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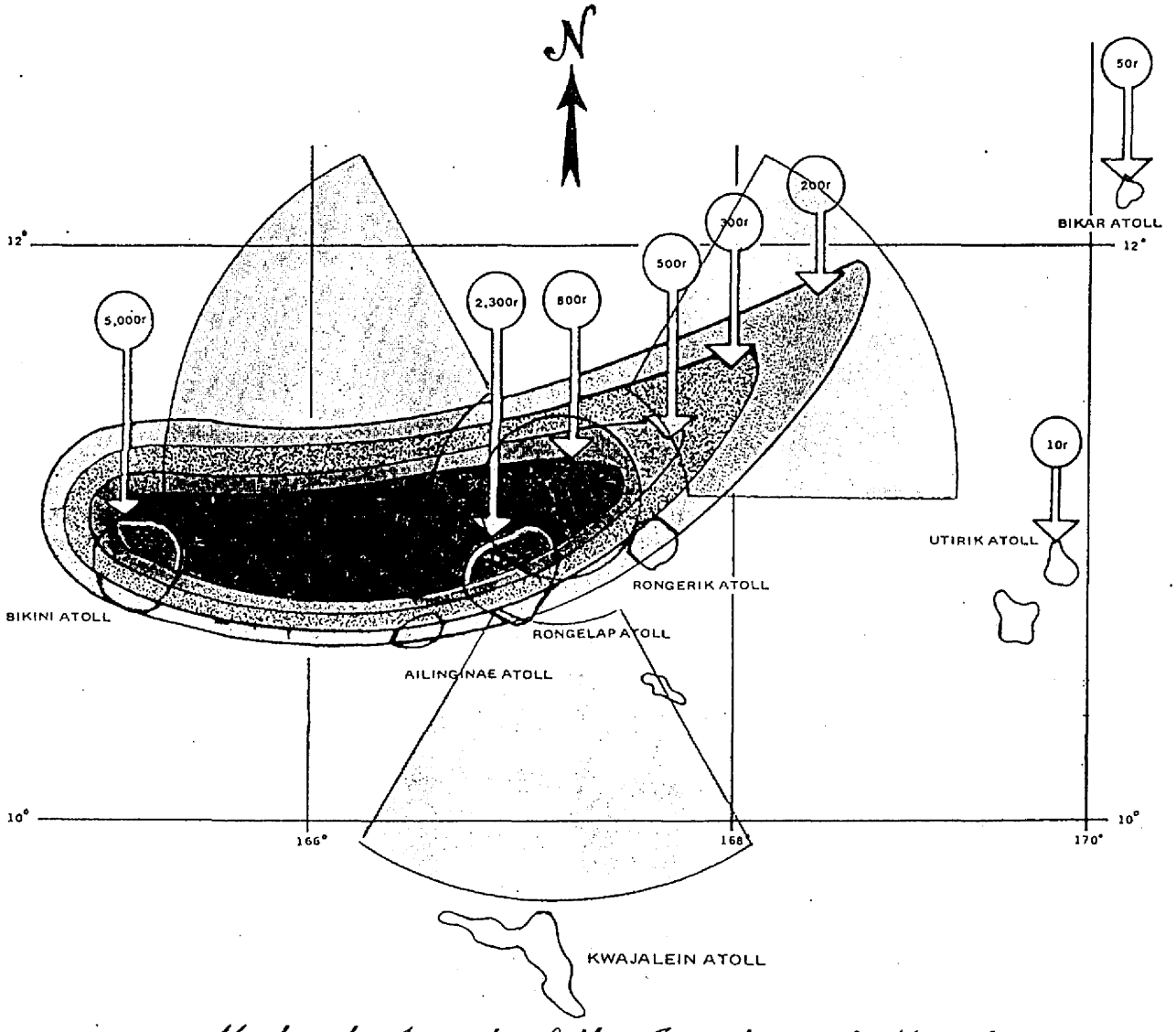
a report on Rongelap and Utirik to the Congress of Micronesia



Medical Aspects of the Incident of March 1, 1954
by the Special Joint Committee Concerning
Rongelap and Utirik Atolls

[redacted] 5010243

A Report on the People of Rongelap and Utirik

Relative to

Medical Aspects of the March 1, 1954 Incident

Injury, Examination, and Treatment

Presented by

The Special Joint Committee Concerning Rongelap and Utirik Atolls

(Public Law No. 4C-33)

to the

Fifth Congress of Micronesia, First Regular Session

February 1973

CONGRESS OF MICRONESIA

SAIPAN, MARIANA ISLANDS, 96950

SPECIAL JOINT COMMITTEE
CONCERNING RONGELAP &
UTIRIK ATOLLS
(Public Law 40-33)

Senator Olympio T. Borja, Chairman
Representative Timothy Olberdi
Representative Hans Williander

Errata Sheet
Report on Rongelap and Utirik
February 1973

P. 16 Second Paragraph. Reference "(FRP, p. 55)" should be "(60, p. 55)."

P. 22 The sentence which begins on line five should read thusly: "While even today the way by which these particles influence bodily or cellular changes is not completely understood, it is known"...etc.

P. 29 Third Paragraph. "...these particles may disturb the nucleus (center) of (not or) the chromosomes"...etc.

P. 35 First Paragraph. "the Phoenix was boarded (not bounded) by the" ...etc.

P. 35 Second Paragraph. the capital letters (ZRR) should represent the reference and page cited thusly (51, p. 679).

P. 46 Third Paragraph. Should read "In this bomb (omit, however,) there was a shaped charge which surrounded a hollow (not hallow) sphere of"

P. 47 Second Paragraph. Parenthetical notation (JIC - p. 55) is reference to publication inadvertently omitted from references, "Japan's Imperial Conspiracy," by David Bergamini.

P. 51 Fourth Paragraph. Spelling of Hiroshima's Mayor should be Yamada (not Yamade).

P. 63 Second Paragraph. Parenthetical phrase on line nine should read "(such as automatic multi-channel blood analyzers)"

P. 66 Second Paragraph. Description of Rongelap should read "which total only .647 (not 647) square miles"...etc.

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P. 55 Line at top of page should read "persons no longer able to walk.." ..(not work)...etc.

P. 73 Reference in first paragraph should read thusly (77, p. 1).

P. 82 Fourth Paragraph. This paragraph actually refers to Rongerik. For Utirik, it should read "Eastward on Utirik, the fallout began 22 hours after the explosion. According to all reports, it was not visible."

P. 94 Second Paragraph, last sentence. Reference (1944, p. 5) should read (44, p. 5).

P. 96 Third sentence from bottom of page should read "emitted from a 360° circle" (not 369°).

P. 100 In the quotation, "Gate" should read "data".

P. 104 In the quotation, the parenthesis should close after "processors),"

P. 107 Fourth Paragraph, second line. "Which have not yet been touched upon."

P. 112 Fifth Paragraph, second line. "a little" should read "little."

P. 136 Second line from bottom of page. Should read "to 167° 04' E." (Omit to 166°). These coordinates come from another source accidentally omitted, "A Guide to Place Names in the Trust Territory of the Pacific Islands," by E.H. Bryan, Jr., Bernice P. Bishop Museum, Honolulu, Hawaii, 1971. (Par. 20).

P. 141 At the end of the second quotation in the reference the capital letters "PC" should be eliminated.

P. 147 Fourth Paragraph, first word, "saga" should read "safe".

P. 152 Third Paragraph. The phrase "and no other group of people in the world have been exposed to the same amounts and differing kinds of radioactivity." is repeated twice.

P. 175 Recommendations one and two have refer to Utirik Island only.

P. 177 Second sentence. Should read "staff member" (not members).

P. 179 Fourth Paragraph. It should be Lisco (not Isico) Eugene."

P. 184 First Line. It should be "Ozenky" (not Cobey).

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XI. Appendices

THE SENATE

CONGRESS OF MICRONESIA

CAPITOL HILL * SAIPAN, MARIANA ISLANDS 96950

February 1973

The Honorable Tosiwo Nakayama
President of the Senate
Fifth Congress of Micronesia
First Regular Session, 1973

and

The Honorable Bethwel Henry
Speaker, House of Representatives
Fifth Congress of Micronesia
First Regular Session, 1973

Dear Mr. President and Mr. Speaker:

It is a distinct honor to transmit to you by means of this letter a report by your Special Joint Committee Concerning Rongelap and Utirik Atolls. Your Committee, as created by Public Law No. 4C-33, has worked faithfully and diligently to fulfill its obligations under the mandates of the law.

During its work, your Committee has been confronted with the technical nature of subject areas, which have in part produced perplexing problems connected with the well-being of the people involved. This report attempts to deal with and explain these, and does make recommendations which it feels are both practical and necessary.

While the Committee is certain that this is the most comprehensive and extensive investigation ever made concerning this matter, it wishes to state that the report is by no means as exhaustive as it could be. Had every medical aspect of this subject been explored, the length of the report would have been increased by half, or doubled. Furthermore, it was a determination of your Committee that

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the area of compensation needs further inquiry and deserves to be the subject of a subsequent report. For these reasons, and others, this report represents the Committee's final determinations in the light of present evidence. It should be noted that your Committee is submitting its report in compliance with P.L. No. 4C-33, even though additional information was being received after the report was written. Consequently, the Committee wishes to reserve the right to include additional information concerning the medical aspects in its subsequent report on compensation. Your Committee feels that this is right and proper, considering the nature of and the circumstances surrounding this subject.

Respectfully submitted,

Senator Olympio T. Borja
Chairman

Representative Hans Wiliander
Member

Representative Timothy Olkeriil
Member

I concur:
Representative Ataji Balos
Interpreter/informant

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Special Committee shall cease to exist.

Section 6. Appropriation. There is hereby appropriated out of the General Fund of the Congress of Micronesia the sum of $10,000, or so much thereof as may be necessary, to defray the expenses of the Special Committee. The sum herein appropriated shall be expended at the request, direction, and upon the approval of the Chairman of the Special Committee to accomplish the purposes of this act. The Special Committee is hereby authorized to hire such consultants and other staff members as it feels are necessary. All funds appropriated under this Section which are not expended or obligated for expenditure by January 15, 1973, shall revert to the General Fund of the Congress of Micronesia.

Section 7. Effective Date. This act shall take effect upon the approval of the High Commissioner, or upon its becoming law without such approval.

_____, 1972

_____
Edward E. Johnston
High Commissioner
Trust Territory of the Pacific Islands

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FOURTH CONGRESS OF MICRONESIA

SECOND SPECIAL SESSION, 1972

P.L. 4C-95
(S.B. No. 261, S.D.1, H.D.1)

AN ACT

To appropriate the sum of ten thousand dollars ($10,000) to cover the cost and contingent expenses of the Special Joint Committee on Rongelap and Utirik Atolls, and for other purposes.

BE IT ENACTED BY THE CONGRESS OF MICRONESIA:

Section 1. The sum of ten thousand dollars ($10,000), or so much thereof as may be necessary, is hereby appropriated from the General Fund of the Congress of Micronesia to defray the cost and contingent expenses of the Special Joint Committee Concerning Rongelap and Utirik Atolls as created under Public Law No. 4C-33. The sum herein appropriated shall be expended at the request, direction, and approval of the Chairman of the said Committee to accomplish the purposes of Public Law 4C-33. The Special Committee is hereby authorized to hire such consultants and other staff members as it feels are necessary. All funds appropriated under this Section which are not expended or obligated for expenditure before January 1, 1974, shall revert to the General Fund of the Congress of Micronesia.

Section 2. This act shall take effect upon approval by the High Commissioner, or upon its becoming law without such approval.

October 20, 1972

~~Edward E. Johnston~~
Deputy High Commissioner
Trust Territory of the Pacific Islands

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Section 3. Duties of Special Committee. The Special Committee shall investigate the results of irradiation on the people of Rongelap and Utirik Atolls in the Marshall Islands District, shall attempt to secure any and all medical assistance and aid for the people of Rongelap and Utirik Atolls from whatever sources possible, and shall attempt to obtain compensation for the people of Rongelap and Utirik Atolls for the injuries which they suffered due to exposure to irradiation.

Section 4. Powers of Special Committee. The Special Committee shall have the power to conduct hearings and investigations, issue subpoenas requiring the attendance of witnesses and the production of books, documents and other evidence and bring suits in any court of the Trust Territory of the Pacific Islands in its own name to enforce such powers, in addition to all of the powers provided in Subchapter IV, Chapter 5 of Title 2 of the Trust Territory Code.

Section 5. Report of Special Committee. The Special Committee shall submit an interim report to the President of the Senate and the Speaker of the House of Representatives on or before May 25, 1972. After said interim report is presented to the President and the Speaker, the Special Committee shall continue its work until the members thereof feel that their mission has been completed. The Special Committee shall submit a final report to the Congress of Micronesia during the First Regular Session, Fifth Congress of Micronesia, after which date the

FOURTH CONGRESS OF MICRONESIA

SECOND REGULAR SESSION, 1972

Public Law No. 4C-33
(H.B.No.199; H.D.1)

AN ACT

To create a Special Joint Committee concerning Rongelap and Utirik Atolls, to appropriate money therefor and for other purposes.

BE IT ENACTED BY THE CONGRESS OF MICRONESIA:

Section 1. Statement of Intent. During the period from 1945 to 1958 the United States of America exploded atomic weapons on Bikini and Eniwetok Atolls in the Marshall Islands District. As a result of more explosions, the people of Rongelap and Utirik Atolls in the Marshall Islands District were exposed to irradiation and have been and are suffering serious ill effects and medical disorders. It is the sense of the Congress of Micronesia that these people should receive the best medical treatment available and that these people should also receive compensation for the injuries which they have suffered. To insure that the people of Rongelap and Utirik Atolls receive such treatment and compensation, the Congress of Micronesia is creating a special joint committee to investigate this situation.

Section 2. Creation of Special Committee. There is hereby created a special joint committee of the Congress of Micronesia to be known as the Special Joint Committee Concerning Rongelap and Utirik Atolls hereinafter referred to as the Special Committee. The Special Committee shall be composed of three members, to be appointed by the President of the Senate and the Speaker of the House of Representatives. Such appointments shall be made on or before March 25, 1972. At the first meeting the Special Committee shall select a Chairman.

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"History shows that these hypotheses about the nature of things are valuable even when, as later experience reveals, they are false. Man approaches the unattainable truth through a succession of errors."

---Aldous Huxley, Collected Essays

FOREWORD BY THE COMMITTEE

As mentioned in the letter of transmittal, had the Committee covered all the aspects of its assigned subject, this report would have been considerably longer than it is at present. Thousands of books and other materials dealing with radiation have been published. Thousands of scientists, technicians and researchers are studying radiation and its effects today. Among these people there are, even today, varying opinions as to the benefits and liabilities of radiation as it is used by and on man. Despite all the scientific inquiry and discussion, the field of radiation and its many aspects is a relatively new one. This is especially true in regards to how radiation affects human beings and will continue to be so since ethics and morality forbid man to experiment upon his fellow human beings. Because of these factors, this report is by no means to be considered either final or comprehensive. There never will be a "last word" on the subject. The Committee does believe, however, that it is perhaps the most extensive treatment ever given to the subject area, for not only does it consider strictly technical medical aspects of the problem, but includes other related topics such as nuclear weapons, experiences in other countries, the personal feelings of the exposed persons themselves, psychological and cultural aspects, and the effects and influences of human judgment, time, circumstance and, if you will, fate. The Committee believes that such a holistic approach--as opposed to an atomistic approach--is the correct one to follow concerning this topic. It is an approach similar to the concept in medicine of treating the whole man, rather than just treating an illness or disease as a single, isolated event unconnected with the complex interrelationships of the total functioning organism.

As mentioned, the Report is not as complete as it could be. By the same token, it is not perfect; there may be errors, flaws, or faulty assumptions contained in it. If there are, they will be noted by those persons who are more

experienced in the subject areas of the report, or, who have had available to them information or facts not available to the Committee. If there be such errors, or flaws, however, the Committee does not apologize for them, but rather asks the reader to accept them as being inherent to the technical nature of the area and the difficulty in collecting information concerning it. The Committee believes that it has done the best possible job with the resources available to it and considering the formidable constraints of time and space of an event which occurred over eighteen years ago, but which is still affecting the daily lives of the people involved, and may affect those of their descendants.

Some readers may object to the narrative form of the section dealing with the detonation of "Bravo" and subsequent events that occurred. The Committee feels that the approach to this section is justified, however, since in combining known facts, with recollections of the pepple the re-creation of the event itself brings into relief certain facts and circumstances and their relationships which could be missed by the casual reader in looking at charts or tables connected with the event. The Committee also believes that this approach also makes what could be a dull and uninteresting section in an already cumbersome report on a highly specialized topic somewhat more interesting for the reader. For instance, the personification of "Bravo" as a "sleeping giant" whose radioactive cloud behaved as if influenced by "trickster ghosts" may be considered repugnant or perhaps improper by some scientists. Be this as it may, no one can deny--not even the most prominent scientists--that the radioactive legacy of such an event has continued to "live" until this day both in a purely physical and biological sense and in a psychological sense.

In writing this report, the Committee has attempted to popularize and simplify the subject of radiation and its effects.

The very subject of radiation is a very complex and large one, a fact which is indicated by the remark of one scientist in talking about radioactive

contamination of certain lagoons as a result of nuclear testing. Paraphrased, his remark was to the effect that we are dealing with the small end of a very large subject.

In all instances it was not possible to explain everything as well as could be wished. Despite this, the Committee feels that there is enough basic information in plain language and plain ideas to give the reader sufficient knowledge to make the report and its recommendations meaningful. The accuracy and appropriateness contained in the introductory section dealing with radiation in general is primarily due to the efforts of the Committee's consultants--especially to Dr. William S. Cole, Dr. E. Eric Pochin, and Dr. Toshiyuki Kumatori. Their assistance in editing this section has been invaluable.

Relative to this, it should be emphasized that the consultants to the Committee should in no way be connected with the validity of the report, its assumptions, conclusions, opinions or recommendations. Under no circumstances should any part of this report--with the exception of the consultants' reports to the Committee--be taken to represent the views of the consultants, the organizations in which they work or with which they are connected, or their respective governments.

In commenting upon its own report in this foreword, the Committee would also like to bring to the attention of the reader what it considers to be some rather interesting circumstances, which may or may not have bearing on the report itself.

One of these, mentioned later on, involves the lack of information received from the Atomic Energy Commission and the Department of Defense. This information was requested nearly one year ago. No response has been forthcoming--despite follow-up letters by the Committee. The Committee believes this points out what is a self-evident fact. The mandates of the Committee by law are basically inimical

to the interests of the Administering Authority. Yet the basic information needed by the Committee must by necessity come from that very same source. Coupled with this are the contradictory natures of Micronesian and American interests embodied in the Trusteeship Agreement which are manifested in the daily operations of the Trust Territory Government. In short, the Committee, in carrying out the wishes of the elective legislature of Micronesia, has had to deal with an incident caused by the United States. In trying to investigate the matter, it has had to request information from U.S. agencies and departments. This situation was further exacerbated by the events which transpired in December, 1971, and January and March of 1972. The issue of the medical treatment of the Rongelapese and Utirikese had beome a "hot potato" politically (a fact which is discussed in the report). As a consequence, a somewhat highly charged emotional atmosphere has pervaded the Committee's work and investigations since its inception. This is clearly evidenced by the pointed absence of an enacting signature on the law which created the Committee. The law and the Committee were passively allowed to come into existence through mechanisms of law, rather than with official approval of the Administering Authority. This apprehension about the Committee and its work has, in some quarters, been lessened as it has continued its work. The Committee has always taken the approach that its studies should be serious, well-considered, careful and conducted in a mature and professional manner. This has resulted in developing excellent rapport and cooperation with the executive branch of the Trust Territory Government, although the same cannot be said to hold true at certain other levels. This has been evidenced at various times by several occurrences described below.

First, the Committee was pleasantly surprised by the fortuitous appearance of Dr. Darling of the ABCC and Dr. Steinfeld of the U.S. Public Health Service while on Saipan. They appeared in a deus ex machina fashion as in Greek plays

of old. Dr. Darling offered the assistance of his Commission, and Dr. Steinfeld the resources of the Public Health Service. While the Committee has no reasons to suspect the intent and motivation behind their offers, it does believe that these visitations were more than just coincidental.

Second, the Committee's reception in Tokyo, Japan, by both that government and the United States Embassy, while cordial, appeared somehow to be unenthusiastic, which contrasted immensely with the reception accorded it in Hiroshima and Nagasaki. The Committee has compared notes with other committees of this Congress and has found that receptions by representatives of both the United States and Japanese governments for committees concerned with status or resources development were far and away more enthusiastic than that of this select committee dealing with the irradiation of Micronesian citizens.

Third, this Committee became aware at the conclusion of the September, 1972, survey of a somewhat amazing fact. As early as March of 1972, even before Public Law No. 4C-33 was allowed to become law, and before the Committee's interim report, one of its consultants was approached by a representative of the Atomic Energy Commission and informed that he might later be asked to participate in the annual examination of the Rongelapese in order to give credence to the correctness of the surveys. That this came to pass, is again, the result of more than just simple coincidence.

Fourth, reference is made to lack of cooperation from the AEC and DOD. The Committee finds this most interesting, especially since it is aware that the AEC, at least, is not unable or unprepared to offer such information or assistance if requested from the proper sources. Specifically, the Committee wishes to refer to a letter from Representative Balos to Senator Henry M. Jackson of the U.S. Congress, which he sent the Senator during the session of the Congress held in Palau in 1972, concerning the plight of the Rongelapese and Utirikese.

Senator Jackson, in turn, referred the letter to the Atomic Energy Commission. The AEC then sent to the Senator a twelve-page report from the General Manager. This report included some information requested by the Committee; however, the Committee only came into possession of it indirectly and not in response to its request.

What the Committee wishes to prove by mentioning these incidents is not that it has developed a pathologically paranoid attitude wherein it believes that information is being consciously and intentionally withheld from it, but rather that there are perhaps larger, unseen forces at work of which the Committee is for the most part totally unaware, but which it believes exist nonetheless, due to the conflicting nature of its mandates which could possibly conflict with certain interests of the Administering Authority.

One final word should be mentioned concerning this report: how to read it. As readers will discover, it has been written in an inductive fashion; that is, evidence is presented, studied and evaluated, which forms the basis for later conclusions. The report at the same time also goes from the general to the specific, an example of which is the early broad sections on radiation in general which help explain discussion of specific radiation effects later on. The Committee began its study with no assumptions, but has formed opinions and conclusions as information has developed. The report is written to reflect this.

Lastly, one word of advice, for those who wish to merely read the recommendations because of the length of the report. The Committee would advise against this. This report is structured so that evidence and information build continuously to the concluding recommendations. Thus the recommendations are not easily understandable without reading the whole report. We, the members of the Committee, suggest that those who only want to read the recommendations, stop reading the report at this point.

" . . . A dead youth is a blasphemy against the God of Life. No one desires war, but a fool or a madman, and there is no longer room in the world for madmen or fools. We deny the infallibility of the atom bomb; we affirm the infallibility of the brotherhood of man the world over."

--Sean O'Casey

DEDICATION

First and foremost, this report is dedicated to the memory of a young Marshallese man, Lekoj Anjain, who was one year old when the world's greatest nuclear explosion was detonated one-hundred miles from his home on March 1, 1954 and who was nineteen years old when he died during treatment for acute myelogenous leukemia in a small hospital room at the National Institute of Health at Bethesda, Maryland on November 15, 1972. It is also dedicated to his parents and the people of Rongelap and Utirik, who were exposed to radiation from the 1954 tests and to their descendants.

Also, by inference, this report is also dedicated, not only to those Japanese and Americans exposed to the effects of nuclear weapons from the Hiroshima, Nagasaki, and Bravo bombs, but to those scientists who willingly or inadvertently sacrificed their health or life in order to gain new knowledge about the little-understood phenomenon of radioactivity. Finally, it is also dedicated to those unknown and unnamed people now, and in the future, who may suffer or die from the effects of weapons-testing conducted by the nuclear powers of the world in the name of national security or through the misuse or mal-application of radioactive materials and instruments. It is hoped that this report will contribute to the understanding of a complex, subtle, and important subject and will serve as a warning to its readers that man must increase knowledge of himself and his neighbors in order to better control forces of nature at his disposal lest those very forces end up controlling and destroying man.

"They were deliberating among themselves as to how they could give wings to death so that it could in a moment penetrate everywhere both near and far."

--The Labyrinth of the World in Czech, 1623
Jan Amos Komenscky,
Comenium, Last Bishop of Unitas Fratrum Bohemorum.

INTRODUCTION

RADIATION IN GENERAL

Man lives in a naturally radioactive environment. He is surrounded by radioactivity much as he is by the great ocean of air which envelops the world. Like air, we cannot see radioactivity with the naked eye, but we know it is there because its effects can be observed and its presence can be measured with special instruments.

If we could give color to the radioactive rays which are naturally present in our environment, we would behold a wondrous display of activity. We would see these rays emanating from the wood of our houses, the rocks and soil of land, from living plants and trees, and from cement buildings and metal structures.

In addition to this, we would see radiation and other rays passing through the air from television sets, power plants, wristwatches, paint, canned foods, the milk we drink, and from the X-ray and other ray-producing machines in doctors' and dentists' offices and in hospitals and research institutes--not to mention facilities which produce radioactive materials and facilities which use them, like atomic power plants.

We could see them shooting out from the sand of a beach, the ocean, fresh-water lakes, fish, birds, and animals. We would also see cosmic rays from deep in space stabbing through the atmosphere and actually passing through our bodies, and other matter.* Finally, if we could see inside our bodies, we would also see rays emanating from different areas--the result of certain radioactive elements, such as potassium, which are possessed naturally

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*Some cosmic rays are so powerful, in fact, that they have been recorded in mines over a quarter of a mile (1320 feet) below the earth's surface. (46)

by us and which form a part of the total amount of radiation which we are exposed to during our lives.

Radiation has undoubtedly been present in the world and the universe since its creation and has resulted in the natural radiation background which surrounds us today. Radiation, the sending out of particles, or invisible "bullets" from an atom can be both natural, meaning it can be found occurring in certain rocks and minerals, or it can be created by man. The atom, then, is the basis of this radioactivity, and a brief discussion of the atom and its relation to man and to radioactivity will be undertaken to help lay the foundation for the understanding of the sections in the report to follow.

If we look at ourselves and at other objects, we see that these things appear to be more or less solid. Yet scientists also know that all matter is made up of smaller parts or components. Thus, while we can look at a beach as a whole, we also know that this physical thing we call a "beach" is also composed of millions of tiny bits of sand. Further investigation will show that the sand itself is made up of many different kinds of minerals, these minerals are made up of smaller parts called molcules, and the molecules made up of atoms, which are, for the practical purposes of this report, the smallest particles of matter which we shall discuss.

The atom, we might compare to a solar system like our own. In a solar system, the sun at the center has, revolving around it, a number of planets. An atom is similar in structure. Around the center, or nucleus, revolve a number of electrons. The nucleus, however, is not generally of one substance, but several, like a handful of marbles tightly bound together by an electrical charge, which is also involved like gravity in a solar system in keeping the electrons operating in their regular positions close

to the nucleus. This is, perhaps, an over-simplified description of the atom, but one which will have to suffice for our purposes. There are a few hundred different atoms and their difference is indicated by the number of neutrons (neutrally charged) and protons (positively charged) "marbles" in their nuclei. An element is defined as an atom with a given number of protons in its nucleus. Isotopes of an element have different numbers of neutrons in their individual nuclei.

Two other qualities of atoms and their relation to radioactivity should be mentioned. Atoms may emit different types of particles of different energies. A second fact is that the number and arrangement of electrons determines the chemical factors of an element. While many are different, there can also be atoms with the same number of electrons and, consequently, the same number of positively-charged (protons) particles in the nucleus. Since they are the same in this respect, they are like chemical brothers. They can form the same larger units like molecules.

There are five types of emitted energies mentioned in this report but only three will be used frequently. The five are:

1. Neutrons
2. X-rays
3. Gamma rays
4. Alpha particles
5. Beta particles

Neutrons: These particles are emitted during the chain reaction which takes place during a nuclear explosion of an atom or hydrogen bomb. A neutron has about the same mass as a proton but is uncharged. It is highly penetrating in all materials except those of mass near that of its own.

[redacted]

X-rays and gamma rays: These are electromagnetic waves of relatively high energy and therefore having relatively high penetrability through matter. They may be emitted from a nucleus, a gamma ray, or produced by electron rearrangements outside of the nucleus, X-rays.

Alpha particles: These are helium nuclei and are emitted from the nucleus of radioactive atoms. These particles have a low penetrability and, when they are emitted from an atom inside the body, they may produce substantial local damage.

Beta particles: These are low to high speed electrons given off by a radioactive material. Their penetrability in matter is between that of alpha particles and X-rays.

Half-Life

The rate of emission of a given type of particle from a sample of radioactive material decreases with time. When this decrease is rapid the isotope is said to be short-lived and when it is long the isotope is said to be long-lived. The time for the rate of emission to reduce to one-half of its initial value is called its half-life. Half-lives of from a small fraction of a second to many thousands of years have been observed for different radionuclides. The half-life for plutonium 239 is about 24,000 years. Thus, after 24,000 years it will have emitted half of that remaining, and so on. It is as though we started out with $100 and after one half-life we have $50, after another half-life we are down to $25, another one leaves $12.50, and so on until nothing is left and the element has returned to its original stable form. Pu^{239} is one of the longest-lived elements. Strontium 90 and cesium 137 have half-lives of about 30 years. Other isotopes have half-lives of a few months, days, minutes, or seconds.

