professional health journals since the time of the BRAVO test. And at your request, Mr. Chairman, in your letter to Secretary O'Leary of December 10 last year, I have asked my staff to look into it and we recently initiated a very comprehensive review and study to locate and identify any additional materials which remain classified that may have relevance to the issue on the Marshall Islands program.

And I can report to you that as of last night, I was telephoned and told that the remaining classified information that resided in headquarters, which I am sure the Secretary spoke to you about, has effectively been declassified and will be delivered very shortly to you, to the committee.

An additional request from the Marshall Islands will also be honored in that regard since they have asked for the materials as well. In addition to that, as committed to by the Secretary, we have located some additional materials which reside in the Federal repository at Suitland. They are in the process of being recovered. We are scanning all the national labs that have been involved in this activity. We are putting an additional task force of all the programs that were involved in this activity next week to do another scan to make sure that we have identified and located all materials. And we are placing the highest priority on a declassification of that information, and it will be provided in a timely manner.

I thank you for this opportunity to share with you our program accomplishments and information on the subject of thyroid disease, especially. I would now be pleased to answer any questions that you may have, Mr. Chairman.

[Prepared statement of Dr. Pettengill follows:]

Statement of
Harry J. Pettengill
Deputy Assistant Secretary for Health
U.S. Department of Energy
Before the
Subcommittee on Oversight and Investigations
Committee on Natural Resources
United States House of Representatives
February 24, 1994

Statement of
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Deputy Assistant Secretary for Health
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Before the
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I am pleased to appear before you on behalf of Secretary O'Leary and Dr. Tara O'Toole, the Assistant Secretary for Environment, Safety and Health. As you know, the Department of Energy (DOE) is currently engaged in working with other Federal agencies such as the Department of the Interior (DOI), the Republic of the Marshall Islands (RepMar) and local Marshall Islands government representatives to provide medical surveillance and radiological environmental monitoring on behalf of the Marshall Islands people exposed to the radioactive fallout from the atmospheric weapons testing in the South Pacific. In 1954, one of the weapon tests conducted in the Pacific resulted in the deposition of fallout on inhabited islands. This test code named "BRAVO" was one of the tests in the Operation Castle series. In response to this unfortunate occurrence, the United States Congress has enacted several legislative initiatives to redress this circumstance. There were 66 atmospheric nuclear tests conducted in the Marshall Islands with one additional test, "YUCCA", detonated from a high-altitude balloon northeast of Enewetak Atoll. The United States Congress has enacted several legislative initiatives to attempt redress of any harm or loss suffered by the Marshallese as a result of these weapon tests.

Program Mandate

Public Law 99-239 of January 14, 1986, known as the "Compact of Free Association" requires that DOE:

"continue to provide special medical care and logistical support to the remaining members of the population of Rongelap and Utrik who were exposed to radiation resulting from the 1954 United States thermonuclear 'BRAVO' test"

Most funding to support Marshall Islands health and support needs is appropriated through and administered by DOI. The Department of Energy receives separate appropriations, however, for the medical surveillance and the environmental monitoring programs.

Public Laws 95-134 and 96-205 require DOE to continue to provide environmental monitoring to characterize the radioactivity remaining at the four affected atolls of Bikini, Enewetak, Rongelap, and Utrik. On August 3, 1990, the Senate passed an amendment stating that "all responsibilities...and all activities at the Department of Energy with respect to medical and environmental programs applicable (by law) in the Republic of the Marshall Islands shall be managed, controlled, and conducted through the Office of Environment, Safety and Health." During the period from November 1982 until April 1990, the Office of Defense Programs had provided this program management role.

Over the years, scientists and physicians have worked diligently to monitor the health of the exposed populations from the four affected atolls of Bikini, Enewetak, Rongelap and Utrik, and to characterize the persistence of radioactivity in the environment for all of the Marshall Islands. DOE's

that possess the specific expertise to provide medical surveillance and radiological monitoring and evaluation. The personnel and scientific expertise associated with these laboratories have generally had a long association with the Marshall Islands and have developed a unique working relationship with the Marshallese people.

The Department of Energy Medical Program

The DOE conducts two field medical missions annually to examine and provide medical surveillance and follow-up medical care for the 253 Marshallese exposed at Rongelap and Utrik Atolls. There are now 147 of this population that still need clinical care and follow up for possible radiogenic illnesses. An initial unexposed control group of 86 Marshallese people has been expanded over the years to include 135 people. The DOE medical missions treat up to 300 persons annually.

The Brookhaven National Laboratory conducts medical surveillance of the surviving people of Rongelap and Utrik Atolls who were exposed to radiation resulting from the BRAVO test. The medical surveillance results of the "exposed" population are compared to the results of the "control group" referred to hereafter as the "unexposed" group. Also, Brookhaven facilitates care for those exposed individuals with suspected radiogenic diseases who require referral to medical facilities outside the Marshall Islands. During twice-yearly surveillance visits, the Brookhaven medical teams also make themselves available to provide consultative medicine services to the unexposed populations after attending to the needs of the exposed population.

The DOE program is limited by congressional mandate to the exposed populations of Rongelap and Utrik. Section 177 of the "Compact of Free Association" provides for a separate Marshallese 177 Health Care Program, independent of the DOE program. The 177 Health Care Program is funded under the Compact and overseen by the U.S. Department of the Interior and provides health care for the peoples of Bikini, Enewetak, Rongelap and Utrik. The local atoll authoritative have expanded enrollment in this program to approximately 10,000 people. DOE physicians refer all non-radiation related disorders of its exposed and control populations to the Marshallese Section 177 Health Care Program physicians who oversee the populations for the Atolls of Bikini, Enewetak, Rongelap, and Utrik. Recently, Section 177 program physicians began to accompany the DOE medical missions. This provides an opportunity to share clinical expertise between the two programs in addition to providing for expedited referrals and consultive practices for all resettled populations.

The DOE and its predecessor agencies, the Energy Research Development Agency (ERDA) and the Atomic Energy Commission (AEC), have had a long history of support efforts on behalf of the Marshallese people since Brookhaven National Laboratory (BNL) physicians first began to treat the exposed populations of Rongelap, Utrik, and Ailinginae Atolls shortly after the BRAVO test. A medical team from BNL, supplemented by a national corps of consultants, continued to implement medical surveillance and treatment programs under the auspices of AEC and later ERDA with the cooperative support from the Departments of Defense and Interior. From its inception, the primary objective of the DOE Marshall Islands Medical Program has been the early detection and treatment of any medical condition that might evolve as a

consequence of radiation exposures resulting from the BRAVO test. Both scientific and humanitarian considerations led to the establishment of an effective field capability for DOE to administer routine and scheduled primary medical care, with facilities being made available outside the Marshall Islands for secondary and tertiary referral.

DOE's Environmental Program

From the time of the BRAVO test to recent years, the medical program has been augmented with long-standing environmental monitoring programs dedicated to the routine characterization of the residual levels of radionuclides on the affected atolls. Currently, DOE conducts two environmental monitoring missions annually. A primary objective of the environmental program is to afford complete grid sampling of vegetation and soil prior to resettlement of each affected atoll. In addition, many years of the program have been devoted to program research on mitigation techniques to reduce uptake of radionuclides by plants and local foods that could impact resettled populations.

To fulfill the congressional mandate to conduct continuing environmental monitoring, Lawrence Livermore National Laboratory (LLNL) has performed radiological monitoring of the environment at Bikini, Enewetak, Rongelap, Utrik and other atolls throughout the northern Marshall Islands. The monitoring has been designed to determine environmental concentrations of radionuclides in indigenous food products, vegetation, and soils and to evaluate agricultural restoration or utilization methods to diminish the uptake of cesium-137 into the food chain. In 1978, LLNL and DOE conducted the Northern Marshall Islands Radiological Survey, a combination aerial

radiological and photographic survey and ground sampling program of 11 atolls which included Rongelap, Taka, Utrik, Bikar, Rongerik, Ailinginae, Likiep, Ailuk, and Wotho in addition to the two islands of Jemo and Mejit. The main purpose of these surveys was to document the remaining external gamma levels for these atolls that may have received fallout from the nuclear tests conducted at the Enewetak and Bikini atolls. The aerial portion of the survey was performed to quantify the levels of gamma emitting radionuclides on the ground, and the ground segment involved selective sampling to provide more accurate and comprehensive information.

In November 1982, DOE published the results of the Northern Marshall Islands Radiological Survey in the form of a bilingual report. In December 1982, DOE introduced and presented at the capital island of Majuro in the Marshall Islands, a report entitled, "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978." In the spring of 1983, the report was also presented to the populations at each of the four affected atolls. DOE has continued its radiological monitoring activities between 1982 and 1985 but placed its main emphasis on collection of samples and continuation of environmental studies at the most radioactively contaminated atolls of Bikini and Enewetak. Since that time, radiological evaluations have expanded to include Rongelap and Utrik atolls. Since 1985, the Lawrence Livermore National Laboratory team has collected soil and vegetation samples to determine the levels of cesium-137 in locally grown foods and to determine the concentration of plutonium-239 and plutonium-240 in the soil. These characterizations are continuing and the actual raw data,

results and reports generated on these data are shared with the Marshallese people.

DOE's Dose Assessment Program

Brookhaven National Laboratory conducts a radiological monitoring program of the Marshallese people to determine and quantify the presence of radioactive material which may have been taken into their bodies. The program includes two types of monitoring techniques. The first one quantifies the amount of gamma-emitting radioactive material located within the body by means of a technique known as a whole-body count. This method is typically used to measure predominant long-lived gamma fallout radionuclides such as cesium-137. The second monitoring technique involves the collection and analyses of urine samples to test for the presence radionuclides which emit alpha particles such as plutonium, a secondary dose contribution. Since plutonium does not emit any gamma-rays that can be readily detected using the whole body counting technique, both techniques must be used to generate an accurate assessment of radioactivity that might have been acquired from weapon tests.

Memorandum of Understanding for Resettlement of Rongelap Atoll

With the signing of a Memorandum of Understanding between the DOE and the Republic of the Marshall Islands in 1992, an entity known as the Rongelap Resettlement Project was established to conduct an independent assessment of the habitability of Rongelap atoll. DOE scientists from LLNL have at times split samples, shared and compared results with each other to assure the best science is applied to make the resettlement decision. The Rongelap Resettlement Project also sponsors a number of other independent studies in

order to fully evaluate habitability. A final report on this action should be completed by May of 1994.

Incidence of Thyroid Disease in the Marshall Islands

Mr. Chairman, an important issue of great concern to the Committee is the reported elevated incidence rate of thyroid abnormalities in population from the northern Marshall Islands as compared to population in the southern Marshall Islands. I wish to provide you with the following DOE perspective on this subject.

The Republic of the Marshall Islands as provided for under Section 177 of the Compact of Free Association is currently completing a Nationwide Radiological Study to establish residual environmental radiation levels throughout the Marshall Islands. The Nationwide Radiological Study is most timely since it will document what potential for radiation exposure still exists on all the atolls and will provide data to assist in an effective dose reconstruction.

The Nationwide Radiological Study is also conducting a separate thyroid nodule and disease survey utilizing independent physicians from an institute in Japan. A phase 1 survey was done using current inhabitants at Ebeye on Kwajalein atoll. After the data has been fully evaluated, the study will be expanded to include surveillance of thyroid disease in other parts of the northern Marshall Islands. The survey utilizes an ultrasound imaging technique which provides more resolution when defining thyroid nodules. Arrangements have also been made to include these same physicians using the

ultrasound technique to accompany the DOE sponsored medical missions to outer atolls in 1994.

The DOE and its predecessor agencies conducted extensive environmental monitoring activities throughout the northern Marshall Islands. During a recent review of the supporting documentation that accompanies the document entitled, "Marshall Islands Chronology, 1944 to 1990" which was compiled in January, 1990, we discovered radiological survey information, conducted relatively soon after the Castle BRAVO test, which indicates that the fallout levels on the atolls to the south and east of the four affected atolls (e.g., Wotje, Maloelap, Likiep, Ailuk, Kwajalein, Lae, and Ujae) at about 3-4 milliroentgen/hour were typically several orders of magnitude less than those levels observed at Rongelap Atoll which ranged from 2000 to 3000 milliroentgen/hour initially. Because the primary fallout radioiodine (iodine-131) decays away quickly because of its 8 day half-life, significant exposure to any mid-belt inhabitants would likely be small when compared with thyroid doses received by inhabitants at Rongelap and Utrik Atolls. Additionally, fallout levels measured during the 1978 aerial survey showed that levels at that time were comparable to and consistent with generally known worldwide fallout levels outside the four most affected atolls. However, there is a possibility that fallout from the other 65 tests may have deposited radioiodine and other short-lived radioisotopes that should be considered.

In your December 10, 1993 letter to Secretary O'Leary, you referenced Dr. Thomas Hamilton's confidential statement to your Committee. Since the time

that Dr. Hamilton made his statement, his findings were subsequently published in the *Journal of the American Medical Association* (Vol. 258, No.5, August 7, 1987, pgs. 629 - 635). In summary, Dr. Hamilton suggests that a linear relationship between distance from Bikini Atoll and the prevalence of thyroid abnormalities could be ascertained throughout the northern atolls and not limited to only Rongelap and Utrik. Dr. Hamilton suggests that these findings indicate that fallout from the BRAVO test extended much further south than is currently believed and resulted in exposures to more people than the populations of Utrik and Rongelap atolls. However, these mid-belt atoll contamination levels, as stated earlier, were significantly below those of the four affected atolls.

A study related to weapons testing thyroid disease titled, "A Cohort Study of Thyroid Disease in Relation to Fallout From Nuclear Weapons Testing", a combined publication of 9 individuals, was published in the November 3, 1993, issue of the *Journal of the American Medical Association* (JAMA Vol. 270, No.17, pgs 2076-2082). In this study results were reported as a function of three separate histological categories which were identified as nodules, neoplasms, and carcinomas. The investigators report that "the associations found were specific to neoplasia and were not seen for non-neoplastic nodules or any other thyroid condition". An increased risk was cited for thyroid neoplasms at doses greater than 400 mGy (40 rem). The mid-belt atoll exposures were significantly less than this.

An additional source of information may have relevance to this issue. The National Research Council, acting in its capacity under the auspice of the

National Academy of Sciences have prepared a series of reports to advise the U.S. government on the health consequences of radiation exposures. The most recent report is entitled, "Health Effects of Exposure to Low Levels of Ionizing Radiation" (alternatively known as the BEIR V report) and was published in 1990. This report contains a section devoted specifically to thyroid carcinoma. The data of Dr. Hamilton is reviewed in addition to other populations exposed to I-131 or radiations of external origin.

The BEIR V report observes that: 1) "the development of thyroid cancer from initiated cells is profoundly dependent on hormone balance."; 2) "there is wide variation among reports of spontaneous thyroid cancer incidence among different Polynesian populations "; 3) "there are major differences in background thyroid rates among unirradiated individuals of different reported cohorts. Analysis suggests that these differences are related, at least in part, to life-style, although ascertainment may also play a critical role."

Because of the low potential for exposure to radiation, any follow up study on the mid-belt atoll inhabitants probably would be inconclusive in that low exposure doses among such a small population would make it extremely difficult to detect significantly increased rates of thyroid disease. Such studies would require significant increases in current levels of appropriations for the DOE Marshall Islands Program.

DOE's Openness Initiative

As you are aware, on December 7, 1993, Secretary O'Leary announced the Department of Energy Openness Initiative. As a result, the Department is

undertaking the declassification of many weapons testing related documents. I am currently unaware of any previously classified documents which would add significant value to the immense database of health effect or medical information already existing on this topic. Much information has been already published in the professional health journals since the time of the BRAVO test. My staff has recently initiated an effort to identify, locate and review information that remains classified on the subject of weapons testing in the Marshall Islands. The Secretary has directed that any documents relevant to the Marshall Islands be identified and declassified whenever possible.

Mr. Chairman, I thank you for this opportunity to share with you our program accomplishments and information on the subject of thyroid disorders in the Marshall Islands.

I would now be pleased to answer any questions that you may have.

Mr. MILLER. Thank you very much. On the question of declassification, the Secretary mentioned that the materials, I guess what you referred to from headquarters, would be delivered to us on the twenty-fifth. Are we still to assume that that is the case?

Dr. PETTENGILL. Yes.

Mr. MILLER. Okay, thank you. I am not in a position today to do dueling studies back and forth, and that is certainly not my field, but let me ask you, I am led to believe that you have a problem with Dr. Hamilton's study. Is that so?

Dr. PETTENGILL. Personally, I have no problem at all.

Mr. MILLER. I don't mean personally. I assume you wouldn't have one personally.

Dr. PETTENGILL. No. In fact the first time that I reviewed the study was shortly before I met with your staff. I reviewed his journal publication, which occurred in, I guess, 1987, after he had provided confidential testimony to this committee. And I found the publication to be reasonable and a good one.

The staff did as we normally do. I have a staff of epidemiologists. One of my offices is the Office of Epidemiology and Health Surveillance. They reviewed it, and they looked at it from a professional standpoint. They identified and pointed out a number of weaknesses, a view of which Dr. Hamilton himself has spoken to and even identified one himself in the publication. We offered those comments, and I believe they were transmitted on to Dr. Hamilton.

Mr. MILLER. And so what conclusion are we to draw from that as laypersons?

Dr. PETTENGILL. Well, from all the information that was put in front of me, it was a very credible study. I mean he surveyed 7,000 people from the northern Marshalls. Approximately, 2,000 of those individuals were alive at the time of the BRAVO test. And he made some calculations and his survey showed that there was essentially, as I recall, a 33 percent increase in prevalence, in incidence of the disease. And based on his information and what is provided in his study, I have no reason to question that.

Mr. MILLER. Should that have any impact on your ongoing work?

Dr. PETTENGILL. Not at this point in time, because as I indicated, the Department of Energy is operating under a very strict mandate where we were given the provision under law to provide medical surveillance and care for a defined group of individuals that were exposed directly to fallout from test BRAVO. That involved 253 individuals, approximately 86 that were on Rongelap and I believe 167 on Utrik.

Mr. MILLER. Does Dr. Hamilton's study set off any bells or whistles that might be of concern, just out of humanitarian reasons?

Dr. PETTENGILL. Well, to me, looking at it now, I would think that there is the possibility that there should be wider medical surveillance; it should be a consideration. And I believe that is what the chairman heard from the elected representatives of the various atolls.

Mr. MILLER. When you say wider medical surveillance, you mean both geographically and personnel?

Dr. PETTENGILL. Right, number of people and geographically, for the areas where, if they were alive during the testing era and there

was the possibility of fallout having any impact on that population, then medical surveillance is a reasonable approach.

Mr. MILLER. I followed you through this, but I am not sure I understood it. Your environmental monitoring assessments leads you to what conclusion in terms of safety or impacts? I am not sure I am using the right words, but you are going to have to educate me on this.

Dr. PETTENGILL. What we attempt to do, primarily with our environmental monitoring programs—and again, we are mandated to look at the four most affected atolls, and that is important to emphasize—so that is why we look very closely at Rongelap, Utrik, Bikini and Enewetak.

The main essential element of that is to develop routine characterization of those atolls in order to validate what the residual levels of radioactivity are in the soils, in the vegetation on those atolls. And as such, we have laid out a program. Livermore is working very diligently at that. We are doing what I would call baseline gridding surveys of those four atolls, where we have at this point in time an understanding of what the activity levels are throughout the atoll, okay. And then over time with some frequency, you can go back and you can spot check, so to speak, Mr. Chairman. You wouldn't necessarily have to do the entire grid, but you would do primary areas on the grid.

You go back and reevaluate and see whether the radioactivity is decaying slower, at or greater than the rate that you might have predicted.

Mr. MILLER. What have you learned from the baseline?

Dr. PETTENGILL. Well, we have learned a number of things in those areas that we have baseline. As we did understand, there are different elements here. The first element is the physical decay, which is established by the half-life of the radioactive material itself.

A second element, which is also an inducing factor, is what we call the environmental half-life, that while you have the actual physical decay of the radioactivity, there are other forces in the environment that are essentially removing that radioactive material from that location in the environment and transporting it somewhere else. As in the case of cesium-137, for example, which is the predominant dose contributor to populations because of its uptake.

It has an environmental half-life, we are finding at the end of our research after many years in that area of the world, of approximately around 18 years, as compared to the 30-year physical half-life. So the good news is that the radioactive cesium will be leaving the environment a little quicker than one had assumed.

Mr. MILLER. And that would lead you to anticipate what in terms of maintaining risk or potential danger?

Dr. PETTENGILL. Well, in terms of that being the major, the predominant dose contributor to resettled populations because they would take in cesium by ingestion of local foods that had taken it up through the root system and into the fruit product, that would result in lower activities in the fruit and result in less uptake of the individual. Thus, less dose.

Mr. MILLER. So that goes where on the scale? I am just not familiar with what would create a potential danger or something that

you would highlight. Is this sort of thing not a matter of concern, or is it a matter of concern in certain areas?

Dr. PETTENGILL. In my mind, it is always a matter of concern, but I think what it does is, it allows you to make a reasonable estimate of what the expected exposure to individuals living in those environs will be. And based upon that and based upon the risk estimate of that exposure, then they can make a judgment as to whether it is safe or not.

Mr. MILLER. Would we have a different risk calculation or potential exposure with respect to children who are relocated in those areas, or do we know enough about that?

Dr. PETTENGILL. I don't personally, but from what I do understand, I think in terms of cesium, probably not, because it is taken up in the body in such a manner. There is something like iodine-131, which we have discussed in terms of its uptake and specific concentration in the thyroid gland, that is much more hazardous to a child because their thyroid is much smaller in physical terms.

Mr. MILLER. That is no longer a risk?

Dr. PETTENGILL. That is no longer a risk because essentially the iodine-131 that resulted from these activities was decayed in a matter of three months.

Mr. MILLER. So in that case, we are dealing with those who were alive at that time?

Dr. PETTENGILL. Right.

Mr. MILLER. Not dealing with follow-on generations?

Dr. PETTENGILL. Exactly.

Mr. MILLER. What is the threat to follow-on generations, if any?

Dr. PETTENGILL. From what we have seen from other studies of radiation in populations, we have seen very little genetic effect at these kinds of exposure levels, as evidenced by the studies that have been done on the bomb survivors in the Japanese populations.

Mr. MILLER. But there have been no studies on this specific population?

Dr. PETTENGILL. No, because you are talking about a population that initially numbered 253 people. It is highly unlikely that you could have any kind of statistical powers to be able to apply to that kind of a study.

Mr. MILLER. On page 9 of your statement at the bottom, you say that fallout levels measured during 1978 aerial surveys showed that levels at that time were comparable to and consistent with generally known worldwide fallout levels outside the four most affected atolls.

What are you saying there?

Dr. PETTENGILL. Well, another person who was here earlier today talked about contributions from all forms of atmospheric testing coming from the Chinese, the Russians, Nevada, the Marshall Islands, the French, and so forth, that contributed to the worldwide, global fallout level. I think it was Dr. Simon who discussed that. And in the area of the Marshall Islands, if you went back before atomic testing, you would find essentially a very low background level because of the way they were formed.

The point I am getting to is, the measurement in the 1978 survey for those atolls outside of the four affected ones, the levels were so low that they were essentially the same levels that you would

measure throughout other areas of the world that were basically contributed to by the global fallout.

Mr. MILLER. Then what does the sentence mean, "however, there is a possibility that the fallout from the other 65 tests may have deposited radioiodine and other short-lived radioisotopes?" What are you telling me there?

Dr. PETTENGILL. Because of the extreme interest in test BRAVO and the expectation that BRAVO is the major contributor to the thing, I think the general acknowledgment there is that there was fission product released from all the tests and that they may have been co-contributors to the other atolls as well.

Mr. MILLER. So there may have been some cumulative impact here of the other tests?

Dr. PETTENGILL. Yes, and I think that I saw in Dr. Simon's testimony one graph that talked about cumulative yields, and you can just sort of plot along that there would be some cumulative effect.

Mr. MILLER. On page 11, in the middle paragraph, they are referring to the BEIR V report. Your last sentence says analysis suggests that these differences are related, at least in part, to lifestyle, although ascertainment may also play a critical role. What are you telling me there?

Dr. PETTENGILL. Pardon me? Would you go over that?

Mr. MILLER. What is it you are saying there? You talk about the BEIR V report, and then you say that analysis of these differences, that difference is what, between Dr. Hamilton and the BEIR V report? I am on page 11 in the middle paragraph.

Dr. PETTENGILL. Page 11. Oh, well, I would suggest that what that could mean there, Mr. Chairman, is that it could be a combination of any of these factors. BEIR V was also mentioned. BEIR V indicated that there was an increased risk of cancer induction in the range of 2-4 from low LET radiations, as opposed to what had been previously thought. And in the context of creating BEIR V, Dr. Hamilton's data was reviewed by the BEIR V committee and they did note in that and other studies there could be hormonal balances which can affect the prevalence rate of thyroid nodularity, that there was an evidence of higher incidences in Polynesian populations in general as compared to populations in the United States of thyroid nodularity, and that all these kind of things could have an additive effect.

Mr. MILLER. That is not to suggest that that explains the high incidence Dr. Hamilton found?

Dr. PETTENGILL. No. No, sir.

Mr. MILLER. Lifestyle in your last sentence refers to Polynesian populations or what? What does lifestyle refer to?

Dr. PETTENGILL. Well, in terms of the diet, that it was very high shellfish contribution in the diet of South Pacific islanders, and there would be a lot of iodine taken up which is concentrated in the thyroid, so it could help explain that.

Mr. MILLER. But do we know that?

Dr. PETTENGILL. Not totally, no. Not totally.

Mr. MILLER. Is this population being compared to a Polynesian population somewhere else that ate a lot of shellfish and got thyroid cancer?

Dr. PETTENGILL. No, not to my knowledge.

Mr. MILLER. Well, what is it being compared to? I don't understand.

Dr. PETTENGILL. Well, there were studies that they had available to them, the BEIR V committee, that they looked at and they felt that there were possibly other contributing factors which may have contributed to a higher incidence of thyroid nodularity in Polynesian populations, as compared to other populations throughout the world, that may be due in part to radiation, but may not be due in part to radiation. It may be due to dietary factors, hormonal factors, etc. That is what that is attempting to explain; even BEIR V felt that there are a lot of other contributing factors as well. You can't explain it totally on the basis of this.

Mr. MILLER. Well, I think this is my concern. When I read that and I read the Hamilton study, my concern is that there may be a lot of things that explain it, but 65 nuclear blasts may explain it, too. And I just don't know how do you apportion the weight here. Eating shellfish and a nuclear blast are weighted the same? Can't be, I don't think so.

Dr. PETTENGILL. I think another factor, which may be important to point out, too, is that even in Dr. Hamilton's study, and the recent survey done under the Nationwide Radiological Survey, there was a significant portion of those populations that were surveyed which were born long after the testing era. And there was, to my understanding, there was increased incidence of thyroid nodularity in those population age groups as well, which would make one assume that there were other contributing factors as well.

The underlying prevalence rate here in this population, short of the radiation exposure, may, in fact, be elevated over other populations throughout the world.

Mr. MILLER. But we don't know that.

Dr. PETTENGILL. We don't know that totally. We don't know that totally.

Mr. MILLER. Right, we don't know it or we don't know what we don't know, is what you are saying. Nobody has run a study.

Dr. PETTENGILL. To my knowledge, nobody has run a study which subtracts that out totally and probably with extreme accuracy that all scientists would buy on to. However, I think the studies themselves do demonstrate that there is increased prevalence in populations that were born long after the testing.

Mr. MILLER. Maybe it is in the shellfish for a different reason.

Dr. PETTENGILL. It wouldn't be iodine.

Mr. MILLER. "Shellfish Institute" may not want to hear that, but we will go to Chairman de Lugo.

Mr. DE LUGO. Thank you very much. I am concerned about what you said about Dr. Hamilton's findings and conclusions. I want to clarify whether you think that Dr. Hamilton's findings indicate that the extent of serious fallout may have gone beyond the four atolls. You answered the chairman's questions, and I was wondering, did you rule this out?

Dr. PETTENGILL. No, I believe that was the nature of our testimony. We are saying that you couldn't rule out the impact of not only the BRAVO test, but of other tests extending beyond those four atolls being a contributing factor to increased thyroid

modularity in those populations that were alive during the testing era.

Mr. DE LUGO. Okay. I want to say, Doctor, that I am pleased to hear about the May timetable for the study of habitability on Rongelap. As you know, it has taken quite a long time to get to this point. And as you also may know, some of us thought that your office, Health, was more of an appropriate one to address these issues than your predecessor Defense programs. So we have waited on you to deliver a report that would meet the requirements of the law.

What can you tell us now about the findings so far?

Dr. PETTENGILL. I really can't tell you an extreme amount about the findings. I thank you first for your kind comments on the Office of Health. When we took over the program in 1990, we recognized that there was a major issue to be dealt with and that was the habitability of Rongelap, as provided for under the compact. And we worked very diligently with the Republic of the Marshall Islands and the Rongelap local atoll government and with the Department of the Interior, and we were successful putting together what I think is a very credible scientific work plan that would go back and make an independent evaluation of the habitability issues.

As such, it was extremely important that those studies be carried out under the auspices of the Republic of Marshall Islands and Rongelap, being directed by scientists of their choosing. They have done that as such. Our contributions at the Department of Energy were to provide additional logistical support to provide expertise in doing split samplings and to contribute with the actual surveys that were done. We have done that.

All the data has been analyzed that we split samples on. That has been very timely returned to the Marshallese scientists that were assigned this task to work on the thing. In reviewing the data by our own scientists, etc., I would offer that it seems very encouraging that the levels are at a level which, when you do the final calculations, may provide a possibility of resettlement.

Mr. DE LUGO. While the study is going on, is the Department of Energy still telling the people of Rongelap that it regards Rongelap as safe, or have you suspended that pending the results of the study?

Dr. PETTENGILL. No, sir, I do not tell anybody it is safe, especially the people of Rongelap.

Mr. DE LUGO. Doctor, when you say that the findings are encouraging, does that include dosage that individuals might have received personally from the fallout?

Dr. PETTENGILL. No. What we are talking about is the estimated annual exposure the maximally exposed individual would receive from resettlement and living in Rongelap.

Mr. DE LUGO. Resettlement, all right.

Dr. PETTENGILL. Nobody is encouraged by the exposures that those individuals suffered on the actual fallout.

Mr. DE LUGO. We have heard a lot about what was known or knowable when the compact was being negotiated. The issue is largely the extent of serious contamination. Is it beyond that previous knowledge or other atolls affected? From previous testimony

it appears that all of the information that could have been discussed by all concerned wasn't made available during the negotiations.

DOE seems to have control of the information flow within the Federal Government. Does the new leadership at DOE have any concern about the agency's handling of the matter in the past?

Dr. PETTENGILL. Yes, and I believe even the past Administration. That was one of the concerns that resulted in the realignment of the activity within the Office of Health. He wanted to give reasonable assurance to the people of the Republic of Marshall Islands and to the Congress that there were scientists, at least such as myself, with background and expertise in those areas that we could provide that kind of management.

Mr. DE LUGO. What is your reaction to the information from Dr. Simon that the rate of thyroid cancer is 100 times the worldwide level?

Dr. PETTENGILL. Well, I think that I would offer that I have only been given the preliminary information. Steve, Dr. Simon, has briefed us on the preliminary information on the thyroid survey that was done in Ebeye, and I think it bears a lot more scrutiny and that is why we were very interested in it. At his request we agree with the idea and we like the idea of including ultrasound as part of our survey technology that we use on our medical surveillance missions, as well as including the category of scientists that he has put together to operate with us on our mission and do surveys in the outer atolls, as well. We think it is quite beneficial.

Mr. DE LUGO. Doctor, what is your assessment of the National Radiological Survey which is being undertaken by the Marshall Islands? Does it coordinate with DOE? And if so, how?

Dr. PETTENGILL. Yes, very much so. We have had the opportunity in a few circumstances, I believe, to provide some logistical support when Dr. Simon and his people may have wanted to come along with us on a mission, to be able to take his personnel and his equipment to one of the outer locations to do surveying. And I might offer that that surveying wasn't always necessarily a component of the Nationwide Radiological Survey, which he has been very busy on over the last several years, but also as essential element of the Rongelap resettlement activity, and that is where we have the most interface.

Mr. DE LUGO. You look on this study as a highly creditable study?

Dr. PETTENGILL. The Nationwide Radiological Survey is, very much so, and I think I have stated that in the testimony.

Mr. DE LUGO. What is your reaction to the statements of Bikini Senator Balos regarding conflicting signals from Mr. Ray, who has played such a key role in the Department's Marshall Islands programs, as well as in the compact negotiations?

Dr. PETTENGILL. Well, I myself find it very difficult to answer that question specifically because, as I indicated, my history with the Marshall Islands is only from the period of 1990 on. John Rudolph, who was with the Office of Defense Programs and was a very close associate with Doctor Ray, may desire to answer that question.

Mr. DE LUGO. Mr. Rudolph.

Mr. RUDOLPH. I can make some comments on this although this also happened before my time in this program. But my recollection is that the level of contamination on the Island of Bikini was such that it was deemed at the time within acceptable exposure limits for the people to be returned to the island, provided they limited their diet to food that was provided by the Department of Agriculture, and that they stayed away from locally grown food because of the cesium uptake in coconuts, which was a predominant component of the diet.

And so since the Bikini people wanted to go back, the resettlement was authorized. The people were monitored continuously during this resettlement period and the monitoring showed that they were beginning to notice an unacceptable uptake of radionuclides in the people. And so before that level reached any level that would have been hazardous to their health, they were evacuated again. And that is my recollection. I believe that the record will support that.

Mr. DE LUGO. How long was the time period between their return and their subsequent evacuation?

Mr. RUDOLPH. I think they went back in 1968, and evacuated in the middle 1970s, approximately ten years. But that is a matter of record.

Mr. DE LUGO. They were there for a decade, ten years, a decade?

Mr. RUDOLPH. Yes, ten years. During that time they were continuously monitored and when it appeared that the resettlement was not going to work as it was intended, they were evacuated.

Mr. DE LUGO. Was this also the atoll where they were told that it was safe provided they didn't have children?

Mr. RUDOLPH. I am not familiar with the not having children part, but I don't think the Department of Energy ever said that an atoll or an island was safe or unsafe. What we tried to tell the people was the level of contamination and the estimated dose commitment over time and let the people themselves decide whether the risk of going back and the desire to live on their homeland was more important than staying in the islands to which they were evacuated. But that was a decision that we chose to leave to the people. I believe we gave them all the information that was necessary, that we had available, for them to make that decision.

Mr. MILLER. Did you have all the information available that was necessary to make that decision?

Mr. RUDOLPH. Did we? All the information that we had available, we shared with the people.

Mr. MILLER. But would that be enough information to make an informed decision?

Mr. RUDOLPH. We believed it was, yes.

Mr. MILLER. Was it?

Mr. RUDOLPH. In my opinion, yes, it was.

Mr. MILLER. All right.

Mr. DE LUGO. When were they evacuated the second time?

Dr. PETTENGILL. I believe 1978.

Mr. DE LUGO. Oh, I see. Well, let me just say Secretary O'Leary's doctrine, or the O'Leary approach, is very encouraging to this Member. And it is encouraging to read in your statement, Dr. Pettengill, that the Secretary has directed that any documents rel-

evant to the Marshall Islands be identified and declassified whenever possible.

Thank you very much, Mr. Chairman.

Mr. MILLER. Mr. Abercrombie.

Mr. ABERCROMBIE. Yes, thank you, Mr. Chairman.

Dr. Pettengill, does the DOE's openness initiative extend beyond this immediate instance? Is it an across-the-board initiative in the Department of Energy?

Dr. PETTENGILL. Yes, sir. It extends totally throughout the whole framework and the fabric of the Department of Energy.

Mr. ABERCROMBIE. Very good. Mr. Chairman, this has been a long day, but there are some difficulties, not directly associated with you today. I am raising the issue in conjunction with a point of inquiry made by myself, by the chairman of this committee, and colleagues of mine representing the South Pacific, as well as the Caribbean. Those of us who come from island areas—I come from Hawaii, Mr. Underwood comes from Guam, Mr. Faleomavaega, American Samoa—and as you know, we have a special relationship not only with the Marshalls, but with the Marianas, the whole South Pacific.