Connected with this physical half-life of the isotope is another kind of half-life called the "biological half-life" which is the amount of time it takes for one-half of the radioisotope to be removed from the body, through elimination of waste matter. A further aspect of radiation that is of interest in the present context is that charged particles lose energy along their path to the mediums they are penetrating. This energy may break up molecules or even produce radioactivity. For the energetic particles of interest here, thousands of molecules may be affected along the track of the particle. Because of the positive-negative electrical charges, these particles can tear electrons from atoms they strike. It takes anywhere from ten to one hundred electron volts of energy to tear an electron from an atom. Usually the radiation energy of particles is measured in the thousands (kilo electron volts -- kev) or millions (million electron volts -- mev). Consequently, particles in the kev or mev can disrupt or ionize thousands of other atoms before their energy is used up and they stop.

Measurement

The amount of radiation may be measured in a number of different ways. Of particular interest here are measures that indicate the interaction of the radiation with various types of material.

The "Roentgen" is a unit for exposure which indicates the ability of the X or gamma radiation to produce ionization in air.

The "Rad" is a unit of absorbed dose which indicates the amount of energy absorbed in a material per unit mass of material.

The "Rem" is the unit of dose equivalent. The dose equivalent is for radiation protection purposes and provides a common frame for assessing the combined effects of different kinds of radiation on the human body. For

external radiation, the dose equivalent is obtained by multiplying the absorbed dose of a given type of radiation by the quality factor for that radiation and summing these products for all radiations incident at a given point in the body. The quality factor is defined in terms of the energy deposition per unit path length of the charged particles at the point of interest in the human body.

The "Relative Biological Effectiveness" (RBE) is the ratio of the absorbed dose of two radiations producing the same biological effect. One of these radiations, called the reference radiation, is frequently moderate energy X- or gamma rays. This term is most often used in reporting the results of biological experiments and the reference radiation is often moderate energy, X- or gamma rays. Thus, if the absorbed dose of the reference radiation is 20 times larger than the absorbed dose of the radiation of interest to produce the same effect, one would say that the RBE of the other radiation is 20.

Lethal Dose: The LD-50 (LD equals lethal dose) is the absorbed dose that will kill 50 percent of the organisms exposed. This term is usually used when the radiation is administered acutely. One needs also to indicate the time span over which the observations are made following the irradiation. Also, it is usually used when the absorbed dose is more or less consistent throughout the organism and the magnitude is given for no pre- or post-treatment of the organism. The LD-50 in 30 days for man is about 300 rads. This is a numerical value stated in the Langham National Academy of Science report on space travel.

Treatment for Acute Effects

There are no methods of treatment which will cure the immediate effects of severe doses of radiation -- only treatment for the different kinds of

illness it produces. Thus, liquids should be given to replace dehydration and loss of body fluids from vomiting; skin burns should be treated as normal burns to aid the healing process; and, most importantly, antibiotics should be administered. There are other measures which may be taken, but for the most part they are unproved. These are:

Protective Measures. These are designed to counteract, or moderate, the effect of radiation. Most of the information available deals with animal experimentation. The measures generally involve injecting animals with certain chemicals before they are exposed. These chemically will generally increase the animal's chance of surviving what normally would be a lethal dose. There are no human experiments of this type.

Recovery Agents. These are used to treat immediate damage and to prevent or minimize damaging results later on. Other than the usual methods described for acute treatment, these include blood transfusions, drugs to control bleeding, and bone marrow injections. The evidence for bone marrow injections, which help the marrow of the affected person produce blood cells until the patient's marrow recovers, is not clear. Testimony on blood transfusions from Dr. George B. Darling, former head of the Atomic Bomb Casualty Commission in Japan, who met with the Special Joint Committee, is somewhat negative as to their effectiveness.

Removal Agents. This is one method which has had mixed success in the administration of chemicals to the exposed person. The patient drinks or is injected with the material, which helps to carry away from the body greater than normal quantities of the radioactive material. This kind of treatment is usually only effective if administered almost immediately after the internal exposure has taken place.

SOME KNOWN INCIDENTS INVOLVING IRRADIATION OF PEOPLE

The following examples give an indication of the range of acute doses of radiation received by human beings and the treatment given:

Los Alamos - During 1945 ten persons were accidentally exposed to radiation during two accidents. One person received 2,000 r's and died in nine days, another received about 600 r's and died in twenty-six days, and a third developed cataracts in both eyes after three years. The seven other people apparently recovered.

Windscale - On October 10, 1957, a British nuclear reactor sprayed radioactive matter (I^{131}) on the nearby countryside. Later, milk in that area was found to be slightly radioactive. No injuries were reported according to the source of information.

Oak Ridge - On June 16, 1958, an accident happened at a plant which makes radioactive material. It was determined that five men received 236 to 365 RADS and three men from 25 to 100 RADS. They suffered acute symptoms, but apparently returned to normal health.

Yugoslavia - An atomic reactor accident near Belgrade, in 1958, exposed six men to very high gamma and neutron radiation. They suffered acute effects of the radiation and one of them, who received the highest exposure (the figure is not available), was given bone marrow injections but later died. Four others, who received less, were also given the injections which helped until their own bone marrow became active again. The sixth person recovered without injections. Expert opinion is divided as to whether bone marrow injections can help recovery from high exposure.

NUCLEAR WEAPONS AND MAN

The year of 1938 was not particularly auspicious, historically perhaps, with one exception.

In 1938 the United States was struggling upward out of a worldwide depression which had been triggered in 1929. It was not a particularly notable year for movies, fashions, or politics; isolationism characterized the international mood of the American people.

In the Marshall Islands in 1938, sixteen-year-old John Anjain was probably contemplating his daily chores, the possibility of going fishing, and the increasing presence of Japanese military personnel in his islands.

A singular event, however, did take place that year which would affect the future lives of Japanese, Americans, and Marshallese alike--in fact, all the people of the world. It was the autumn of that year that German scientists at the Kaiser Wilhelm Institute in Berlin split an atom of Uranium 235 (U^{235}) (54 pg. 9). While it had been theoretically considered possible, this was the first time that it had been actually accomplished. Splitting of this atom meant that a chain reaction was possible and creation and control of a chain reaction meant that man had, within his grasp, control of a basic force of nature and the universe. How this power was to be used would startle the world.

In May of 1942, the President of the United States of America, with a simple "OK, FDR" notation, made a decision that the United States would make an all-out, massive effort to develop the first atomic bombs before Germany could (54, p. 13). The successful operation of an atomic pile by Dr. Enrico Fermi and the "Chicago Group" on December 2, 1942, at 3:25 a.m. (54, p. 88) proved that the controlled chain reaction, necessary to produce plutonium for an atomic bomb, was possible. Later, processes were

developed to produce both uranium and plutonium, each of which would provide the critical material for the atomic bombs developed by the United States.

The process of the splitting of the atom, or "fission," is nearly impossible to imagine, understand, or explain. Atoms, which we cannot see, smell, touch, or hear because they are so small, have a fantastic amount of potential energy which, when released in the form of an explosion of a single bomb, is capable of flattening buildings and scorching earth over hundreds of square miles; of killing and maiming millions of people immediately, and more millions in the near and distant future.

In effect, however, the basic power of the atomic bomb comes from two things: the force which binds the atom together and a chain reaction. Even though atoms are very tiny, the amount of force binding the atom and its parts together is very great for its size. When a neutron strikes a fissionable atom, the atom may split, and following the splitting, may produce additional neutrons. In turn, these neutrons may produce splitting of nearly fissionable atoms. A chain reaction is said to exist when the splitting of one atom produces on an average the splitting of more than one nearby atom. An example of a "chain reaction" is where a ball is tossed into a room in which the floor is covered by mouse traps set with ping pong balls. The ball trips one mouse trap, which in turn sets off its neighbors, which in turn set off still more, until all have been sprung. When this chain reaction is slow and controlled, it can be used for electricity-generating atomic power plants. The reaction heats water and turns it into steam, which drives turbines connected to generators, which produce electricity.

When, however, this reaction is "uncontrolled," it results in an atomic explosion. The tremendous relative energy contained by fissionable material as opposed to regular sources of energy might be illustrated this way: the

fission of one pound of uranium bomb material is equivalent to 9,000 tons (18,000,000 lbs.) of TNT.

On May 7, 1944, the United States detonated 100 tons of TNT at its Alamago test site in order to approximate--at scale--the possible effects of the test of a plutonium bomb in July. On July 16, 1944, at 5:29 a.m., "Trinity," the first test of an atomic bomb, took place and was supposedly equivalent to 5,000 tons of TNT. This was 50 times as powerful as the May test, but only one-quarter the yield of the Hiroshima and Nagasaki bombs.

The "fusion bomb," or better known as the "hydrogen bomb," works on a somewhat different principle, although it uses the basic nuclear force of the atom as well as a chain reaction. In fusion, instead of splitting atoms apart, they are fused, or welded together to produce a chain reaction. To do this requires a huge amount of heat--something in the order of 100 million degrees. Since this high temperature can practically only be reached by detonation of an atomic bomb, the atomic bomb and fusion process provide the "trigger" for the fusion process. The fusion process, which utilizes hydrogen atoms, results in even a higher energy yield than that of fission: 1 pound of fusion material is equal to 11,000 tons of TNT. (49 p. 15) Scientists also discovered that the fusion bomb "wasted" radioactive material in that it produced a lot of extra neutrons. They solved this problem with the addition of another uranium element which the fusion process would use. Simply put, the fission process triggers a fusion process, which in turn triggers a final fission process. This was the basis of the BRAVO device to be tested at Bikini in March 1954.

In millionths of a second, the fission--or fusion process--is completed and in thousands of a second a fireball is formed and is generating heat and shock waves, that will produce destruction in all directions. Regardless

of whether a surface or air burst, the fireball will spread upward from 100 to 300 miles per hour at the beginning, and slowing as it approaches peak altitude. If the explosion occurred on the ground, the fireball will suck up with it great quantities of soil and incinerated materials, carrying the lighter ones to its highest altitude. Local fallout of this material will be heavy and only the lightest particles will ascend to thousands of feet. If, however, an air burst, the heat and shock waves will be maximized, but little material drawn up into the cloud with the fireball; consequently, there will be little local fallout. Great amounts of radioactivity are sent out during the gaseous fireballs' formation and as it rises. However, if it is an air shot ,little radioactivity will be dispersed locally since little material has been uplifted, and since the majority of the some 200 radioactive products are so short-lived that many of them have gone through one or two half-lives before the cloud has peaked. Essentially, in an air burst the main radioactive elements are from the material itself, water vapor in the air, and the metal bomb parts themselves, which have become mixed with the fireball. A nominal 20 kilotron (20,000 tons of TNT) burst will rise to about 20 or 30,000 feet. A one megaton bomb (1 million tons of TNT) will rise within 10 minutes to a height of roughly 100,000 feet. If it was a ground burst, it will have pulled up with it tremendous amounts of matter and made it radioactive. The cap of the cloud will have poked itself into the stratosphere where high winds will begin dispersing it worldwide. The rest of the cloud column will be torn about by lower winds which will carry the radioactive debris with it. The heavier particles fall out first, and lighter ones fall back down later upon the earth below, in a design created by the wind.

RADIATION AND MAN

External Exposure

While mankind has lived for probably millions of years in a naturally radioactive environment, it has only been since the creation of artificial sources of radioactivity such as X-ray machines, atomic reactors, and nuclear bombs that man-made radioactivity has presented an increased danger individually or on a mass basis to man.

As discussed in this report, external exposure from nuclear devices or fallout from their explosion will be mainly considered, although the effects are the same whether from bombs, reactor accidents, or medical overexposures.

As mentioned before, one peculiar quality of radiation is its ability to "ionize," that is, the ability of a particle to pass through material and disrupt the atom arrangements. Particularly dangerous in the area of external exposure are neutrons and gamma rays, since they are very penetrating and can actually pass through the human body, leaving in their path ionized atoms. In effect, the thousands of these particles which pass through the human body may disrupt hundreds or thousands of atoms comprising the molecules of the body's cells--its basic building blocks.

In regard to low exposure to whole-body (total body) radiation, little is known. Most data about such exposure is limited to that of from 50 rads up to thousands of rads.

From 50 to about 300 rads would be considered a sublethal dose within 30 days, although at the upper end it approaches the LD-50 range. This is also dependent upon available treatment. This means that it is not likely for death to occur; however, within this range a number of "acute" or severe effects,

having a sudden beginning--a sharp rise and a more or less short course would be noticed.

The range of acute effects within this dosage include nausea, vomiting, diarrhea, itching and burning of the skin and mucous membranes, loss of hair, skin burns, and a lowering, or depression, of various kinds of blood cells due to the bone marrow (the material within our bones which makes blood) being affected.

At about 500 rads (depending upon individual response, health, age, etc.) as mentioned before, more than 50 percent of the people exposed would be expected to die.

As the amount of exposure increases, fewer people would be expected to live until at about the 800 rad level generally 100 percent of the exposed persons would be expected to die.

Higher doses above 1,000 rads whole-body irradiation would produce what is called "gastro-intestinal death." The radiation results in destroying the lining of the small intestine and causes nausea, vomiting and diarrhea. Death would occur within a few days or a week.

Central nervous system death would occur at doses over 3,000 rads. This size of dose causes extreme excitability, trouble with breathing, lack of balance and coordination, and convulsions. Death may be immediate or after a few hours.

Should, somehow, a person survive these extreme dose symptoms, he would undoubtedly die from hemopoietic depression, where severe disorders of the bone marrow, which produce blood cells, lead to internal bleeding, anemia, and lack of resistance to infection. This effect can also be seen at the sublethal to lethal range. (94, p. 937)

Many of the above types of disorders would be brought about by direct exposure to the original explosion of the nuclear blast. Those people who

were not close enough to be destroyed by the thermal flash (heat) or blast wave (pressure) would probably be bombarded with neutrons, gamma rays, and possibly alpha particles at a rate that would decrease with the increase of their distance from the center of the explosion. The alpha particles are of biological importance only when they are emitted from inhaled or ingested material. Neither are of importance for irradiation by external sources following nuclear explosions.

These same effects, however, would also be experienced by a person being in, or going into, an area where there is heavy radioactive fallout. In such an area, he would be exposed to gamma radiation and beta radiation from the fallout material. In terms of external exposure the gamma radiation, because it is able to penetrate or pass through the body, would be the most harmful. The beta radiation, which has lower energy, would mainly be dangerous externally if the material fell on the hair or uncovered skin of the person. While beta particles are not deeply penetrating (generally only the upper layer or layers of the skin) they can--in sufficient quantity and if of enough strength--cause loss of hair and skin "burns" in several degrees, from light to severe. "Beta burns," then, are dangerous in the sense that if a person received a gamma dose high enough to lower blood cell counts and thus resistance to infection, and a beta skin burn became seriously infected, the person could die as a result.

Internal Exposure

As has been described, human beings can be exposed directly to radiation either through closeness to the original explosion of a nuclear weapon (or source of radiation) or through exposure to radioactive fallout. A second

way of being exposed to radiation is through internal exposure, or internal contamination. This can happen through two ways: direct contamination or indirect contamination.

It should be recalled that a nuclear explosion results in the creation of approximately 200 radioactive elements, or isotopes. Many of these are short-lived, such as polonium (Po^{222} or Po^{84}) which has a half-life of 3.0 minutes, or astatine (At^{218} or At^{85}) with a half-life of 2.0 seconds (FRP, p. 55) and actually become ineffective or return to their stable forms before they can reach the ground. However, longer-lived isotopes like strontium (Sr^{90}) and cesium (Cs^{137}) have half-lives of about 30 years. Radioactive iodine (I^{131}) has a half-life of about eight days. It is these three elements which are among the most dangerous to man in terms of fallout, or the material which returns to earth after being lifted into high altitudes by the explosion. This fallout material may result in exposure of human beings (and animals and fish) should they fall into their source of drinking water, onto food, or if they are inhaled. Or, as happened in a few cases where the fallout material landed on or near the people, curiosity compelled them to pick up a flake of material and taste it to determine what it was. All of these result in the radioactive material, which emits both gamma and beta radiation, being deposited internally into the human body.

A second way man may be exposed to radioactivity internally is what might be called "indirect" exposure. It is through a more complicated mechanism: the processes of his own environment.

The emphasis on ecology and environmental protection during the past few years helps clarify how a person can become radioactively contaminated internally from a nuclear explosion which occurred thousands of miles away and years ago. The present emphasis on protection of our environment from pollution has made the general public aware of the interrelationships between

man, animals, plants, and nature's processes. We now know that to continually dump sewage or chemicals into a body of water such as a lake may kill certain small organisms, or animals, which provide food and oxygen for larger animals, and eventually fish, which a person might depend upon for his food or business. It is through examples like this we see that there are "ecological chains" which, if broken, may result in the destruction of the whole chain. Nature, we have observed, "likes" order and balance. Within nature are many "chains" which complement or supplement ecological patterns. While the first example was how a chain could be disrupted by pollution, or contamination, such a chain can also transmit contamination. In some areas, factories produce a waste chemical of mercury. This waste is discharged into a fresh water lake. The mercury is absorbed into the tissues of the smaller organisms and thus transmitted through the food chain until it reaches man. If the concentrations or amounts of this chemical are large enough, the man may become ill from mercury poisoning. The same sort of thing can happen with radioactive contamination or "pollution."

At this point, it would be well to stop for a moment and recall what happens when a nuclear explosion--especially a hydrogen bomb explosion--occurs. If on the surface, the burst will lift up an incredible tonnage of material into the atmosphere. The gassy inferno fireball shoots upward surrounded by vapor and particles which roll and boil around it in a maelstrom of radioactivity and turbulence at the cap of the "mushroom cloud."

The lower part of the cloud, or column, contains the heavier particles of material (soil, water vapor, rock) which have been made radioactive. This part will be carried away by the winds in the lower atmosphere (the Troposphere or zone in which is found most of our weather). The heaviest particles

will fall first, near the explosion. Lighter ones will be carried on winds, hundreds or perhaps thousands of miles, before settling to the ground naturally from the force of gravity, or more rapidly should they become mixed in a weather front and be brought down in a rainfall. This is what is generally referred to as "local fallout." It is heavily radioactive in nature and lands within a few hours, or days. It contains "mixed fission products"--that is, isotopes of many kinds, i.e., strontium, cesium, iodine, zinc, cobalt, giving off beta and gamma radiations of different energies. Generally this local fallout can be seen in a cigar-shaped pattern, with the lightest activity at the outer edges and the heaviest toward the center.

Not all of the fallout, however, comes down in the first few hours or days. This is the material which has been injected into the stratosphere (a zone beginning at about 40,000 feet). The particles which have ascended to this height and above in the towering cloud are very fine and light, like particles of smoke. These radioactive particles will be circulated about in the stratosphere--which rarely has clouds and in which the temperature is relatively constant--until it has spread out all over the earth. This material will take months and years before it has returned to the earth's surface. The radioactivity, which may be spread throughout the world more or less uniformly, will return to the earth in the same manner, although it is possible that some areas of the world will receive heavier amounts of this fallout than others.

How this radioactivity, once it has returned to the earth, comes to be consumed and retained by man is due to one of the unique properties of radioactive materials.

Most poisons are chemicals which--if diluted by water or other harmless substances--also become ineffective or harmless. If radioactive isotopes had the same qualities, decontamination of a fallout zone would be much easier--the material could simply be washed down and the major danger would be eliminated. Persons who accidentally ingested the material could drink quantities of water and literally wash the radioactivity out of their systems. Unfortunately this is usually not true with radioactive substances. As mentioned earlier, the electron structure of the atom of many kinds of isotopes are like "chemical brothers" of other stable elements, or elements naturally found in our bodies. Our naturally-appearing elements like calcium, and potassium have their "counterfeit" counterparts like Sr^{90} and Cs^{137}. As pointed out by Dr. William F. Neuman in the United States Congressional hearings on "The Nature of Fallout and Its Effects on Man": (94 p. 710)

> "Just as a dispensing machine can be made to operate with a slug having a shape, weight, and properties similar to a genuine coin, so also can the body be 'fooled' when presented with a chemical counterfeit.
>
> "Natural strontium is the chemical counterfeit of calcium, an alkaline earth which is required for the maintenance of health and well being . . . like calcium about 99 percent of the strontium is found in the bone."

Thus it is that these counterfeit chemicals which get into man's body locate themselves where their brothers are normally found. Calcium is an important component in our bones and thus strontium resides there. Potassium is found in our muscle tissue and so is cesium. Iodine is important in the operation of the thyroid gland and so we find its radioactive brother there, too.

How these elements get there involves the food chain. If the fallout lands on the ocean, it is taken up by microscopic organisms, like plankton. Plankton, in turn, serves as food for small fish and other sea life which, in turn, are food for other, larger fish. Eventually, at the end of the chain, man catches a fish which has been contaminated as a result of the original fallout, eats, it, and becomes contaminated himself. If the fallout

is on land, it goes through a similar process. Strontium 90, for example, is taken up by plants and grass. The grass is then eaten by cows, which manufacture milk containing strontium. Human beings then drink the milk and consequently some of this contamination will reside in the bones of their bodies.

This state of affairs would be extremely dangerous to man if it were not for one factor, which Dr. Neuman also mentioned:

> "No counterfeit is perfect, however, and there are slight differences in properties between strontium and calcium which permit our regulating systems to select calcium preferentially, or to discriminate against the less desirable strontium." (p. 710)

The same is true for plants, animals, and fish. For example, if we started out with $100 worth of strontium fallout on the ground in a small area around a plant, the plant might absorb $60 worth. The milk from the cow that ate the plant would only contain $20 worth of the strontium. The man who drinks the milk would, perhaps, retain at the end only $5 worth of the original $100 worth of strontium. While the proportions are not real and only used as an example, they illustrate what is called the "discrimination factor"--a factor which means that part of the counterfeit chemical is rejected all along the route of the food chain. Despite this rejection factor, however, worldwide stratospheric fallout and local fallout still present considerable threats to the health of the average person and future generations.

Sr^{90} gives off beta particles. Although these particles are high-speed in nature, they are also relatively small in mass, or size and weight; cannot travel far through matter; and can be stopped easily by a layer of clothing or the upper layers of the skin. However, when they enter the body and reside in the bone close to the marrow, they can, in sufficient quantities, do great damage.

In The Effects of Nuclear Weapons, it is noted that:

> " . . . internal sources of . . . beta particles, or soft (low-energy) gamma-ray emitters can dissipate their entire energy within a small, possibly sensitive, volume of body tissue thus causing considerable damage." (51 p. 604-5)

The implication of the above statement denotes an area about which there was much controversy during the discussion about radioactive fallout and its effects in the United States. Many scientists described dosage and exposure in terms of averages, e.g., the maximum permissable concentration (MPC) of strontium 90 allowable in the body of a worker in atomic industries. This is 1000 "Sunshine Units" which is 1000 micromicrocuries (abbreviated as uuC--one millionth of a millionth of a curie, a small unit of radioactivity) per total weight of calcium in a person's body. Since the average person has 1000 grams of calcium in his body, it equals 1 uuC per gram. The equivalent maximum permissible concentration for the general population (those not working in atomic industry) is 1/10th of that, or 100 "Sunshine Units." There are also other MPC's for other radionuclides. What this averaging does not indicate, however, is the fact that strontium, like other isotopes, not only selectively concentrates in certain tissues or organs, but that its distribution in these areas is now always uniform. This means that it is possible for a worker to have a total concentration in his body or an organ of less than, or equal to the MPC of strontium, but that because it is unevenly deposited, he may have high concentrations or "hot spots" where the MPC* of 1 micromicrocurie (or 1/10 of a micromicrocurie) for each gram of calcium is exceeded.

Thus gamma and beta-emitters like Sr^{90}, Cs^{137} and I^{131} which selectively

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*The term MPC since that time has been changed to Recommended Permissible Concentration (RPC).

concentrate in certain areas (bones, muscle) or organs (thyroid) are greatly feared, despite the fact that the body does not take up all of the material available and that it also slowly eliminates some of the retained material little by little. The danger, of course, is due to the ionizing aspect of the beta and gamma particles. While even today the way by which these particles influence bodily or cellular changes, it is known that continuous exposure to sufficient quantities can produce bone tumors and leukemia in the case of strontium; cancer and tumors in the case of cesium; and tumors and cancer in the case of iodine.

How these effects are initiated by ionizing radiation deserves to be outlined briefly, before considering long-term effects.

BIOLOGICAL EFFECTS OF RADIATION

Chromosomes, Genes, and DNA

Like the whole beach we mentioned that is composed of tiny grains of sand and smaller particles, our bodies are composed of tiny cells. These cells, which have different functions and different shapes, all have nuclei, or centers. Within these centers are string-like materials called chromosomes, which are in turn made up of genes. The genes are also composed of a number of chemicals, the most important of which is DNA, short for desoxyribonucleic acid. All of these things are composed of molecules and, their smaller parts, atoms. These chromosomes, which are a series of long and short worm-like or thread-like shapes, determine the workings and divisions of the cell. The genes, which are like different bands of color or segments on a thread, each serve a function in making up the form of the chromosome. The DNA and other chemicals form the genes. These chemicals contain codes, or chemical signals which regulate the shape, form, and life of the genes. The genes then determine the shape and form of the chromosome, and the chromosome the shape and function of the cell. The cells ultimately control the shape and form of our bodies.

Almost all the cells in our body are continuously producing new cells, some slower, some faster. It is easier to understand if we consider that when we cut our hair, or fingernails, they grow again. If we get a cut or burn, the blood lost will be replaced, or the skin damaged will be replaced. This is done by the cells reproducing, or duplicating themselves, and it is the basic process which allows us to grow to

maturity, and to maintain our health. Billions of cells in our bodies are constantly "dividing" or making exact copies of themselves to produce new cells. Basic to this copying process is the chromosome, which insures that each new cell of its kind is an exact copy. If it is not, it may die, or it may produce an altered form of the cell which is not useful, or possibly harmful, to the other cells and ultimately the body. Perhaps trillions of these divisions, or duplications, go on in our body during our lifetime -- and despite the near perfect accuracy with which it is usually done -- sometimes there are "mistakes" made, or defects. "Breaks" may occur during the division and one cell may end up with an imperfect chromosome. This cell may be unable to duplicate itself and die, or may duplicate the new defective form.

While these abnormal cells may be produced normally through "mistakes," they may also be produced by ionizing radiation. Gamma and beta rays, neutrons, and alpha particles passing through the atomic structures of the DNA chemicals can distrupt their physical structures. The chemical changes that can be made by these electrons and other particles can cause defects in the DNA and genes, and in turn the chromosome, and thus the cell.

In large doses, these effects to cell duplication are easily seen. Damage by gamma particles to the cells which line the small intestine cause nausea, vomiting, and diarrhea. Beta damage to the skin and hair results in skin burns and partial or complete loss of hair (epilation).

The long term effect of doses which do not prove fatal, and of low doses, is another matter.

Long Term Effects

So far we have seen how man can be exposed to radiation and what acute effects he can suffer, ranging from mild itching and burning of the skin to convulsions and a miserable death. These effects are

bad enough in themselves, especially since there is no known radiation-specific medication which can alleviate the effects. What is perhaps even more insidious than these effects are the long-range consequences of irradiation, both external and internal.

Here, it would be well to make an important point about long-range effects of irradiation: the diseases and effects (with possible exception of genetic effects) caused by radiation are not special "radiation" diseases which did not exist before the explosion of A-and H-bombs. Rather, it appears that exposure to certain amounts of kinds of radiation may encourage the development of, or actually cause a person to have an "ordinary" disease which he might not have had if he were not exposed to radiation. This has been proven in Japan where there was a higher than normal incidence of leukemia in exposed persons at the peak incidence than those not exposed. Also, in the Marshall Islands, nearly all the people exposed on Rongelap to fallout at less than ten years of age have developed nodules (benign tumors) of the thyroid.

Just as there is no special "radiation disease," there also is no special treatment for persons who develop disease because of radiation. Treatment for radiation-induced leukemia is the same as for leukemia not induced by radiation. The treatment for thyroid nodules or cancer induced by radiation is the same for such diseases not induced by radiation. Exposure, as will be pointed out, apparently "disturbs" certain processes in the body's chemical system and, while after a long time there are no traces of radiation in the body, it may develop diseases because of a one-time exposure, or exposure over a period of months or years. Thus a person may develop lung cancer because of his irradiation; the cancer itself is not radioactive, and the treatment is the same as for "normal"

lung cancer; it might be slowed down by special drugs, removed by surgery, or "burned out" by X-rays.

Cancer

A neoplasm is any new or abnormal growth in the body. Examples of such growths are warts, moles, cysts, and certain tumors. There are generally two kinds of neoplasms. One kind is benign (not harmful). The other is malignant (harmful). Most harmful growths are called cancers. What makes these growths harmful is the fact that cell production in them is uncontrolled; it is as though the cell growth has gone wild. Cancer cells duplicate themselves faster than their normal neighbors. They do not serve the body's needs, but use up the chemicals needed by other cells. The normal course of cancer is usually fatal. If the cancer is in a local area, it may be removed by surgery or by X-ray treatment and a cure results. However, if only a few cancerous cells are left, the cancer will begin to reproduce itself again. Cancer may develop as a tumor or tumors in a single organ, such as the lung or liver, or as a malignant tumor such as a mole or wart not in an organ, or in the blood, or it may spread throughout the body (metastasis).

As a result of the atomic bombs dropped on Hiroshima and Nagasaki, perhaps the most well-known long-range effect of radiation of human beings is the increase of leukemia. Leukemia is a cancer of the blood. It is a condition in which there is an abnormal increase in a certain kind of blood cell, the leukocyte. The disease can be either acute (having a short course, or life) or chronic (having a long course, or life). While leukemia cannot be cured, it can be arrested, or retarded.

The use of certain powerful chemicals can stop acute leukemia from causing immediate death, or cause chronic leukemia to disappear for some time. The end result of leukemia, however, no matter what kind, is ultimately fatal.