We have had more interaction previously, not with the Office of the Secretary for Health in the Department of Energy, but with the Assistant Secretary for Environmental Restoration and Waste Management. I bring it up because in the capacity that I mentioned of representatives of island people, we have inquired about plutonium shipments.

Now, the Virgin Islands, Hawaii and the Northern Marianas so far have made inquiries. My understanding is that the Marshall Islands will also be making inquiries with respect to plutonium shipments and the safety factor associated with them. We haven't received an answer. Are you familiar with this area at all?

Dr. PETTENGILL. No, I am not, sir, but I can certainly check on it when I get back to the Department.

Mr. ABERCROMBIE. All right. The reason I raise it, and I won't carry it much further for purposes of this inquiry, but I think that the Secretary of Energy should be put on notice that the report that we received to this point (not from your subsection, if you will, Dr. Pettengill, but from that of the area of environmental restoration and waste management) as it affects the shipment of plutonium to Japan through waters which might include the Marshall Islands, is unsatisfactory.

I will be submitting material and inquiries further to the Chair on this issue. The reason I raise it, and I want to repeat, the reason I am raising it in the context of this Marshall Islands hearing is that the people of the Marshall Islands have been through such horror and been through such tragedy and been through such trauma for so many years, to find the Department of Energy stiff-arming them again at this stage with the possibility of perhaps an accident taking place in a typhoon or something of that nature, and then finding the Marshall Islands subject to plutonium radiation, the half-life of which is considerably greater by factors of thousands than some of the radiation that we have been talking about today, would be beyond irony.

And so because the Department of Energy has authority here and has obligation with respect to safety and health and environment where radiation is concerned, I raise that issue with you and would ask you to take it into account in the context of this hearing, even though you are not directly concerned.

Dr. PETTENGILL. Okay. I shall and I will—

Mr. ABERCROMBIE. Thank you. I appreciate your indulgence, Mr. Chairman, on being able to raise this issue, and I will pursue it further with the committee.

Mr. MILLER. Thank you. There are no further questions. I want to thank you. I have some additional questions, but I am not sure I can formulate them in an intelligent fashion at the moment, so we will try to see if we can put them down in writing and get them to you so that we will be talking on the same wavelength.

Okay. Thank you very much for your help today and for your continued help in the future.

Mr. de Lugo.

Mr. DE LUGO. Mr. Chairman, I do want to put something in the record. I was pretty tough on one of the witnesses here today, Howard Hills, and I didn't want to give impression in any way that the fact that I was tough on Howard was I dislike Howard or there is anything personal in it. Far from it, I have a high regard for him. I happen to like him. But if that is the way I am going to treat my friends, be glad—the fact of the matter is that I feel I have a job here, the same as Howard has his job. And I felt that it was very important that we bring out some things for the record. So I know I was tough on him. It is much easier when you are on the dais than it is when you are sitting at the witness table and having these tough questions hammered at you. But I just don't want anyone in the audience to think that there is any animosity towards this gentleman who I have a high regard for.

Mr. ABERCROMBIE. Mr. Chairman, Mr. Chairman, I notice Mr. de Lugo left our names out of the last colloquy.

Mr. MILLER. I think it is time to adjourn this hearing. Thank you very much and I want to thank all of the witnesses. It has been a long day and I appreciate you sticking with us. And to all those individuals that helped us put this hearing together, I want to thank them for their time and effort, and certainly to the people who came representing the Marshall Islands for their time and their travel. I know how difficult it is. Thank you. And to the staff of the committee, thank you.

[Whereupon, at 4:46 p.m., the subcommittee was adjourned.]

APPENDIX

FEBRUARY 24, 1994

ADDITIONAL MATERIAL SUBMITTED FOR THE HEARING RECORD

U.S. House of Representatives
Committee on Natural Resources
Washington, DC 20515-6201

March 9, 1994

Dr. Steven L. Simon
Director
Nationwide Radiological Study
C/O Embassy of the Marshall Islands
2433 Massachusetts Ave N.W.
Washington, D.C. 20008

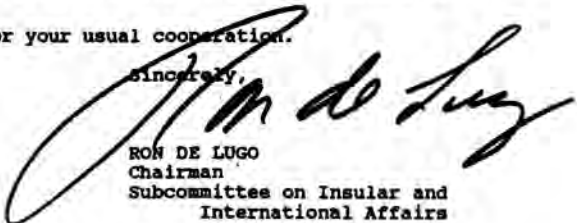
Dear Dr. Simon:

Attached are a few questions which I did not get a chance to raise with you at last month's Oversight hearing on Nuclear Testing in the Pacific.

I would appreciate it if you could respond to the questions by March 25th.

Thank you in advance, for your usual cooperation.

Sincerely,



RON DE LUGO
Chairman
Subcommittee on Insular and
International Affairs

cc: Hon. George Miller

Enclosure

ADDITIONAL QUESTIONS FOR PANEL THREE AND FOUR
OF THE OVERSIGHT HEARING ON
RADIATION EXPOSURE FROM NUCLEAR TESTING IN THE PACIFIC
FROM THE HON. RON DE LUGO
February 24, 1994

Dr. Steven Simon

- * Your preliminary findings of thyroid cancers 100 times the worldwide rate were, of course, alarming.

Do you have any reason to doubt these findings?

- * Has the Radiological Survey indicated contamination of a serious nature beyond the four atolls?

What does the survey information indicate, so far, about the habitability of Rongelap?

- * The Brookhaven National Laboratory's 20 year report on the Marshalls exposure for DOE said that thyroid tumors "have been seen as late as forty years after exposure" meaning that we only this year may see them. (Bravo was in 1954.)

What are the implications of such a statement?

Since nuclear weapons were less than 30 years old when that report was written, is it possible that it may take even longer than 40 years for the tumors to appear?

- * What, if anything, do you know about the health problems at Ailuk or Likiep Atolls?



NATIONWIDE RADIOLOGICAL STUDY

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27 April 1994

Honorable Ron de Lugo
U.S. House of Representatives
Committee on Natural Resources
Washington, D.C. 20515-6201

Dear Congressman de Lugo,

I apologize for not being able to reply earlier to your inquiry dated 9 March 1994. Among other responsibilities, I have been preparing a report to the U.S. Senate Energy Committee on the findings of detailed studies that have been underway for two years concerning the safety of Rongelap Island. I know that you will be interested in these findings. I have also been conducting a continuation of the Thyroid Study that began in Ebeye about one year ago. The study is now underway in Majuro where there are well over 5000 persons who were alive at the time of the nuclear testing. We have now completed an additional 1600 examinations in addition to the 1400 last year at Ebeye. There are no new results to report yet, as pathological analysis on numerous biopsy samples is now underway in Japan.

I am most happy to answer your questions as best I am able. Following is my reply to your queries.

(1) Do I have reason to doubt the preliminary findings of thyroid cancers 100 times the worldwide rate?

The answer to this requires some detail and qualification. Evaluating and comparing the rates of disease among nations and populations is a very difficult issue. Preparing a response to you on this question is the same problem faced by international health agencies in determining which nations have elevated disease rates and in establishing world health priorities. One problem in providing a brief answer is that disease rates vary tremendously, mainly for unknown reasons, in different parts of the world and

between genetically disparate populations. However, it is still possible to make some comparisons as long as the caveats are understood. Here I am citing thyroid cancer incidence rates from probably the world's best source of such information: Cancer Incidence in Five Continents, Vol. 5 1987, World Health Organization. I have selected a few countries as examples.

As you can see from examining the data below, the confirmed thyroid cancer rate in the Marshall Islands as determined by the Ebeye phase of our study is many times the value in most countries and quite close to that in a few countries. Because the information for the Marshall Islands is based only on the 1568 persons examined in Ebeye (it does not count the exposed Rongelap or Ujae populations), and because the exploratory surgery has not been conducted on these cases, the true rate of disease is still unknown. Collecting further data as is now being done will help resolve the issue as to what degree, if any, the thyroid disease rate is elevated in the Marshall Islands.

| Country | Notes on Population | Thyroid Cancer Rate Per 1000 People | |
|--|------------------------------|-------------------------------------|-------|
| | | Female | Male |
| New Zealand | Pacific Polynesian Islanders | 0.18 | 0.01 |
| U.S. Hawaii | American population | 0.45 | 0.17 |
| Japan | Miyagi Prefecture | 1.96 | 0.49 |
| Philippines | Rizal Province | 2.15 | 0.70 |
| Iceland | | 1.63 | 0.66 |
| Republic of Ireland | | 0.19 | 0.10 |
| Norway | | 6.96 | 2.34 |
| Netherlands | | 0.43 | 0.22 |
| Republic of the Marshall Islands (RMI) | confirmed cases | 4.90 | 1.87 |
| RMI | possible cases* | 19.58 | 15.08 |

*includes unconfirmed cases

(2) Has the Radiological Survey indicated contamination of a serious nature beyond the four atolls.

Your question is one of the central objectives of the RMI Nationwide Radiological Study. Our main goal is to determine the geographical extent and the degree of radioactive contamination from the tests conducted at Bikini and Eniwetok. The analysis of the results of this study will hopefully be completed late this summer, reviewed for scientific correctness and released to the Marshall Islands government. At this point, I do not feel it would be appropriate to preliminarily disclose details of our findings. The main reason, is that numerous quality control checks on the data still have to be made.

However, to provide you with the best answer possible, I can offer some generalizations. First, the definition of "contamination of a serious nature" has to be defined; otherwise, any discussion may imply different meanings to each of us.

There are various types of contamination. However, we can simplify this discussion by speaking of previous and present day contamination. Usually contamination at any one point in time is a good predictor of contamination at any later date because the laws of radioactive decay have been well established by physicists. This is certainly true for radioactive cesium and plutonium. This is not necessarily the case for radioactive iodine. As you may know, the radioactive iodine that exposed peoples' thyroids was present for only a few weeks following each test before it decayed away. Usually it is thought that the quantity of cesium (with a half-life of 30 years) is a good indicator of the past level of radioactive iodine. At some locations though, there may have been reasonably high radioactive iodine concentration in the air immediately following a nuclear test, yet a proportionately great amount of cesium was not deposited on the ground. That process entirely depends on the meteorological conditions when the fallout passed by any particular island.

Today we cannot measure the radioactive iodine which could have exposed people. We can only try and extrapolate it from our present day measurements of cesium, which is, at best, an uncertain calculation. This is true except for one other possibility. There is a single long-lived isotope of iodine (129-iodine) which is only created by nuclear fission and which has a half-life of several million years. With very sophisticated technology, this can be measured as a surrogate to the shorter-lived iodine. With funding that we hope to receive this summer from the Centers for Disease Control and Prevention, measurements of 129-iodine will be made this year on Marshall Islands soil samples. Therefore, one measure of "serious contamination" is whether past doses (i.e., at the time of the nuclear tests), particularly from radioactive iodine, were particularly high. This evaluation is still in progress.

Thus, "serious contamination" can apply to the past or to the present. We should agree, however, on what is "serious contamination." The seriousness of contamination is usually judged by the degree of exposure that it causes among the public. Over the

years, international scientific organizations have continued to recommend lowering the limits on the amount of radiation exposure that is acceptable for the public. As late as 1990, the International Commission on Radiological Protection recommended the lowest value yet for the annual dose limit for the public. The new recommendation is 100 millirem per year above the background. It is known that some locations worldwide, particularly those at high altitude and those with high mineral content in the environment, have radiation exposures from the natural background that exceed this value. Nevertheless, this is a new international recommendation. Thus, a second measure of "serious nature" could be whether current or future doses would exceed the maximum recommended amount. Please understand that 100 millirem/year applies to the dose to the whole body. Significant thyroid doses must be 100 to 1000 times this amount.

Presently, our data shows that there probably are not areas south of the four principally affected atolls (Eniwetok, Bikini, Rongelap and Utrik) that will now exceed the 100 millirem per year suggested limit. However, there is evidence from our recent measurements that atolls other than the four northern atolls received radioactive contamination from the nuclear tests conducted in the Marshall Islands. This admission has also been made by the U.S. Department of Energy. Therefore, whether other atolls received significant enough contamination to have exceeded exposure guidelines in past years is not yet determined. In particular, the past degree of exposure to radioactive iodine is worthy of our continued exploration.

(3) What does the survey information indicate, so far, about the habitability of Rongelap?

You will be glad to know that a report answering this question in detail will be made available by 5 May 1994. However, as that report is essentially now ready for distribution, I am more than happy to answer this question. In a four-way Memorandum of Understanding (MOU) between the U.S. Department of Interior, Department of Energy, RMI National Government and the Rongelap Atoll Local Government signed in February 1992, it was agreed to determine habitability using a dose limit of 100 millirem per year above background to every resident consuming a locally grown diet of food. In addition the level of transuranic radioactivity (plutonium plus americium) in the soil must be below 17 picocuries per gram of soil. After detailed radiological measurements of Rongelap Island and all the other southern islands of the atoll and following extensive calculations, the following two conclusions were reached.

- A significant portion of the the residents of Rongelap (between 25% and 75%) would likely exceed the 100 millirem per year limit if they subsist only on locally produced food items.

- On Rongelap Island, only 1.2% of the soil samples exceed the soil transuranic limit, though 14% of the samples on the other southern islands of Rongelap exceeded the limit.

In both cases, it was recommended that relatively simple remedial actions could bring both limits into compliance and allow safe rehabilitation of the island.

Please keep in mind, however, that neither the MOU or the reported measurements indicate the level of contamination of the northern islands of Rongelap Atoll. Measurements made by the RMI Nationwide Radiological Study as well as the U.S. DOE indicate that these islands are contaminated to a level of about 10 times that of Rongelap Island. Remediation of these islands will not be a simple issue because there is not yet any well developed technology for cleaning soil, yet the traditional lifestyle of the Marshallese is to visit numerous islands for the purpose of food collection.

- (4) The Brookhaven National Laboratory's 20 year report on the Marshalls exposure for DOE said that thyroid tumors "have been seen as late as forty years after exposure" meaning that we only this year may see them (BRAVO was in 1954).

What are the implications of such a statement? Since nuclear weapons were less than 30 years old when that report was written, it is possible that it may take even longer than 40 years for the tumors to appear?

The statement of the Brookhaven report is consistent with other scientific literature but I would like to provide some additional information to you. The minimum period of induction for solid cancers is usually between 5 and 15 years. The first appearance of thyroid cancers in Marshallese was 8 years after exposure. It has also been observed in some studies that thyroid cancers have continued to appear as late as 40 years after exposure. However, there is no inference that cancers will continue to appear at the same rate after that time. In fact, some studies have indicated that the risk to people decreases after 40 years post-irradiation. All of the findings of previous studies lastimately depend on the type and level of exposure which occurred, the population being studied, the genetic characteristics of the people and probably their lifestyle as well. Most scientists would probably agree that, although a few cancers might appear after 40 years, most would have already been expressed by that time. Making continued observations of the disease rate among populations exposed more than 40 years ago becomes increasingly difficult because the spontaneous occurrence of cancers dramatically increases with the aging of the population.

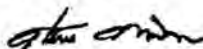
- (5) What, if anything, do you know about the health problems of Ailuk or Likiep Atolls?

I am not a good source of good information on this question. I assume that you are interested in whether any radiation induced disease has occurred at these locations. It

should be of interest to you that as of 31 December 1993, the RMI Nuclear Claims Tribunal had made 31 awards to 29 different people whose birthplace was Likiep and 20 awards to 20 different people whose birthplace was Ailuk. Of course, it is necessary to know how many people lived on these atolls at the time of the nuclear tests to evaluate the relevance of these numbers. The census records of the Marshall Islands shown that in 1958 (the closest year for which records are available) indicate that there were 656 and 419 people, respectively on Likiep and Ailuk. Thus, the number of awards was in about equal proportions from these two locations, slightly less than 50%. This proportion is not as high as some other mid-latitude atolls, e.g. Ujae and Lae, which are closer to 100%. Please note that I provide these figures because of your interest but it should be understood that filing claims is the responsibility of individual citizens and thus the award rate is not necessarily a good indicator of disease rates.

I realize that information on the radiological conditions in the Marshall Islands may reach you by both word-of-mouth or by technical reports from my office or the DOE. In either case, these issues are usually not simple to understand. I hope the information contained in this letter is of help to you in better evaluating the radiological situation in the Marshall Islands. If I can be of further service, please do not hesitate to call on me.

Sincerely yours,



Steven L. Simon, Ph.D.
Director, RMI Nationwide Radiological Study

cc. RMI Minister of Health and Environment
RMI Minister of Foreign Affairs

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February 28 1994

Representative George Miller
Chairman
Committee on Natural Resources
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Miller:

I appreciated the opportunity you gave me to appear at the hearing you conducted on the legacy of the nuclear testing program in the Marshall Islands. As I testified, it is significant that in the forty years that have passed since that tragic event occurred, this was the first time I have been asked to record my knowledge of the matter, despite the central role played by the laboratory I directed. Many of the unusual circumstances surrounding the BRAVO fallout, as known to me, are described in my autobiography, *An Environmental Odyssey*, to which several references were made during the hearing.

I found myself in disagreement with much of the anecdotal information presented by others concerning the allegation that heavy fallout must have occurred far beyond the islands that have traditionally believed to have been affected. As I testified, the AEC Health and Safety Laboratory (HASL), of which I was then director, undertook extensive aerial surveys of the islands of the Central and Western Pacific, and our findings are a matter of record. My own participation in those surveys was limited to the D+1 day over-flights of the islands downwind of MIKE, and the D+6 day over-flights of the islands north of Guam in the far Western Pacific. Other associates, the late Dr. John Harley, Mr. Mel Cassidy, and Mr. Alfred Breslin made similar flights over islands.

A copy of my field notes from October 30 1952 until I left the islands on November 7 is attached to this letter. Note that I surveyed 20 islands from a height

of 200 feet. The ground level dose rates were all found to be less than 0.3 mr/hr on BRAVO + 1 Day. Of the 13 islands surveyed by Mr. Cassidy on the same day, the highest reading was 0.5 mr/hr. Breslin reported negative findings. I do not have any recollection of the manner in which his flight was vectored, but that should be a matter of record.

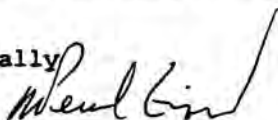
Somewhere there must be a compilation of the data obtained on these over flights for subsequent tests. Thus there need be speculation as to the extent of the fallout on the Islands of the Pacific, starting with the MIKE test on November 1 1952.

Note that, early on my flight of November 2, I found no fallout on Ujelang at 0845 local time. I don't remember the meaning of "passed word to LST", but it can only mean that it was the boat on which the Ujelang inhabitants had been evacuated, and that I was asked to report to the LST that conditions were safe for their return. This is in contrast to the testimony of The Honorable Ismael John that everything was covered by fine dust, and that the inhabitants suffered from radiation effects. Incidentally, I am quite certain that HASL had located monitoring equipment on Ujelang, which would have required that the island be visited every few days for servicing purposes.

As I said at the hearing, it is unlikely that any undisclosed information exists that will affect our understanding of the extent of the BRAVO fallout. However, after forty years, such documentation that does exist may be hard to retrieve except by a lot of searching at HASL (now EML), CINCPAC headquarters, and the files of the former AEC Division of Biology and Medicine to which HASL then reported.

There are a considerable number of unanswered questions concerning the events prior to and subsequent to BRAVO. I think these questions should be answered for historical purposes, and I have been greatly impressed with the diligence with which Ms. Linda Chase has attempted to locate important relevant documents. If I can be of any assistance in this regard I hope you will call on me.

Cordially



cc: Dr. Steven L. Simon
Dr. Harry J. Pettengill
Ms. Linda Chase

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FAX/TEL (919)967-4561

March 7 1994

Representative George Miller
Chairman
Committee on Natural Resources
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Miller:

This is with further reference to the subject of my letter of February 28 in which I stated my objections to some of the anecdotal information presented at the hearing you held on February 24. You will recall that in that letter I acknowledged that there were a number of unanswered questions about the events prior to and immediately following BRAVO, but that I was confident that that the extent of fallout from all tests of the CASTLE series as well as those of the IVY and REDWING series had been fully documented in reports prepared by the AEC Health and Safety Laboratory (HASL), of which I was then Director.

Immediately following the hearing I requested the help of Philip W. Krey, the Acting Director of the DOE Environmental Measurements Laboratory (HASL's new name) in locating reports of the HASL monitoring activities during those tests. I am happy to report that he quickly sent me the enclosed report, Radioactive Debris from Operation CASTLE, Islands of the Mid-Pacific. The report is dated January 18 1955 and was prepared by Alfred J. Breslin, and Melvin N. Cassidy.

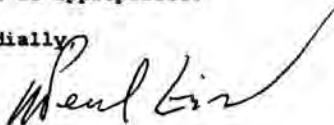
It is particularly significant in view of the allegations of secrecy, that the 73 page report was unclassified when issued.

Twelve automatic radiation monitoring stations were placed on various islands, including Ugelang. The tracings from those stations are included in the report. Also included are the important measurements made by over flights after each test of the CASTLE series, of more than 100 islands in the Central and Western Pacific. The dose estimates for forty of the most heavily exposed islands are Given in Table 1 on pages 37 and 38.

I have been told that reports similar to the enclosed are available for IVY and REDWING and that copies will be sent to me as soon as they are located. You will recall that I sent the data obtained by me during the D+1 over flights downwind of MIKE with my February 28 letter to you.

I request that my two letters to you be added to the hearing record, together with whatever material from the enclosed report you feel is appropriate.

Cordially

A handwritten signature in dark ink, appearing to read "Paul Lin", with a long, sweeping flourish extending from the end of the name.

cc: Harry Pettengill
Steven Simon
Philip Krey

UNCLASSIFIED

MASTER

UNITED STATES ATOMIC ENERGY COMMISSION

WFO-443 (REV. 1)

SELECTIVE INDEX FROM OPERATION CAPTIA
RELATION OF THE MID-REACTOR

by

Alfred J. Swallow
Nathan S. Gandy

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| Reprint Price \$15.30 |
| Microfilm Price \$1.50 |
| Available from the Office of Technical Services Department of Commerce Washington 25, D. C. |

January 18, 1955

New York Operations Office
Health and Safety Laboratory

Technical Information Service Extension, Oak Ridge, Tenn.



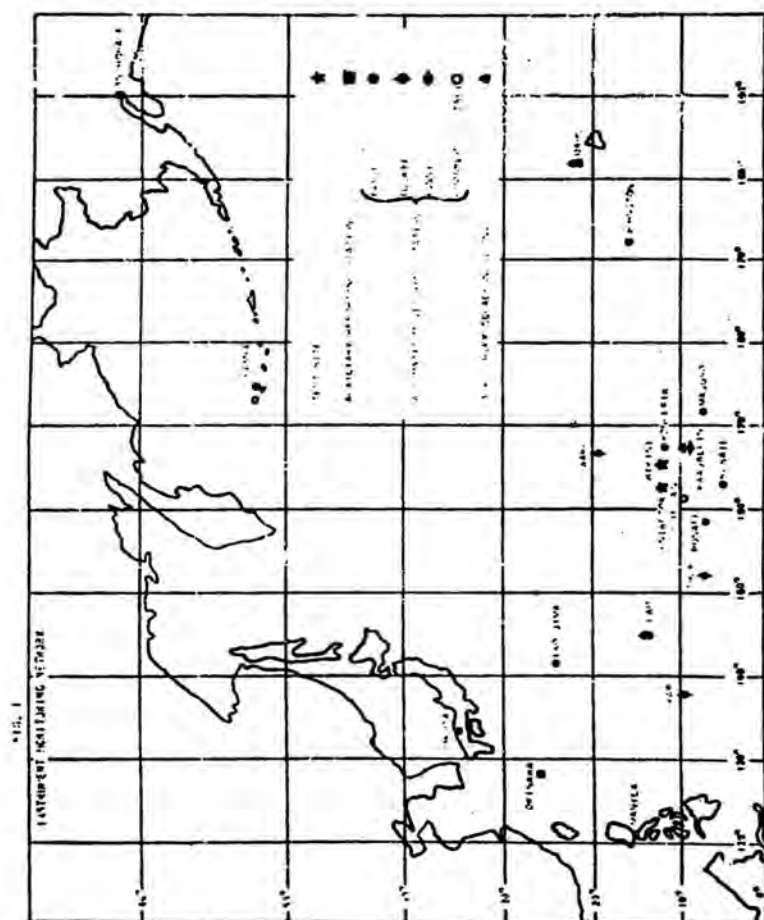
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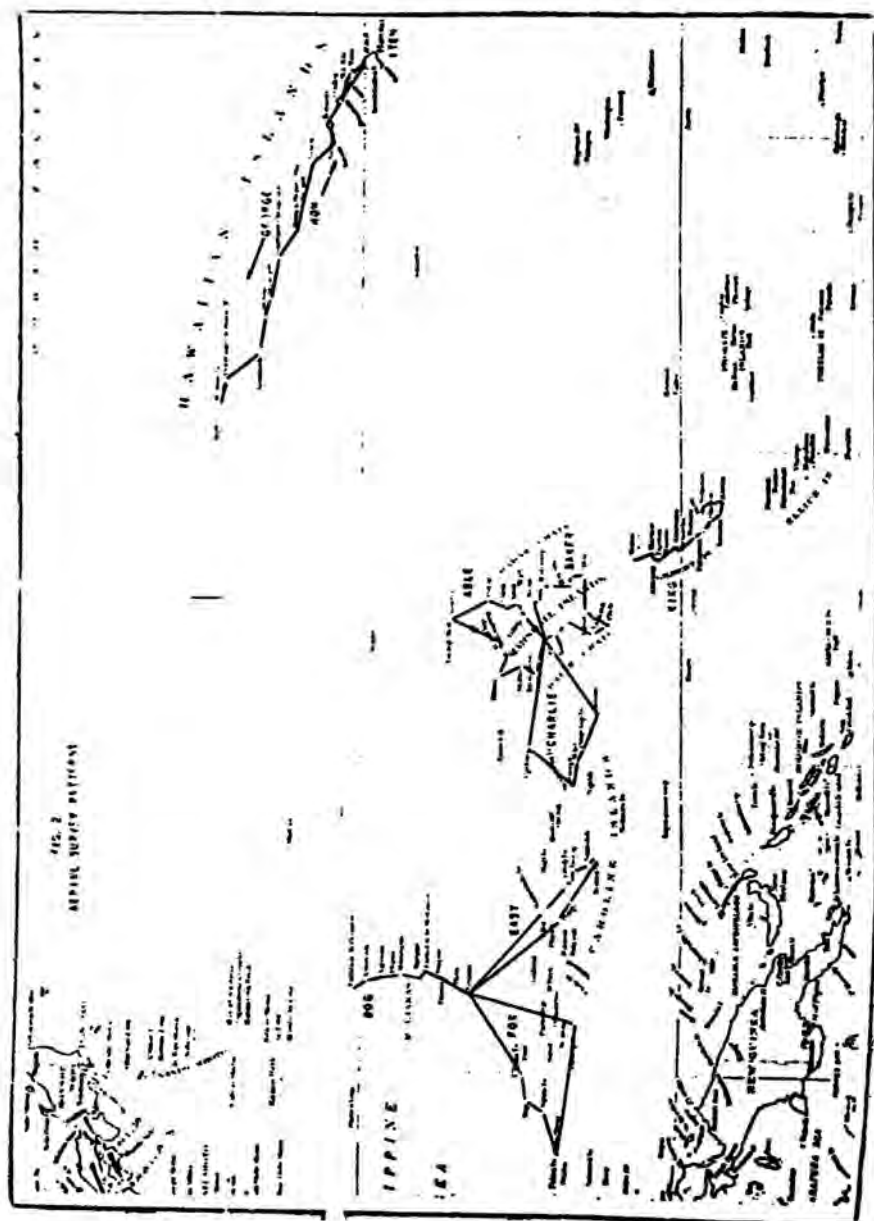
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Some editions are listed in Figure 2.

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11. ASD 172

1. Automatic Monitoring Stations. Twelve automatic monitoring stations were originally installed for CASTLE. Eleven were operated continuously during the series. These were: Two Japs, Guam, Truk, Wot, Ponape, Fanning, Makuro, Eniwetok, Bikini, Wake, and Johnston.

Gamma intensity versus time after burst is plotted in Figures 3 thru 16, for those locations where significant radiation (generally greater than 100 mR/hr) was measured following a particular event.

Range-rate-RATE. No control data are available after 8 & 9 hours when the gamma intensity exceeded the upper scale limit (100 mR/hr). Utilizing the ABE survey measurement at 8 & 12 hours, an estimation of the peak radiation value may be obtained graphically by extrapolating the automatic gamma monitor curve above 100 mR/hr and extending the line backward to the time of the burst. This is shown in Figure 17. Cumulative radiation versus time is shown in Figure 18. The range-rate-RATE gamma (figure 18 below) is computed for Range-rate using the peak radiation value obtained from this synthetic graph.

Beta Dust Concentration. No beta dust concentrations were obtained from the nearest automatic stations. At Ujae, the new new station, beta dust concentrations were obtained only during the first 10 hours. It is noted that significant dust was detected prior to the event, a variety of operational and instrumental difficulties recently rendered the instrument ineffective.

2. Auxiliary Monitoring Stations. Remote stations at Oahu, Samoa, and Anchorage recorded gamma radiation daily throughout CASTLE. No significant reduction was detected, i.e., there were no measurements greater than 0.5 mR/hr.

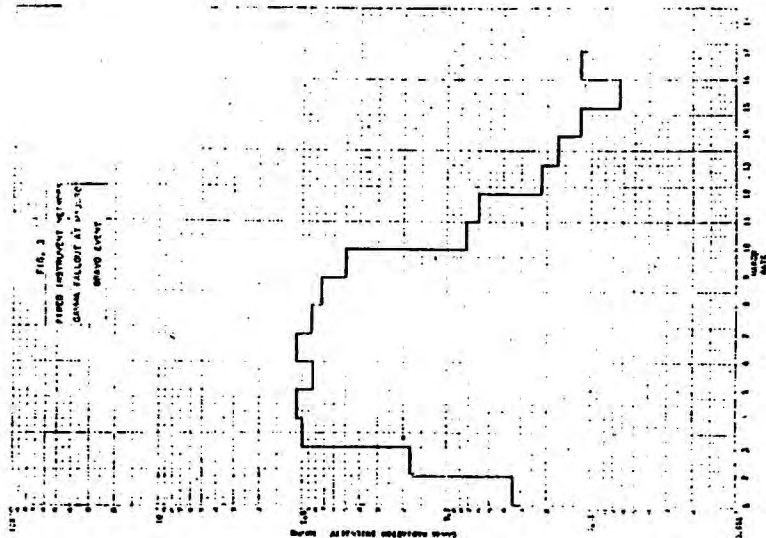
3. Aerial Monitoring. Thirty-three aerial survey missions were flown during CASTLE. Of these, fifteen followed pattern ABE and seven followed pattern BAE.

With the exception of station F20, all survey patterns were declined prior to the test series. F20 was approved following MAJN to survey the Gilbert Islands. It was not repeated.

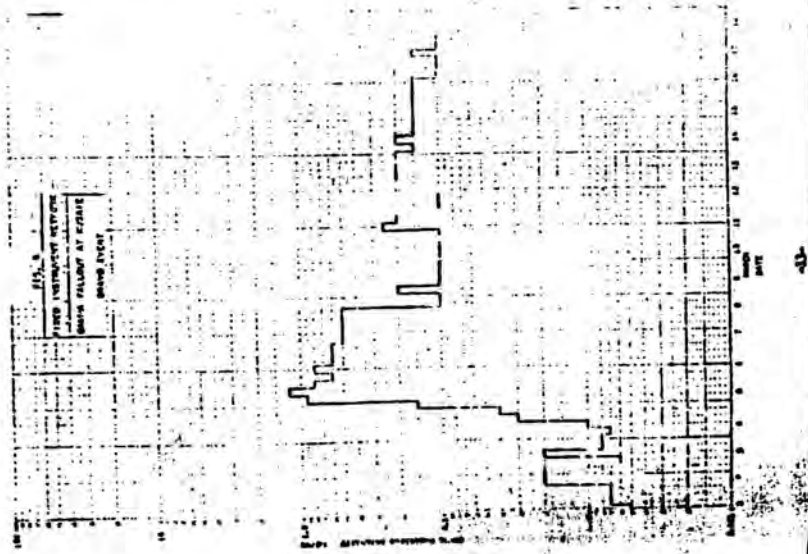
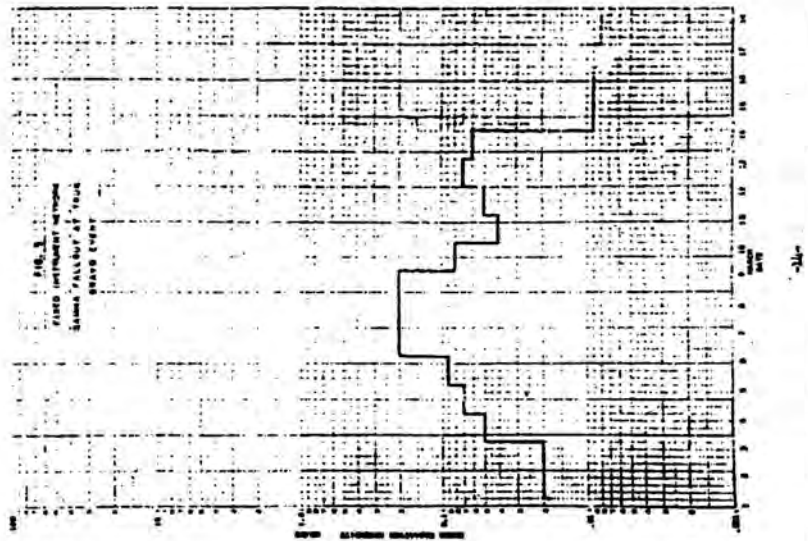
As a result of the widespread and unusually heavy fallout from 9P40, all survey patterns (except F20) were arbitrarily executed to detect any areas of unobserved fallout. In all of the following events,

HOW is identical to GEMET except for the direction of flight.