Another disorder related to cancer noted from Japanese A-bomb survivors is thyroid cancer, and thyroid "nodules" or tumors, which has also been found in the exposed Rongelapese even though the exposures were different. Reports of the Atomic Bomb Casualty Commission (ABCC) and scientific studies on animals and human beings treated with radiation for therapeutic reasons indicate that irradiation generally results in an increase of tumors and of cancer in general.

In the early days of radiation studies, it was thought that it took as much as 1000 roentgens of absorbed radiation to cause cancer. According to one source, however, "Now it has been found (this, by the British) that as little as three to five roentgens received by the unborn child in its last two months before birth has been responsible for cancer of all types appearing a few years later." (94, p. 1264) This finding was supported by the 1964 report of the UN Scientific Committee on the "Effects of Atomic Radiation" speaking of in utero irradiation which said, "These studies have provided the important suggestion that under certain conditions low radiation doses, of the order of a few rads, can induce malignancy." (95, p. 7)

Life-Shortening

Mainly through animal studies, it is generally agreed among scientists that exposure to radiation, depending upon age at time of exposure and amount of dose, may result in shortening the life of an exposed person by

a few days, months, or years. This appears to be true especially with high doses, although evidence from low doses with animals indicates that irradiation may, indeed, lengthen life somewhat, although at the same time the life span of the group is not increased. Since life-span studies involve long periods of time (20-40 years), results so far have proved inconclusive; however, it is generally accepted by scientists that high doses of radiation more than likely lead to shortening of the life span, through the production of malignant tumors. Whether or not life may be shortened from nonmalignant causes is still in doubt.

Stillbirths, Miscarriages, Fertility

It has previously been thought that irradiation of the fetus, as it is growing inside the mother, may cause birth of a dead child (stillbirth), or early delivery of the fetus (miscarriage). Loss of fertility (temporary sterility) of the mother or father can also be caused by radiation. Evidence is still unclear in regard to most of these effects. Kumatori's study of Japanese fishermen exposed to the Bravo fallout did, however, indicate loss of fertility of the men through depressed, or greatly reduced, production of sperm cells (75, p. 262), which would indicate that irradiation does indeed affect human fertility. While findings on miscarriages and stillbirths are inconclusive, there are other effects on the developing child (fetus) irradiated inside the mother which were discussed previously or will be discussed later.

Growth and Development

Children irradiated before birth have been studied in both Japan and the Marshall Islands. In both instances it has been found that such children show reduced height and weight and growth retardation, ranging from slight to severe. More detailed discussion of these findings will be included in the relevant chapters to follow.

Blood Cell Aberrations

As mentioned earlier in the section dealing with early or acute effects, moderate to heavy doses of radiation will result in the decrease of the production of certain kinds of blood cells. One of the late effects noted is the production of aberrations, or unusual forms of certain cells through a change in the chromosomes which make up the reproductive part of the cell.

All cells in the body are able to reproduce themselves, that is, they are able to go through a process of division, wherein one cell will split into two cells with each such cell having the same number and kind of chromosomes, thus enabling them to reproduce themselves again. This basic biologic feature allows our bodies to repair themselves, or to maintain certain necessary chemical balances. Thus, a cut or scratch can heal and the skin be replaced with new tissues; we can manufacture new blood should we be seriously injured or if we donate a pint to a blood bank; or certain organs or tissues of the body, which are damaged, can complete a repairing process which will enable us to function normally again.

Again, we must recall the unique effect of the rays emitted by radioactive materials or sources -- the fact that they can ionize along their paths through tissues or substances. In passing through the blood or the areas which manufacture the blood (bone marrow), these particles may disturb the nucleus (center) or the chromosomes and produce unusual or aberrant forms. This may result in cells which are unable to divide and reproduce themselves, or in cells which reproduce themselves in an aberrant form. These aberrations can be seen many months or years after exposure

either because the types of cells affected are long-living and may not reproduce themselves for a long period, or because shorter-lived cells keep reproducing their aberrant or unusual forms.

Man normally has aberrant cells in his blood, which may have reached him through the genetic material given to him by his parents, or through the exposure to certain nonradioactive chemicals, or from other sources. Radiation has been found to cause aberrant forms since people irradiated have more aberrations than nonexposed. The effect or influence of these unusual cells has been and is being thoroughly studied, although just exactly what relation they may have to the development of cancer, including leukemia, has not been definitely proven. The UN report of 1964 stated that:

> "4. The mechanisms of carcinogenesis in general are not well understood. However, the evidence is that the neoplastic change occurs at the cellular level and is frequently associated with observable modifications in cell structure (particularly chromosomal constitution) and function." (95, p. 181)

Simply put, this means that how cancer develops (mechanisms) is not clear. Evidence shows that neoplastic change (the formation of new cells -- in this case referring to those of cancer) begins at the cell as a result of changes produced in the cell, especially in the arrangements of chromosomes. In short, the scientists, like detectives, have a lot of "circumstantial evidence" that radiation causes cancer. They have found that it causes aberrations. They have found that persons irradiated develop more cancer than those not irradiated. They do not know exactly how this happens. They can only strongly suspect that the "accused" radiation is really the "guilty party."

Heredity and Genetic Effects

In the previous section, the effects of radiation on normal blood, or other body cells, was discussed. Part of this discussion involved how the cells go through division in order to reproduce somatic, or cells of the body. The sex cells of the body also are composed of chromosomes, made up of smaller parts called genes, which are composed of special chemicals (and chemicals, we will recall, are composed of molucules and atoms). These also go through a kind of "division" or reduction process.

While there are some similarities, normal somatic cell duplication process and the process which creates sex cells, there are two major and important differences. The first is that the chromosome and genetic material in a somatic cell are responsible for duplicating another cell. A sex cell (sperm or ovum), however, is responsible for creating an entire human being, including all the billions of somatic cells. The second difference is in the duplicating process. A somatic cell can duplicate itself. The cell produced (daughter cell) and the original cell (parent) can again both duplicate new cells. Sex cells, however, are unique in the fact that there are "parent" cells in the testes and ovaries which reserve the ability to produce immature cells, which then go through a subsequent process of division and are transformed into mature cells. If immature cells are irradiated, those affected may pass on mutations. This, however, is affected by the fact that other normal cells will be competing with them in the fertilization process and also that they have a certain life span. However, if the "parent" cells which produce immature cells are irradiated and mutated, this will result in the constant production of mutated immature and mature cells. (46, p. 93)

Mutation of somatic cells then only affects the "host" or human within which they occur; mutation of "sex" cells may result in mutation of the newly created human, in early or late death, or in the transmission of these mutations to later generations resulting in illness, feebleness, or death.

When the male sex cell (spermatazoa) is united with the female sex cell (ovum), the chromosomes and genetic material begin going through a uniting and dividing process which insures that every cell in our bodies contains half of our mother's and half of our father's chromosomes. If, however, the genetic material is damaged, for instance by ionizing particles, then, instead of reproducing themselves perfectly, they will produce defective cells which result in mutations, or changes, from the originally intended form.

Mutation is no stranger to mankind. It is responsible for what is called individual variation. This is shown by differences in size and weight, color of hair and skin, and shape of nose, mouth, ears, eyes, etc. If there were no such thing as mutation, all human beings would look alike. But because small defects occurred, or "mistakes" (changes) were made during the replication processes, we find a great variety of variation within the human race. Man today, then, is the end product of millions of years of genetic change and mutation and in this sense it may be said that the genetic pool of the present population as a whole has benefitted from mutation even though it represents the deaths of many people. What, however, we are generally not aware of is that many if not most mutations are generally harmful to those who carry them and generally result in the death or the elimination of the recipient. Hemophilia

(bleeder's disease) is where certain elements in the blood, which normally would stop a person from bleeding to death, are inadequate or missing. This means that his blood will not clot or thicken and harden at the site of a wound. A person with this disease may die from a simple cut. Diabetes is another disease with genetic origins. How mutation works was explained by Dr. James F. Crow, Professor of Genetics and Biology at the University of Wisconsin, before the U. S. Congressional hearings on fallout:

> "Let me answer Senator Bricker's question.
>
> "The implication of your question is that if I say the great majority of mutants that occur are harmful, why is it that the great majority of genes that now exist in the population are beneficial?
>
> "The reason for this is natural selection. The mutant genes that have occurred in the past have been weeded out by the process of natural selection so that the genes which now are part of the normal population are those which have been retained by this process of natural selection. Therefore, even though the great majority of mutants at the time they occur are such as to cause harmful effects to the descendants, the ones which cause the most harmful effects are eliminated by natural selection. The genes left in the population are the beneficial ones . . . .
>
> "A mutant that causes a great deal of harm is eliminated in a few generations. But one that causes only a small amount of harm will persist much longer, and thus affect a correspondingly larger number of persons. On the average the larger number affected by a mild mutation roughly compensates for the lesser effect on the individual . . . .
>
> "The total harm to the population, as measured by effects on future generations, is strictly proportional to the total amount of radiation received by the reproductive cells of the population." (94, p. 1012-3)

This illustrates the basic difference between irradiation of normal somatic cells (like blood cells) and of the reproductive cells. Both can be dangerous; however, damage to somatic cells can be repaired -- and at

the worst will only result in the death of one person. Genetic damage, however, cannot be repaired and may only show up and transmit itself through many generations, resulting in the deaths of one, a few, to hundreds of persons depending upon the number of people affected. The amount of radiation needed to produce such effects will be the subject of the next chapter.

LINEAR VS THRESHOLD: THE GREAT DEBATE

On July 2, 1958 an American-owned, Hiroshima-built yacht sailed into the test zone near Bikini Atoll in the Marshall Islands District. On it were Dr. Earle Reynolds, his wife and children, and a Japanese citizen born in Hiroshima. About 12 hours after entering the latitude and longitude of the zone, the Phoenix was bounded by the U.S. Coast Guard and ordered to Kwajalein. Their entry into the zone was intentional, the result of a moral decision to protest the testing by the United States of nuclear weapons. The adventure of this sole sailboat in the waters of the Marshall Islands was representative of a great worldwide concern by many people at that time with the effects of radioactive fallout on man as a result of nuclear testing.

The world's first "superbomb" perhaps better known as a thermonuclear or H-(Hydrogen) bomb was detonated by the United States on Eugelab Island of Eniwetok Atoll on October 31, 1952 at 1915 (GCT). A little over one year later, the Union of Soviet Socialist Republics detonated its first H-bomb device on December 12, 1953. The United Kingdom followed with its first H-bomb explosion on May 15, 1957 (ENW). The international anxiety which developed over the effects of these tests and their fallout was due to the fact, discussed earlier, that thermonuclear explosions in the megaton range reached heights of 90,000 feet or more. A-bomb explosions normally left their fallout in the troposphere which soon returned to earth. H-bomb detonations, however had begun to "load" the stratosphere with fallout that would disperse all over the world and only gradually fall out over a period of months or years.

Public concern generated by stories in magazines and newspapers resulted in the holding of hearings by the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy of the Congress of the United States. The hearings, with the title "The Nature of Radioactive Fallout and Its Effects on Man," were published as three volumes totaling 2,216 printed pages. Unlike the hearings of some Congressional Committess concerning activities of agencies of the U.S. Government, these were generally "harmonious," as one writer put it, marked by only one or two sharp exchanges of opinion between members of Congress and those testifying before the Subcommittee. Most importantly, perhaps was the public airing of many facts about nuclear weapons and fallout. Of special interest to this report, was the discussion of the effects of doses of radiation, particularly as to whether or not there is a "threshold", or minimum amount of exposure which can cause damage below which there is no effect, or if, indeed, the effects of radiation are "linear", meaning that any radiation exposure, no matter how small a dose, has a damaging effect.

Many scientists and experts, both from the Atomic Energy Commission and from independent universities and institutes gave testimony supporting both theories. Those who proposed that the fallout from then current testing was harmless posited that evidence indicated that there was a threshold dose for most somatic mutations, and that there was no evidence

to support the linear theory.* Proponents of the linear theory, however, pointed out that evidence for threshold response was not sufficient to definitely prove there was such a thing.

Much of the debate over the linear versus threshold theories results from the establishment of Maximum Permissible Concentration (MPC) as mentioned in the Internal Exposure section. The MPC for human beings is established on a basic assumption: that there exists a threshold effect for radiation; that is, there is an amount of radiation above normal background radiation which human beings can absorb and which will not cause harmful effects (or effects so small as to be able to be tolerated).

Dr. H.L. Friedell, of the School of Medicine at Western Reserve University, testified before the U.S. Congressional Subcommittee thusly:

> "At the very low levels where the levels begin to approach the natural levels we are facing, I think there is grave uncertainty. This, of

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*An interesting, entertaining tour de force diatribe against the linear theory by one Alden Potter appears on pages 1987 to 1996. Mr. Potter attacks many commonly held scientific concepts in biology, genetics, statistics and mathematics to allege that there is indeed no linear experience in nature. A simplication of his reasoning is that we see threshold relationships all throughout nature; nature is ordered by certain basic, unchangeable laws and thus radiation effect must, too, be of a threshold nature. He states as an example:

> "But if sensory equipment has its thresholds, living conditions are also narrowly restricted to those prevailing in the so-called biosphere. Some heat is essential; much more or less, is lethal. It's a case of not crossing a threshold and getting too much of the good things of life; including life itself . . . . Then there are the trace elements, essential to plant growth, an excess of which is toxic. In short, there is no such thing as a 'linear' relation between life and the elemental forms of matter and energy. A threshold is the very essence of life."

What this reasoning does not take into account is: 1. Human tolerance to the effects of radiation may be possibly so low but for all practical

course, is concerned with the whole concept of whether the effects will be occurring at low levels in the same rate that they are occurring at high levels, and whether there is such a thing as threshold. In other words, is there some level below which nothing will happen?

"Again, this is very difficult to establish. The evidence, as I see it, is very inconclusive in this direction, and if I had to choose, . . . I would hesitate to accept this concept that a threshold does not exist."

Dr. Shields Warren, a former Director of the Division of Biology and Medicine of the Atomic Energy Commission indicated he favored a threshold effect.

"With acute or chronic radiation there is what is called a threshold effect in body cells. In other words, because many cells can continue to function even though irradiated and many cells in the body can be repaired even though damaged, we find that at low levels of radiation there is no observable effect . . . .

"I have favored the concept of a threshold for most carcinogenic agents for a number of reasons. First, that in our experiments with carcinogenic hydrocarbons, which are known to be derived from such substances as coal tar, we find that a threshold exists for them. We find that, with many of the medicines that are commonly used for one or another effect on cells, there is a threshold effect to these medicines. We know, by analogy with simple things in physics there is a threshold effect. For example, I can push very lightly against this stand of the microphone, and it will not move until I reach the threshold of where that push is greater than the friction which tends to hold it still."

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purposes there is no threshold. Thus he is attempting to prove a generality with a generality. 2. Also overlooked in Potter's exposition is the unalterable fact that radioactive substances are unique in nature and neither behave like nor have the same effect as stable elements. For example, it is possible that the ingestion of certain chemicals (like some pesticides, or other poisons, like cyanide) may cause chemical and thus genetic damage within the body's somatic cells. It has not been proven, however, that such ingestion will cause hereditary damage in sex cells lasting for generations, as does radiation.

Potter goes on to state:

"Linear projections or extrapolations are a semantic fiction originating in the Euclidean concepts that arose in the days when the earth was called flat and everything in geometry was worked out in terms of rectilinear and rectangular frames of reference, a state of affairs that still plagues the problems of solid state physics."

Potter's assertion here is not entirely clear. It may be that he is playing a semantic game himself with the word "linear" or with the method of expressing effects in terms of a two-dimensional chart using a straight line. Could he just as effectively apply the inappropriateness of the word "proportionality"

In testimony before the Subcommittee, there were a greater number of scientists who doubted that a threshold existed, and were inclined to accept the theory of "linear" effect until it could be disproven. The following is a sampling of some of their statements:

Dr. Hardin Jones, University of California Radiation Laboratory:

> "I think life-span effects do exist. I have no reason to doubt this at all. I have some reason to believe that we should look with caution that a threshold effect exists, although we cannot be absolutely certain that a threshold effect might not exist. But as far as my opinion is concerned, on the basis of having examined all the facts at my disposal, I do not believe a threshold effect is very likely to exist . . ."

Dr. Ernest Pollard, Biophysics Department, Yale University:

> "I think the linear line is rational. I would like to see policy momentarily at least based on it. If later on it seems there is a threshold then we are not too badly off. But if there is not a threshold and we bet there is one, we are in trouble."

Those who supported the then existing MPC and by consequence, the continuance of testing often used such arguments that the additional amount of exposure from worldwide fallout was probably less harmful than smoking one

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instead of "linear"? What he is apparently attacking here is representing the interaction of three-dimensional matter in a two-dimensional form. Non-Euclidean geometry is an even newer field than that of radiation. It may be that in the future such geometry will prove applicable to the study of radiation and its effects. However, it should be remembered that all current data relevant to the study of radiation has been presented in terms of conventional geometry and mathematics, and we are thus forced to base our conclusions of these data, and cannot disregard them simply because "The meaning of symbols, such as the linear representations of Euclidean geometry, is at stake," as Potter states. If, indeed, his quarrel is with using two-dimensional representations for three-dimensional states, then he brings into question the validity of constructing, with two-dimensional symbols, concepts in non-Euclidean geometry. Thus, by his reasoning one should be suspicious of the validity of his thoughts as represented on the two-dimensional plane of the page on which it was written, and by the same token, this page which you are reading now. It should also be noted that while Potter attacks the deceptiveness of metaphysical meaning, he also thus brings attention to his own use of metaphysical language. Lastly, it should be noted that Mr. Potter's critique appears to be oriented policy- and philosophy-wise to the support of continued testing in the fact of continuing Russian tests. Despite its faults, it contains some intriguing and fresh approaches to certain scientific philosophies.

package of cigarettes a day, or being overweight--that such a small number of persons might be affected or die as a direct result was so small as to be worth the risk. Those who did not support the MPC, or who believed in the linear dose indicated that the argument regarding the cigarette smoker was not applicable, since he had a choice whether or not to smoke, whereas general populations have no choice in the amount of radiation uptake. Additionally they pointed out that from a moral viewpoint, even one additional death, or a limited amount of mutations was too high a price to pay for such testing.

The whole debate over MPC and linear versus threshold effect as it related to testing was perhaps best summed up by the testimony of Dr. Walter Selove, Department of Physics, University of Pennsylvania, who quoted from a report by a committee on radiation hazards of the Federation of American Scientists:

> "The committee study of the available scientific facts has led to two conclusions:
>
> "First: The added radiation hazard from continued nuclear weapons testing at the present rate is no greater than that from other radiation normally encountered . . .
>
> "Second: This small added radiation, from whatever sources, will cause many deaths.
>
> "The committee believes that both conclusions are scientifically correct, and in no way contradict each other.
>
> "Unfortunately, those who believe that we should continue testing . . . often emphasize the first conclusion and ignore the second. Similarly those who believe that a test ban is desirable . . . often emphasize the second and ignore the first. The Committee believes that both statements must be taken together since either alone is misleading."

Whether or not low doses of radiation have a threshold or linear effect, has not yet been proven. The "jury," in a sense, is still out. There is still not enough evidence to show that one or the other of the theories is correct for somatic damage. However, for the hereditary effects of

irradiation of the gonads, or "sex" cells, there was nearly complete agreement among all the scientists that there was no threshold, and that any amount of radiation over normal background levels could induce genetic damage, and thus cause mutations.

Although the reason for the debate centered primarily over the effects of testing, it is included here because it is necessary for the reader to understand certain conclusions and recommendations which will follow in this report. The committee would like to state that it is biased in favor of the linear theory, for the reasons which Dr. Pollard and others mentioned. It draws strength in this stand from the statement of Dr. Lauriston S. Taylor, Chief of the Atomic and Radiation Physics Division of the National Bureau of Standards who testified before the U.S. Congressional Subcommittee:

> " . . . I frequently feel compelled to say that this question of radiation safety and premissible dosage standards is not a subject for which there is a clean and simple answer. The whole question of setting radiation exposure limits depends on physics and biology. It depends enormously on ethics and morality, and on an enormous amount good [sic] judgment and good wisdom on the part of the people who are responsible for setting them. It is by no means a clean-cut quantitative physical problem."

The Committee thus has made a judgmental decision based on scientific opinion and evidence and morality. It is in basic agreement with Dr. Karl Z. Morgan of the Oak Ridge National Laboratory, who in an article "Standard Man --Standard Patient" in "Medical Radionuclides: Radiation Dose and Effects," a symposium sponsored by the AEC and the U.S. Public Health Service, said:

> "I believe the prudent assumption in administering a radionuclide to the patient is that <u>all ionizing radiation to the patient is harmful</u>, and therefore the physician should carefully weigh the need for a radioisotope diagnostic procedure or radiation treatment and evaluate the expected usefulness of the diagnosis or therapy against the <u>possible radiation damage</u> . . ." (emphasis added) (94, p. 100)

Thus the Committee supports the theory that all radiation exposure above background levels is harmful and that the effect--until disproven--is roughly proportional to the dose. As for hereditary damage, the Committee notes with considerable interest and dismay that it is a proven fact that all penetrating radiation delivered to the "sex" cells, or gonads, is definitely harmful both in the short and long run.

The Special Joint Committee thus finds itself also in complete accord with the intent and purposes of House Joint Resolution No. 105, H.D. 1, passed during the Second Special Session of the Fourth Congress which condemns the Republic of France for testing H-bomb devices in the South Pacific. It is clear to the Committee after its studies that the testing of nuclear weapons--whether in space, the atmosphere, in and on the sea, or underground--has no beneficial use for mankind. The intent of such testing is infamous in the first place, and the testing itself is detrimental to all mankind in the long run. No nation on the earth as the right--in the name of selfish national pride and self-interest--to endanger the lives of innocent generations of children all over the world.

"In some crude sense, which no vulgarity, no humor,

no overstatement can quite extinguish, the physicists have

known sin and this is a knowledge which they cannot lose."

--J. Robert Oppenheimer, nuclear scientist
in a lecture, November 25, 1947

Give me water!
Oh! Give me water to drink!
Let me have some!
I want rather to die---
To die!
Help me, O, help me!
Water!
A bit of water!
I beg you!
Won't anyone! ...

The heaven split;
The streets are gone;
The River,
The river flowing on! ...

Night!
Night coming on
To these eyes parched and sere;
To these lips inflamed
Ah! the moaning of a man
Of a man
Reeling,
Whose face is
Scorched, smarting;
This ruined face of a man!"

--Tamiki Hara, Hiroshima writer-poet
(1905-1951), a suicide

HIROSHIMA AND NAGASAKI

By August of 1945 the United States had won the "race" with Germany to develop atomic bombs. Germany had not developed a bomb and had already capitulated to Allied Forces. Japan, however, was still considered an instransigent belligerent. While U.S. Forces were fighting their way up from the Solomons and New Guinea, they were also making a devastating drive across the Pacific through the Ryukyu Islands and through the Carolines, Marianas and Marshall Islands, all with the intent of launching a massive invasion of the Japanese heartland. Incendiary bombing missions on civilian populations of Japanese cities had already been carried out by U.S. planes. It was clear to both sides that the current of war was running strongly against the Japanese and the end was near. One writer has even suggested that Japan was only waiting for the appropriate moment to capitulate. Whether or not this is true may never be known.

In August 1945, two American B-29's would lift off into the skies for Japan carrying what was in essence the end result of three years of the most intensively planned and coordinated, massive industrial efforts in the history of mandkind -- just to produce a few pounds of fissionable material. This material, weighing less than 50 pounds, had cost more than three billion dollars ($3,000,000,000), or $6,000,000 per pound.*

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*this of course does not include the plutonium used in the Trinity test, nor does it consider the cost of facilities, being spread out over their usable lifetime for production of subsequent material.

"I am a little world, made cunningly
of elements and an angelic sprite."

---John Donne, Holy Sonnets

"Though in many of its aspects this visible
world seems formed in love, the invisible
spheres were formed in fright."

---Herman Melville, Moby Dick

Thus, while the "Atomic Age", in terms of military use, technically began with the test of a plutonium (Pu^{239}) bomb at Alamagordo, New Mexico on July 16, 1945, it was officially and publicly begun in August when, in the first use of atomic devices against civilian populations, roughly 50 pounds of fissionable material killed over 100,000 men, women and children and injured another 100,000 more at Hiroshima and Nagasaki in just a few minutes.

At 2:45 a.m. local time on August 5, 1945 the B-29 Enola Gay lumbered off the runway on the Micronesian island of Tinian, now a part of the Mariana Islands District of the Trust Territory of the Pacific Islands. In the cold, metal belly of the plane was the "Little Boy," uranium bomb, so called because of its smaller size in comparison to the larger size of the "Fat Man" plutonium bomb. The firing mechanism of this "Little Boy" bomb was deceptively simple. The heart of the device was a special gun barrel. At one end was a "bullet" made of refined uranium (U^{235}). At the other end was the "target" a large lump of U^{235} estimated to be about 5 kilograms, or 11 pounds. As long as the "bullet" and the "target" remained apart, nothing could happen. But when the bullet was fired into the target, the amount of U^{235} occupying the same place became critical* and the terribly destructive energy of the tiny atom was unleashed.

At 08:15 on that day over Hiroshima, the Enola Gay's bomb

*"Critical" means that the amount of material was large enough to automatically cause a violent chain reaction. This is one of the unique qualities of radioactive material. Such reactions cannot take place in nature in unrefined uranium ore, but after refinement, are possible.

bay doors yawned open and the bomb and its parachute plummeted downward. The plane turned and sped away at full power. The parachute opened, and the bomb drifted slowly down over the bustling city and, at about one quarter of a mile above Hiroshima's Industrial Promotion Hall, it exploded.

It is in the description of such events that the limits of language are approached; even pictures, while more descriptive, ultimately must fail in conveying the ultimate ferocity and horror of an atomic explosion over a populated city.

In millionths of a second, a huge radioactive fireball existed where there was once blue sky. In the next instant some 19,663 buildings within one kilometer of the hypocenter were destroyed in the gigantic thunderclap. More than 60,000 people were immediately burned to death by the thermal wave or crushed to death by the pressure wave. Thousands of others were penetrated by powerful neutron and gamma rays. The expanding fireball then sped upward toward the heavens from whence it came, pulling up behind it the ash and smoke of the incinerated people and buildings until it finally slowed and peaked at the limits of the troposphere, nudging the base of the stratosphere. Thirty thousand feet below, the city of Hiroshima was the scene of a fiery holocaust; the buildings ignited within a mile of the center began to burn as air rushed in to follow the hot fireball's ascent. Winds of 30 to 40 miles per hour fanned the flames of the already blistered and

burning city. Ultimately it was estimated that 76,327 buildings were completely destroyed, and 70,147 partially destroyed, or nearly 92% of all the structures in the city of Hiroshima. A census taken five years later indicated that some 200,000 men, women and children may have been killed from the one bomb. (64, p. 4)

NAGASAKI

On the morning of August 9, 1945, the B-29 "Bock's Car" lifted off the Tinian airstrip and headed for Japan to drop the second atomic bomb, this one using plutonium. The primary target for this drop was Kokura, but poor visibility forced the plane to head for its secondary target, Nagasaki. At exactly 10:58 a.m. local time, the bomb fell away and later the parachute opened.

The A-bomb which floated donward from the heavens on its parachute over Nagasaki was called the "Fat Man", because of its egg-like shape. It contained approximately 30 pounds of plutonium. The firing mechanism was unlike that of the "Little Boy". It was based on a new concept called "implosion". Normally in an explosion the force of the blast is directed outward. In implosion, the force is directed into a point. In this bomb, however, there was a shaped charge which surrounded a hallow sphere of plutonium, like the meat surrounding the seed of a mango. As long

as the plutonium remained in this form, it could not become critical. However, when the explosives were detonated, the blast's force compressed the plutonium into a solid critical mass, thus causing a chain reaction and releasing its destructive force.

"Fat Man" exploded about 1500 feet over Nagasaki, but was about two miles off target when released. (JIC - p.55). Despite this fact, the explosion leveled the city in an instant and killed nearly 40,000 people. One interesting incident different from Hiroshima's experience, was the fact that the Nishiyama District near to Nagasaki that was spared direct radiation from the explosion, was exposed to an estimated 30 rads of radiation from fallout which drifted into that area. The people still living in that area have been studied since 1945 and are the subject of a new report still unpublished at the time of the writing of this report.

JAPAN: COMMITTEE FINDINGS

As outlined in its Interim Report of May 16, 1972, the Special Joint Committee Concerning Rongelap and Utirik Atolls traveled to Tokyo, Japan on June 16, 1972.

The Committee included: Senator Olympio T. Borja, Chairman and members Representative Hans Wiliander and Timothy Olkerill; informant/interpreter Representative Ataji Balos; Acting Legislative Counsel Mamoru Nakamura (now Deputy Attorney General), the committee's staff member, and Dr. Masao Kumangai, Deputy Director of Health Services (now Director) who acted as liaison from the Executive Branch. The Committee first made contact with the U.S. Embassy and held a meeting with officials of the Health and Welfare Ministry of the Japanese

Government. These included Mr. Mamoru Tsunashima, Director of the International Affairs Division; Dr. Tomokazu Kato, who heads the Planning Section of the Bureau of Public Health of the Ministry; Mr. Sapuro Ishikwa, legal counsel; Mr. Tosikawa Takeuchi, Assistant Chief of the Seamen's Section; and Mr. Watanabe, who acted as interpreter. The Committee received 1965 English version copy of the 1957 national law which provides for medical care of A-bomb survivors.