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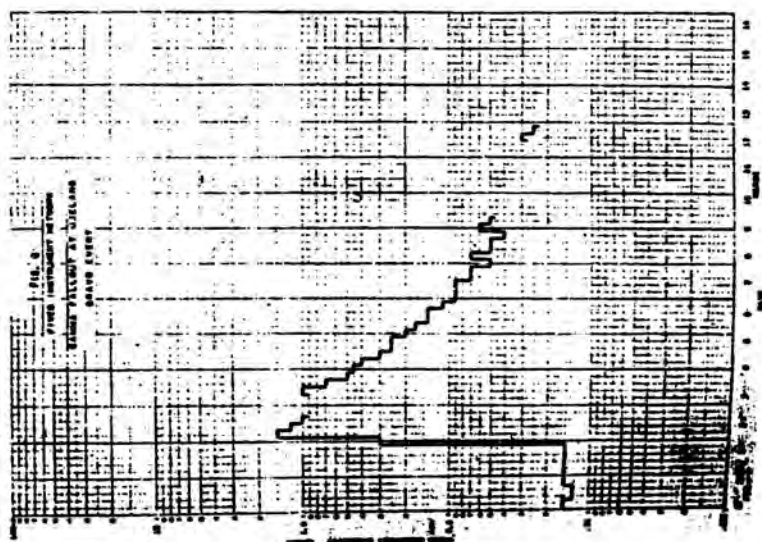
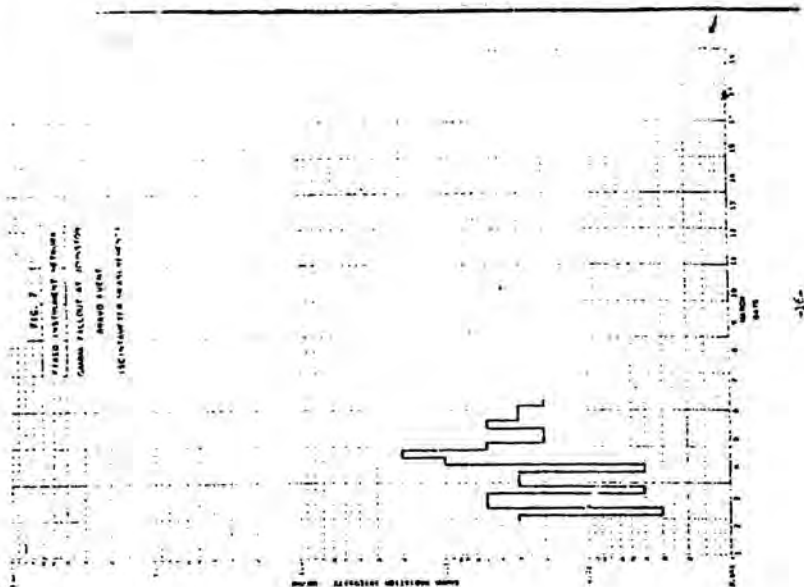


FIG. 17
FIELD INSTRUMENT RECORD
TANK FILLING AT 1.000
MARCH 1967

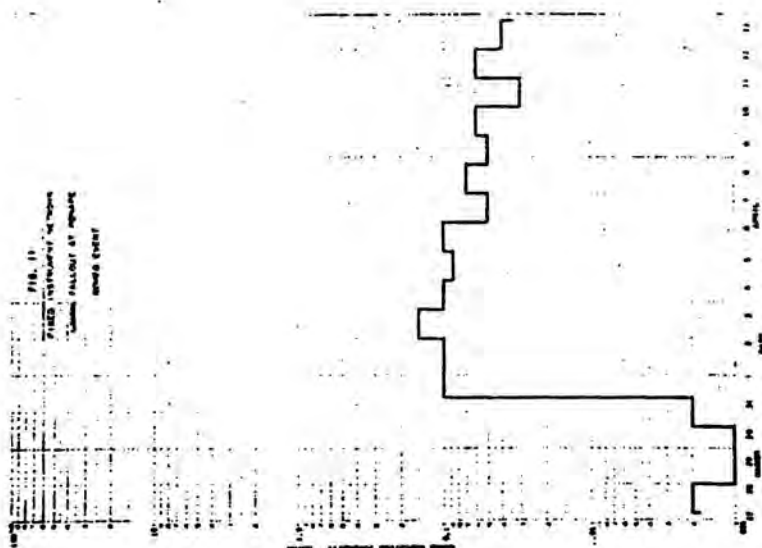
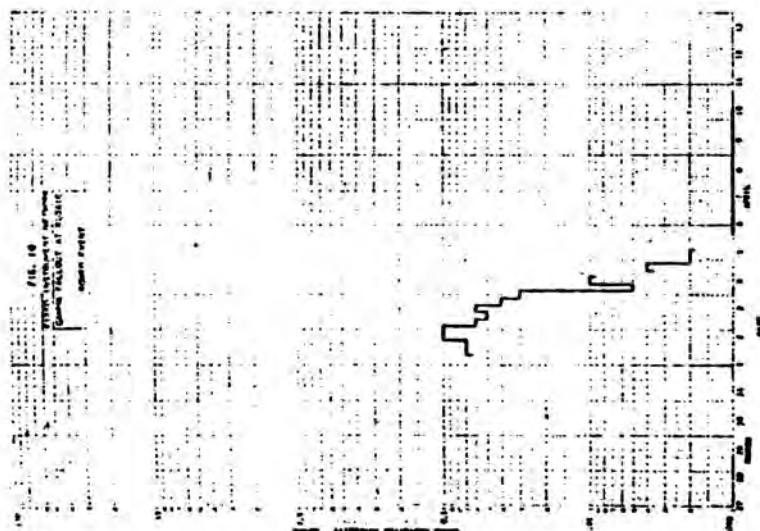
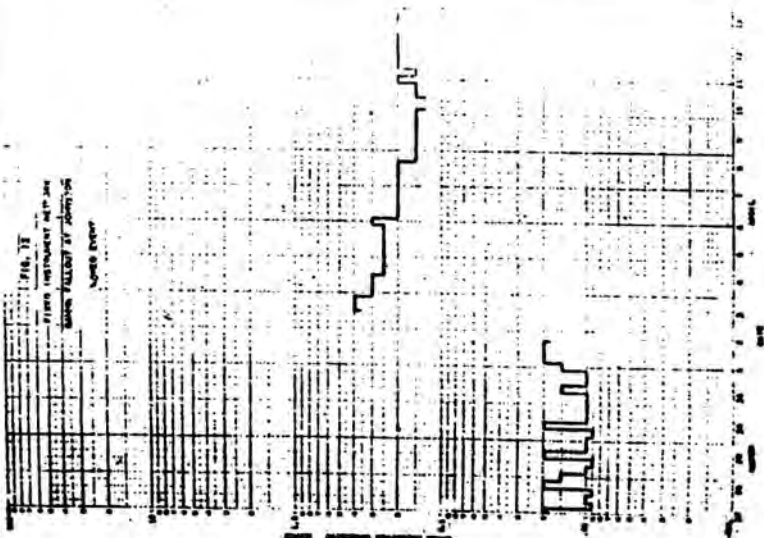
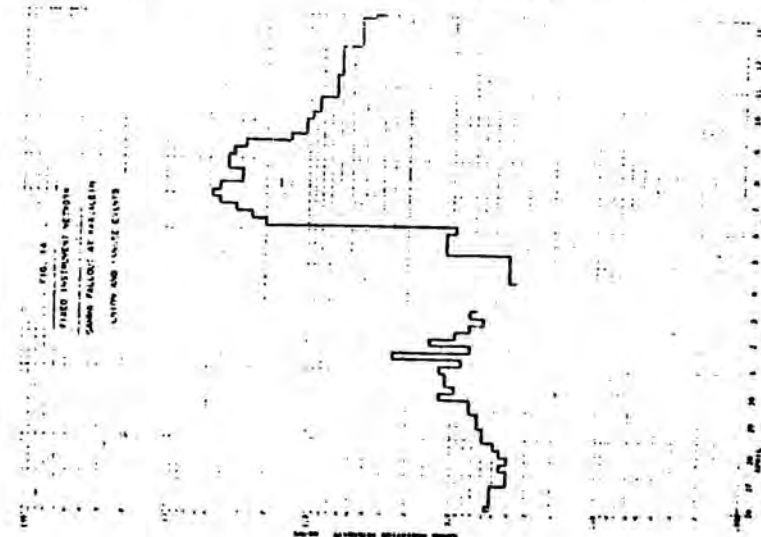
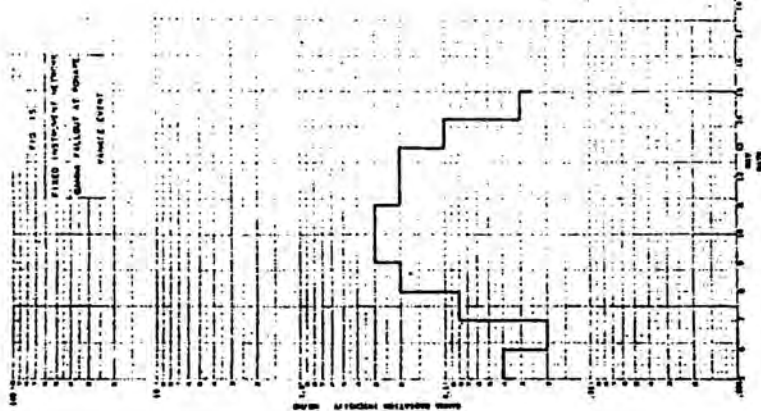


FIG. 18
FIELD INSTRUMENT RECORD
TANK FILLING AT 1.000
MARCH 1967







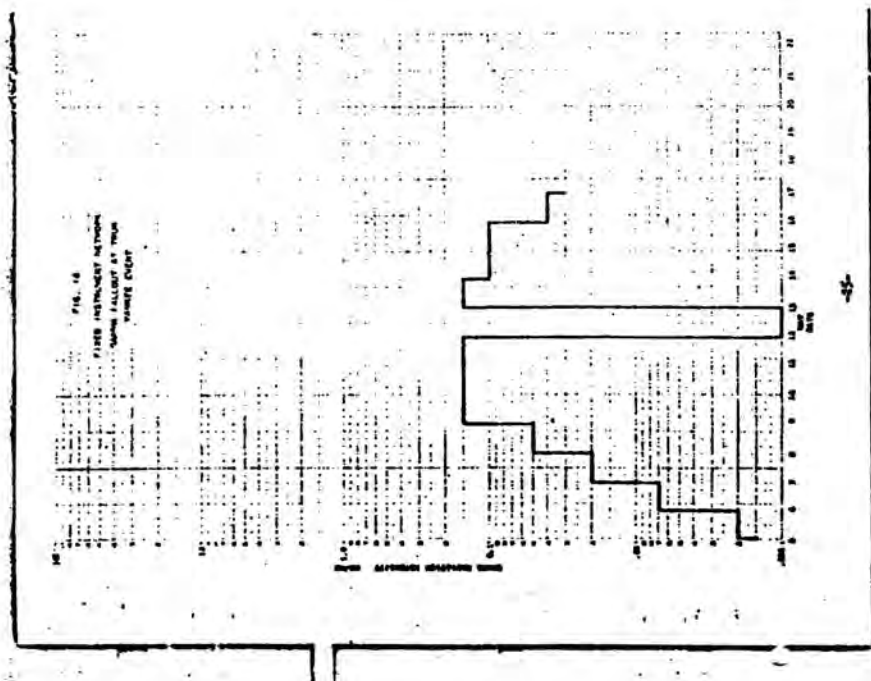
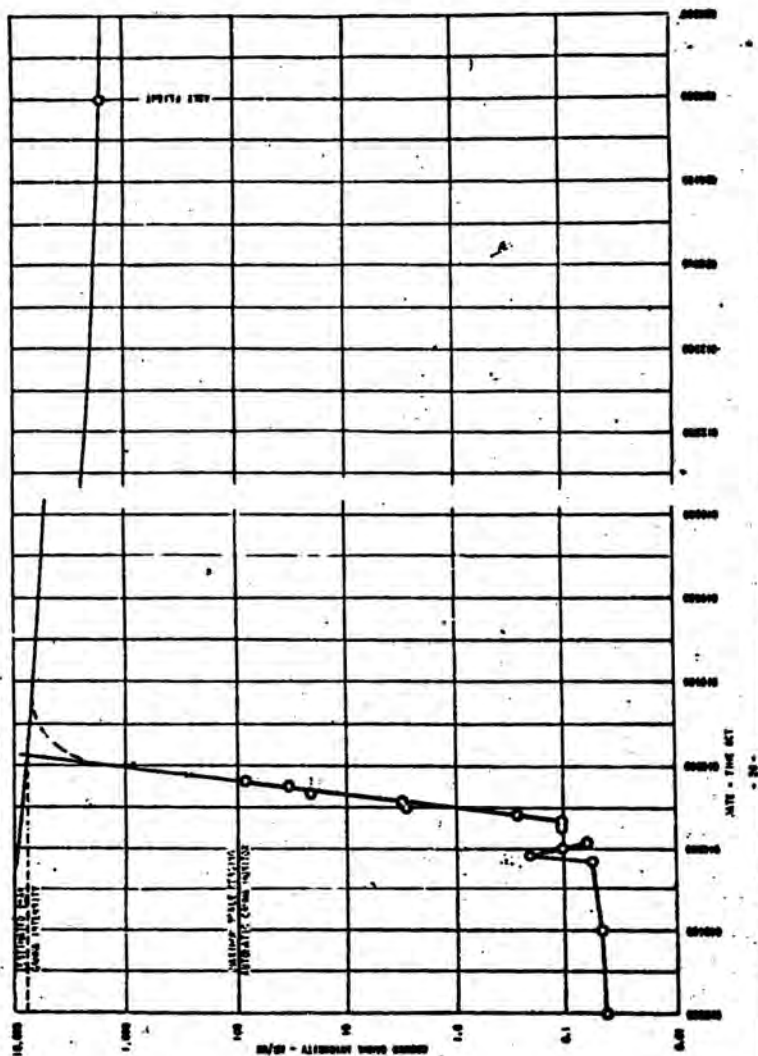
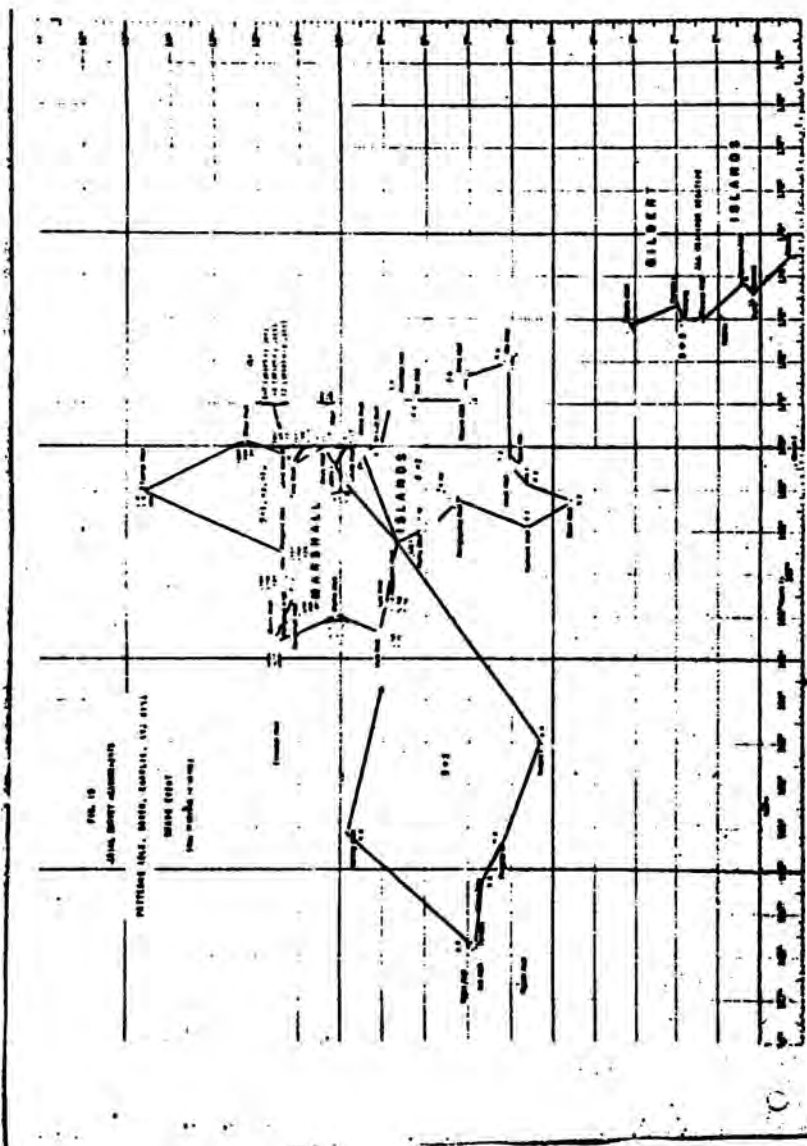
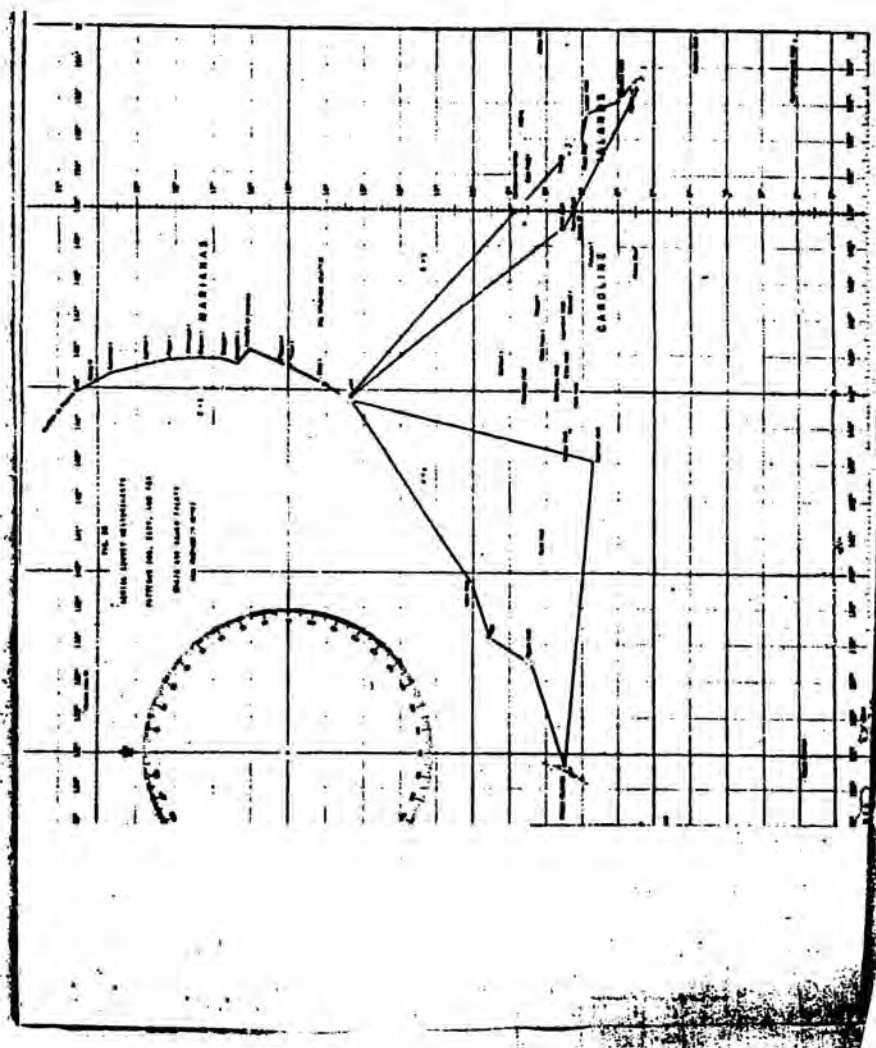
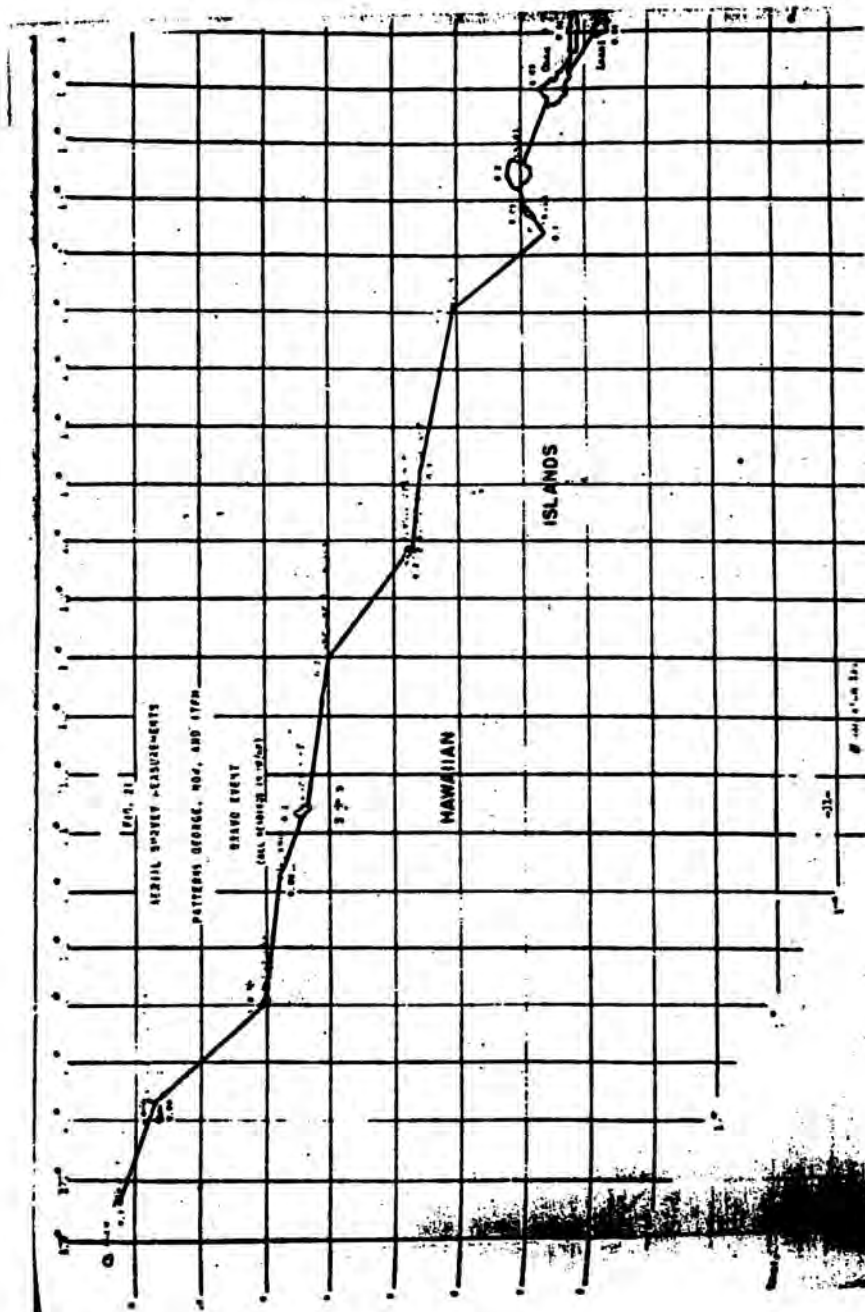


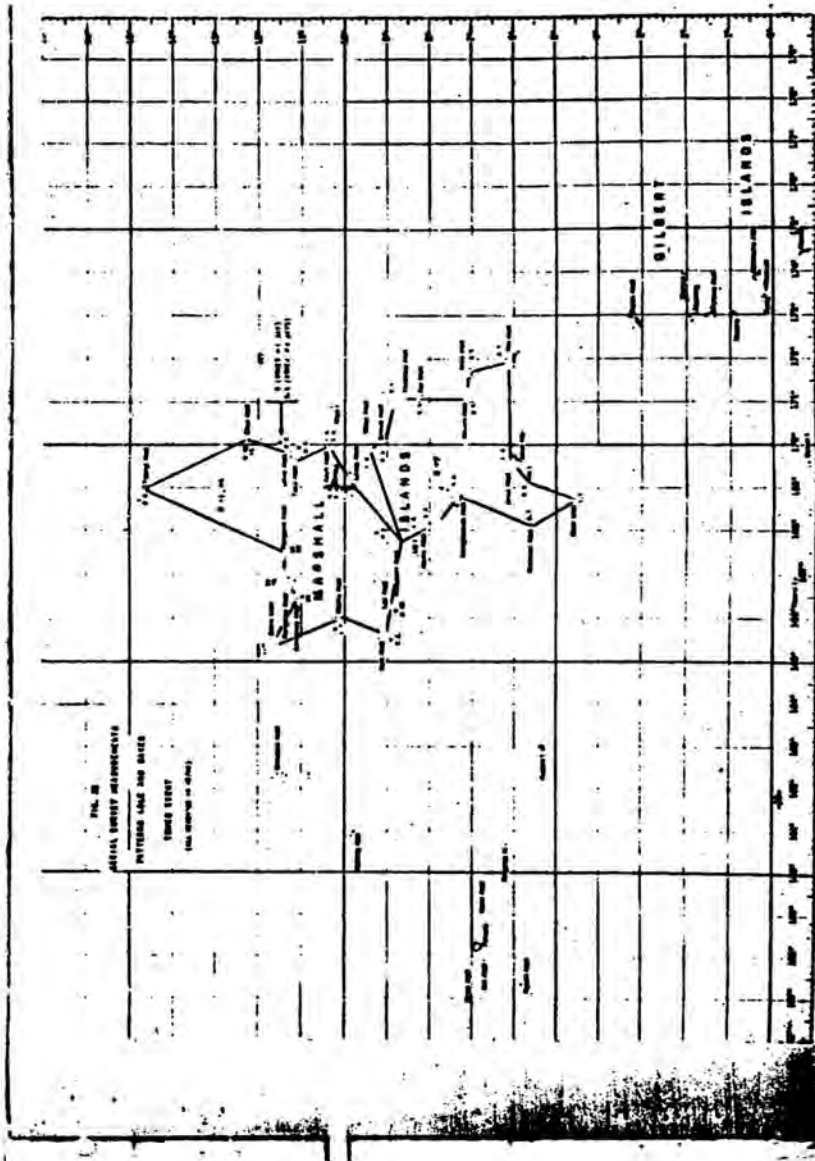
FIG. 17
RECOMBINED DATA: REACTION VELOCITY
AT PUMPIN FOLLOWING DRIVE

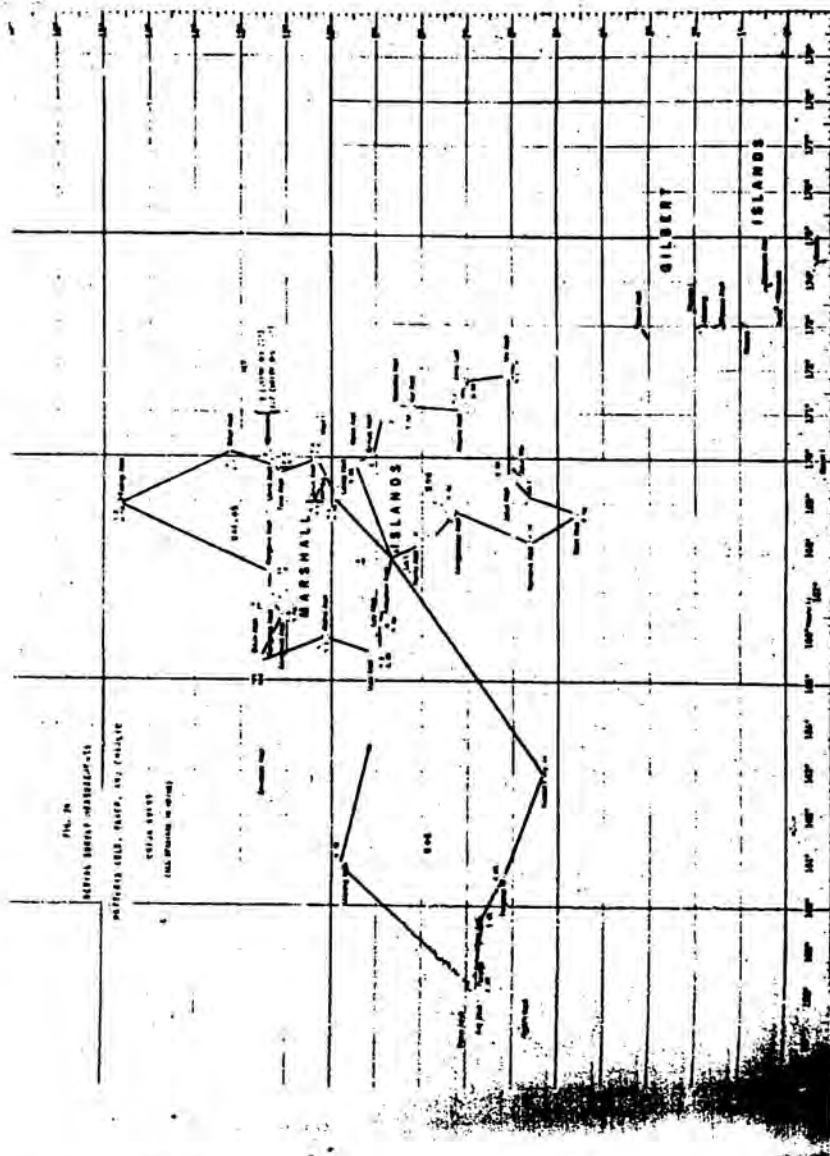


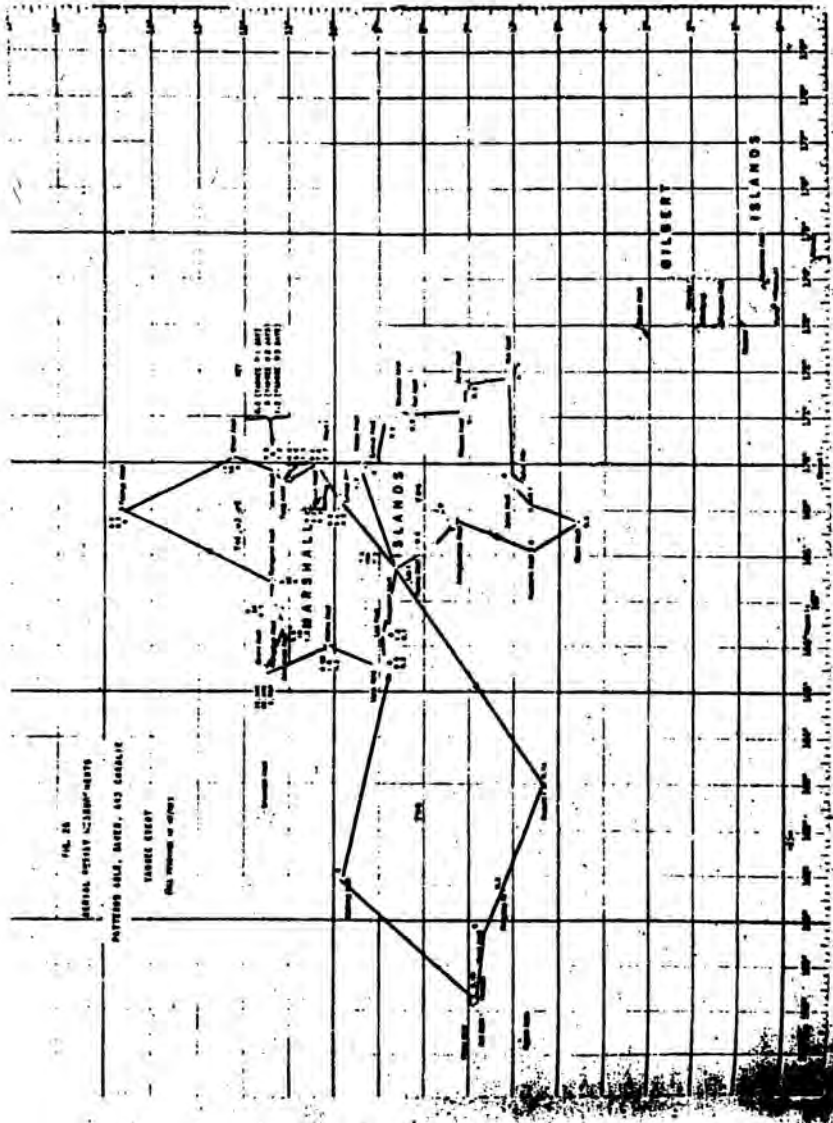












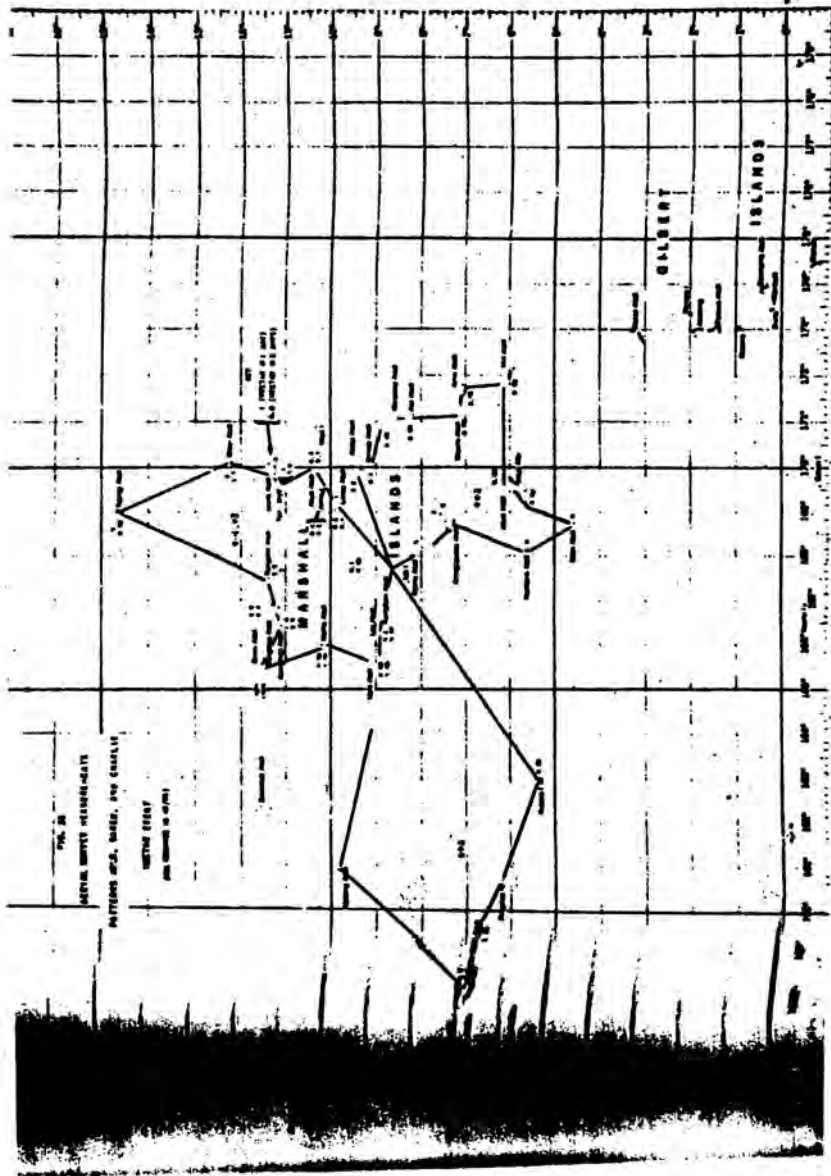


TABLE I

CUMULATIVE GORES BY EVENT AND LOCATION
(Units: Gores to Rect. Point - 25)

| EVENT | AREA | RECT | UNION | UNION | RECT | TOTAL |
|----------------------|--------|-------|-------|-------|------|--------|
| Days between event - | 26 | 11 | 19 | 9 | 10 | |
| Aerial Monitoring | | | | | | |
| Ias | 5.5 | 12 | 12 | 7.5 | 78 | 125 |
| Ujan | 6 | 32 | 17 | 9.5 | 68 | 116 |
| Wobho | 250 | 270 | 110 | 55 | 95 | 706 |
| Ailinglase | 60000 | 3600 | 3300 | 8 | 600 | 67000 |
| Zangalap | 180000 | 11000 | 6000 | 1700 | 300 | 208000 |
| Bongelak | 190000 | 9000 | 5000 | 1100 | 280 | 208000 |
| Tongel | 280 | 60 | 9.5 | 10 | - | 370 |
| Bhar | 60000 | 3000 | 1200 | 650 | 1700 | 67000 |
| Ularik | 220000 | 1200 | 700 | 100 | 330 | 26000 |
| Taka | 150000 | 800 | 1000 | 120 | 380 | 17000 |
| Aluk | 5000 | 110 | 110 | 100 | 500 | 6110 |
| Jawa | 1200 | 110 | 130 | 18 | 200 | 1970 |
| Lirip | 1700 | 170 | 80 | 30 | 200 | 2196 |
| Sham | 1.5 | 90 | 100 | 0 | 95 | 210 |
| Ailinglase | 20 | 160 | 100 | 8 | 0 | 255 |
| Humorik | 20 | 160 | 70 | 2 | 0 | 252 |
| Bum | 20 | 250 | 50 | 8 | 25 | 353 |
| Ell | 20 | 200 | 70 | 0 | 0 | 291 |
| Jelak | 20 | 370 | 70 | 8 | 0 | 401 |
| Mill | 60 | 160 | 200 | 20 | 0 | 441 |
| Aree | 60 | 200 | 300 | 8 | 25 | 494 |
| Makro | 200 | 200 | 50 | 20 | 0 | 471 |
| Aur | 16 | 200 | 50 | 8 | 40 | 311 |
| Malaklap | 350 | 120 | 50 | 0 | 25 | 549 |
| Erubak | 390 | 200 | 50 | 0 | 0 | 647 |
| Wokio | 1800 | 300 | 200 | 13 | 220 | 2543 |

based on arrival estimated from Bongelak data.