Specific treatment for Japanese radiation victims is provided under this law and subsequent amendment or interpretation by executive Ministerial orders. This law defines who is to be classed as a victim (survivor, or "sufferer" is another term frequently used) and entitled to free medical treatment and, in some cases, compensation. There are generally two classes of these survivors, determined by distance from the bomb at time of explosion or other factors determined by a medical consultation board. The first group is composed of persons exposed within a 2,000 meter radius of the hypocenter. The second group is composed of people who were exposed at a distance of 2,500 meters or more from the hypocenter or who entered the city within two weeks after the explosion. These people are entitled to free annual examinations at medical welfare centers in Hiroshima and Nagasaki. If disease is found, then they are asked to return for another, detailed examination. The Medical Center, while it does maintain

records and keeps statistics has the primary function of identifying or diagnosing cases from examinations. If it is decided that a person requires a specific treatment (other than prescribed medic ines which can be gotten from the center) he is sent to the Red Cross A-bomb Hospital where he can be "treated" (ie: surgery, x-ray therapy, administration of drugs, etc), or placed on an outpatient care basis. Each of the two classes of survivors hold books, color-coded for their class and while the annual examination is sufficient, should one of these people become sick, he can go to the center to be examined. If he is in the second group and his illness is found to be related to radiation, then his costs are paid for by the government and he receives a new book, placing him in the first class. If his illness is not related, then either his own national health insurance or that of his company pays for the examination and treatment. A third area related to treatment is the care provided for elderly survivors of the A-bomb. In both cities there are homes for such people. To qualify, it must be shown that they or their families cannot support them, or that such support is a hardship, or that the bomb killed all members of their family.

As to financing of such facilities as A-bomb Hospitals and Old Age Survivors' Homes, this has been done mostly by public donation (similar to fund drives by the Red Cross or Community Chest in the United States) but their operations are

financed largely through city, prefecture and central government appropriations. The research institutes, of course, are government financed and the ABCC facilities are primarily supported from money which indirectly comes from the U.S. Atomic Energy Commission. It was explained by Dr. Kato that those people who were in the highest areas of radiation are able to receive one to four examinations per year. One examination is adequate, he said, if no disease is found and that most people usually came in for only one examination. The examinations are "free" the Committee was told, in the sense that they are part of the national medical programs to which all people contribute. They were conducted in the 840 Health Centers throughout the 47 Prefectures (states). Other matters of concern were discussed -- primarily related to compensation, which will be discussed in a subsequent report.

Before departing Tokyo for Hiroshima, the Committee met with Dr. Tosiyuki Kumatori, who heads the Division of Radiation Health in the National Institute of Radiologial Sciences in Chiba-shi. Dr. Kumatori has been responsible for conducting annual medical examinations of the Japanese fishermen who were irradiated by fallout from the March 1, 1954 H-bomb test which also affected Marshallese and Americans. After conferring with the Committee Dr. Kumatori indicated that, if it were interested, he would be willing to try to bring one of the Lucky Dragon survivors to

Tokyo to meet with the Committee on its return. The Committee then departed for Hiroshima on Friday, June 23, 1972.

HIROSHIMA TWENTY-SEVEN YEARS AFTER

Hiroshima today is no less a miraculous transformation from its burned and tortured self to a modern metropolitan city than is the fabled legend of the phoenix, a mythical Egyptian bird which was consumed by fire and yet again rose out of its own ashes in youthful freshness.

While the Committee's busy schedule of visiting official facilities permitted little time to explore the city extensively, the impression is very strong that no physical trace--except for a preserved monument--remains today of the past destruction of the city, unless it be in the deeper recesses of the hearts and minds of the people who witnessed the explosion and survived.

The Committee paid courtesy calls to the Honorable Itsuo Nagano, Governor of Hiroshima Prefecture and to the Honorable Setsuo Yamade, Mayor of the city of Hiroshima. During its official work in Hiroshima it was aided invaluably by Mayor Yamada's Foreign Affairs Chief, Mr. Kaoru Ogura who acted as guide and interpreter. The various facilites seen by the Committee are described below in the order visited.

ATOMIC BOMB CASUALTY COMMISSION (ABCC)

The largest operation and headquarters of this Commission are in Hiroshima. It was founded in 1947 with the primary purpose of studying athe A-bomb victims and their children. The ABCC is funded mainly (90%) through United States Atomic Energy Commission money channeled through the U.S. National Academy of Sciences-National Research Council and partly through the Japanese National Institute of Health. The Committee had met June 9 with the Director, Dr. George B. Darling on Saipan and he indicated that while he would not be in Japan during the Committe's visit, he would write to the staff to inform them in advance. The Committee thus met with Dr. LeRoy Allen, Jr., Deputy Director, and his staff.

It was explained that originally the ABCC was established to study the acute effects of radiation exposure, but later the emphasis was changed to long-range studies of radiation effects. During its early years the ABCC treated, as well as examined, radiation victims; but today this agency's work is strictly based on examination and the gathering and evaluation of statistics. Patients who need medical treatment are referred to public medical centers and private clinics or physicians.

It was explained that the Commission's main work was divided into three areas:

(1) A life-span study which is designed to determine

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whether or not the length of a survivor's life will be shortened by exposure. There are 100,000 people in the group studied in both Hiroshima and Nagasaki.

(2) An adult health study composed of a group of 20,000 people of the 100,000 in the life-span group. The purpose here is to study what effects irradiation may have on the exposed persons, such as certain kinds of cancer, cataracts of the eye, or growth retardation. About 10,000 persons are examined annually and thus it requires two years to complete the survey of the whole group.

(3) A pathology study involving the examination of those survivors who die. This is done in order to find out if there are effects of the radiation which cannot be found in the ordinary annual examinations.

The ABCC's major finding up to 1972 were increased leukemia and thyroid cancer. It was also stated that cancer in general seemed to be increased, including that of the salivary gland, lung, and breast. This was apparently developing in children who were 10 years old at the time of the bomb and who received 100 rads or more. The incidence of leukemia peaked in 1952, but is still not normal and the incidence of thyroid cancer has not yet peaked. It was also explained that children born after the bomb have so far not shown any increase in cancer or early death.

Additional comments by the ABCC doctors indicated that they were still finding new things. The children who were less than 10 years

old in 1945 are now coming to the age when persons would normally start developing cancer and they are beginning to find more cases in the exposed. As to leukemia, it was stated that in Nagasaki the threshold dose appeared to be from 50 to 100 rads, while for Hiroshima there appeared to be no threshold.

MEDICAL WELFARE CLINIC

At 9:00 a.m. Saturday morning, the Committee traveled to the Hiroshima Medical Welfare Center and met with Dr. Yutaka Mizuno, Chief of the Countermeasure Section. Dr. Mizuno explained that the Center's three areas of work are health control, research, and treatment. He explained that there are about 95,000 survivors in the Hiroshima area and that this Center cares for about 80% of them. Most of their work is concerned with health control, and they cooperate with the Hiroshima University Research Institute for the research portion, and with the A-bomb hospital for treatment. As to health control, their main work, he said that this is carried out in two ways: 1. a general examination in which health teams are organized to canvass areas by school district and 2. "close" or detailed examinations of persons who, the general examination indicates, should undergo a more thorough clinical checkup.

RESEARCH INSTITUTE FOR NUCLEAR MEDICINE AND BIOLOGY, HIROSHIMA UNIVERSITY

An adjunct of Hiroshima University, this Institute is headed by Dr. Shunzo Okajima. He explained that the Institute's work is

different from that of the ABCC and that they concentrate mainly on statistics and social aspects. Occasionally, he said, they provide consultants to the ABCC. In answer to a question, he stated that the Institute's findings generally agree with those of the ABCC, with minor differences. One member of the staff of the Institute also present at the meeting was Dr. Haruo Ezaki, a professor and surgeon who specializes in work with the thyroid. Dr. Ezaki accompanied another doctor and some other Japanese to the Marshall Islands in December of 1971, at the request of Representative Balos, in an unsuccessful attempt to examine the people of Rongelap and Utirik. Dr. Okamoto was asked about the possibility of Dr. Ezaki accompanying the Brookhaven National Laboratory team (commonly known as the "AEC") team) to complete the annual survey which was stopped in March, 1972. Dr. Okamoto indicated that the Board of Directors of the Institute would have to make the decision on such a matter and that advance notice would have to be given.

THE OLD AGE A-BOMB SURVIVORS HOME

This facility is an impressive, three-story, concrete structure with a solarium and meeting room as a small fourth story. The Home cares for two classes of survivors: 1. elderly persons who, while they may have families, are not able to be adequately cared for 2. those older persons whose families were wiped out by the bomb, or are no longer living today. The Home has accommodations for 150 persons, 50 on each floor. The first floor is devoted to those

persons no longer able to work and the other two floors for those who can walk. The Vice-Director of the Home explained that this is not a hospital, but a home like their own home. They do, however, have one doctor and three nurses on the staff and if any treatment needs to be done, there is a hospital right next door. Employees take care of the maintenance and the many social activities, clubs, etc., as well as television and areas to make handicrafts. The ambulatory residents are allowed to go shopping by themselves, but must return for their meals.

The Vice-Director also related that there are about 60 people on a waiting list in the city office and that they expect to have another 100 rooms sometime in July of 1972. The majority of the people in the home were those with no home or those who had been living with a family in a home that was too small. The question was asked about persons under 60 who are healthy but have no family. "Younger people can work for themselves," the Committee was told.

The Committee noted that one of the reasons the building was impressive, was that it was new--built in 1970. Previous to that year there were several smaller homes throughout the city. This new facility cost 200,000,000 yen (about $700,000 at that time). The central government provides 80% of the operational funds, while the prefecture and city split the remaining 20%. Costs per patient on the first floor run about $160 a month, and about $86 a month for those on the other two floors.

THE A-BOMB MUSEUM, HIROSHIMA MEMORIAL PEACE PARK

This facility, run by Director Kazuharu Mamasaki contains photographs, scale-model reproductions and artifacts relating to the air burst which destroyed Hiroshima. It is as though that instant of destruction still exists today; for as a visitor enters the museum he is thrust backward in time to 8:15 on the morning of August 6, 1945: dead clocks record the time; pictures show charred, scarred and blistered bodies mutely frozen forever in obscene poses of death; there are bottles and coins which were melted like wax figures under a too hot sun; one photo shows a man's outline burned into a ghostly silhouette on a building, a glass case holds the charred remains of a schoolboy's uniform, and a painting depicts the dirty, grey, mushroom cloud hanging over the city.

THE RED CROSS A-BOMB HOSPITAL

The Committee was introduced to Dr. Fumio Shigeto, Director. Dr. Shigeto is one of the A-bomb survivors and has worked in Hiroshima since the bomb and with the hospital since it was built in 1956. Funding for the Hospital came from the sale of Easter Seal-type stamps. It has a 160-bed capacity and the patients receive free medical care. Operational costs are divided equally by the central, prefectural and municipal governments. The youngest patient is 38, but persons as young as 27 or 28 can be admitted (in utero exposure).

Some of the common diseases treated are breast cancer, cataracts, and leukemia. Some 80 patients die annually, or about 50 percent of the hospital's capacity.

Dr. Shigeto told the Committee that there is a difference between A-bomb and regular patients. They feel different in that they are more uneasy and uncertain about their futures. This uneasiness, he explained, is doubled that of those who may think that a regular disease may have been caused by the A-bomb. All survivors there have this feeling, according to the doctor. Many who survived have no one to care for them. "It is a very uneasy feeling", he said. "If patients recover", he related, "they can go home, but may have to come back again."

The doctor then took the Committee members on a tour of the hospital where they saw many survivors, some of them still showed the scars from the burns they suffered nearly thirty years ago.

NAGASAKI TWENTY-SEVEN YEARS AFTER

The Committee arrived by train in Nagasaki on the evening of June 26, 1972, and that evening held a brief meeting with city officials to plan a schedule. The next morning the members met with the Honorable Soichi Urabe, Deputy Mayor of the city of Nagasaki. After that, a brief press conference was held. The Committee then visited facilities similar to the ones visited in Hiroshima; for the sake of brevity, only that information which differs from what has already been related will be included.

MEDICAL WELFARE CENTER

The Committee was told that of those who take the annual general examination about 30 percent need further examination. In the Nishiyama District (which was the only one to receive fallout) some 320 of the 832 survivors there are recognized by the government as having been affected. The kinds of illnesses found include leukemia and thyroid cancer. The Committee was told that, in general, the examinations did not bother the people, except perhaps for the younger generation.

ATOMIC BOMB CASUALTY COMMISSION

The Committee met Dr. Sadihisa Kawamoto of the Department of Medicine, in place of the Director, Dr. Ngai, who was ill. He said that their examination group is about 6,000 (of the 20,000 total) and that they examine about 4,000 people per year. All 200 of their employees are Japanese. He talked briefly about findings in the Nishiyama area and said that about 80 persons have been estimated to have received 30 rads during their life-span and that these are in the highest exposure group.

Dr. Kawamoto said he felt it very important to continue pediatric studies, since it is hard to tell whether leukemia is induced by radiation or not. He said that the leukemia rate in Nagasaki was much higher for exposed persons. He said that he thought a once-a-year examination was sufficient in screening cases for leukemia and thyroid cancer. He also stressed that the ABCC takes great pains to note the X-ray history of persons examined, since that might be a factor in the occurrence of disease later.

Dr. Kawamoto then informed the Committee that Dr. Okajima of Nagasaki University was working on a new study of the Nishiyama area which would be out after several months. The Committee then toured the facility.

A-BOMB HOSPITAL

This was built in 1958 with donations from the central, prefectural and municipal governments. It has 360 beds, and about 330 patients, 70 percent of whom are A-bomb survivors.

THE OLD-AGE A-BOMB SURVIVORS HOME

After the August 6th bomb at Hiroshima, many people of Nagasaki feared the same fate would befall them, and so many were evacuated to a place in the mountains above the city. After the bomb on the 9th, they returned to the city to help. Since these people were saved, they felt that the same place would be a good one on which to build a survivors home. Another factor considered was that the land in the area was fertile and good for farming. The Japanese Catholic Sister, who is the director of the Home, explained its great distance from the city. The Sister is a survivor, herself.

The facility, the residents and the staff of the Home made a deep impression on the Committee. When they arrived, the Chairman delivered a speech in Japanese to the gathered residents and staff, which was reciprocated by one of the residents. The residents, wearing black and gold kimonos, performed two dances for the Committee

and two members of the Committee reciprocated by singing or chanting in their own languages. The Committee was then taken on a tour of the Old-Age Home and found it to be one of the best such facilities it had visited. It was new and airy, the rooms and corridors were sunny and the accommodations were clean and comfortable. Particularly, because of its location, it was also quiet and restful. The Sister explained that 80% of the cost of the Home is from the central government and the rest from donations. They had accommodations for 150, with 50 on the waiting list and 100 beds planned. The tour included visiting the living quarters, therapy rooms, handicraft work areas, auditorium, and cafeteria. At the end of the tour, the residents and staff sang a song for the Committee as it boarded the bus for the return trip to Nagasaki.

A-BOMB MUSEUM

As in Hiroshima, it is difficult to imagine today that Nagasaki once reeled under the blows of an atomic bomb. A seaport city, Nagasaki is modern and picturesque. There are great shipways within the city's limits and the sight of half of a 300,000-ton tanker sliding down the ways into the sea was eloquent testimony to the rebirth of Nagasaki from its own ashes. As in Hiroshima, however, there are still reminders.

Located within view of the hypocenter, the Nagasaki A-Bomb Museum contains the same terrible evidence of the terrible destruction and death caused by the bomb; particularly poignant and ironic were

the remains and pictures of St. Mary in Grief, of St. John and of the images of angels at Urakami Cathedral blackened and disfigured by the heat, radiation and shock of the blast.

ATOMIC DISEASE INSTITUTE, NAGASAKI UNIVERSITY

The Committee met with Dr. Shunzo Okajima, Director of the Institute. He explained that of an estimated population of 9,000 in the Nishiyama District, about 500 people had been affected by fall-out. Three hundred of these had been studied in order to get from them a group of 80 to study. He said that there is little radiation remaining in the soil that low, although significant amounts of radiation could still be found in the study group. He indicated that this group showed a higher frequency of chromosome aberrations than a comparison group. Although not exposed to direct radiation from the bomb, maximum exposure was estimated to be about 30 rads. He said that the people don't seem to mind the tests and that--relatively speaking--body burden counts were high, they were very small, in the order of 1/2000th of threshold. He indicated that his institute is preparing a study entitled "Radioactivity and Fallout Effect Survey, Nishiyama Residents and Comparison Subjects, Nagasaki," which would be published within the next several months.

TOKYO

The Special Joint Committee departed from Nagasaki for Tokyo on Wednesday, June 28, 1972. After arriving, it contacted Dr. Kumatori

and, as he had promised, he had contacted one of the Lucky Dragon survivors, and arrangements were made to meet him that evening. On the late afternoon of June 29, the Committee members met with Dr. Kumatori and Mr. Matashigi Oshi. During the meeting Mr. Oshi discussed his experience, his compensation, and his health, and Dr. Kumatori presented the Committee with some articles dealing with studies of the Lucky Dragon fishermen as published in several scientific journals. After the meeting the Committee hosted a dinner for its two guests. On June 30, 1972, the Committee departed from Japan for the Trust Territory.

JAPAN: SUMMARY

In Japan there are well-defined and regulated facilities to take care of those people exposed to the bomb in 1945. The programs which produced these facilities came about nearly 12 years after the bomb, through the passage of a national public law. This long delay was due, in part, to the fact that Japan was an occupied country until about 1955. It is clear that the main support of these programs comes from the local and central governments of Japan. Examination, treatment and care for the victims are up-to-date, efficient, and comprehensive. The Committee noted that the medical equipment (an automatic multi-channel blood analyzer) in most of the facilities, matched or exceeded in sophistication, that found in most, if not all of the Trust Territory district hospitals. At the same time, as daily medical care is carried out,

extensive long-range research studies are being continued by both the Japanese Government and the ABCC on survivors of the A-bomb, while the National Research Institute carries on annual studies of the Lucky Dragon survivors. It is obvious that an annual medical examination is sufficient for Japanese A-bomb survivors because of the multiplicity of facilities available and the relative ease with which the patients can get to them. A comprehensive compensation program is also in existence and will be discussed in a later report of the Committee.

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MARCH 1, 1954

A Narrative of the Incident

Some ten knots west and somewhat north of 11° 09' north latitude, 166° 54' east longitude, in the deep blue and purple waters of the western Pacific ocean, a 100-ton dragon lay wallowing in the sea. The longline tuna fishing vessel Diego Fukuyu Maru, or Lucky Dragon No. 5 was riding easily with the early morning swells as its crew began to fight off the ghosts of sleep. Sea birds which had nested for the night, began lifting skyward to begin the endless hunt for food. In like manner, tuna and other fish beneath the surface would begin seeking small bait fish near the surface. Between the tuna and the birds waited the Lucky Dragon, also preparing to join the hunt.

The Lucky Dragon's journey had begun January 22, from its home port of Yaizu City. Ship's captain Hisakichi Tsuitsui had at first headed his vessel toward the fishing grounds near Hawaii and Midway. When these grounds proved unproductive, he headed the Dragon and its 23 man crew south, toward the Marshall Islands. (62, p. 170). The captain, and the fishing master Hoshio Misaki, apparently disappointed and anxious about their small catch, decided to fish near Bikini Atoll, the site of the first postwar atomic bomb tests--despite the fact they risked being caught by the U.S. Navy for fishing in Trust Territory waters. Perhaps also nagging at the back of their minds was the knowledge that Bikini had been the site of nuclear tests--but that had been nearly eight years ago. The lure of a final big catch to fill their holds must have outweighed any such anxiety as they pushed closer to Bikini. It was, after all, nearly a matter of now or never, since an accidentally cut line and dwindling fuel reserves would soon force them to return home. The Dragon's luck had not been good this voyage and,

unknown to the members of the crew, it was going to get much worse, for, on the morning of March 1, 1954, the sun rose twice.

At 11° 09' north latitude and 166° 54$^{8'}$ east longitude, lies an atoll known at one time by the name of the great Russian composer "Rimski-korsakoff," known to the Japanese as "Rongorappu To", but best known to its inhabitants as Rongelalappelap, Ronjlap, Ronge lappelap, or, simply--Rongelap. Rongelap is typical of many atolls. Composed of 61 scattered islands along its necklace-like rim, which total only 647 square miles, the great bowl of Rongelap Lagoon itself covers more than 387 square miles.

While the Lucky Dragon fishermen still dozed halfway between sleep and awareness, the 64 men, women and children of Rongelap--like most island people--arose early to start the day. The women would have kindled fires to cook pandanus or arrowroot for the day's meals and to recook fish, if any, left over from the night before, while children would still be drowsing and the men would be starting to repair fishing gear or canoes for a fishing trip or planning where they would begin collecting and husking dried coconuts to make copra for the field trip vessel's next call. One particular person on this island on this morning had reason to be contemplative. He was John Anjain, the magistrate. Many thoughts must have crossed his consciousness that morning: the needs of his wife--especially that of his new son, Lekoj who was one year old--the island work to be done, council meetings, land and personal disputes which often come the way of the magistrate. He was probably wondering when the 18 people on Ailinginae, some 20 miles to the southwest, would be returning to Rongelap from their fishing and copra-making party.

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Perhaps he was a bit more apprehensive and anxious these days than he had been in the past, not only because he was 32 years old--rather young by Micronesian standards to carry the responsibility of magistrate--but also because he had been told a disturbing thing by the Hawaiian field trip officer on the most recent field trip ship. The officer, indicating the last segment of his finger with his thumb, had told John that,"Your life line is about that long." John asked him why if they knew there was some kind of danger to the people--they were not removed from the island. The officer replied, "We have no orders." But it was unlikely that at this time on this morning John consciously remembered the remark, as he would recall it later. As on every day, there were many things to do. Besides, it was hard to conceive of a threat to anyone's safety unless it would be from a natural disaster like a typhoon and the weather signs indicated no such pending phenomenon. A sense of calmness and peace must have pervaded the Island of Utirik many miles to the east, yet they, too, soon would share a common, unfortunate bond with their neighbors to the west. It was, in fact, hard to imagine anything threatening on that tranquil morning in the Pacific. Rongelap was home. Rongelap was security. Rongelap, as a traditional part of the Kalik or western chain, was stability. The sun always rose on the "Ratak" or eastern chain of islands which included Utirik Atoll, and set in the "Ralik" or western chain where Rongelap lay. That morning, however, the sun would first rise in the west.

Some 30 miles east of Rongelap on that morning, twenty-three white and five black U.S. servicemen stirred uneasily in their RadSafe aluminum

building as they prepared to take observations in connection with the testing of the most powerful explosive device ever to be detonated by man. They stayed on Rongerik as a Radiation Safety team connected with Joint Task Force Seven. They were the only inhabitants of the island aside from rats, flies, and coconut crabs. Their quarters, while spartan, were well stocked with canned food, and water and they had a refrigerator to keep food and drinks cold. Even early in the morning they must have begun to perspire--not because of the heat, but from the intense humidity of the island. The feelings of boredom and anxiety, of frustration and excitement must have permeated most of them to varying degrees. To some it was a job, to others an interesting experience--to some it was probably drudgery. The paradisical Pacific islands were not always physically and psychologically kind to transplants from the mainland. There were no girls and no bars, no steak and no movies--at least on the island. On the ships, the men fared better. Despite this, however, it was a well-known practice for enlisted men, weary of the duty, to slip radiation badges into their shoes and thus receive their maximum dose of radioactivity rapidly from the relatively "hot" decks of the Task Force ships so that they might be transferred. (90)

But there was little chance of this on the island, since the test would be more than one hundered miles away. The men checked their small radio unit, over which they would hear of the "things" detonation, their badges and the radiation monitoring device. The checking and rechecking of familiar objects was a comfort in itself. There was no reason to

worry--if there were, the men would not be on the island. Anyway, the test was so far away.

At about 11° 33' north latitude and 165° 32' east longitude was the island of Bikini, Bikini Atoll, some 229.42 square miles of turquoise waters surrounded by a reef sporting 36 islands or islets. On one of those islets sat a device surrounded by steel and concrete and costing millions of dollars. The device represented the culmination of the efforts of the German scientists at the Kaiser Wilhelm Institute in 1938, Enrico Fermi and his Chicago Group in 1942, the Manhattan Project which developed the first atomic bombs, and postwar efforts by such renowned scientists as Dr. Edward Teller, together with the testing at the Pacific Proving Grounds of Bikini and Enewetok. Cold, inorganic and impersonal--it was just there. Composed of 200 pounds of uranium 235, 200 pounds of lithium deuteride, and more than a ton of uranium 238, complicated mechanisms and electronic circuitry to insure it would go off, and go off at the proper time upon a radio command. The device was there, and its sensory apparatus awaited the human signal to order it to transform itself into a living, terrifying giant--a giant which would live and in its living destroy itself and everything within its reach. Cold, efficient, and unfeeling, it sat on the island, oblivious to the muffled roar of the surf on the reef.

Roughly thirty miles east of the device and seventy miles west of Rongelap, ships of Joint Task Force Seven heaved and fell against the swells. Aboard the dull, grey ships were five basic groups comprising the whole force: 7.1 scientific and technical personnel; 7.2 the Army;

7.3 the Navy, 7.4 the Air Force, and 7.5 the contractors (primarily from the firm of Holmes and Narver) and Department of Defense people. The Joint Task Force concept was one originated for the Able and Baker tests at Bikini Atoll in 1946 and was continued thereafter. It had been proven the most effective and efficient way of combining technical know-how, military and security interests and an equitable sharing of the knowledge resulting from such tests. Upon the shoulders of the Task Force Commander, and the heads of the five segments of the Force rested the responsibility for the safety of all personnel and the successful execution of the tests. Sometime in the early morning hours of March 1, 1954, information was received concerning the status of the ships, personnel and security surrounding 50,000 square mile zone which extended from 10^{o} 15' to 12^{o} 45' north latitude and from 160^{o} 35' to 166^{o} 16' east longitude. Also received was meteorological information concerning wind and weather conditions. After all data was received and evaluated, the decision was made to go ahead with the first test of the "Castle" series. The code name for the sleeping giant bottled up in its steel and concrete womb was "Bravo."

At one minute, or even a few seconds before 06:45 Kilo (local) time on March 1, 1954, the tragic events which would follow "Bravo's" detonation could have been prevented, but incredibly, the decision was made to go ahead, despite an incomplete and somewhat alarming report concerning the winds above Bikini.* For "Mike" shot on Enewetok in 1952 available wind information showed winds heading to the west from sea

* See appendix for "Mike" and "Bravo" wind direction charts.

level to 90,000 feet, with no data for winds at 95,000, 100,000, and 105,000 feet, and data for winds at 110,000, 115,000, and 120,000 feet indicating they were flowing to the east, or toward Bikini. For the "Bravo" shot, however, winds from sea level to the end of the troposphere at 55,000 feet were generally heading east, or northeast, in the general direction of Rongelap, Rongerik and Utirik. From 55,000 feet to 90,000 feet the winds were generally heading to the west. Above 90,000 feet, there was no data available.

Had the shot been delayed 24 hours, wind conditions might have changed, which would have altered the fallout of the explosion and the enraged nuclear giant would have only expended its energy and visited its curse upon the flora and fauna of the uninhabited spits of sand in the Pacific. Unfortunately, such was not to be.

The decision to "go" that was made sometime early that morning would produce much confusion and conflict, suffering and suspicion. It would result in a controversy that is unresolved to this day, and an anxiety-ridden and uncertain future for nearly three hundred human beings and their descendants.

The decision had been made. "Bravo" lived and died.

In July of 1946 Operation Crossroads--the detonation of two "nominal" yield atomic bombs--took place at Bikini. The first test, coded "Able", involved an air drop of a bomb which burst at 500 feet over a fleet of dilapidated American and Japanese naval vessels. The second test was the first underwater shot ever conducted. It involved the detonation of an atomic bomb suspended about 90 feet--or halfway

between the surface and the floor of the Bikini lagoon--below an LSM around which were arrayed the remnants of the fleet from the first test. The magnitude of the explosion and its effects were stunning: a huge bubble thrust upward from the quiet lagoon and then burst into a tumult of spray; within seconds a tremendous column of water, hollow in the center, rose one mile into the air. The Arkansas, a 26,000 ton battleship was upended like a toy and then plunged to the bottom. The column, which was estimated to carry 10,000,000 tons (twenty billion pounds) of water, also carried with it sludge and sediment which the rising fireball had scooped from a circular half-mile area of the lagoon's floor. Waves, 80 and 100 feet high, were sent out as the water fell back into the lagoon. The psychological trauma of the blast itself was so tremendous that some Operation Crossroads personnel, observing the event on ships more than 10 miles away, began vomiting over the side.

If the effects of "Baker" were stunning, then those of the "Mike" shot in the "Ivy" series of tests at Enewetok were astounding. "Mike" was the name for the very first thermonuclear, or H-bomb, device ever exploded by man. It utilized liquid hydrogen cooled to almost absolute zero (-273.16° centigrade). It was a "device" and not a deliverable bomb, since the cooling apparatus involved weighed some 65 tons (62, p. 15). The cooling mechanisms and the fission and fusion material were located in a building on Elugelab Island of Enewetok Atoll. When "Mike" was detonated, not only did the island disappear, it was vaporized into calcium oxide and sucked up with the cloud, but the blast

also gouged a hole one mile in diameter and 175 feet deep in the reef. "Probably more than 100 million tons of material were disloged and thrown into the air," (94, p. 170), great waves were sent out that rolled over nearby islands, and a huge mushroom cloud rose to a height of 130,000 feet (25 miles) in just 15 minutes. "Mike" was indeed a superdevice, estimated to have a yield of about 5 megatons or the equivalent of 250 (Hiroshima-type) atomic bombs.