TABLE I (Cont'd)
 CUMULATIVE DEGREE BY EVENT AND LOCATION
 (Values Based on Next Event) - μ

| EVENT | MAINT | PAVED | ROAD | UTIM | TAHIRE | MACTAR | TOTAL |
|--------------------------|-------|-------|------|------|--------|--------|-------|
| Days between event. | 26 | 21 | 19 | 9 | 9 | 10 | |
| Fixed Instrument Network | | | | | | | |
| Dajalein | 1.3 | 1.0 | 2.5 | 1.2 | 3.0 | 1.7 | 1235 |
| Majuro | 15.6 | 1.7 | 5.3 | 2 | 2 | 0.7 | 351 |
| Banale | 8.5 | 4.2 | 0.7 | 0.2 | 4.5 | 0.1 | 40 |
| Ponape | 5.5 | 2.3 | 3.1 | 21 | 3.8 | 6.2 | 122 |
| Truk | 2.1 | 1.2 | 2.3 | 0.9 | 15.1 | - | 18 |
| Yap | - | - | - | 0.7 | 4.7 | 4.6 | - |
| Guam | - | - | - | - | - | - | - |
| Ibo Jima | - | - | - | 6.8 | 12.7 | 2.0 | 155 |
| Ujae | 65.4 | - | 1.6 | 52 | 11.2 | - | 12 |
| Maka | 3.3 | 1.9 | 3.0 | 2.2 | 1.2 | 0.7 | 475 |
| Johnston | 11.0 | 2.8 | 6.0 | - | - | - | 495 |
| Oahu | | | | | | | |
| Shemya | | | | | | | |
| Ar-Orga | | | | | | | |

TABLE II

PEAK QUAKE INTENSITY BY EVENT AND LOCATION w/IN

| Location | BRAVO | TOWER | Aerial Monitoring | | FAMOUS | MACTAR |
|-------------|--------|-------|-------------------|--------|--------|--------|
| | | | DOWN | UPDOWN | | |
| Laos | 0.08 | 0.18 | 0.2 | 0.12 | 1.2 | 0.2 |
| Udon | 0.1 | 0.5 | 0.3 | 0.2 | 0.8 | 0.03 |
| Wichai | 2.7 | 4.0 | 1.1 | 0.2 | 1.6 | 0.01 |
| Alingdon | 1600e | 55 | 57 | 1.6 | 10 | 1.4 |
| Kongolap | 12500e | 155 | 95 | 61 | 30 | 6 |
| Kongarik | 8000e | 130 | 82 | 11 | 24 | 5.8 |
| Taongl | 3 | 1.0 | 0.12 | 0.2 | 0.2 | 0 |
| Sikar | 1200e | 37 | 20 | 11 | 34 | 3 |
| Utirik | 1900e | 17 | 12 | 2 | 6 | 1.0 |
| Taka | 3200e | 8 | 16 | 2.4 | 5.6 | 1.0 |
| Atluk | 75 | 6 | 1.7 | 0.4 | 7.7 | 0.4 |
| Jama | 15 | 6 | 2 | 0.2 | 3.4 | 0.4 |
| Likiep | 15 | 2.5 | 1.2 | 0.6 | 3.2 | 0.3 |
| Mama | 0.02 | 0.8 | 0.8 | 0 | 0 | 0 |
| Alinglaplap | 0.08 | 1.2 | 0.8 | 0.09 | 0 | 0 |
| Mamrik | 0.2 | 1.4 | 0.6 | 0.02 | 0 | 0 |
| Rhoo | 0.2 | 2.2 | 0.4 | 0.09 | 0 | 0 |
| Kili | 0.2 | 1.8 | 0.6 | 0 | 0.3 | 0 |
| Jaluit | 0.2 | 2.8 | 0.6 | 0.09 | 0 | 0.02 |
| Kili | 0.6 | 1.4 | 1.5 | 0.2 | 0 | 0.04 |
| Arno | 0.6 | 1.7 | 2.3 | 0.09 | 0.3 | 0.02 |
| Maure | 2.0 | 1.7 | 0.4 | 0.2 | 0 | 0.02 |
| Ant | 0.4 | 1.7 | 0.4 | 0.09 | 0.4 | 0.04 |
| Kalcolap | 3.6 | 1.7 | 0.4 | 0 | 0.3 | 0.06 |
| Erikub | 1 | 1.7 | 0.4 | 0 | 0 | 0.1 |
| Woljn | 20 | 2.6 | 1.6 | 0.15 | 2.5 | 0.15 |

Refer to table 1 for estimated arrival based on Mamrik data.

TABLE II (Cont'd)

| Location | Peak Value Intensity of Street and Location m/sec | | | | |
|-----------|---|------|------|--------|----------|
| | BLIND | DOWN | DOWN | UPSIDE | INTERVAL |
| | Fixed Instrument Network | | | | |
| Banjalain | - | 7.5 | 2 | 0.15 | 0.4 |
| Major | 1.3 | 1.5 | 0.3 | 0.04 | - |
| Kuala | 1.2 | - | 0.05 | 0.003 | - |
| Petapa | - | 0.15 | 0.07 | 0.04 | - |
| Truk | 0.2 | 0.01 | 0.01 | 0.009 | - |
| Tep | 0.005 | - | - | 0.009 | - |
| Qua | - | - | - | - | 0.03 |
| Tuo Jiam | - | - | - | 0.07 | - |
| Ujaling | 1.5 | - | 1.0 | 1.7 | 0.03 |
| Waka | - | 0.02 | 0.02 | 0.05 | - |
| Johnston | 0.2 | 0.4 | 0.25 | - | 0.007 |
| Quin | 0.05 | 0.05 | 0.05 | 0.05 | - |
| Shanya | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Anchorage | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

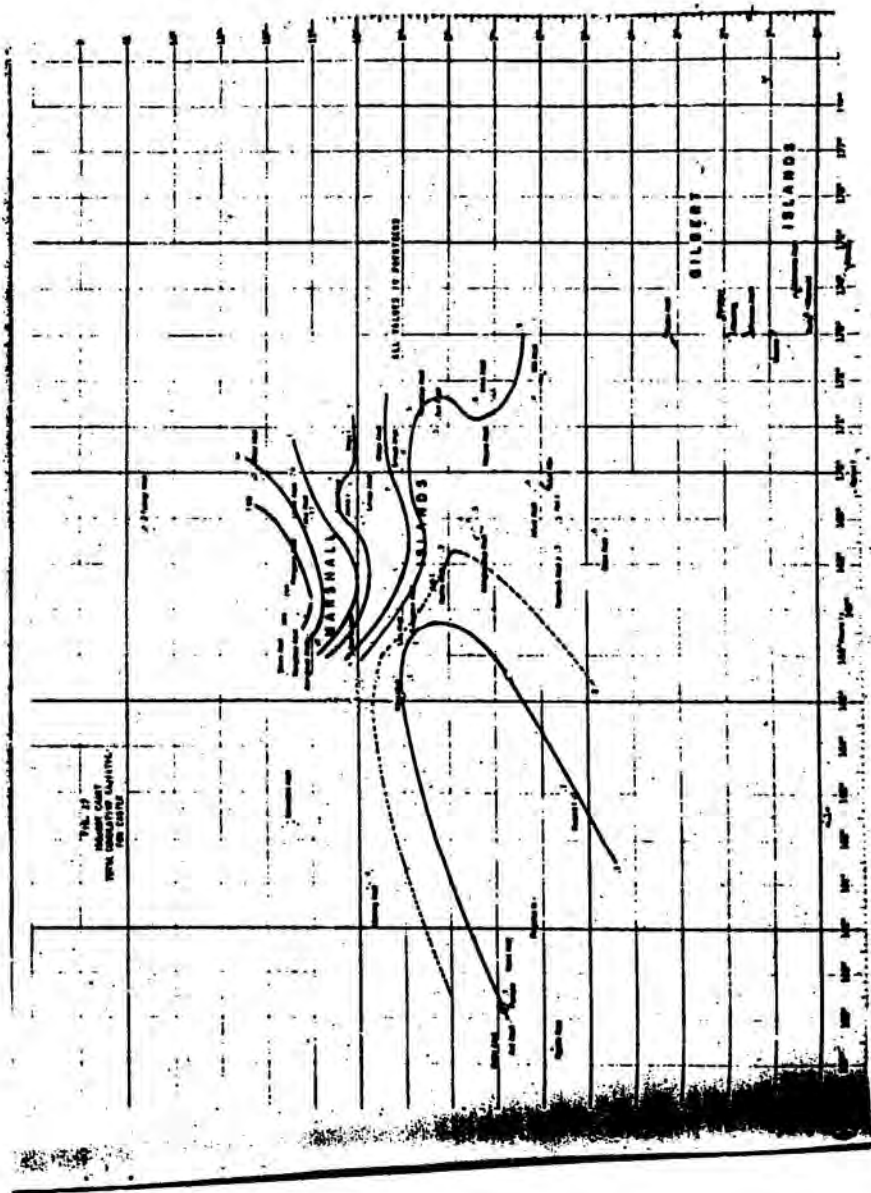
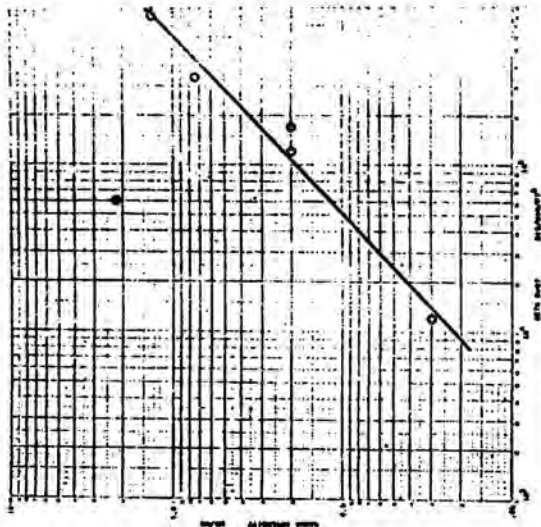


FIG. 26

ACTIVITY OF THE GROUND SQUIRREL VS. GROUND TEMPERATURE AT 3 FEET



To establish an empirical relationship between beta dust activity and ground temperature at three feet over the entire activity period, the data were plotted (Figure 26). The values obtained are listed in the following table. The significant relation following a given hour, beta activity has been extrapolated from counting data to sampling holes. The sensitivity of values is due to incomplete data; dust samples are standing in certain sequences and similar failures observed at various times.

The values presented are preliminary. Further review of the available data may disclose additional useful improvements and a refinement of computations may alter the existing values somewhat.

FACTORS RELATING TO DATA INTERPRETATION

1. Automatic Monitoring Station

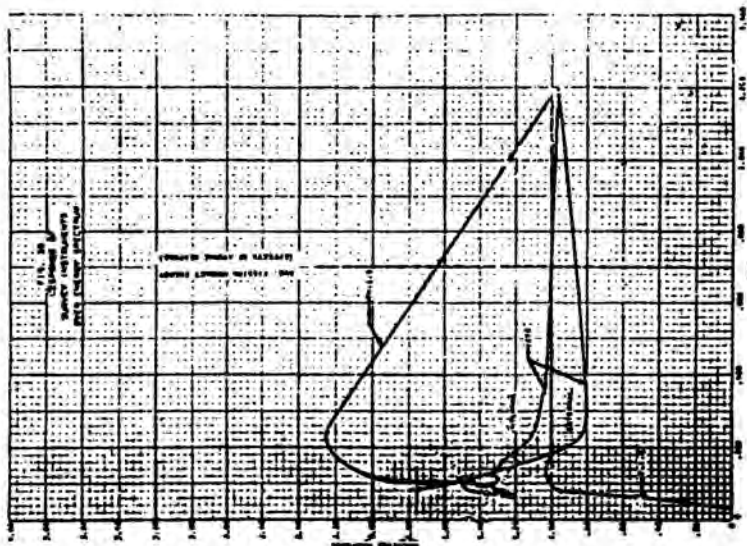
4. Dipole Variation: Shortly after their installation, the AC-coupled antennas exhibited a regular diurnal variation apparently due to temperature change, humidity, or both. The variation was so great as to render of some importance. For this reason, the practical lower limit of detection was about 0.1 mV/Hz although the design limit was 0.001 mV/Hz. Interpretation of radiation intensities less than 0.1 mV/Hz was difficult and on one occasion, fallout of low intensity was assumed when it occurred. A later, careful reanalysis of this data revealed that the CHARM-100 response would have been exceeded and it is possible that the significant fallout may have been detected at other stations in the area.

A review of the data and the instruments' behaviour has indicated that the late night instrument reading was in most cases a reliable measure of low intensity radiation. In several instances of light failure, (Pompe-BOMBO, Fras-BATO, Fras-LINEX) only the 1600 \AA value was used for plotting time graphs. Similarly, at several stations only the 1600 \AA values were used in computing cosmic-ray variations.

The diurnal variation was consistently so high at Ocum that none of these data, all of which are low levels, are considered valid.

29. Comparison with General Film. In these instances of suspected tampering, the general film was used to produce monitor data of questionable reliability. The data were compared with the appropriate general film analysis from the World Wide Sampling Network. In each case, the general film displayed no increase in activity corresponding to the tampering. Thus, the monitor data was qualitatively confirmed as reliable. For example, the comparison of the general film analysis with automatic monitor values is shown in Figure 29.

[illegible]



The values presented on Figures 3 thru 17 and used in computing qualitative and peak radiation are net radiation values, i.e., background has been subtracted from the measured total intensity. It should be noted that low intensity values may be considerably in error where background levels are of the same order as the measured total intensity.

5. Relation of Aerial Measurements to Ground Level Intensities. Continuity was broken factor limits the agreement which may be achieved between any particular pair of corresponding aerial and ground measurements. This is the most difference in the effective areas sensed by the two methods of survey. A single ground level measurement with a portable gamma instrument is made at a point, whereas an aerial measurement is made over an area of 10,000 square feet at an altitude of 200 feet or more and an area of perhaps 10,000 to 15,000 square yards.

It is well known that measurements on the ground will show considerable variation over a relatively small area. This is particularly evident in the case of the aerial measurements. The aerial measurements are made by means of a small area of the ground, and the measurements are made by means of a large area of the ground. Thus, the measurements are made by means of a small area of the ground, and the measurements are made by means of a large area of the ground. This is the most difference in the effective areas sensed by the two methods of survey.

In the like manner, aerial measurements can be distorted by terrain factors, including the lee or windward side of a mountainous island, and perhaps other factors.

After BMD-10, survey parties reported substantial variations in side radiation measurements on all of the islands surveyed.

Generally, one aerial measurement should approximate the average of many individual side radiation measurements. This is the case when the measurements are made by means of a small area of the ground, and the measurements are made by means of a large area of the ground. The measurements are made by means of a small area of the ground, and the measurements are made by means of a large area of the ground. This is the most difference in the effective areas sensed by the two methods of survey. The measurements are made by means of a small area of the ground, and the measurements are made by means of a large area of the ground. This is the most difference in the effective areas sensed by the two methods of survey.

7. EFFECTIVENESS OF MONITORING PROGRAM

The aerial survey and the automatic monitoring network must be reviewed together to analyze the effectiveness of the program properly for they were designed to complement each other. The program was a practical compromise between two extreme monitoring methods, one being the use of aircraft equipped with detectors of fallout on each of the islands included in aerial monitoring (the "island method") and the other being daily or more frequent flights over each of the survey patterns from 2 x 1 repetitively for a number of days following each event.

It is believed that the monitoring program did successfully fulfill the major requirements of providing timely fallout information over a substantial portion of the Pacific and of demonstrating cumulative radiation in those areas. The information obtained by the system following the Bikini burst is an excellent illustration of its effectiveness in performing the former function.⁶

At 1530 H on 8 day the automatic monitor in Rongerik 130 W East of Bikini, west of Eniwetok (see Figure 1) reported a radiation level of about 1000 R. This information, received at the Task Force headquarters about 1000 H, was the first indication of cumulative fallout outside of the chain of the Task Force and Bikini atoll itself. A radio message was sent with a scheduled island resupply flight on the following morning to clarify the fallout situation which had been indicated by the automatic monitor. At 1000 H on 9 day, a message to the Task Force headquarters was received from the automatic monitor at Rongerik 130 W East of Bikini, stating that the automatic monitor had reported a radiation level of about 1000 R. The report was delayed until that hour to include the possibility of the survey aircraft passing thru the radio active cloud. Due to communications difficulties, the message did not clear the radio for about twelve hours after it was originated and the flight did not leave Eniwetok until about noon on 9 day. At 1535 H on 9 day, the first flight report was received from the survey aircraft. The report included measurements of dose-rate radiation, fallout, and other information. It confirmed measurements of dose-rate radiation made on Eniwetok by the automatic monitor a few hours earlier. On his recommendation, evacuation of Rongerik had begun immediately and was complete when the first island flight message was received. By 1000 H the radiation level at all atolls in the AEEZ pattern were known and plans were formulated for the evacuation of additional north Marshall atolls. By 8 x 5 days, all over-land radiation measurements had been completed and the decision to survey the Gilbert Islands and the eastern and southern coasts of the Pacific was clearly defined.

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Figure 10, the response of the SCINTILLATOR at 0.7 Mc, 5 the average of count fusion product activity, is about 80% greater than both the T18 and the 27C internal probe and about 100% greater than the 27C external probe.

Thus, it can be readily understood that readings of the different instruments in the same place field may be different and even the overlapping action of the same instrument may not agree.

The size of the islands surveyed within the range of this study apparently does not affect the reliability of the altitude to ground intensity conversion curve. Calibration for the SCINTILLATOR was performed over areas of various sizes including both small and large islands in the Johnston and Bikini atolls. Data from these several locations agreed very closely.

Obviously, judgment is needed in evaluating radiation intensity in terms of potential exposure whether ground measurements or aerial measurements are the source of data.

-50-

FIG. 31
AERIAL MONITORING MEASUREMENTS - CONTINUED

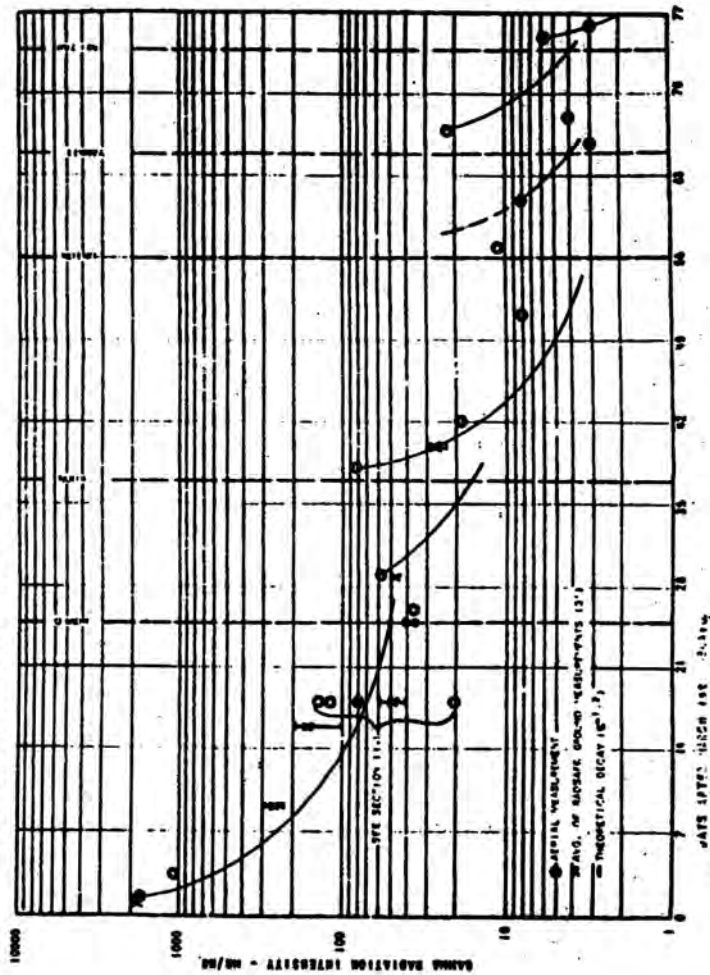


FIG. 32
AERIAL MONITORING MEASUREMENTS - BILLINGS, MT.

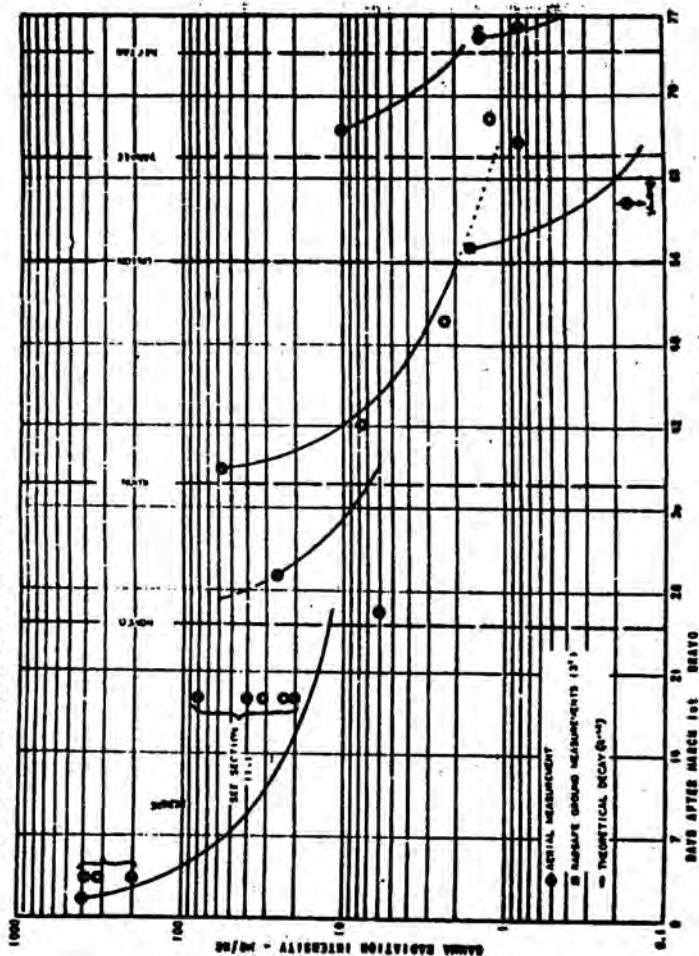


FIG. 34
AERIAL PHOTOGRAPHIC MEASUREMENTS - YTIKIV

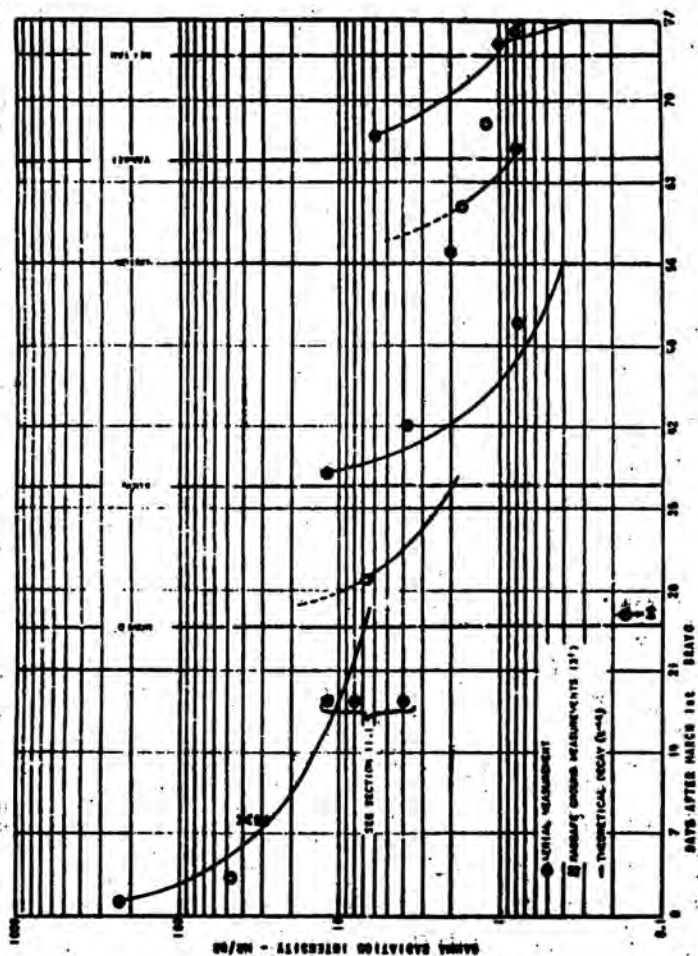
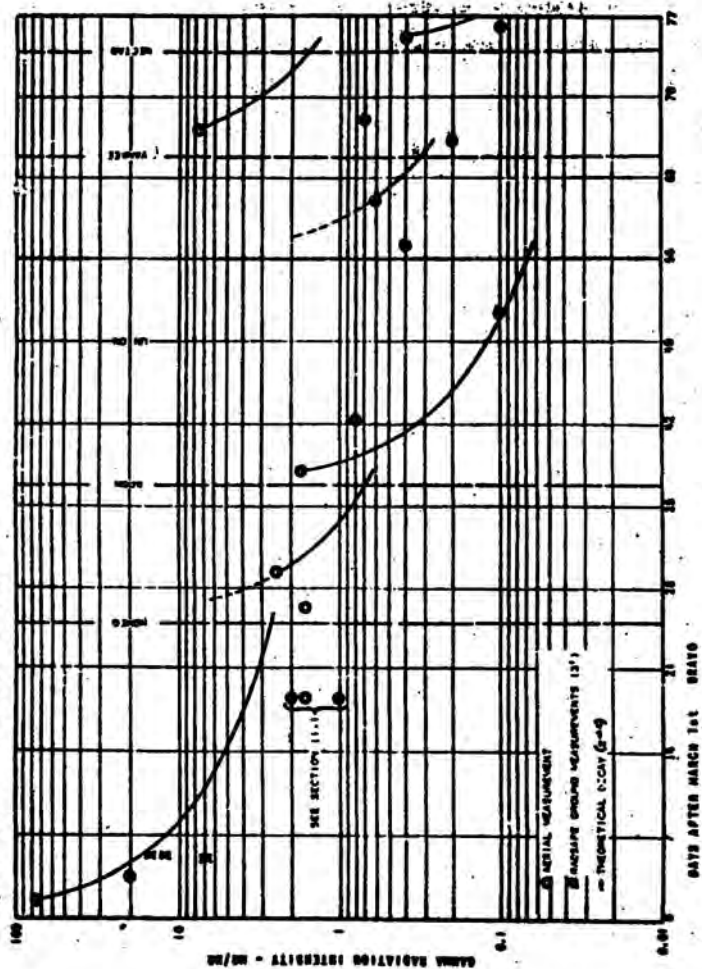


FIG. 34
AERIAL MONITORING MEASUREMENTS - ALICE



Based on different scenarios, agree partially will with each other but diverge from both sets previously mentioned. The scenarios of the OMS and Nevada data are plotted on Figure 34. The reasons for the discrepancies are not clearly understood. Any combination of the possible errors mentioned above may be responsible. It is felt that the effects of reaction product are of local and instrument energy dependence are factors which require further investigation.

2. Field Calibration: Sodium was used in the calibration of the 2201-100000000 and Low end of the High Level unit so, Caesium was used for checking the upper end of the 220-7-4 unit.

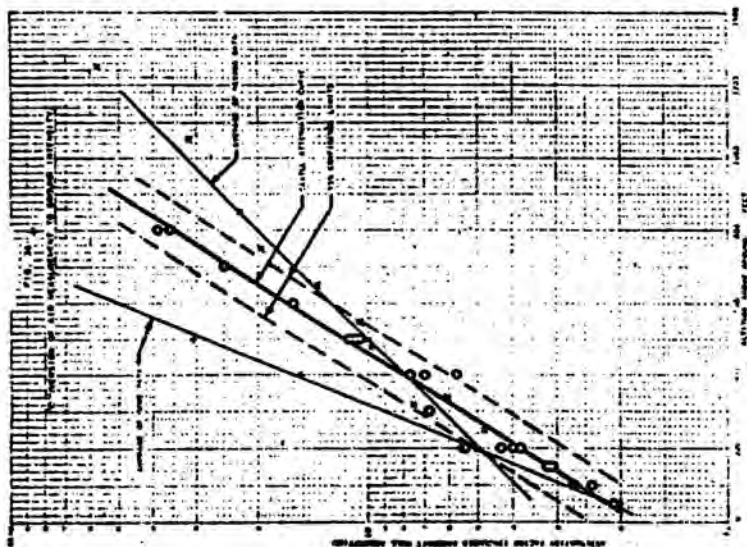
[illegible]

2. How can we determine the

Finally, **SOOTING** activities was performed at Milwaukee, Chicago, and Olean. Air conditioning systems was available in buildings because of the high temperatures of the day in the city at Milwaukee. Because of the massive loads that were being drawn, the massive loads that were being drawn were not seen on the power lines.

[illegible]

Whenever the first point was checked, a reading was taken in a direction field equivalent to greater than half scale deflection to insure that the remainder of the circuit was operating properly.



At times either aircraft vibration or rough handling affected the vibro-graphometer (vibro) read adjustment making errors common. To correct this, four rubber pads were provided to cushion the instrument while in the survey aircraft.

Operation Difficulties. Some circuit difficulties he was relieved shortly after arrival at the forward area but these were usually corrected. Circuit component failures were infrequent. Usually components were replaced from a stock of spare parts maintained in the forward area.

Battery replacement was necessary on the average after 70 hours of motor operation. Replacement necessitated opening the battery compartment doors. Each time this was done there was air conditioned room was unavailable the engineers realized out of service for up to 12 hours until the vehicles had dried.

[illegible]

2. Recommended Product Name:

- [illegible]

Calibration was likewise a tedious procedure because of high humidity. Calibration controls were feasible only by sending the instrument out so that a waiting period was required every time an instrument was returned to allow the desiccant to become "dry" or "inactive." Occasionally, calibration if one instrument would require several days because of the waiting periods. Frequently the humidity was so high the postage of desiccant could not completely absorb all the moisture within the instrument case after it had been sealed.

Mill Background. The frequent use of several large sources by personnel from other projects in the vicinity of the roadside millling, where the M&E instruments were installed on Perry, prevented collection of the low end of the 70-80 and 70-90 sections. A decrease in background of as much as ten times over the normal of .01 to .015 $\mu\text{g}/\text{m}^3$ was noted at each time.

Fallout from BWAF raised the background at Bismarck so that law and goals collection was impossible at any time; in order to continue the program, all low level SCIENTISTS were moved to Kazakhstan for arduous. On occasion, the fallout even on Kazakhstan was sufficient to prevent law and collection, although these periods were of relatively short duration.

Background radiation rarely interfered with the collection of the high level SCINTILLATIONS, the minimum scale reading being

6. Field Section. In field use, the SECURITIES were found to be most satisfactory by land forces personnel who used the instruments. These characteristics which were considered most desirable were: portability, ruggedness, light weight, simplicity of operation, single reading scale system, and sealed elements. The legs manufactured were particularly helpful for long back-country service since the instruments were insensitive to altitude changes.

Position is Aligned. Our experience has shown that the position of the instrument within the alveoli must be selected so that the radiation from radium disks on vertical dental instruments is negligible and the absorbing material unobstructed to x-rays and ultraviolet light. (A position over a gingival fold is undesirable). For repetitive surveys are planned, the same position within the alveoli should be used each time.

The battery operated side-scan air sampler, SRO type 23-5-4, takes eight consecutive one hour dust samples on its built diameter filter papers. Dust sampling begins automatically when the air-reading gamma radiation exceeds a predetermined value, 0.1 mR/hr and ends during CASTLE.

The **MR-100** installation type survey meters manufactured for the very low full scale ranges of 0.5, 5, 50 and 500 mR/hr. These are provided to certain automatic monitoring installations to complement the standard units if radiation information is required.

The DuPont Instrument Corp. Model 2610A survey meter uses a ^{252}Cf source. This source provides nucleus readings of 0.1, 2.0, and 10 mR/hr. These instruments were used from 1955 via APOA-1 instruments to the military stations. The maintenance of these instruments was performed in the forward area.

3. **Field calibration.** The sensitive measuring instruments were mounted on a heavy board for maintenance and calibration prior to their distribution to the measuring stations. The results made previously concerning the effects of sources on SLIMMETER calibrations are equally applicable to the automatic sets.

2. Data Summary

The T2-3, T2-4 and the gamma channel of T2-5 were used to study thermal variation in radiation peaking which was adversely affected by the repeatability of the radiation measurements within 0.1 mV. This was a continuous source of difficulty during the work. Field tests were conducted if they seemed during the planning process to determine the cause.

The investigation was continued at RAE, New York, where the residence of the individual mentioned on the back of the Amden 312-11340 was found to coincide with temporary.

There are other factors likely to contribute to the divergent variation in the amount of change in the mean of the dependent variable. The effect of heredity is strongly suspected. The 30 boys and 30 girls who had resistance components are selected in a tabular random sample from the population of the school. The 30 boys and 30 girls who had no resistance components were the probers on the alternate instrument. Since this was a immediate effort on collection as it is the case when *STRENGTHS* is used, the subjects were not disturbed during normal instruction. Since this was a delayed effort, the subjects had daily handling and coming of measure. It is possible that the probe over a period of time may be partly responsible for the increase in the resistance component and the 30-30 comparison may be a function of the variation.

(b) A minor should be directed to Nation the entry response clearinghouse.

8. Fixed Investment Network

[illegible]

L. Identification of Test Organisms.

The authors have nothing to disclose.

7d) The units of MTO type 706-6, a 110 volt 60 cycle 60 tube vacuum unit, together with a quasi-logarithmic response allowing a range of 0.05 to 25 mV to be recorded on a linear 6-1 cm recorder.

[illegible]

30 The units of ISO type 754-A, a 110 volt, 2 cycle oil tube vacuum meter with a logarithmic response allowing a range of 0.1 to 100 mm. Hg. is mounted in a 1 liter 600 ml. container.

3. The units of 150 Wm 75-1, a battery operated game sold with a logarithmic response allowing a range of 0.01 to 100 m/p/r. The surrounding game latency is recorded for five m/r : a high bet on a 0-1 at linear recorder.

For detailed descriptions of instruments see "BASE-LS, OPERATING PROCEDURES, PATIENT MONITORING FOR CASTLE."

REFERENCES

1. Radioactive Beams From Operation TIT, NIO-564, April, 1952.
2. Radioactive Beams From Operation CASTLE, Lathrop-Pallast, (To be released)
3. Radioactive Beams From Operation CASTLE, aerial Survey of Open Sea Following TITUS-564, NIO-564.
4. Survey Instrument Characteristics Measured by ILL, Instruments Branch staff.
5. The Effects of Atomic Weapons (Page 295).

END

measurements. The sources which are shown background measurements for corrections are capable and are activity. The proper application of shielding at this survey instrument could eliminate substantially all radiation originating in and on the aircraft.

6. Anomalous Russian product that measuring instruments should be performed and utilized at stations within three hundred miles of the target area.

7. A continuing effort should be made to increase fallout density per unit area of ground with radiation intensity. Sampling by ground film or equivalent should be done at monitoring stations.

8. The maximum measurement of fallout over the open sea from aircraft has been demonstrated. Prediction of this technology could greatly provide for accurate evaluation of fallout patterns up to ten to three hundred miles downwind from nuclear range bursts. Although the aerial survey program described herein was not designed for that particular service, the program could be extended for actual briefings.

9. Survey aircraft aircraft between the shells can measure sea radiation and surface radiation. These measurements could be used to determine the relative intensity of fallout within certain limits, and the areas of maximum fallout without sampling the shells survey functions. Mutual overlapping of survey stations could be avoided in this manner.

10. Aerial radiation data would supplement the sea surface data, broadening the scope of the study.

11. Under suitable circumstances, the shell data could provide a direct relation between sea measurements and ground activity.

12. Knowledge of the fallout path direction, derived from sea surface measurements, would be useful in determining appropriate shell survey requirements.

13. The correction of radiation measurements from the air to ground intensity should be more accurately defined. Phenomena necessary to be studied are instrumental energy dependence, effects of radiation product age and composition, and the relationship of ground intensity as determined by air measurement to ground intensity measurement by conventional portable survey instruments.

14. Recommendations concerning instrumentation are included in Section VI.

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