"Bravo," the slumbering nuclear giant, was "born" at 06:45 a.m. on March 1, 1954. It burst forth from its "womb" in a blinding rage of light, with boiling and blistering heat and radioactivity, a cataclysmic, thunderous roar accompanied by a mighty shock and pressure wave which shook the earth, sea, and sky.

In millionths of a second the chain reaction occurred and the bomb and its housing simply disappeared--vaporized by the intense heat somewhere in the neighborhood of tens of millions of degrees. In a one megaton (one million tons of TNT) blast the fireball, looking like half of a giant, luminous bubble, and consisting of vaporized bomb particles, air, water and soil, would have expanded to more than 7,000 feet in diameter after 10 seconds. "Bravo," however, according to conservative estimates was 15 megatons in yield (although it may have been larger). It was of a magnitude to stagger the imagination.* Undoubtedly the diameter of the fireball and its surrounding hemisphere of burning gases, thermal and shock fronts was from three to five miles in diameter, an area in which no living organism could survive. In the first few

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* In the early 1960's Russia boasted of detonating a 50 megaton device, and of having the capability of detonating a 100 megaton monster bomb. Such a bomb would be the equivalent of 5,000 Hiroshima or Nagasaki-type-bombs.

seconds of its life, it would shoot upward at a rate of about 300 miles per hour, rising in one minute to an altitude of 5 miles. The bomb's energy would be spent in four different areas. The first area would be that of thermal radiation accounting for about 35 percent of the total energy yield. The initial thermal pulse of the blast was of heat and X-rays which heat the air near the explosion. The light from this process was visible more than 50 miles away and was brighter than the sun. The fireball momentarily cooled, and then a second thermal pulse was generated lasting for several seconds which vaporized the ocean's surface waters, and seared and scorched, blistered and burned the nearby fauna and soil of the neighboring islands. This immense heat or thermal radiation was so strong that it probably could be felt 100 miles away.

In addition to all this, tens of square miles around the blast center would be riddled by 5 percent of the blast's energy in neutron and gamma rays.

At least half of the energy of this titantic bomb was expended in a high-pressure blast, or shock wave. The shock front caused by the fantastically fast-expanding fireball cracked outward; like a near-solid wall of tightly compressed air, it initially sped outward miles ahead of the fireball, at more than 2,000 miles per hour, and even more than a dozen miles from the center it was still traveling faster than the speed of sound. At its beginnings, it exerted pressures of several million pounds per square inch, gradually weakening as it traveled outward to more than twice the normal atmospheric pressure at several

miles distant. Trees swayed and snapped violently as the wave thundered over the desolate islands--sand, rocks and dust would have literally "jumped" into the air. Following the shock wave came unearthly winds several hundred miles per hour near the center and 70 to 100 miles per hour several miles away which stirred the lagoon's waters into a froth and stinging spray like that during a full scale typhoon, blowing away sand and soil cover of the islands and flinging waves breaking on the reef back into the sea. Some time after the fireball had risen, these winds ceased and "afterwinds" began flowing toward the forming mushroom cloud, following the path of the rising superheaded air. Within minutes these "afterwinds" would increase to near gale velocity, some distance from the center, and the remaining trees on the islands would be bent toward the explosion. The lagoon once again was whipped into a frenzy by the freakish wind. At the same time awesome waves towering more than 100 feet high would have rolled out, which--even though diminished by distance--would be large enough to completely wash over whole islands on Bikini's rim.

During its origins, "Bravo" would have also pulverized and lifted into the sky an immense portion of the Bikini reef, along with seawater vaporized by the blast. Since "Bravo" was roughly three times more powerful than Mike, it undoubtedly lifted several hundred million tons of matter into the air immediately, or through the action of the "afterwinds" which sucked matter up through the base of the column. During the period of the fireball's rise, the final 10 percent of the bomb's energy was expended in residual radiation which was deposited

upon the uplifted calcium oxide (coral) and water vapor.

By 06:55 a.m., "Bravo's" giant nuclear cloud stood 21.6 miles tall. Half of "Bravo" extended through the troposphere, and the upper half rose nearly 60,000 feet into the stratosphere. Within a few minutes the winds began tearing the giant form apart; heavier particles of uplifted material began falling back into the sea; lighter particles, however, would be carried along with the dismembered cloud by the winds. It was at this point that the first indications became apparent that something was horribly, irrevocably wrong.

JTF-7

By design, the human beings nearest the bomb's detonation were the inter-service, inter-agency personnel of Joint Task Force Seven. No known "accidents" had ever occurred in the course of America's previous 43 tests involving nuclear weapons. Ships of the Task Force were arrayed at what was expected to be an upwind position some 30 miles from the blast. "Bravo," as explained earlier, was the first hydrogen device to use the fission-fusion-fission process in order to make maximum use of neutron emission and was the reason for the addition of several thousand pounds of U^{238} to the mechanism. This would produce an exceptionally powerful explosion, and one which would be exceptionally dirty in terms of radioactive fission products. While meticulous safety precautions had sufficed before, what can only be regarded as an underestimate of the unknown potential strength of this bomb, resulted in placing the JTF fleet perilously close to ground zero. The officers,

crews, observers and scientists aboard their ships must have been both shocked and amazed by the blast as they felt the heat of the thermal radiation and pressure of the blast wave, heard the thunderous roar of the fireball ascending and felt the blast winds, now reduced by time and space to a light breeze.

In fact, had "Bravo" been a medium altitude air burst, there undoubtedly would have been some casualties among the Task Force personnel, since a 10 megaton burst can produce second-degree burns up to 25 miles away from the explosion.

More insidious and frightening than the effects experienced by the Task Force, were the aspects of the white cloud's height and the direction in which it began to drift away and downward. As though inhabited by the trickster ghosts rampant in Micronesian legends, the dead form of the cloud began heading almost directly for the fleet, as though in its final paroxysms, "Bravo" intended to play a last impractical, and very deadly joke upon its creators. Inherent to the fallout was the legacy of "Bravo's" processes of fission and fusion, a boiling mass of harmless-looking clouds containing tens of thousands of deadly rads of gamma and beta activity.

Within minutes after the cloud began breaking up, everyone's worst fears were realized; RadSafe staff members had already noted the unexpected movement of the cloud and soon thereafter Geiger counters on some of the ships began to record a steady increase over normal background radioactivity. Orders were given. All personnel were ordered below decks, hatches and watertight doors were dogged down and, while

there is no record of it, the Commander of JTF-7 must have ordered all ships to proceed due south at the flank speed of its slowest vessel in order to escape "Bravo's" radioactive curse. While the ships hared away from the danger zone, RadSafe planes crisscrossed the area, like typhoon hunters, to determine the extent and direction of the fallout and its intensity. In their frantic search, they must have missed a curious and chilling sight; a small Japanese tuna vessel rolling peacefully in the sea--unaware of the fate about to befall it. Thus it was, as the ships ploughed southward, and a gentle "snowfall" of radioactive particles began drifting toward the ocean and three inhabited islands, a second misbegotten decision was made, one which would cause incalculable misery and suffering during many years to come.

THE LUCKY DRAGON

A lone fisherman, Shinzo Suzuki, stood on the deck of the Lucky Dragon on the morning of March 1st, bracing himself against the gentle roll and pitch of the ship and listening to the familiar creaking sounds of the working of the wooden-hulled vessel and the steady thump of the diesel engine. The sky was beginning to lighten in the east as he became aware of a strange phenomenon--it appeared that the sun was also rising in the west, for a huge yellow glow filled the horizon in that direction. Excited, he rushed into the crews quarters to awaken his shipmates. His amazed companions then were able to witness the second rising of the sun, which was later accompanied by a "deafening explosion" (62, p. 170) and a huge cloud rising in the western sky. According to their later reports, after an hour and a half, a white, gritty ash began

to fall on the ship, its gear, and crew members. Puzzled by this strange snowfall, some of the crew actually tasted the radioactive flakes in an attempt to ascertain just what they were. During the fallout which lasted some 5 hours (77, 2/454) several of the men suggested they had witnessed a nuclear test--none of them, however, immediately connected the snowfall with the test.

These peculiar and unnerving events were enough to convince the captain that it was time to abandon any hope of returning with a full catch. They had poor catches, lost some of their fishing gear, were low on fuel--and now this. He headed the Lucky Dragon northward for home. Three days later all of the members of the crew would suffer the acute effects of their exposure, itching of the skin and mucous membranes, nausea and vomiting. Two weeks after their exposure they would arrive in their port city of Yaizu and discovery of their experience would result in an international controversy and fear and panic in Japan.

Unknown to the Joint Task Force, the little ship started its journey homeward; the radio operator, who would later die, sent no messages to Japan or to other ships telling them of their experience.

RONGERIK

Upon receiving word of the cloud's erratic behavior, the RadSafe crew on Rongerik must have intensified their observations. Information indicated that it might be heading their way and they sent in readings from their instruments and findings of their observations. At 13:33

local time the radiation monitoring instrument began recording a steady rise in radioactivity. At 14:03 the needle swept past the extremity of its scale at 100 milirads per hour. (44 p. 6) All personnel donned extra clothing and remained inside the tightly shut building. The heat, humidity, and anxiety inside must have been tremendous. Outside, a radioactive "rain" was falling on the aluminum building. Gamma rays were penetrating the metal of the house, and the clothing and flesh of the people inside. They also penetrated the steel sides of the refrigerator, registering a total of 38 rads on a radiation badge inside. One badge left outside later registered nearly 100 rads.

Within 12 hours after "Bravo" had exploded the second decision had been made. Ships of the Task Force turned east and headed for Rongerik. Sometime past midnight, the ships, cautiously prowling near contaminated waters, ghosted past Rongelap and Ailinginae. On the morning of March 2, 1954, contact was made with the 28 Americans on Rongerik. By 11:15 a.m. eight men had been evacuated and by 16:45--or 34 hours after "Bravo" exploded--the remaining 20 military personnel were aboard ship and headed away from their now radioactive island.

RONGELAP, AILINGINAE, UTIRIK

At 05:53 a.m. on March 1, on the islands of Rongelap and Sifo (Ailinginae Atoll) several people noticed an unusual reddish-yellow glow in the western horizon; several minutes later they heard the dull roar of an explosion as the true sun brightened in the east. Some 180 miles to the east in the "Ratak," or "Sunrise" chain, and about 15 minutes later, the people of Utirik Island, Utirik Atoll, heard the muffled

thunder of the explosion, and some of the people on the island rumored that another war had possibly started.

On Rongelap, talk probably turned to the visit of a Navy Commander to the island a couple of weeks ago. The Commander had tried to explain something to them about a test, and bombs--but despite the efforts of an interpreter, the people did not understand what he was talking about. Perhaps this noise and light had something to do with it. At this point, John Anjain must have briefly recalled the field trip officer's remarks--but, since they had only seen an unusual light and heard the noise of an explosion far away, there appeared to be no immediate worry. Maybe the Hawaiian had been mistaken.

Four to six hours after the detonation, as the Lucky Dragon crew was puzzling over the strange ash falling on them and their vessel, the people on Rongelap and Ailinginae witnessed the third unusual phenomenon; fluffy, white particles, like the ash of a fire blown into the air, was settling down upon the island from the heavens, the lagoon and the atoll. Two young boys at that time were climbing a papaya tree to pick some fruit and, as they looked up, the ash fell into their eyes. An older man, paddling near shore in the lagoon also looked up. He had been having trouble with his eyes lately and so intentionally let some of the flakes fall into his eyes. He then rubbed them with his eyelids shut, hoping that this strange substance would help his affliction.

Back on the island, the "snow" was falling steadily and soon the ground, tree leaves, and the roofs of houses sported a white, powdery

layer of the stuff making Rongelap look as though it had been the scene of a freakish snowfall in the middle of the Pacific, only 600 miles north of the equator.

Villagers scuffed up the powder as they walked, and some tried to brush it off their hair and bodies. Children, delighted with the unexpected event, played with the snow. Several people, like the Japanese fishermen, tried tasting the powder to determine just what it was.

Sometime in the early morning the Rongelapese spotted a plane or planes buzzing by the island. Someone conjectured that the snow they had seen had been dropped by the planes and that perhaps its purpose was to kill mosquitoes.

Eastward, on Utirik, the snowfall began 22 hours after the explosion. It was lighter and described as "mistlike".

That evening, as the sun set and darkness fell over Rongelap, the fallout ceased. The powder now had reached a depth of about one and one half inches and at night gave the island an eerie aspect. Sometime earlier in the afternoon it rained. The raindrops spattered the white powder, and as it increased, rivulets of water carried the radioactive ash from leaves to the ground, and from rooftops into water catchment tanks.

The fallout of Bikini's pulverized and irradiated coral reef had ended--but its long lasting effects had just begun to work.

H+ 34 to H + 78

Thirty-four hours after the bomb (H+34) the 28 Americans were safely aboard ship. That same day, according to reports from the

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people, RadSafe crews had visited Rongelap by amphibious plane, found the radiation levels dangerously high and had left to report their findings. Before they left, they left the people with one word of advice: "Don't drink the water." Nearly one day after the Americans had been evacuated, craft of the Task Force converged on Rongelap, and later Ailinginae Atoll, to the southwest, where some 18 Rongelapese had been temporarily visiting. On Rongelap, as on the other islands, the people were reportedly told they must leave the island immediately, or they would "die". They were allowed to take only those personal possessions which they could carry and as they hurried to board the craft which would take them away, RadSafe personnel monitored the village and the people themselves with radiation detection devices.

At this point, individual readings ranged from 10 millirads per hour to 240 millirads per hour (see Appendix No. 4).

At H+50 hours, 16 of the people with the highest readings were air evacuated to Kwajalein and at H+51 the remaining Rongelapese were aboard ship and also bound for Kwajalein. Seven hours later at H+58 the 18 Rongelapese on Sifo Island of Ailinginae were evacuated from their radioactive location. During the same period, ships reached Utirik Atoll, and after a survey of the island evacuation was begun at H+55 hours and by 10:53 a.m., Bikini time, at H+78 hours, or three days and 6 hours after "Bravo" had exploded, the last exposed people were taken from their islands.

Some 24 hours later, after H+78, while the Lucky Dragon plunged its way northward to Japan, the 18 people from Ailinginae, the 64 people from Rongelap, the 28 Americans, and the 157 people from Utirik had arrived at Kwajalein. At that time, like the Japanese fishermen, many of them began to experience the symptoms of acute radiation exposure: itching and burning of the skin, eyes and mouth; nausea, vomiting and diarrhea. At this time, the people were instructed to decontaminate themselves by washing with soap several times a day to clean the radioactive fallout from their bodies. It was a particularly difficult task for the women, who traditionally used coconut oil on their hair, which caused the fallout particles to cling tenaciously to their long tresses.

About 2 weeks later the second stage of acute affects manifested themselves: the hair on the heads of many people wholly or partially fell out, and skin "burns" caused primarily by beta activity began appearing on the necks, shoulders, arms and feet of the more heavily exposed. During this two week period and for some time afterward, the doctors took daily blood and urine samples. The blood samples were watched carefully as they indicated the effect of the radiation on the marrow and its ability to produce new cells. If the number of certain kinds of cells in the blood dropped far enough below a normal level, then internal bleeding leading to death could occur. As they were watched and counted, the levels dropped: granulocytes dropped to 1000 cm^2 (with one count of 700), leukocyte counts dropped to 4000 or

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below, and neutrophile counts dropped to 2500 or less. The symptoms of several persons who developed upper respiratory infections during this period were carefully monitored. When their temperatures rose threateningly, they were given antibiotics to prevent further complications and they responded favorably. In all, 12 persons were treated with medication. Fortunately no immediate serious illnesses appeared, nor where there any fatalities. Urine samples were taken to try to calculate the original amount of radioactive material taken into the bodies of people and to try to determine what amounts of radioactive material still remained. Fifty-two days after the bomb exploded, seven people were selected from the Rongelap group to be given a recovery agent, ethylene-diamine-tetra-acetic acid (EDTA), which has the ability to help speed the process of elimination of some radionuclides through the body's normal functions. The attempt was ended after five days, however, when it was determined that the general effect of reducing the amount of the body's radioactive burden was so slight as to be virtually useless. This was due to the fact that little was being excreted at that time, due in turn to the fact it had been nearly two months since radioactive material had been ingested, and it had become firmly settled in the tissues of the bodies.

By the time two months had passed, after exposure, it appeared that any possible immediate danger had passed. The exposed American servicemen, after careful study which showed no positive findings, were released to their duty stations. At the end of three months, the people of Utirik, who reportedly received the lowest dose of radioactivity,

"Uncertainty is the greatest fear."

---Attributed to Tomás de Torquemada
Grand Inquisitor of the Spanish Inquisition

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were returned to their home island. The Rongelapese, however, were not so lucky--for their island and atoll had been severely contaminated by fallout, and like their neighbors the Bikinians eight years earlier, they could not return soon to their island. In April of 1954 the AEC contacted the company which had carried out much of the construction connected with the atomic proving grounds in the Pacific, Holmes and Narver. They were instructed to build homes for the Rongelapese on Eijit Island of Kwajalein Atoll. By June, 1954, the houses were completed and the Rongelapese were moved from their temporary quarters on Ebeye, to the island. There, they remained for over three years.

THE ANNUAL EXAMINATIONS

The Lucky Dragon

Discovery of what had happened to the crewmen of the Lucky Dragon after they arrived in Japan caused a furor, touched off by the natural sensitivity of the Japanese concerning radiation exposure because of the experience of Hiroshima and Nagasaki. It also engendered a later nationwide hysteria concerning radioactive contamination of tuna and other fish caught near the test zone.

At that time Dr. Toshiyuki Kumatori, who would later visit Rongelap with Dr. Conard's team in 1964 and would again accompany the team in 1972 as a consultant to the Special Joint Committee, was working at the First National Hospital of Tokyo. Seven of the more severe cases were sent to the Tokyo University Hospital. Since he had worked at the University Hospital for several years previously and knew the hospital director, he requested that the other 16 be sent to his hospital. During its visit to Tokyo in 1972, Dr. Kumatori discussed generally what had happened to the men, who ranged in age from 18 to 39 years. They suffered effects similar to those experienced by the Rongelapese, and they were given normal medication and treatment. After six months, case no. 14, exposed to an estimated 510 - 590 rads, who was the radio operator and who had not informed anyone of their experience near Bikini, died. Dr. Kumatori stated that it was not clear whether this was caused by his irradiation, or from another cause. He noted that blood transfusions were given to some of the men, and since at that time hospitals did not use disposable syringes, the possibility of the patient contracting

infectious hepatitis, which would have been very serious in his weakened condition, could not be ruled out. He noted that an autopsy performed upon the man indicated significant, but low counts of radioactivity in the bone, kidney and liver, but in the order of micromicrocuries.

The Committee took special note of a paper given to it which Dr. Kumatori and Dr. Miyoshi presented before a meeting on treatment of radioactive poisoning jointly sponsored by the AEC and the World Health Organization in Vienna, in 1962. This article showed how, through reproduction of fallout-like material and reconstructing where each member of the crew spent his time on the ship until it reached Japan, individual estimates of exposure were calculated, ranging from a low of 190 - 220 rads to a high of 660 to 690 rads.

The patients were kept in the hospital for 14 months. Upon being released, they were told not to return to the strenuous activity of fishing and if possible to take it easy for an additional year. In August of 1954 they were measured with a whole-body radiation counter and their body burdens were found to be no higher than those in a control group. Recovery agents had been used on two persons during their stay in the hospital, but to little effect.

One early effect noted by Dr. Kumatori was a severe drop in the spermatozoa counts of the men, some falling to zero and lasting for several months. Another he mentioned was a disturbance of the normal function of the liver which was not serious or severe, but which was noticeable.

The men, to this day, are examined on an annual basis by Dr. Kumatori at the National Institute for Radiological Sciences in Chiba-shi, near Tokyo, where he is chief of the Clinical Research Division. He stated that of the 22 survivors, usually he sees about 15 to 16 every year. Some of them are

very busy and just don't bother to come for the examination. Many of them have changed their jobs and work as merchants, or own their own apartment buildings. One man, to his knowledge, is still fishing.

No late effects have been noticed, such as thyroid nodules, but he did state that the change in liver function persisted for 12 or 13 years. Most of the men have since married and have had normal, healthy children. Aberrations in the chromosomes of the blood cells of the former fishermen, however, still persist.

Rongelap and Utirik

Initial Medical Teams

The first assistance to the affected Marshallese and Americans was given by the medical department of the U. S. Naval Station at Kwajalein. In the meantime, the Commander of Joint Task Force Seven had requested the Defense Department and the AEC to provide care and make studies of the fallout victims. This group was organized in the United States jointly by two agencies: the AEC's Division of Biology and Medicine, and the Armed Forces Special Weapons Development Project of the Defense Department. Within eight days after the incident, a group had been organized and been fielded on Kwajalein. Within this group were Dr. E. P. Cronkite and Dr. Robert A. Conard, both from the United States Naval Medical Research Institute.

Annual Reports

One of the first reports published concerning the affected Marshallese and Americans came out in August, 1955, under the seal of Brookhaven National Laboratory, a research center connected with Associated Universities

Incorporated of Long Island, New York. A second, much more comprehensive report entitled "Some Effects of Ionizing Radiation on Human Beings," was published in July, 1956, by the United States Atomic Energy Commission. Thereafter, the major data published on the people of Rongelap and Utirik was the result of surveys conducted by Brookhaven National Laboratory (BNL). The reports were published after three years (March 1957), four years (1958), five and six years (one report covering 1959-60), seven years (1961), eight years (1962), nine and ten years (one report covering 1963-64), eleven and twleve years (one report covering 1965-66), and thirteen, fourteen and fifteen years (one report covering 1967, 1968, 1969). (The report covering the years 1970-1972 will be published sometime during 1973.) Contained in the reports are descriptions of the annual surveys and general findings of the doctors who accompanied the team. A great number of articles have also been published in journals and periodicals by participating doctors as a result of their findings in examinations.

From the first year report, to the most recent BNL report, the size, sophistication and scope of the examinations and findings have increased greatly. In gross terms, this can be seen by an increase in the number of pages, from 12 in the twelve-month report to 128 in the latest report, which, of course, includes the results of three annual examinations and numerous appendices. More specifically, the first report considered general physical conditions, with special emphasis on effects on the skin, blood, and eyes of the irradiated Marshallese. The 1969 report, however, gives a description of general medical findings from physical examinations, and then very detailed descriptions of examinations and findings in the following areas: ophthalmological (eye), thyroid, aging, blood (both chemical factors and chromosome aberrations) as

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well as a summary of findings over the years since 1954. These include: acute effects, malignancies, degenerative diseases, growth and development, thyroid, eye, skin, blood, dental, aging, radionuclide intake from environment, blood groupings and special studies. Also included are appendices which give statistical data for the areas studied, as well as case histories of those persons operated on for thyroid abnormalities. The reports, documented with footnotes, appear to be exhaustively thorough, highly professional and extremely detailed. In addition to all this, the language of the reports is clear and concise. In short, they are well written, illustrated in an interesting fashion, well laid out, and carefully edited. Generally speaking, if there is a "flaw" in the reports themselves, it is due not to the report or its contents, but rather due to the nature of the subject matter covered. For the most part they are so technical in nature and replete with scientific data as to be virtually incomprehensible to the layman -- however, the summaries of work carried out, and of past medical findings are generally understandable and valuable to the average reader. Specifically, however, the Committee finds certain threads of reasoning, assumption, and exposition running through the reports which it finds both frustrating and somewhat disconcerting. One of these is inherent to the basically conservative nature of scientific investigation and seems to permeate medical and scientific expositions concerning relatively new fields of inquiry. It appears to be a basic tenet -- and not necessarily an unwarranted one -- that scientists are loath to make conclusions with any sort of finality about their findings and the implications of such, unless there is voluminous statistical data to support such definite conclusions. Thus, for example, many times the reader will encounter such statements as "although these findings appear to

be statistically significant, no definite causal relationship can be proven due to a number of variable factors, or the possibility of an unknown influence." A second area of concern by the Committee related to certain unproven assumptions and statements contrary to this hesitancy to make definite statements made in earlier reports, which apparently influenced assumptions and statements made in later reports. These general areas of concern will be elaborated upon more fully as appropriate, in the sections which immediately follow.

AREAS OF PARTICULAR CONCERN

Dose Estimates of Whole-Body Radiation from External Sources

Since there was no RadSafe team with radiation monitoring instruments or radiation badges on Rongelap, Ailinginae, or Utirik at the time of the fallout, the exact amount of radioactivity to which the people on those islands were exposed cannot be calculated, and will never be known. This is generally the result of three factors: One, no one of these islands had a watch or clock which could have recorded the time which lapsed from the time the fallout began to when it appeared to have ended. If someone did have a watch, they did not do so. Two, there was great individual variation in exposures. For example, children, because of their greater activity and curiosity, may have been exposed to greater amounts of fallout than older persons. Conversely, this may be attenuated by the fact that children are wont to play in the ocean during hot days and may have inadvertently cleansed themselves of what larger amounts they picked up. Young, and middle-aged adults, however, may have received the largest doses because of following habitual patterns of daily activity which

would keep them outdoors much of the time. Older people might have received the lesser amounts because of their lesser activity and their penchant of normally staying indoors, or in the shade or at one locale. Three, especially for the islands of Rongelap and Sifo (Ailinginae), the amounts of radioactivity present when RadSafe personnel did arrive was so high as to preclude their staying on the islands long enough to get enough accurate data.

Estimates, or "best guesses" can be calculated if some dose rates in the area are known, and because -- although radioactive elements are unstable, this form of instability is a stable characteristic -- in other words, the behavior of radioactive materials is a known factor. Basically, this is how the doses were arrived at for the four groups of people. The three major sources upon which calculations were made are listed and discussed below.

Rongerik

Fortunately, at least for the purposes of dose calculation, the RadSafe team on Rongerik had radiation badges (strips of film, which indicate exposure to radioactivity) on their persons, outside the building, and inside their refrigerator in their quarters. They also had a monitoring device. From the differing exposures indicated by the badges after being exposed for 27.2 hours (time of arrival of fallout H+6.8 subtracted from time of departure, H+34) exposure values could be calculated. One badge left outside registered 98 rads; a badge inside the refrigerator indicated 38 rads; and badges worn by team members who were both inside and outside showed 50-65 rads. These rates also helped to indicate the length of time of the fallout. The monitoring device was useful for determining when the fallout began, and at what rate it rose. Unfortunately, all calculations of rate increase had to be based on indications

of the first half-hour of readings, since after that time, the instrument went off scale at 100 millirads per hour.

Later Surveys

One known factor concerning radioactive materials is the rate at which the radioactivity "decays", or decreases. This rate is directly proportional to time. As an illustration, it is known that the activity will decrease by a factor of ten after a sevenfold increase in time. Thus after seven hours, the radioactivity will be one-tenth of the original, after two days (7 x 7 = 49 hours), it will be one-one-hundredth, after 24 days, one-one-thousandth, and so on. Consequently, when it was relatively safe, RadSafe crews returned to Rongelap and other islands and took measurements of the radioactivity there several days after the people had been evacuated. From the readings on their instruments, combined with the approximate known time when fallout ended, scientists calculated roughly how intense the radioactivity had been during the time the people were exposed. In other words, since normal decay rates are known, the present level of radioactivity known, and the rough time of when the fallout stopped was known, what scientists did was to calculate backwards, so to speak, from the period several days later, to the time when the people were still on the island. One discovery by this later survey was that the readings taken during the time of the evacuation were apparently too low by one-half, or 50 percent. This was apparently due to the fact that the instrument used at that time had not been calibrated (checked for accuracy) before it had been used. (1944, p.5)

Another discovery they made concerned the nature of "mixed fission products." The fallout was composed of many kinds of radioactive isotopes giving off gamma and beta rays of different strengths. The relative strength of these particles is

measured in kilo electron volts, or kev. On Rongelap there were found three major "energy regions," of 100, 700, and 1500 kev. That is, within the fallout on the ground there were particles which were being emitted in these three general regions (levels) of strength.

Fallout Samples

A third source of information upon which would be based whole-body doses, was actual fallout material. By studying the radioactive calcium oxide (incinerated coral) scientists determined the mixture of different radioactive elements and their energies. However, it is interesting to note that the doses calculated for all the exposed persons, according to the 1956 report by the AEC, "came from fallout samples taken soon after the detonation at points some distance from the contaminated atolls." (p.6) Why the samples were not collected from the islands on which the people were exposed was not explained.

One of the important factors in calculating the amount of radiation exposure is the length of time of the fallout itself. The only way this could be estimated was from the reading on Rongerik, and personal eyewitness estimates of time.

Based on the early and later readings at Rongerik, it appeared that the period of fallout was about 16 hours, or, a long fallout. However, other information, including reports of persons who saw the fallout, indicated that it was shorter than 16 hours and that it ended early. A long fallout also conflicted with readings taken later. Finally, it was concluded that whether or not the fallout was long, or short, the result would be nearly the same, since in a short fallout, the heavier material would descend during the same length of time as it would during a long fallout. In other words, the heaviest

part of the fallout would take about the same amount of time to descend on the island, even though the lighter parts took longer.

Ranges of fallout time and the dose that would result from them were calculated as follows:

Location	Dose in Rads* Fallout Time 16 hr.	8 hr.
Rongelap	159 r	209 r
Ailinginae	72 r	92 r
Rongerik	70 r	106 r
Utirik	12 r	15 r

Since it was believed that the fallout time was less than 16 hours, and because of data from other sources, the figure used for the report, and the reports from that time on were based on a fallout of 12 hours:**

Location	Best Estimate of Gamma Dose in Air
Rongelap	175 r
Ailinginae	69 r
Rongerik	78 r
Utirik	14 r

One additional factor of interest concerns the effect of a field, or area, of fallout as opposed to that of X-rays. Particles of a single energy from an X-ray machine come from a "point", or single source. However, particles in a fallout field, are not emitted from a single source, but many. They are emitted from a 369° circle around the person as he stands or walks and they are at different energies. It is as though the person is constantly being irradiated by X-ray machines of different energies, placed around him in a

*From "Some Effects of Ionizing Radiation on Man", p. 6

**Ibid, p. 3

circle. The significance of this kind of fallout radiation compared to normal X-radiation from a single source is that the fallout radiation has a greater effect than radiation from a single source. This is to say that the gamma radiation from fallout on Rongelap penetrated deeper and in many more places than a normal X-ray exposure would have. Thus, scientists calculated that the gamma dose received by the Marshallese and Americans was 50 percent more effective than a similar X-ray dose. To put it another way, in order to come up with what the dose in fallout was equivalent to in X-rays, the fallout dose had to be multiplied by 1.5. This means that if a person received 10 rads of fallout radiation, it was the same as receiving 15 rads of X-radiation (1.5 times 10). On this basis the best estimate doses in gamma radiation are shown below in what would be the same dose delivered by X-rays:

Location	Gamma Ray Dose		Equivalent in X-rays*
Rongelap	175 r	=	260 r
Ailinginae	69 r	=	100 r
Rongerik	78 r	=	120 r
Utirik	14 r	=	20 r

In a section of the 1956 report dealing with effects of radiation on the blood, it was stated that if the low levels of blood cell count observed was any indication, then "the effective dose received by the Rongelap people approached the lethal range." The report also mentioned that experiments on the effects of radiation on dogs showed that an additional 50 to 100 rads when the blood count is at a low level (1000 mm^2) can produce fatalities. The report also noted that although data on animals could not apply to man, and while human beings seem to be able to survive lower blood counts than 1000 mm^2 that

*From "Some Effects of Ionizing Radiation on Human Beings", p. 9

it was likely that another 75 rads of laboratory, or X-radiation, would have caused some deaths. The report concluded that the minimum lethal dose for man was probably 225 rads in a fallout field. The "best estimate" figure was used consistently, with acknowledgments, for a period covering ten years. In 1964, undoubtedly as a result of the first findings of thyroid nodules, a recalculation was carried out. This recalculation, by one Ralph A. James of the Lawrence Radiation Laboratory of the University of California, was interesting for two reasons.

First, in earlier calculations of the fallout, the dose of the cloud passing over the island could not be calculated (1956 report). Ten years later, in 1964, because of evidence from tests conducted after 1958, a recalculation was made, including the dose from the cloud. This review took into account the dose delivered as the radioactive particles passed over the islands. James, in his exposition, noted that the exact method of arriving at the original 175 rad estimate for the people of Rongelap was "not given" and that it apparently did not include "the dose from the cloud, but only from fallout" (36, p. 79). James' recalculation included dose received (based on 12 hours) from time of beginning to time of end of fallout, 114 rads; cloud passage, 47 rads; and from the fallout during cloud passage, 47 rads, a total of 208 rads. James, then, in allowing for factors which might change or alter this amount for individuals who might have remained indoors, noted that the probable dose was 175 rads, plus or minus 25 rads.

The second reason this recalculation was so important was because it dealt with and partially explained the reasons for the late development of thyroid nodules. This second aspect of the recalculation involved the amount of

radioactive material taken in by ingestion (eating) and inhalation (breathing), and are discussed in the following section.

Dose Estimates of Irradiation From Internal Sources

Like the amount of external exposure, the probable amount of radioactive material taken in and retained by the exposed persons was only an estimate at best. While the doctors and scientists studying the people could measure how much radioactivity was being carried out from their bodies by analyzing samples of urine and feces -- they could not check the actual amounts still remaining in the bone and other tissues. The only way this could be done would be to take out samples of tissue during an autopsy and measure the actual amounts. This was one of the limitations accepted by doctors when dealing with human patients. Another limitation was due to the fact that there was at that time extremely little information concerning internal deposition of radioactive elements in human beings. As mentioned in the previous chapter, despite the great death and destruction at Hiroshima and Nagasaki, only a relatively few people in the Nishiyama area of Nagasaki received internal contamination. The only other studies related to the plight of the Marshallese and Americans were those made of radium watch dial painters in the United States during the 1920's and 1930's who received high internal contamination as a result of the practice of wetting the tips of their brushes with their tongues during work. Even this information was not wholly applicable, since radium emits alpha particles, which are about four times as strong as gamma emitters like strontium and cesium. In fact, the doctors had very little to go on; it was as though they were "shooting in the dark." There was, however, one source of information which

could be related to the people, for when the Rongelapese and other affected persons were evacuated, their pigs and chickens were left behind on the island. These animals were later collected and sacrificed at various times and radiological studies made of all their tissues. With the findings from these studies, the doctors then attempted to extrapolate the information to human beings. While they realized that extrapolations from animals cannot truly represent the actual situation with humans, they at least provided a guideline. The conclusions in the 1956 report considered the possible effects of radioactive iodine, cesium and strontium. As to the effects of iodine, it was thought that the amount received was estimated to be "about 150 rep. for Rongelap group (sic) and 50 rep. for the Americans." This amount, the report said, while high, was relatively low in comparison to doses persons receive in radiation therapy. As to the other radioactive elements, such as strontium, the report concluded:

> " . . . an evaluation of the date on the internal contamination, including that of Sr^{89}, leads to the conclusion that the internal hazard to the contaminated inhabitants of the Marshall Islands is minimal both from the acute and long range point of view." (p.74) [emphasis added]

With the discovery in 1964 of thyroid nodules in exposed Rongelapese, a recalculation of the total internal dose of all radioactive elements, including radioactive iodine was made by James for children (Rongelap girls 3-4 years old). James' recalculations yielded figures considerably higher than the original estimates for he had considered a factor overlooked in earlier calculations. This factor was the relative size of the thyroid in children as opposed to adults. The earlier calculations had assumed a constant thyroid weight for all persons (about 20 grams). James, however, used a

range of weight from 1.9 to 3.1 grams for the children, which gave a "most probable" dose which ranged from 685 to 1445 rads, (including whole body radiation) and which was much higher than the 150 rep. figure first used.

Exposure to Residual Radiation

A third general area about which the Committee is concerned will be noted here. This is the amounts of radiation the Rongelapese, and to a lesser extent the Utirikese, were exposed to after being returned to their islands. There was radioactivity remaining from the "Bravo" shot in 1954 which was taken up into the ecological systems of the atolls and also additional radiation of these areas from later nuclear weapons tests. As noted earlier, the Rongelapese were kept from their island over three years and the Utirikese three months. The Rongelapese were returned on June 29, 1957, three years, three months and 26 days after they had been evacuated. Previous to their return, Holmes and Narver, at a cost of $348,375 to the AEC, had constructed a new village on Rongelap. However, it was virtually impossible to remove the radioactivity in the soil, plants, and crabs on the land and from the fish, and other fauna and flora of the lagoon.

In addition, the Rongelapese and Utirikese were exposed to radiation after their return as a result of additional tests in the area, especially from the "Redwing" series which included the explosion of thermonuclear bombs in the megaton range. As to the residual radiation remaining from "Bravo", the BNL three-year report indicated that from external sources "the dose rate at the time of repatriation (July 1957) would be less than 30 mr/week and at

[redacted]

the end of the first year the accumulated dose would probably not exceed 0.5 rem with lower doses in succeeding years." (p. 21) As to internal contamination, the report stated that if land crabs "(which selectively concentrate Sr^{90}) were eliminated from the diet" a value which "has been considered allowable by the U.S. National Academy of Sciences report."

Despite these reassuring assumptions, the Committee takes no great pleasure in noting the results of subsequent tests and examinations which indicated that body burdens of radioactivity in the Rongelapese did increase and remain relatively stable over a period of years as a result of fresh fallout. The BNL five and six year report indicated that body burdens of cesium 137 had increased by 60 times during the first year after the Rongelapese had been returned, and that strontium 90 increased by some 20 times. Even as late as 1960 the cesium levels had risen from 14.1 muC, in 1959, to 14.7 muC and was "300 time the mean of that of the medical team carrying out the study (0.048) (p. 42, seven year report). Undoubtedly a major factor in returning the Rongelapese before testing had ended was the desire of the people themselves to go home, plus the realization that the longer they stayed on Eijit the more their later life patterns would be changed. One of the Committee's consultants estimated roughly that the Rongelapese had received no more than a three percent increase in additional radiation from residual radioactivity and fallout from recent tests. He also estimated that such a small amount was not likely to be harmful. While the Committee is inclined to agree with this assumption -- and it is just that, an assumption -- it is also disinclined to agree for reasons previously mentioned but which are worth repeating at this point. The Committee believes that basically "all ionizing radiation . . .is harmful," and thus any additional

exposure -- even of 1 uuC -- should have been avoided at all costs for two reasons: 1. many of the exposed persons had already been exposed to near lethal doses of radiation, and 2. data on the effects of low doses like those received from residual radiation are virtually nonexistent. Thus to assume small additional amounts will not be harmful is to do so in the absence of statistics which support such an assumption. In connection with this, there is also no known data on the effects of subsequent irradiation of persons already exposed to near-lethal doses or of persons who after exposure constantly lived in a radioactively-contaminated environment. In this, the Rongelapese and Utirikese are unique -- for unlike the Japanese and Americans, since returning to their home islands, they have continually lived in a mildly radioactive environment.

Aspects of Findings Over the Past 18 Years

The Special Joint Committee, through the courtesy of Dr. Robert A. Conard of BNL, has had available to it copies of most of the reports and articles published by that institution under contract to the Atomic Energy Commission. As mentioned earlier, they are quite extensive in scope and detail as well as being, for the most part, very technical in nature. Rather than review each report individually, however, the Committee has chosen to study only certain of the medical aspects of the annual examinations, to wit: effects on the blood cells, genetic effects, miscarriages, stillbirths, fertility, growth and development, effects on the thyroid, and miscellaneous considerations.

Effects on the Blood

Aside from initial acute effects on the blood of the exposed people, causing the number of certain kinds of blood cells to drop dramatically to dangerously low levels, there were found to be other effects which, while not themselves debilitating, were an indication of what are most likely permanent changes made by ionizing radiation. These may or may not be indicators of diseases which could develop in the future, like leukemia. Some of the changes noted in studies of blood from exposed persons included lower white blood cell counts than those of unexposed persons. According to the 1969 report, this "implies a residual radiation effect on the bone marrow." In other words, either from both the initial whole body radiation, and/or later internal contamination, by such elements as Sr^{90} being deposited in the bone, the ability of the marrow to produce these cells has been affected. Other abnormalities and aberrations found in elements of the blood included:

> "An alteration in the myeloid-erythroid ratio (increased red cell precursors, presence of cells with abnormal chromatin material and double nuclei, and also increased mitosis. Examination of peripheral blood smears revealed increased numbers of atypical lymphocytes in the exposed people and an unexplained increase in these forms in the children of exposed parents. Also, chromosome studies at 10 years post exposure revealed a high incidence of aneuploid cells and 2-hit aberrations in the blood of the exposed group." (p. 47)

Of particular interest is the fact that the blood of the children of exposed parents, who were themselves not exposed, is also showing unusual forms of lymphocytes. Two possible reasons for these changes are 1. the irradiation of the parents caused damage in the genetic material of the sex, or germ cells which were then passed on to the children who, in turn, produce mutated forms of the cells, or 2. by virtue of their living in a radioactively-contaminated environment -- even though the levels are alleged to be within the tolerance

of human beings -- the residual radioactivity, while small, has been sufficient to cause these observed abnormalities. So far as it is known, no genetic studies of germ cell material has ever been made in the Marshallese affected, therefore, it will be difficult, if not impossible, to connect any possible future developments in later generations with exposure of their antecedents. Since this is an important aspect both scientifically, and in a practical sense for the health and peace of mind of the exposed persons, the Committee finds it difficult to understand why no such studies have been made. Further elaboration on material concerning this aspect will be developed in the section immediately following this one.

Genetic Studies

In the three year report of 1957, the pattern was set for the rest of the reports concerning the possibility and desirability of doing genetic studies on the exposed Marshallese. It was stated that genetic studies of children of exposed Japanese in Hiroshima and Nagasaki "failed to show any significant abnormalities." The report further stated that no abnormalities had been found in the 13 children born of exposed Marshallese since the fallout occurred. The report then listed three reasons why genetic studies would be both desirable and "fruitful", i.e.:

> "1) The people live together as a unit and thus are easily available from year to year for study. 2) They appear to be a rather homogeneous race anthropologically, having lived in the Marshall Islands for about 2000 years with little outside intercourse. Intermarriage for such a period of time tends to produce genetic homogeneity. Height, skin color, and features are fairly uniform. 3) Consanguinous marriages are prevalent . . . and have produced a backlog of 'bad' genes as evidence by the high incidence of congential abnormalities. Radiation induced mutations would be likely to be reinforced by such marriages." (p. 20)

Even in consideration of all these aspects favorable to such a study, the concluding paragraph in that section of the report listed a single reason for not conducting such studies.

> "In spite of these factors, the small numbers of people involved in this study (compared to the large numbers in the Japanese studies) make it unlikely that these studies will be fruitful."

In effect, then, the exposed Marshallese because of the three factors mentioned, represent an almost ideal group to study for genetic effects with the exception of the overriding factor that the group is too small in number for any developments to be statistically significant. While the Committee is appreciative of the constraints imposed by both the rules and mechanics which govern the statistical analysis -- it believes that there are more than just statistical significance, accuracy, or validity at stake here, viz., the overriding consideration in these studies should be the concern for the future welfare and peace of mind of those persons exposed and their descendants. The Committee believes that the arguments <u>for</u> having such studies far outweight the arguments <u>against</u> such. They are:

1. An absence of observed abnormalities in first generation children (in Japan) does not preclude the possibility of later developments in either the second or third generations. This is possibly indicated by the fact that children of exposed Marshallese exhibit blood cell abnormalities.

2. Data on Japanese possibly may not be relevant since almost all exposures were external, one-time and primarily due to neutron and gamma rays. The Marshallese were exposed to a considerable amount of radiation from internal contamination from long-lived fission products, over a longer period of time.

3. The assumption that it would be "unlikely" that such studies would be fruitful, does not rule out the possibility of their actually being fruitful. Should such studies in fact yield no information, that in itself is a finding, and would give some comfort to future descendants of those exposed.

4. The earlier cases of thyroid abnormalities, and the later development of one case of acute myelogenous leukemia tend to reinforce the assumption that other kinds of late effects may develop. Since studies of germ cells would add to the general knowledge of either indicators or actual mechanisms connected with these diseases, the information in itself is valuable. That is to say, the more data at hand not only help to indicate whether a person contracts a disease as a result of irradiation, but may also indicate how the disease developed, and whether it is one that can be predicted or genetically transmitted.

5. While the one death from leukemia which has occurred may not be statiscally significant, and while in no way can it pathologically be proven that this disease was related to the patient's exposure, it would seem to be almost impossible to state the converse, that the case of leukemia was not caused by the person's irradiation. All the circumstances and evidence would tend to support a connection. It would take the appearance of only one more such case for the connection to be conclusive.

The Committee is, conversely, aware that there are certain monetary and sociological factors involved, which have not yet been touched. This will be mentioned in later discussion. For the record, however, the Committee is of the disposition that if a decision to do or not to do something in this case is a matter of statistics, or general health and welfare of the people, it

would prefer to "err" in favor of humanitarian concerns rather than on that of statistical data.

6. During the hearings on the effects of fallout on man in the United States Congress, a recurrent refrain was the lack of the effect of low doses of radiation on human beings. These statements belie another refrain consistently repeated in the annual reports to justify the less extensive examination of the Utirikese, namely, due to the small amount of radiation they supposedly received. Considering that it is acknowledged by experts on the subject, both within and without the AEC, that in terms of genetics, any dose of radiation is ultimately harmful, it is difficult to understand why the annual surveys of the Utirikese are not equivalent to those of their neighbors in the eastern chain of the Marshalls. Again, perhaps, the supposed importance of "statistical significance" is the reason. The Committee is basically not in agreement with this position, and would rather see the people of Utirik receive more comprehensive and more frequent examinations.

Miscarriages, Stillbirths, and Fertility

There were some reports which discounted the possibility that long term effects would appear, because they supposed that internal contamination had been small. Some reports discounted or minimized the possibility that exposure of women to irradiation had caused miscarriages. The two reasons for the latter view were: (1) lack of statistical data, and (2) inability to examine the "products", that is, fetuses delivered, because no doctor was available or aware of the miscarriage. The three year report indicated that, despite one miscarriage and two infant deaths according to limited statistics, "this

incidence does not seem greater than that in unexposed Marshallese people." (p. 18) This statement was revised somewhat in the five and six year report after review of a table summarizing information concerning 1958 pregnancy terminations. The table showed that exposed Rongelap women had fewer live births, more miscarriages without live births, fewer recorded pregnancies, more women with one or more, or two or more miscarriages, and more pregnancies terminating in miscarriages than an unexposed control group. Especially significant was the fact that 41 percent of exposed Rongelap women who were pregnant had one or more miscarriages, while unexposed Rongelap women during the same period had only 28 percent of pregnancies end in miscarriages. The report noted that "The date on pregnancy terminations . . . also show an increased incidence of miscarriage in the exposed group."

As to stillbirths and miscarriages in general, when the people themselves were questioned, they seemed to feel that there was an increase. On Rongelap, in particular, the people mentioned four instances of unusual deliveries after the bomb: one woman (supposedly irradiated during the first three months) delivered a "grape-like" mass; another (supposedly irradiated at nine months) delivered a baby whose brains were outside of the skull; another woman's baby was born with a deformed leg and later died; and a fourth woman (irradiated at five months on Ailinginae) delivered a baby whose eyes protruded from its head, making it look like an "octopus." A check of health records later indicated that the baby with the deformed leg whose mother was said to have been irradiated at nine months, was born on August 17, 1960. Since so long a time had passed since the incident, it is possible that faulty memory has something to do with these stories -- however, it is equally possible that since no doctor was available to examine these stillbirths and reported

abnormalities at the time of delivery, that they did, indeed, occur and were perhaps due to irradiation of one or more of the parents.

As to fertility, the final word was written in the three year report which said that "It is entirely possible that a temporary loss of fertility may have occurred shortly after exposure in some of the people." This possibility, however, according to the report, will never be known because of the oft-mentioned lack of "satisfactory vital statistics" and because the numbers of individuals are too small to reach any definite conclusions. Rather, in consideration of the evidence of temporary sterility induced in Japanese fishermen as found by Kumatori, the Committee believes that "entirely possible" should be changed to "almost certainly." Aside from the increased incidence of stillbirths and miscarriages recorded in early years, there appear to be no long term effects in this area. One possibility which cannot be entirely discounted is the likelihood that there were even more stillbirths and miscarriages not reported and that it is likely some of them were caused by irradiation of one or more of the parents.

Growth and Development

Of particular interest to the Committee were the survey findings connected with growth retardation of exposed children. This development was acknowledged as early as the 1956 report which recorded weight loss during the first six weeks after exposure in persons under 16 years of age. (p. 22) The 1957 report at three years expressed the sense, as the reports do with many areas, that it is "difficult to evaluate the effects of the radiation exposure on growth and development because of the small numbers of children involved." (p. 18) Weight and height differences in children 4-10 years old were

inconclusive, although "bone development studies seem to indicate a slight degree of retardation in the exposed group." (p. 18) The report discounted the possibility that such retardation was due to internal absorption of isotopes, or due to external beta activity. What seemed most likely was that since the children were smaller and thinner than adults, they received higher amounts of penetrating radiation than adults and that this, while not enough to affect the bone itself, may have affected some hormone-producing gland, such as the thyroid, which then affected growth. These tentative findings were further complicated as noted in the four year report which stated that a slight lag in development of some children was being reevaluated since there was "uncertainty in the ages of some of the children." (p. 28) The five and six year report indicated continuing difficulty in trying to determine the exact ages of some of the children. Despite this "It was noted, however, that in the 6-year chonological age group three boys and one girl out of five boys and two girls exposed to radiation were markedly retarded in skeletal maturation." (p. 20) This report concluded

> "It might be speculated from these limited observations that these children were exposed to radiation at a particularly vulnerable age and that the resulting retardation in osseous development led to failure in statural growth. On the other hand, it is not possible to exclude completely the possibility that some process unrelated to radiation damage was responsible for the retardation in skeletal development." (p. 23)

This hesitancy to ascribe growth retardation to the effects of radiation may have stemmed from early newspaper reports which indicated that the people had been severely stunted by their exposure. This was indicated in the 1957 congressional hearings on fallout by Dr. Cronkite who had participated in the first survey and who is a senior member of the BNL staff today.

> "There does appear to be a statistical evidence suggestive of slight impairment of growth and development as measured by a comparison of height and weight in the control and exposed children. You cannot look at these children and pick out any abnormalities.
>
> "I would like to comment on this rather emphatically, because of the headlines that I saw a few minutes ago. There is no gross stunting of the growth. It can only be detected by a careful statistical anlaysis of the data, by taking measurements of height and weight." (p. 51)

The seven year report repeated the same information as the earlier two year report, adding that studies were not yet completed to determine the ages of certain children. The eight year report dealt extensively with growth retardation noting several cases where growth was "significantly" retarded. This report also noted that "It was interesting that the boys born soon after the fallout had more retarded skeletal ages than those born more recently." (p. 21) The section concluded that the differences "were not statistically significant and the data available at this time would not support any conclusion concerning factors related to the retardation of skeletal maturity in these boys." (p. 21) [emphasis added]. The nine and ten year report was more conservative in nature. It noted:

> "The slight retardation of growth in the male children who were exposed when (less than) five years of age as compared with unexposed males of the same age suggests that radiation may be a causal factor although possible mechanisms are not clear."

Perhaps, due to the not amazing but unsuspected development of thyroid nodules in the Rongelapese during the tenth examination (1964), a little attention was given immediately to growth development. The next report dealing with the eleventh and twelfth examinations (1965 and 1966) however, considered this area extensively.

During the 1965 survey, because of the development of thyroid nodules in many of the exposed people, it was decided to give thyroid hormone to possibly help induce regression of the nodules and to also stimulate growth in the

retarded children.

> "Accordingly, at the time of the September 1965 survey, the 55 people in the more heavily exposed group were started on L-thyroxine at a daily dose of 0.3 mg to all people (less than) 50 years of age and 0.2 mg to all people (more than) 50."

Thus it was nearly nine years after discovery of indications of growth retardation that medication was first administered. The results, especially for one of the two boys who not only showed marked retardation, but also developed thyroid function problems, was startling. Cases nos. 3 and 5 showed "definite" spurts in growth, and there was a "remarkable change in appearance of no. 3 after thyroid hormone therapy for 6 months." (p. 40)

The thirteen, fourteen and fifteen year report noted that as early as 1964 (ten year report) these two boys "had developed obvious atrophy of the thyroid gland with an almost complete loss of thyroid function . . . By this time their blood had low thyroxine and very high TSH levels. They showed body dysgenesis, sluggish Achilles tendon reflexes, puffy faces, and dry skin." (p. 25) For some reason, however, this was <u>not noted</u> in the 1964 report; in fact, that report states in a photo caption that "The retarded boy shows no evidence of <u>hyper</u>thyroidism or skeletal disease clinically, other than markedly delayed osseous maturation." (p. 24) [emphasis added] The Committee finds itself puzzled about how, during the 1964 survey, the boy is noted as not having <u>hyper</u>-thyroidism and yet in a later report was supposed to have been at that time in a <u>hypo</u>thyroid condition.

The implications of these findings and treatment regarding growth and development will be discussed in the final section of the report.

Thyroid Abnormalities

Small growths (neoplasms) were felt in the thyroids of three young girls at 9 and 10 years post exposure. They were subsequently operated upon and their thyroids totally or partially removed. Since that time in 1963, operations for thyroid nodules have been performed on 20 people, 17 from the Rongelap exposed, one from Ailinginae, one from Utirik, and one person from Rongelap not exposed to the original fallout. While it is generally acknowledged that most of these nodules are nonmalignant (not cancerous), the operations were performed for two reasons, (1) to check for possible malignancy, and (2) for removal based on the fact that the thyroids were no longer functioning and to anticipate the possibility of the growths turning malignant at a later date. In all, four of these nodules were found to have "malignant lesions" according to a report from Dr. Conard. (See appendix summarizing the 1972 survey).

As explained before, it was known that the thyroids of the persons had been exposed to doses near or above tolerance. However, especially in the case of exposed children, the differing size of the thyroid was not taken into consideration and this resulted in little expectation of later nodule development. Despite this fact, and probably in consideration of thyroid findings in exposed Japanese at Hiroshima and Nagasaki, the thyroid was watched carefully in all of the surveys and various tests were conducted to try and locate -- short of surgery -- any possible abnormalities. These tests, however, failed to indicate any future possible problems because of the presence of an unusually high amount of certain chemicals (iodoprotein) in the Marshallese compared to Americans. Thus it was that the eleven and twelve year report commented that:

"Minimal hypofunction of the gland may have been missed in the past, since the apparently normal PBI (Protein-Bound Iodine) levels may have been spuriously high, the true thyroxine level being masked by the elevated iodoprotein component charactersitic of the Marshallese." (p. 42) [emphasis added]

While it cannot be stated with any certainty that no new thyroid nodules will be found (two new possible cases were found during the 1972 survey) it is most likely that if they are found, they will be in persons who were less than ten years of age when exposed, although so far there have been three cases (including one on Utirik) in persons older than 20 years and one case in persons older than 10 years (12 years old, exposed on Ailinginae). This has been borne out in the case of the Lucky Dragon fishermen who have not developed such nodules. This may be due to their generally older age (18-39) and possibly due to the fact that much of their drinking water, unlike that of the Marshallese, may have come from water tanks not affected by fallout.

At present, as for the most part in the past, surgery is carried out in the United States by experts in the field, such as Dr. Brown Dobyns at the Cleveland Metropolitan Memorial Hospital, and Dr. Bentley Colcock of the Lahey Clinic. The Committee, however, in reviewing the reports, takes special note of one case, no. 21, who was operated on at the U.S. Naval Hospital in Guam during August of 1964. In Appendix 6, Hospital Summaries of Thyroid Surgical Cases, eleven and twelve year report, page 96, the summary indicates that "One parathyroid gland was identified after its pedicle was divided . . . and this was implanted in the belly of the right sternomastoid gland. No other parathyroids were seen, and none were subsequently found in the specimen by the pathologist." Later reactions of the patient indicated that the parathyroid

replantation failed to take and consequently the person must receive medication for parathyroid function, in addition to thyroxine for thyroid function, for the rest of her life. The Committee has asked Dr. Conard about the circumstances surrounding this apparent accidental removal of an unaffected gland, as part of a series of questions concerning the past medical reports. Because of the large number of questions (about 100) and the submission during December, 1972, the answers have not yet been received, but will be included, if relevant, in subsequent reports by the Committee.

In conclusion, it can be seen that the development of thyroid nodules which was connected with other conditions (growth retardation) was one of the important early findings and one which still bears constant watching for the future health of these people.

Leukemia

During the September, 1972, survey, one 19 year old Marshallese youth was found to have a low white blood cell count when examined on Rongelap. This person, Lekoj Anjain, the son of the former Rongelap Magistrate John Anjain, had been operated on for partial removal of his thyroid gland in August, 1968. Listed as Rongelap Case no. 54, he was admitted on August 4, 1968, to Brookhaven Hospital, and discharged 26 days later on August 30th. The hospital summary from Brookhaven, signed by Dr. Conard, indicated that he had "been very inconsistent in taking (thyroxine)." At the end of the summary, it was noted by Dr. Conard that he was "To continue thyroid hormone therapy for life. A letter was sent to the Marshallese practitioner in charge of this patient stressing the importance of continued thyroid hormone treatment." (p. 72) According to a communication from Dr. Conard, when last seen in 1971,

Lekoj "was found to be healthy." However, during this survey he was taken into Majuro with the team because of the low cell count and there another blood test was given. This second one showed the count even lower than it had been on Rongelap. Arrangements were then made to take him to Tripler Army Hospital in Honolulu, where attempts to get a "successful bone marrow examination" failed and "we decided to take him back to Brookhaven National Laboratory," according to Dr. Conard. There the diagnosis of acute myelogenous leukemia was determined after which arrangements were made to have Lekoj treated at the National Cancer Institute, Clinical Center in Bethesda, Maryland, where he was taken on October 3, 1972. There, on the thirteenth floor of Building No. Ten, on November 15, 1972, 18 years and seven months after his exposure, Lekoj Anjain died of pneumonia during "attempts to induce remission of his leukemia," according to a BNL release of the following day.

This is the first such case of this type of blood cancer to appear in any of the Marshallese or Japanese exposed to "Bravo's" fallout. Whether it is a single incident, related or unrelated to exposure to ionizing radiation from fallout, cannot be stated for certain. Future findings, or the lack of such, will undoubtedly be the determining factor. Needless to say, because of the higher incidence of leukemia in Japanese exposed to atomic bombs, the situation bears watching with the most careful attention.

Miscellaneous Considerations

Since the inception and carrying out of the regular annual surveys of the Rongelapese and biannual and triannual surveys of the Utirik people, certain difficulties connected with the examinations have been noted in the BNL reports.

In the three year report these included:

1. The language barrier, although the team was aided by interpreters.

2. Lack of vital statistics concerning births, deaths, etc., which would help in evaluating medical findings.

3. Related to no. 2 is the unreliability or absence of records of exact ages of some of the Marshallese.

4. Unhygienic living conditions also complicated the medical picture (the presence of parasites, chronic skin diseases, and poor oral hygiene).

5. Lack of a good comparison, or control group (this was later solved when a number of Rongelapese and Utirikese who were not exposed moved back with the exposed people.)

In all of the subsequent reports, the first three problems are repeatedly listed as being continuing difficulties. Of special interest were additional comments regarding the attitudes and questions of the Rongelapese and Utirikese, which appeared in the five and six year report (1959 survey) and the seven year report (1961 survey). Because these reports are extremely important in characterizing certain issues connected with the surveys in the past, they are reproduced here completely, with no summarizing:

From the 1959 report: (p.6)

"ATTITUDES OF RONGELAP PEOPLE

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

[redacted]

the prime source of income, there was some concern over the slowness with which the people were getting back on their feet economically. It had become necessary to extend food subsistence beyond the time originally planned. Fishing was not being carried on as actively as it should have been.

"At the village meeting the main questions centered around the necessity for the continued medical examinations in view of statements on the part of the medical team in the past that the people were generally in good health. It was difficult to explain to them that, although they appeared to be in good health and to have recovered from the acute effects of radiation, very little was known about the possible late effects of radiation, and continued examinations were essential in order to detect and treat any untoward effects, should they arise. The coconut crab problem was brought up again, and the reasons for prohibiting their consumption carefully explained through the interpreter. To correct a misconception that several cases of fish poisoning during the past year had been due to eating radioactive fish, it was explained that fish poisoning had been going on in these islands for years and was not connected with radioactivity. After much discussion, it seemed that the people were satisfied with answers to the questions, and preparations for the examinations proceeded. Thereafter complete cooperation and the usual friendly relations prevailed throughout the stay on the island.

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

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

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

and from the 1961 report: (p.7)

"On arrival, an outrigger canoe came alongside the ship with the Magistrate of the village, who came aboard. The objectives of our visit to Rongelap were discussed with him, and it was considered advisable to hold a village meeting so that the proposed examinations could be explained to the people and any questions they might have could be answered.

"During the village meeting, held in the Council House, the medical examinations to be conducted and the reasons for them were explained. The people expressed continued concern about the effects of fallout on their health, but to no greater extent than at meetings during past surveys. As in the past, they claimed that fish poisoning was related to the fallout, and said that certain fish have a black spot in their abdomens, which they believe to be due to radioactivity and to cause sickness in those eating such fish. It was again explained to them that fish poisoning was in no way related to the fallout. A new complaint was that several families had developed inflammation and blistering of the mouth and upset stomachs from eating arrowroot flour which they felt was affected by fallout. It was explained that this type of effect has been noted in other islands when the flour is not properly prepared. They asked whether coconut crabs could be eaten yet and were told that these were still not safe but that continuous tests would be carried out and that they would be informed when the crabs had reached a low enough level of contamination. This is the only item in their diet which they are forbidden to eat. Another complaint was that the coconuts were small and that certain changes had been noted in the coconut and pandanus trees which they believed resulted from fallout.

"Despite the above complaints the people were very friendly and cooperated with the examining team in all aspects of the examination that followed."

No other problems with the examinations or with the people are mentioned in subsequent reports with two exceptions. There is a brief mention in the eleven and twelve year report that, "The conditions of field examinations naturally limit the procedures and methods that can be used." In the thirteen, fourteen and fifteen year report it was noted, in connection with the lack of vital statistics, that "Trust Territory officials are attempting to improve registration of such data."

The Committee is particularly interested in these mentions of problems connected with the attitude of the people being examined. It is noteworthy that the first such mention in a report came five years after exposure, and the second mention only two years later, at seven years. The Committee discussed some of these problems with Dr. Conard, as will be mentioned in the section dealing with the September 1972 survey.

Radioactive Coconut Crabs

One of the few anomalies which has resulted from the radioactive fallout persists even today. The coconut crabs of Rongelap Atoll, called birgus latro, or, the robber crab, have retained significant amounts of radioactivity to this day. This is in part due to these crabs feeding on material which contains long lived radioactive isotopes like strontium and cesium. The cesium 137 tends to concentrate in the muscle of the crab, while the strontium concentrates in the carapace, or shell (in effect, the strontium locates in the calcium-rich shell, just as it does in the bones of human beings. The shell of the crab is actually the outer, or ectoskeleton, the equivalent of the internal human skeleton. What has made this creature become a dietary item forbidden to the Rongelapese is the crabs' habit of eating their own shells which they have sloughed off, or discarded periodically. In this manner, they manage to retain a relatively high amount of radioactivity in the shells and thus the Rongelapese have been told not to eat them. During the 1972 survey, Dr. Conard brought the Rongelapese what appeared to be good news concerning this crab, rightly considered by the people to be a delicacy. He told them that the crabs from Rongelap and a neighboring island could now be eaten at a rate of one per person per day. The crabs from other islands on the atoll, he indicated, would still remain on the restricted list until radiological analyses showed that they were safe to eat.

The 1972 Annual Survey of Rongelap and Utirik

The events leading up to the delay of the regular 1972 survey which normally would have taken place in March of that year, and leading to the

creation of the Special Joint Committee Concerning Rongelap and Utirik Atolls of the Congress of Micronesia under Public Law No. 4C-33 have already been outlined in the Committee's Interim Report of May 16, 1972. However, since only a limited number of copies (100) of that report were printed, and since other developments have transpired since that time, the Committee feels a brief review for background purposes should be included here.

The Interim Report indicated that in 1971, Congressman Ataji Balos in whose representative district live the Rongelapese, had invited a Japanese survey team headed by a Dr. Ezaki and a Dr Honda to study the victims of the 1954 fallout. He had invited the team, he said, because the peoples of Rongelap and Utirik had become suspicious that the AEC-sponsored team was not treating them properly, as indicated in the preceding section. His idea was to invite the Japanese team in order to provide comparative medical opinions. In November, 1971, Representative Balos attempted to secure permission for the entry of the Japanese from the Trust Territory Government. By December no answer had been received, and the Japanese in their impatience to come, entered the Trust Territory with tourist permits, hoping to straighten out their status after arrival. No small amount of confusion then ensued. First, the acting Attorney General ruled that they did not appear to be a bona fide medical survey team and thus cables flew back and forth between Majuro and Saipan. Finally, the acting Attorney General reversed his approach and ruled that the group was indeed a research team, but because they had entered under a tourist permit could not change their status and would have to return to Japan. This they did, without completing any extensive examinations.

On January 26, 1972, during the Second Regular Session of the Fourth Congress of Micronesia, in Palau District, Congressman Balos delivered a speech on the

floor of the House of Representatives in which he charged that the United States had intentionally exposed the people of Rongelap and Utirik to radiation and that they were being used as "guinea pigs." In his remarks he also related the fate of the Japanese group in December and called upon the World Health Organization to conduct a survey of the people. At this same time, he introduced a bill which later became P.L. No. 4C-33. The speech caused considerable controversy which resulted in meetings between the Congressman and the executive branch, in Palau, where it was agreed that three Japanese doctors would be requested to accompany the regular Brookhaven survey team. Unfortunately, when the survey was attempted in March only one Japanese doctor, a Dr. Hayakawa, was present. Dr. Toshiyuki Kumatori had also been invited but would arrive late by plan. Dr. Haruo Ezaki who also had been invited, was unable to attend. At that point, with only one Japanese doctor with the team, and a doctor with little or no experience in the fields of thyroid or radiation medicine, Congressman Balos and Congressman Charles Domnick, who represents the people of Utirik, asked the people not to submit to examination and the survey was cancelled.

On April 14, 1972, House Bill No. 199, H.D.1, automatically became law without the signature of the High Commissioner and on April 17, 1972, the three members appointed by the Presiding Officers of the Congress: Senator Olympio T. Borja, and Representatives Hans Wiliander and Timothy Olkeriil, met on Saipan for an organizational meeting. Also attending the meeting was Representative Balos. Senator Borja was elected Chairman and Representative Balos was appointed by the Committee to serve as its interpreter/informant.

On April 19, 1972, through former Director of Health Services, Dr. William Peck, the Committee was honored to meet with the Surgeon General of the United

States, Dr. Jesse L. Steinfeld, who had come to visit the Trust Territory to see what programs or projects of the Health Education and Welfare Department could be developed in Micronesia. The Committee was very impressed by his open and helpful manner. This was evidenced by his offers to commit the resources of his office upon request by the Committee to carry out the following:

1. Assemble a medical survey team from the resources of the United States Public Health Service which would conduct a survey independent of the BNL survey; and continue conducting the annual examinations in the future, if requested.

2. Provide a qualified medical consultant to the Special Joint Committee from PHS. (This consultant would later accompany the Committee to Rongelap and Utirik and also accompany the Committee during the completed 1972 survey in September).

3. Field a radiological survey team which could study radiation levels at Bikini and Enewetok Atolls before the people were returned to them.

On Saipan, the Committee was also pleased to later meet, through Dr. Peck, Dr. Knud Knudsen, of Brookhaven National Laboratory. Dr. Knudsen had chosen to take his sabbatical from BNL by being stationed for one year on Kwajalein, Marshall Islands, so that he could do a follow-up examination of the people on Rongelap and Utirik and check the accuracy of vital statistics. Also, most of his time would be spent on Ebeye, helping out at the Trust Territory health facility there.

By May 16, 1972, the Committee had issued its Interim Report as called for by the public law. Among the points and recommendations made in that report were:

1. The sense that the health of the people of Rongelap and Utirik were of "utmost importance."

2. An agreement with the High Commissioner that a doctor from the World Health Organization and Dr. Ezaki from Japan shoud accompany the Brookhaven team at "the earliest date possible," and recommended the addition of an American doctor from the U.S. Public Health Service.

3. The Committee would seek medical consultants from Japan and the U.S.

4. The Committee would make a trip to Japan to study treatment of A-bomb survivors, and make a trip in July to the islands of Rongelap and Utirik in the Marshall Islands District.

By the end of July the Committee had completed its travel and in conjunction with the High Commissioner's Office had requested the presence of four consultants to travel with the Brookhaven team on behalf of the Committee as soon as possible.

These consultants were: Dr. Haruo Ezaki, Dr. Toshiyuki Kumatori, Dr. William S. Cole of the U.S.P.H.S., who had traveled with the Committee to the Marshalls in July, and Dr. E.E. Pochin, Director of the British Medical Research Council's Department of Clinical Research at the University College Hospital Medical School, London, England. Dr. Pochin, while not representing the World Health Organization directly, had worked as a consultant to it previously and was recommended by WHO. Contact was also established with Dr. Conard of Brookhaven, who subsequently indicated approval by his institution and the AEC of the consultants accompanying the team and proposed a starting date of September 7, 1972. Despite some apprehension on the part of the Committee that some of the consultants would not be able to handle the red

tape involved by that date, all of them were able to arrive on schedule.

At 15:00 hours on September 9, 1972 (local time) the Brookhaven team, the Committee members and staff, and the Committee's consultants departed Ebeye aboard the M/V Militobi, Captain Willie M. Poznanski, Master. The ship arrived at Rongelap at 07:00 hours (local time) on September 10, 1972.

Dr. Conard was a Navy Captain (now Commander) at the time he participated in the first survey in 1954. Since 1957 he has headed the annual medical surveys. On this particular trip his colleagues included: Dr. Knud Knudsen of Brookhaven, Dr. Larsen, a thyroid specialist, Dr. Wataru W. Sutow, a pediatrician from M.D. Anderson Hospital, University of Texas, and Dr. Austin Lowery, U.S.A. (ret.). Providing technical assistance to the BNL team were Doug Clareus, William A. Scott, and Mike Makar of Brookhaven. From the Trust Territory were Dr. Ezra Riklon, Dr. Jetton Anjain, Dental Officer, Kimura Riklon, Dental Aide, Assistant Medical Repair Specialist Kosang Mizutoni, Laboratory Technicians Sebio Shoniber and Nelson Zetika, and Joe Saul, Health Aide.

By previous arrangement with Dr. Conard, the Committee's medical team ate, slept, and worked with the other members of the crew in their quarters and facilities on Rongelap. They consist of a trailer which is a combination mess hall and X-ray room, an A-frame sleeping quarters, a building which houses a jeep, trailer and small bulldozer, along with a 40 kw generator, and another large trailer used for examinations, and a small trailer in which blood samples are taken and prepared.

The Committee, in order not to interfere with the normal routine of the team, ate and slept aboard the Militobi and only made trips to the island in

order to briefly observe the activities of the team or to meet with the people of Rongelap.

Later that day arrangements were made to have a meeting with the people of the island at 6:30 p.m. At that meeting the purpose of the Committee's accompaniment of the team, and the presence of the consultants was explained. The Committee asked the people, for their own health and welfare, to cooperate with the examinations. The consultants then introduced themselves. Dr. Conard talked about the work they would be doing and introduced the doctors on his team. He made three announcements: (1) sick call would be at 8:00 a.m. every morning; (2) a feast would be held the following night and at the same time (3) a movie would be shown. He also announced that due to radiological analysis of crabs taken last year, the people of Rongelap would be able to eat the crabs from Rongelap and Arbar islands at the rate of one crab per person per day. Then he opened the meeting to questions.

One questioner stated that they wanted someone to look after them all the time and they hoped that full responsibility would be given to the AEC to do this. Dr. Conard replied that Dr. Knudsen was stationed on Kwajalein for a year. He said he hoped this practice could be maintained all the time, but that it was difficult to find doctors willing to come out and do such work.

Another questioner asked why, if the team is really interested in their health, there is only one examination a year. Dr. Conard replied that "We are doing our best under the circumstances."

A last questioner asked why there was only one crab per person per day allowed. Were they still radioactive? Dr. Conard replied that, "Yes, they were, but only slightly, and that they would take some back this year from Eniaetok to see if they could be declared safe.

On Tuesday, September 12, it was decided that the team would not depart the following day, but on Thursday. That evening a feast, hosted by the BNL team was given for the Rongelapese. Doctor Conard and his crew and the Committee's consultants manned the serving line for the people and passed out the food prepared by the team. It consisted of hot dogs, beans, rice, orange juice, sashimi, donuts, and coconuts.

On Wednesday, September 13, the Committee met informally with the island's magistrate. During the discussion the following points were brought out. While the people have learned to expect the team in March and are usually informed ahead of time they are never asked for permission to let the team come on the island. Relative to this, the team never meets with the magistrate and the council, but rather calls an island meeting. Usually, they are asked to provide some local food, but were not asked this time. Finally, they are usually told the same things: there will be sick call; there will be a feast; there will be a movie. The Committee then made arrangements to meet with the magistrate and council the following morning at 9:30 a.m. at the Prostestant Church. The points made during the meeting were:

1. The people would like the doctor who is on Kwajalein to be stationed on Rongelap.

2. The people question whether or not the crabs are safe to eat since there is still a limitation. Many people still do not eat killer clams today because they were apparently told not to do so upon their return to the island in 1957. They would like someone to come and study the soil, plants, trees, fish, etc., to tell them if these things are really safe to eat.

3. Some people expressed their general feeling about the survey. They said that the general attitude is the same as in the past. They (the team) come and do as they want. One person said that he is afraid of Dr. Conard. The general feeling is that the team acts as though they own the island when they come for the survey.

At 14:30 with everyone aboard, the Militobi departed Rongelap for Utirik. Unknown to the Committee, young Lekoj Anjain was also aboard. Unknown to Lekoj, as the ship left the lagoon and Rongelap fell from sight, it would be the last time he would ever see his home.

The Militobi weighed anchor at Utirik Island at 10:30 on September 15, 1972, after Captain Poznanski had guided it through the treacherous passage in the atoll's reef. A meeting with the magistrate and people of Utirik was arranged and held at 17:30 hours.

A brief statement was made by the Committee and its consultants were introduced. Dr. Conard then did the same and introduced the members of his team. He announced that there would be a daily sick call, that there would be a movie, and that there would be a party before they left. The Committee then asked if there were any questions from the people.

One questioner asked Dr. Conard if the people still had radioactivity in their bodies. Dr. Conard replied that all people have radioactivity in their bodies, that the people of Utirik received a small amount of radioactivity from fallout, and that the amount that they have is below the amount that is hazardous to man.

A second question was: How did the people of Utirik compare with the people of Rongelap? Dr. Conard explained that the Rongelapese receive about

175 rads and the Utirikese, 14. Many people in the U.S., he said, receive as much as 14 rads in a normal medical examination.

On the next day, Saturday, September 16, 1972, the Committee met informally with one of the island leaders. The discussion centered primarily around the question of compensation. It was noted that this was only the second time they were to have a party with the team. The people, it was noted, are not asked if they want the party. The question was asked if they liked the parties and the answer was, "Well, there is food, so we go." Was there enough food, he was asked? The reply was, "No, not enough."

On Monday, September 18, the Committee met with Dr. Conard in the afternoon. He explained that there were some people from Rongelap and Utirik who would be traveling on the ship because of "general medical findings" and who would be treated in Majuro. He stated that there were no new findings since the last complete survey in 1969 (of Utirik). He also added that general sanitation on the islands was poor, that the health aide was short of medicine (there was not even aspirin on Majuro, he noted), and that Dr. Ezra Riklon was trying to implement a procedure of having a standardized list of drugs which could be checked on every field trip.

The Committee then discussed several matters with Dr. Conard.

He was asked if he thought that Dr. Knudsen would be able to stay one or two weeks on Rongelap and Utirik. Dr. Conard noted that Knudsen would be traveling to the islands on the field trip ship and would look at the people for radiation and other problems. He was asked if AEC or Brookhaven could continue this program. Dr. Conard said he doubted it, since it would be

difficult to recruit someone to do this. The doctor was asked if it would be good to have Medical Officers of the Trust Territory trained in certain techniques of examination and sent out on field trip vessels to give the same kind of attention as Dr. Knudsen. Dr. Conard replied in the affirmative.

Dr. Conard was then informed that the Rongelapese still had reservations about eating the coconut crab. He reiterated that the quota was based on the assumption that no one would eat more than the equivalent of one per day per person and that tests had shown that it would be safe to eat them. He was further advised that the people are still afraid to eat the killer clams. He expressed amazement over this and indicated that he had never heard that they had been on the restricted list.

He was asked if the people were dutifully taking their thyroid medicine and has response was that by and large they were, but some of the teenagers were not very consistent.

To the question of why the team had studied the people of Likiep in 1969, Dr. Conard replied that it was for the purpose of gathering baseline information about the thyroid in the Marshalls.

The doctor was also asked if he believed the people of Rongelap and Utirik were normal today. He responded that there is very little difference between the people of the two islands today except for early acute effects, and a slight increase in miscarriages. Other than the development of thyroid nodules, their illnesses are the same. "Of course," he added, "we don't know what will happen in the future, and that is why we keep returning each year."

Finally, he was asked if he heard the same kinds of questions from the people during each survey. He noted that he did, and that they must have

failed in some way because of communication problems, perhaps because of the language barrier.

That evening a party was given similar to the one in Rongelap. After that, a movie about Dr. Conard and the people of Rongelap was shown. It was produced at the expense of a drug company which manufactures the kind of thyroid medicine taken by the Marshallese.

The next day, the Committee met with the magistrate and the council of Utirik and discussed some of the information it had talked about with Dr. Conard.

At 12:30, Tuesday, September 19, the Militobi departed Utirik for Majuro, arriving there the next day at 14:00 hours.

While the examinations were going on in the Majuro hospital, the Committee met with officials of the Office of the District Administrator. On Thursday, Dr. Kumatori and Dr. Ezaki departed for Japan, via Saipan, and on Saturday, Dr. Cole and Dr. Pochin departed Majuro for their homes.

On Sunday, September 24, the Committee met with the people of Rongelap and Utirik living on Majuro, during which time the results of the survey were explained to the people. By September 27, 1972, all members of the Committee had departed Majuro as Dr. Conard and his team prepared to return to the United States.

"On March 1, 1954, an experimental thermonuclear device was exploded at the U.S. Atomic Energy Commission's Eniwetok Proving Grounds in the Marshall Islands. Following the detonation, unexpected changes in the wind structure deposited radioactive materials on the inhabited atolls and on ships of Joint Task Force #7..."

---Statement of Charles L. Dunham, M.D., Director,
Division of Biology and Medicine, AEC, 1956

"GUINEA PIGS" OR VICTIMS OF CIRCUMSTANCE?

The Event

Were the Rongelapese and their neighbors used as are guinea pigs in laboratory experiments? Did the United States of America intentionally cause 239 Marshallese to be exposed to deadly radioactive fallout in order to study the effects on human beings? Or did the incident which occurred as a result of the March 1, 1954, test simply come about from the often-stated "unexpected shift of wind"? The Special Joint Committee believes that the answers are more complex than can be implied in a single statement. Although consideration of this subject area is not specifically a part of the Committee's mandate under Public Law No. 4C-33, it believes that since the issue was raised and given great publicity and since it is inextricably intertwined with the work of the Committee, the subject deserves to be broached and discussed. Furthermore, the Committee has had available to it a great quantity of information and data, much of which pertains to the question, and some of which has never been widely known, a situation the Committee wishes to correct by including it in this report.

Location

Bikini (and later Enewetok) was an ideal test site for nuclear weapons. It suited all necessary specifications: it was within 1,000 miles of an airfield which could handle a B-29, there was no continuously heavy weather and no extreme cold, it offered an anchorage large enough for test ships and support vessels, it was far from densely populated areas, fishing zones, coastal waters and shipping lanes. Two other requirements were also met in choosing Bikini: although inhabited, the islands could be evacuated without causing hardship to a "large number of inhabitants" (62, p.22) and perhaps most importantly it was under control of the United States (originally under the Navy,

and later under a strategic trusteeship).

Originally Bikini was used to test the effects of atomic weapons on naval vessels or the effects over, on, or below the ocean. Later, as more information was compiled, tests were carried out in Nevada. The Pacific Proving Ground, as it was known, was later reserved for an even more important role, that of being a test area for the first hydrogen devices. As noted by Dr. Gordon M. Dunning of the Division of Biology and Science of the AEC during Congressional hearings in 1957: "Several measures have been used to reduce the radioactive fallout off the test site. First, of course, only small nuclear devices are tested at Nevada" (62, p. 1). No weapons in the megaton range were ever tested on or near the continental United States. All thermonuclear weapons were either tested in or above the Pacific and Atlantic Oceans.

Public Relations and Safety Teams

Testing in Nevada was accompanied by intensive public relations work by the AEC and meteorological surveys. During the hearings in the U.S. Congress, Dr. Dunning described some of the public relations work carried out:

> "The off-site monitoring program during Operation Plumbob (Spring 1957) illustrates the extensive system organized not only to take numerous radiological measurements but also to provide close liaison with the citizens of nearby communities. The Atomic Energy Commission and the United States Public Health Service jointly organized a program wherein the areas around the test site are mapped out into 17 zones. A technically qualified man has been assigned to live in each zone. His duties consist not only of normal monitoring activities but also, prior to and during the text series, of learning the communities and families in his zone, to know the people and having them know him. In addition to the 17 zone commanders, as they are called, there are 8 mobile monitoring teams on call to go to any locality to assist if needed to travel to areas outside the 17 zones."

The public relations work in these communities involved public discussions and showing of films (for more detailed information, see Appendix No. 6). Information from the AEC in the 1957 hearings notes that "Practically every

person throughout the off-site area saw at least one film and listened to at least one discussion by monitors. This was accomplished through civic clubs, schools and PTA and other groups." According to the AEC, one person in a town which had been shown the AEC movie "Atomic Energy," attended by sixty persons, had remarked,"There must be some fine people at the test site, since they were taking such precautions even in a small place like Goldfield."

Several thousand miles to the west of Goldfield, Nevada, was the Pacific Proving Grounds (PPG). What information that has been made available to the Committee indicates that there was no public relations policy for the Marshallese. There were no monitors living in the villages, attending PTA meetings and church services, or showing movies about Atomic Energy to the people. There were, however, emergency instructions to be followed in case of fallout contaminating the islands. It is reproduced here because of its relatively short length.

"RADIOACTIVE FALLOUT AND ITS EFFECTS ON MAN 475

"RADSAFE EMERGENCY INSTRUCTIONS FOR POPULATED ISLANDS

"1. The commander, JTF-7, has designated a representative for each off-site location outside the PPG. For the populated islands near the PPG, the representative is responsible for the radiological safety of the local population and the members of the task force.

"2. The representative of the task force commander is provided guidance as follows:

(a) The Marshallese magistrate and irou if on hand and the Marshallese health aid and council on each atoll or island should be assured that every precaution has been taken to prevent exposure of the natives to radiation hazards resulting from fallout.

(b) The representative will consult with the local magistrate to insure that a method exists whereby all residents of an atoll may be summoned to a central location and evacuated by air or water transportation if a fallout emergency exists. A fallout emergency will be determined by the commander, JTF-7; however, the local representative will assume that a fallout emergency exists at such time as radiological survey instruments, when held at a position 3 feet above the ground, indicate a rate of 1 r./hr.

(c) Should evacuation by air be necessary, baggage will be limited to that which each individual can carry or approximately 50 pounds. Whether evacuation is achieved by sea or air, no animals will be evacuated. A tabulation of animals left behind should be made as soon as possible to

insure the accuracy of claims against the Government.

(d) The local magistrate should be informed that in event of an unforeseen emergency, doctors will be flown from the United States by special airlift to care for local inhabitants who will be evacuated to Kwajalein Atoll and that evacuation plans are in existence to permit the task force to cope with any emergency.

(e) Fallout of a dangerous nature can be suspected by the presence of a saltlike precipitate or unexpected mist. Should such an event take place, it should be confirmed by monitoring.

"3. The representative will arrange through the local magistrate and native health aid to inform the Marshallese of the basic health measures that they may take to protect themselves from danger in case fallout is suspected or confirmed. These measures are:

(a) Remain indoors or under cover to protect themselves from the falling or settling radioactive particles.

(b) If particles settle on clothing, dust and shake off clothing.

(c) Bathe and keep clean. Particular attention should be given to washing under the arms, the groin, face, and hair.

(d) Keep food covered to prevent ingestion of fallout particles.

(e) Should the readings exceed 5 r./hr. it is recommended that the natives be advised to stand out in the water (ocean) and immerse themselves as often as practicable or keep themselves under water. This recommendation is based on the fact that water does extremely well in attenuating radiation."

Since these instructions are not dated, it is impossible to tell whether they existed prior to, or were developed after Bravo. If before, then for some reason there were no monitors on the affected islands and they did not know what to do; if after, it indicates that there was neither a public relations program nor a safety program for the Marshallese.

Danger Zone

Another area of interest related to the event was the size of the test zone and its relation to the atolls of the Rongelap-Rongerik group and Utirik. When Bikini was added to the test zone, the danger area was enlarged to 50,000 square miles and ran from 10° 15' N up to 12° 45' N and from 160° 35' E eastward to 166° 16' E. Rongelap Atoll's coordinates are 11° 08' to 11° 28' N, and 166° 37' E to 166° to 167° 04' E. Below to the south lies Ailinginae Atoll, whose westernmost limit extends to 166° 17' E. This meant that while the northernmost boundary

extended above Rongelap Atoll by almost 90 miles (01° 27'), the easternmost boundary line stopped short of Ailinginae Atoll by 01' (about one mile) and of Rongelap Atoll by 21' (a little more than 21 miles). This was apparently done so that the people of the atolls would not have to be evacuated prior to the test, which would indicate an assumption that even though fallout might go 90 miles north of Rongelap, it could not extend to Rongelap's longitudinal position. However, the Committee notes that if this were the assumption, then why was it that the Radsafe team was stationed on Rongerik, 30 miles further east of inhabited Rongelap.

Whatever the assumptions were at that time, it is interesting to note that the danger zone was enlarged eight times* by the time of the next shot on March 27, 1954, which was witnessed by then-Chairman of the AEC, Admiral Strauss.

Yield and Type of Burst

Other notable factors touched upon in an earlier section deal with both the size and the location of the "Bravo" shot. As to size, Bravo's energy yield was estimated to be about 15 megatons, which would have made it 750 times more powerful than the Able and Baker Bombs in 1946. Neal O. Hines, in his Book 'Proving Ground' noted that the "test may have been of a greater yield than calculated." Other factors which would contribute to the danger from this detonation are outlined by Dr. Graves in the U.S. Congressional hearings.

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*Although the coordinates were not given in Proving Ground, a rough extrapolation based on the proportions of the latitude and longitude boundaries of the former zone would give a new danger zone which included Rongelap, Ujelang, Utirik, and Likiep. Assuming this is true, and the zone remained the same size until the end of testing, it means that the returned Rongelapese and Utirikese, as well as the people on the other inhabited islands were actually living in the danger zone during subsequent tests.

Dr. Graves: "In the case of testing weapons we try to avoid a situation where the device is detonated on the ground because we don't want to have this very heavy local fallout. We would like to avoid this situation if we can. We try therefore to use towers and make them as high as we can, or we use air bursts as in this chart, or we use balloons for holding the device up. All of this is to avoid getting this mixture of dirt into the cloud itself."

While Dr. Graves was primarily talking about the Nevada site, the implications of his remarks are made graphically clear in the following passage from "The Effects of Nuclear Weapons":

"Although the test of March 1, 1954 produced the most extensive local fallout yet recorded, it should be pointed out that the phenomenon was not necessarily characteristic of (nor restricted to) thermonuclear explosions. It is very probable that if the same device had been detonated at an appreciable distance above the coral island, so that the large fireball did not touch the surface of the ground, the early fallout would have been of insignificant proportions." (emphasis added)

The Weather

Sayings about the weather are usually connected with the inability of human beings to tell just what the weather is going to do next. For the average person, what kind of weather he will experience either adds to his comfort or discomfort. For those people responsible for the Nevada Proving Grounds, the whims of weather and wind conditions could cause more than just discomfiture--they could produce disease and death if they affected the fallout from an atomic weapons test. For this reason, weather monitoring and checking of wind directions and velocities was of prime importance in Nevada, as shown by this passage from the Congressional hearings by Dr. Alvin C. Graves, of the Los Alamos Laboratory, who was test director for the Nevada Proving Ground.

Dr. Graves: "Once we have finally come up with a plan whereby the total amount of fallout is minimized, then we have to come to face with the problem of carrying on the tests such that even the fallout that does occur will not hurt anybody. In order to do this, we have assembled in Nevada as competent a meteorological group as one can find anywhere. This meteorological group tells us long in advance what the weather will be like, such that we

can control where the fallout will occur . . .

"Consequently, I would like to give a very considerable hand to this group of meteorologists who we have out there who may make us mad because they make us postpone, but they keep us out of trouble. They tell us the weather with great accuracy, and permit us to be sure that the weather will not give us a fallout situation that we would not like."

Unfortunately for the people affected by the Bravo Test, the meteorologists of the Pacific Proving Ground were not so adept at predicting things so that they could "control where the fallout will occur." This statement is particularly ironic in the face of meteorological evidence from the Mike and Bravo shots, as previously mentioned. For the Mike shot, nearly all wind direction above Enewetok was known, with gaps only at 55,000 feet and from 95,000 to 105,000 feet. Included in the known winds were the majority up to 90,000 feet which almost totally were heading toward the west. Only a freak strata at 50,000 feet and winds above 105,000 feet were heading east. For the Bravo shot, however, the winds in the space above Bikini were blowing in a northeasterly or easterly direction. For 35 percent of the space above that, winds were heading westward, away from Rongelap. The top remaining 30 percent of space above this up to 120,000 feet, the expected height limit of the cloud, there was no data. While it may be granted that such weather reports are of necessity minutes or hours old, it seems somehow incredible that the decision to have the event could be made on the assumption that either the unknown winds were not blowing in an easterly direction (as they were at Enewetok) or that if they were blowing in a westerly direction, they would change by the time the device was exploded. What adds to the incredibility of this decision is that if the JTF-7 fleet was arrayed 30 miles due east of Bikini, then firing of the device when the first 55,000 feet of winds were heading in that direction can only be judged as an act of foolishness or a serious error in judgment which only the fleet's mobility prevented from becoming a disaster.

These events combined to produce a situation noted in "The Effects of Nuclear Weapons," a Defense Department publication which noted that:

"11.149 Valuable information concerning the development and healing of beta burns has been obtained from observations of the Marshall Islanders who were exposed to fallout in March 1954 . . . . Although the fallout was observed as a white powder, consisting largely of particles of lime (calcium oxide) resulting from the decomposition of coral (calcium carbonate) by heat, the island inhabitants did not realize its significance. (emphasis added) (94, p. 602)

Evacuation Times

A further interesting factor is that despite the fact that according to reports the extent and direction of the fallout soon became known, only the 28 Americans on Rongerik were picked up one day after the fallout. Two days after the explosion, the Rongelapese were evacuated. Three days after the detonation, the people of Utirik were aboard ship. While it may be argued that attempting to pick up people from all three islands at once immediately after the detonation might have exposed crew members of the ships to dangerous radioactivity, it can also be argued that the areas of heavy fallout were known and could have been avoided. Decontamination aboard ship could have prevented serious exposure.

Levels of Awareness, Degrees of Injury

Notwithstanding this, it is difficult to this day to understand why it was that the people of Rongelap and the Americans were not evacuated at the same time, one day after, when the fallout had ceased. This is an especially valid question since the Americans would fare better than the Marshallese because of certain factors. In the 1956 AEC report it was noted that:

"Most of the Americans who were more aware of the danger of the fallout, took shelter in aluminum buildings, bathed and changed clothes and consequently developed very mild beta lesions." (p. 35)

Dr. Dunning, before the U.S. Congressional subcommittee, described the situation for the Rongelapese and Utirikese:

"The Marshallese were semiclothed, had moist skin, and most of them were out-of-doors during the time of fallout. Some bathed during the two-day

exposure period before evacuation, but others did not, therefore, there were optimal conditions in general for possible beta damage."

The AEC's Credibility

These later developments (acute effects) were in stark contrast to the press release issued by the Atomic Energy Commission 10 days after the event, and before the Lucky Dragon reached its home port. As one writer put it, apparently the Commission was trying to be "reassuring."

> "During the course of a routine atomic test in the Marshall Islands, 28 United States personnel and 236 residents were transported from neighboring atolls to Kwajalein Island according to a plan as a precautionary measure. These individuals were unexpectedly exposed to some radioactivity. There were no burns. All were reported well. After the completion of the atomic tests, the natives will be returned to their homes." (12, p. 169)

The Japanese, however, were not very reassured upon discovering that the Lucky Dragon's crew had been exposed to near lethal or lethal doses of radioactivity. Especially disturbing was the possibility that vast areas of the Pacific had been made radioactive by the monster bomb, and that possibility caused tremendous concern in both the Japanese public and Japan's fishing industry. Again, the AEC tried to be "reassuring," as evidenced in a statement released on March 24, 1954, which in part said:

> ". . . the warm currents which flow from the Marshall Islands area . . . move slowly (less than a mile an hour). Any radioactivity collected in test area would become harmless within a few miles . . . and completely undetectable within 500 miles or less." (p. 62 p. 178)

The Japanese, despite this statement, organized a scientific survey team which would cruise aboard the Shunkotsu Maru, through and around the test zone. American scientists had been invited to participate, but inexplicably, when they arrived in Tokyo, found that the ship had departed nine days earlier than scheduled, leaving them behind. The findings of the Japanese scientists differed somewhat from the reassuring AEC statement, according to Dr. Roger Revelle, Director

of the Scripps Institute of Oceanography who testified before the U.S. Committee:

> "This area of 1000 miles around Bikini was carefully investigated by Japanese oceanographers and biologists 4 months after the Castle test. They got figures like this in the water: 23,000, 90,000, 79,000, 26,000 disintegrations per minute per liter of seawater. . . . This is at a distance of about 300 miles." (natural radiation, gamma plus beta, for seawater is 500 dpm)

After the Event: Medical Aspects

In discussing the medical aspects of this subject area, the Committee would like to state its observation concerning the dual nature of the examinations and the reports of those examinations. It appears obvious to the Committee that the examinations, while beneficial to the affected Marshallese in terms of both general health and in terms of treatment for radiation-induced disease, also provide a considerable body of scientific knowledge about the effects of a fallout field on human beings which has no direct benefit for the persons affected. By saying "no direct benefit" the Committee is not excluding the known advantages of record-keeping such as that done in normal case histories for patients. What is meant here is that the reports as they are written and presented are of primary interest to scientists and doctors should such an event as happened in 1954 occur again in the future. In short, the reports themselves are of value to the AEC and other such agencies; they are of no value to the Marshallese.

Tendency to Minimize

Like the reports of the AEC concerning the removal of the Marshallese and the radioactivity in the ocean, it appears that consistently the reports have tended to minimize effects, or other aspects of the exposure; i.e., dosages seem "too small" to have any effect, the size of the group is "too small" for

statistical significance, effects are expected to be "minimal" over a long period of time, and exposures are referred to as "sublethal" rather than near lethal. It is to the credit of the reports that at least the later data disproved most of these minimizing statements, even though the language tends to indicate a conservative, minimizing approach to findings. Some people may see this as a mere game of semantics. The Committee, however, would prefer to say that it is not particularly concerned with the choice of words themselves and their connotations, but rather the psychological or scientific "set" of mind which they imply. The Committee is of the impression that there are two possible reasons for this tendency, which are discussed below.

The AEC Report, AEC-Brookhaven Relationship

As mentioned before, the AEC has tended to understate events or facts in order to be reassuring. No doubt this is partly due to the habit of the news media seizing upon the outstanding or interesting aspect of an event. Most "newsworthy" events are usually negative in nature because most people are not interested in what is going well but what has gone wrong. The Bravo event occurred at a time when the public at large was anxious over the development of nuclear weapons and their psychological and real advantages in the post World War II "cold war." The event of March 1, 1954, and the later furor it caused in Japan most certainly had its reverberations in the United States. Whether it is justified or not, it is easy to see why the AEC would want to be "reassuring." It is also easy to see why early reports of the conditions of the Marshallese also tended to "minimize" the effects of fallout. One has only to note that the first major report dealing with the event was published by the Atomic Energy Commission. This report set the tone followed in later reports.

While most of these documents have been published by an organization which appears to be independent of the Atomic Energy Commission, it is a fact that the annual surveys and the reports themselves are financed through a contractual arrangement with the Commission. Thus, while it would be refreshing to find such reports doubting the validity of guidelines dealing with radioactivity set by the Commission, or by the National Academy of Sciences on which the AEC is well represented, no such attitudes or contentions of accepted guidelines (MPC for example) are to be found. Thus one finds nowhere in the reports any doubt as to the reasonableness of established guidelines, or the appropriateness of returning the Rongelapese to their island before testing in that area ended. It is presumed to be realistic that those who carry out the terms of the contract are of a like mind to those who administer and fund the contract. This is not to say that the AEC influences Brookhaven in a manner such as to force that institution not to consider aspects which might undermine the AEC's views or positions--however if such did occur, one can only presume that the contract might be shift to another institute. While the analogy is not a terribly good one, it might be said that a man who has a franchise to sell Datsuns does so because he likes them and believes they are good cars. If, however, he drove around in a Volkswagon, his customers might wonder about the product he sold and the Datsun company might wonder about its franchise.

Specific Aspects

As mentioned before, there appears to be a dual nature or purpose for the examinations. This, the Committee believes, grows naturally out of the nature and significance of the exposure to fallout radiation of the Marshallese. Most human beings have both positive and negative impulses which govern their behavior. One way of expressing this is in the simplistic "approach-avoidance"

concept in elementary psychology. We see an object or are faced with a situation and we simultaneously want to take the object, or face the situation, but at the same time we have strong feelings to leave or reject the object or avoid the situation. For a number of complex reasons, usually one of these impulses is stronger than the other, which results in our taking one or the other course of action. By means of this analogy, it appears that there are two motives, or influences apparently at work in the examinations and treatment. These influences might be characterized by saying that like any practitioner of medicine, the doctors were interested in treating their patients as quickly as possible for any illness or dysfunctions they might exhibit; there was also a natural scientific curiosity to study within the constraints of reasonability such effects to document the limits of their course, short of morbid processes--before administering treatment. These two impulses of medical duty and scientific curiosity were perhaps best exhibited in a recounting of the immediate treatment given concerning blood cell counts in the AEC's 1956 report, and also with regard to the growth and development studies over a period of several years.

Concerning the blood cells counts, the AEC 1956 report stated:

"2.31 Clinical Observations and Leukocyte Counts

"Between the 33rd and 43rd post-exposure days, 10 percent of the individuals in Group I (Rongelap) had an absolute granulocyte level of 1000 per cubic millimeter or below. The lowest count observed during this period was 700 granulocytes/mm.[3] During this interval the advisability of giving prophylactic antibiotic therapy to granulocytopenic individuals was carefully considered. However, prophylactic antibiotic therapy was not instituted for the following reasons:

(1) All individuals were under continuous medical observation, so that infection would be discovered in its earliest stages.

(2) Premature administration of antibiotics might have obscured indications for treatment, and might also have lead to the development of drug resistant organisms in individuals with lowered resistance to infection.

(3) There was no accurate knowledge of the number of granulocytes required by man to prevent infections with this type of granulocytopenia." (emphasis added)

The Committee has submitted to Dr. Conard questions concerning this passage, but at the time of the writing of his report a response had not been received.

It is hoped that such can be included in a subsequent report of the Committee.

To the layman, the three statements, aside from appearing to be unnecessary and therefore somewhat defensive, appear to be somewhat contradictory. If there was no accurate knowledge about the number of granulocytes required by man to prevent infection, how could it be assumed that antibiotic treatment would have led to recovery, despite the fact that the people were under continuous medical observation? The argument that administration of antibiotics might have resulted in the patients developing a resistance to the drugs is a statement that can be made about any prophylactic antibiotic. Lastly, the phrase "obscured indications for treatment" is obscure. Does it mean treatment for that particular effect or for other effects? Would treatment for the effect obscure treatment for that effect? It would seem not. What it must mean is that treatment at that point might have prevented other effects from appearing. In other words, if an antibiotic were administered to help prevent infection, or to help raise the cell count level <u>at that point</u> then a further, later development might be prevented from occurring. This decision was apparently reinforced by the comforting fact that the people were well-attended by numerous doctors. However, it would appear on the surface, that here the impulse of scientific curiosity was somewhat stronger than that of medical duty to respond to the immediate need of the patient.

The Committee feels that the same impulse overrode relatively early administration of Thyroxine or a hormonal medication which would have corrected the retardation of growth experienced by a number of exposed Rongelap children, especially cases three and five. Early reports noted what appeared to be growth

retardation, yet the fact remains that no medication was given for this retardation for more than eleven years after the fallout. Despite the fact that the reports consistently mentioned the fact of unreliability of birth dates, these latter two cases were well documented. Furthermore, despite these unreliable birth dates, the reports kept mentioning the apparent retardation. Assuming that the administration of a hormonal agent would not be harmful to the children--even if it had no effect--it is difficult to understand why the doctors had to wait until the appearance of thyroid abnormalities in order to realize the value of administering Thyroxine to the growth-retarded youngsters.

Another matter of concern to the Committee is the information in the three-year report which indicates that:

> "Eight irradiated and nine unirradiated people were used in a study of immunological response to tetanus toxoid. The primary stimulus of tetanus toxoid had been given 2 1/2 months previously. Sera were obtained just prior to the second injection of toxoid and then six days later. Subsequently, tetanus toxin-antitoxin titrations of the sera were obtained for the two groups in mice by the method previously described." (p. 6)

In other words, these eight irradiated people were injected with a supposedly sage amount of tetanus toxoid and later blood samples were taken just before a second injection. The comparison of the blood's reaction to the first and second injections was an indication of whether the ability of the blood to combat infections (such as tetanus) was shown. What the Committee is especially concerned about is whether the people understood about the test, and whether or not they did, if there was any danger to any of the recipients. Assuming there was no further danger, the Committee questions just what benefit this study was to the people involved. Granted, such a study might indicate a need for greater medical care of the people, should it be proven that their responses were poor, which would leave them open to serious illness in the future from what would normally be a simple infection. However, since it is often stated that the number of people involved is too small for statistical analysis in terms of other effects, it is curious

why the test either was administered to everyone irradiated (great statistical singificance) or even administered at all (no statistical significance). To all intents and purposes, it appears that this incident was just what it was described to be: "Eight irradiated people . . . were used in a study."

Thyroid Studies

Concerning the developments of thyroid nodules in the people exposed (20 cases, four with malignant lesions), the Committee is concerned with three particular areas or aspects.

One, it finds it difficult to believe that original calculations involving this gland did not take into account the smaller gland of the children. Many times, especially in connection with the deposition of radionuclides such as Sr^{90}, mention is made that the retention for children may differ from that estimated for adults because of the natural factor of growth. How was it that the many experts who worked in this field for so many years never accounted for this factor until it was blatantly apparent due to the development of nodules in 1963 and 1964. True, the Committee is aware that doctors and scientists, despite the rigors of their high callings, are human beings and thus subject to errors; however the Committee finds it most disconcerting that such a simple fact was overlooked for so long and only reconsidered when the doctors were faced with a development that was unexpected in the light of earlier assumptions.

By the same token, the Committee finds it also difficult to believe that inconsistent findings of Protein Bound Iodine were never well looked into. Mention was made of the possibility of glass receptacles being unhygenic, or the findings were attributed to some unknown influence. At least from a hindsight point of view, it would appear that considering the near tolerance doses of iodine and considering the later negative findings, someone should have investigated with more detail the reasons for such positive findings which should have appeared to

be inconsistent with earlier dose factors. Later on, it is noted that unusually high levels may have masked findings which would have indicated that thyroid function was not normal in many of the exposed persons. Granted, again baseline information was lacking--however, considering the importance of the studies both to the scientific world and to the people themselves, it appears that a certain amount of overconfidence in finding negative results in the future prevailed, where prudence and curiosity should have reigned.

Finally, in the findings and information connected with the thyroid, the Committee is extremely interested to know if the person whose parathyroid gland was accidentally severed at the "pedicule" was ever informed of this fact. Secondly, the Committee is curious as to whether this incident had any connections with future thyroid operations being performed in the mainland United States as opposed to the Naval Hospital in Guam. Hopefully, the Committee's query will be answered by Dr. Conard.

Miscarriages, Stillbirths, Fertility

The Committee notes that despite the importance of determining whether or not the incidence of miscarriages, and of certain stillborn infants, there was no intensive effort to have a competent medical person available to determine whether these deliveries were possibly connected with radiation. Again, the question of statistical significance must come to the fore--however, the Committee is of the opinion that despite the small number of people, this situation should have had closer attention. The Committee understands that there are certain kinds of effects of radiation which can be observed in the products of miscarriages; examination of such may not have confirmed their relation to radiation, but it would then have been a matter of record, a record which could have been used to indicate that there possibly were no radiation-induced effects.

As to fertility, it seems somehow inconsistent that a Japanese doctor working with a group that was smaller in terms of statistical significance should come up with such a detailed analysis of spermatozoa production after irradiation of the Lucky Dragon fishermen, while the AEC-Brookhaven teams apparently felt it unnecessary to pursue this area with the irradiated Marshallese and Americans. While the Committee might yield to the consideration of the private and personal nature of the tests and examinations connected with such studies, it is unusual that the subject was never even discussed except generally in terms of genetics, and then, again, in terms of statistics.

Conclusions

The circumstances that led up to and followed the detonation of "Bravo" on a clear March morning in 1954 are starkly illustrative of how circumstance, time, error and fortune can all combine to produce an historical event; in this case a tragic one.

The location of the testing site itself was a major factor, in that its placement provided the flexibility necessary for the detonation of large yield weapons, and the safety necessary should anything go wrong. It was in a sense equivalent to the Nevada site, which provided the same flexibility and safety for smaller yield weapons. Unfortunately, unlike Nevada, there was no Public Relations or information program, and no monitors living with the people. In Nevada, tests were conducted to produce small amounts of local fallout. In the Marshalls, however, the world's biggest hydrogen bomb explosion, to that time, was detonated on the ground. In Nevada, it was boasted, they could practically control where the fallout went. At Bikini, someone made the decision to go with an imcomplete picture of the wind. The wind shift was not "unexpected," since nothing was known about the upper level of wind. Furthermore, the test danger zone in the Pacific was cut off at its eastern boundary to

save convenience to persons past that point. Human error or misjudgment was also responsible for underestimating the potential yield of "Bravo," and poor judgment resulted in the Rongelapese remaining on their island for two days, and the Utirikese for three days after the explosion--rather than only one day. Whether these actions and events were the result of human error, poor judgment, miscalculation, and faulty assumptions, or whether they were in reality steps or phases in a conscious and known plan is a decision the Committee will leave up to the reader of this report.

As to the medical aspects, the Committee also finds that human error and faulty assumptions and miscalculations have pervaded the annual examinations and conservative and minimizing attitudes have tended to obscure both the seriousness of the original exposures and the significance of later findings which are related to irradiation. While the Committee finds no gross or flagrant violation of the general principles of the Hippocratic oath, which is, as generally understood, supposed to serve as a guideline in treating patients under the care of a physician, there have been tests and studies of the people involved which did not necessarily prove of direct benefit to the people. This can be shown in the three-year report: (p. 22)

> "The group of irradiated Marshallese people offers a most valuable source of data on human beings who have sustained injury from all the possible modes of exposure-- . . Even though . . . the radioactive contamination of Rongelap Island is considered perfectly safe for human habitation, the levels of activity are higher than those found in other inhabited locations in the world. The habitation of these people on the island will afford most valuable ecological radiation data on human beings."

and in the four-year report: (p. 32)

> "The habitation of these people on Rongelap Islands affords the opportunity for a most valuable ecological radiation study on human beings. Since only small amounts of radioisotopes are necessary for tracer studies, the various radionuclides present on the island can be traced from the soil through the food and into the human being, where the tissue and organ distributions, biological half-times, and excretion rates can be studied."

It is also the sense of the Committee that because of the uniqueness of the experiences of the affected Marshallese, there has been a tendency, perhaps more unconscious than conscious, but nevertheless a tendency to let scientific curiosity at times override immediate action. To be fair,the Committee would also like to note that such tests and studies have not always included the Rongelapese. In the past examinations, American servicemen and members of the teams themselves have had their blood and urine tested for comparison purposes. Even Dr. Conard himself has allowed himself to be used as a "guinea pig" as disclosed by this excerpt from the eleven- and twelve-year report (p. 159):

> "Since facilities for a metabolic balance study were not available on Rongelap Island, one of us (R.A.C.) brought several native food items (pandanus fruit and coconut meat and milk) back to Brookhaven and consumed them under controlled conditions. Urinary and fecal specimens were collected and whole body counting measurements were made over a period of 180 days. The intake of strontium-90 over a seven-day period was twenty times higher than normal and that of cesium-137, sixty times higher than normal."

In conclusion, the Committee offers the suggestion that by the very nature of their experience and conditions and by the very nature of the unique set of circumstances surrounding the daily lives of the two groups, the people of Rongelap and Utirik are "guinea pigs" in the sense that no other group of people in the world have been exposed to the same amounts and differing kinds of radioactivity, and no other group of people in the world have been exposed to the same amounts and differing kinds of radioactivity, and no other group in the world has been so carefully studied for the results of such effects. Again, whether these people are being used as guinea pigs in an extended study of the effects of fallout upon human beings and their treatment is only of secondary importance; or whether they are, by virtue of their experience a group of people who are being examined and studied for the best of humanitarian aims is a decision the Committee will again leave up to the reader. In closing, the

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Committee wishes to express this opinion: the Rongelapese and Utirikese are by their experience, an extraordinary group of people and thus deserve no less than extraordinary care, treatment, and attention.

A DISCUSSION OF INJURY, TREATMENT, AND OTHER CONSIDERATIONS

Injury and Treatment

Today, nearly 19 years after the event, there are few outward signs of injury among the people involved, especially those who were on Rongelap at the time. During a visit of the Committee to Rongelap, only some barely visible scars on the ear of an older man who was examined by Dr. Cole, were evidence of the fallout. This is in stark contrast to the acute and immediate injuries suffered by the people of Hiroshima and Nagasaki, for, even today in the A-bomb hospitals, elderly patients may be seen exhibiting the keloids (skin lesions, or gross scars) caused by thermal radiation. Also today, in the Marshalls, it is clear that the effects of the radioactive fallout were not minimal. A score of people have had thyroid operations which have removed either all, or part, of the gland. Some of these removed thyroid nodules included malignant, or cancerous lesions and while those operated on have had no later operations for other nodules or cancer, it still remains to be seen whether such developments may occur. As to growth and development, it would appear that while late, administration of Thyroxine has caused those affected persons to return to normal. Miscarriages and stillbirth rates, to the extent they can be judged, seem to be normal now, but it is possible that radiation induced effects were missed due to the often mentioned lack of vital statistics and also to the lack of adequate examination of the products. While the Committee has expressed its consternation and reservations concerning certain aspects of immediate

treatment and subsequent examinations, it feels that, as evidenced by the reports of its consultants, (see Appendices) the examinations are thorough and conducted in a professional and humane manner.

Especially alarming to the Committee, as it must have been to the Brookhaven team was the appearance last year of a fatal case of acute myelogenous leukemia. The Committee hopes that the persons responsible for the examinations will give this new development the attention which it deserves for the benefit of the people involved. The Committee takes special note of a story in the Tuesday, November 21, 1972, edition of the New York Times by Times science writer Walter Sullivan, which discussed the death of Lekoj. The story said in part:

> "To prepare the way for the September trip two Japanese physicians and another from Britain were included in the party, and this apparently reassured the skeptics. Had the visit been made earlier, however, it is possible that the leukemia case might have been identified at a less advanced stage."

The phrase "earlier" is a reference to the fact that the annual survey had been delayed six months for the reasons previously mentioned. While it is possible that "detection" might have been accomplished at the usual time of the survey, it is the understanding of the Committee that all forms of leukemia are ultimately fatal, and that acute forms have shorter courses than chronic forms. In addition, the Committee would like to state for the record that if the period of six months is critical to the detection and remission of leukemia or any other disease, then perhaps consideration should be given to having certain tests conducted on more than just a once-a-year basis.

Psychological Aspects

One aspect of the incident which is the subject of this report which has not been widely discussed or been made public concerns the psychological effects of exposure to radiation from nuclear weapons. Dr. William Peck, now Director of the Medex program to the Trust Territory Department of Health Services, was responsible for bringing this area of concern to the Committee's attention. Although his original intention in speaking of the psychological aspects was in connection with compensation, however it also later developed to be a valid and interesting line of inquiry for the Committee during its visits to Japan and the Marshall Islands District.

In some respects, comparision can be made between the Japanese exposed to the Hiroshima and Nagasaki A-bombs in 1945 and the Rongelapese and Utirikese exposed to fallout in 1954. While figures differ, it is generally acknowledged that more than 100,000 people died in Japan as a result of the two bombs: many of them were literally vaporized by the heat of the blast near the hypocenter; others died from heat and radiation burns, houses collapsing upon them, flying debris, drowning, suffocation, or being burned in the fires that spread throughout the cities later. Some simply died from lack of adequate medical care, food, water or shelter. The people in the Marshalls were not exposed to such trauma, but rather to a snowlike or mistlike gentle fall of radioactive particles. Despite these differences, however, there is one aspect common to all these cases: the radioactivity produced by the bombs and its effects upon those exposed. Today, in Japan, people are still dying from effects of

the bombs dropped there nearly 28 years ago and today in the Marshall Islands, people are still being found with diseases apparently caused by H-bomb fallout nearly 19 years ago.

In Hiroshima, Japan, the Committee has the honor to meet with Dr. Fumio Shigeto who, as mentioned earlier, is an A-bomb survivor and director of the Hiroshima A-bomb Hospital. Dr. Shigeto mentioned the uneasiness or the feeling of uncertainty survivors like himself felt about the future, a feeling which, he said, was shared by "all survivors".

Later, during its first trip to meet with the people of Rongelap and Utirik, the Committee posed the question of whether or not the people who were exposed felt uneasy about their exposure. The answer at meetings on both islands was generally: "Whenever we have a cold, or some other kind of sickness, we think of the bomb."

The Committee was most impressed by the answer given by the Lucky Dragon survivor, Mr. Matashigi Oshi, in a meeting in Tokyo with Dr. Kumatori, when asked about his anxiety over his experience. He was first asked, how he felt about the annual examinations he submitted to the Institute where Dr. Kumatori works. Was his mind at ease? Did he feel uneasy? Mr. Oshi's remarks, as translated, were, "Psychologically, I trust Dr. Kumatori and I am satisfied." He was then asked how he felt when he contracted a normal illness. Did he think of the bomb and the fallout? His answer was, "Immediately."

The Committee thus believes that one of the late or long term effects of irradiation in the case of the Rongelapese and Utirikese is that of the anxiety they share about the future. It is the un-

known, the uncertainty of their future health that is just as real to them as was their exposure, dislocation, and repatriation. In the three year report, there was some discussion of the "psychic effects" of the irradiation. The passage discussed the differences between the trauma of Hiroshima and Nagasaki and the "relative calm and rapid adjustment" which the Marshallese exhibited in adapting to their new situations. This discussion concluded that, "There was little real concern expressed about their radiation exposure. It would seem therefore, in the case of the exposed Marshallese that there has been little or no apparent psychic effect of this momentous event."

The Committee agrees that the experience of the Marshallese cannot and does not compare to that of the Japanese, who, in addition to witnessing the death and destruction of the bomb, also lost friends, relatives and even whole families. However, as to the "uncertain feeling," which is held by all of these people, the Committee feels that the people of Rongelap and Utirik share an equal amount of anxiety, if not more than the Japanese, not only because of the uneasiness about the future, but because of another factor which will be discussed below.

Information, Communication, and Culture

Mr. Oshi stated that he felt satisfied with the annual examinations conducted by Dr. Kumatori. The BNL three year report indicated that the Rongelapese and Utirikese had shown little concern about their exposure. While these two statements would seem to be in

agreement, the fact of the matter is that they belie difficult and perplexing problems. In Japan today, there are numerous facilities existing for the specific care of A-bomb victims, which the people can easily reach almost any time they choose. Also, in Japan, the Atomic Bomb Casualty Commission publishes annual reports in both Japanese and the English languages and almost all of the staff at these facilities are Japanese citizens. On Rongelap the people receive an extensive examination once a year, by Americans assisted by a Micronesian medical staff and hear no more about their examinations until the next year.

Originally, the people exposed generally understood what was being done for them and why. There was no need to explain that the bomb had affected them when they could see for themselves the skin ulcerations and hair falling out, or feel the weakness, nausea, and diarrhea. However, as the examinations continued the people became perplexed. Every year the team comes and the doctors tell them that they are healthy, but that they just want to check to see if everything is still alright. Then they go away. The next year the process is repeated. Why, the people have reasoned, if we are healthy, does the team return every year? This attitude, is a small indication of the vast lack of understanding by the people involved as to just what did happen to them, and what the possible consequences of their exposure are.

While the Committee realizes that the area of radiation, as applied to physical health, is a highly complicated and sophisticated subject which would require some effort and expense to translate into

terms which would be meaningful to the affected Marshallese, it seems that this might possibly be the only course in order to resolve not only some of the anxiety and uneasiness in the minds of the people, but some of the resentment and distrust of the examinations and of the team itself.

Time and again the Committee found that the people did not understand anything about their exposure, the amount of the exposure, the possible effects on themselves and their children and on their environment. Dr. Conard, according to one person, was asked why the team did not explain such things to the people. His reported reply was that even the questioner, who was a college graduate, would have difficulty understanding what it was all about. This may be true, if it were expected that the team explain everything about the exposure and its effects during the length of their visit. However, the Committee strongly feels that explanations are possible and should be carried out, either through the use of simple text, pictures, analogies and whatever other kinds of aids necessary to convey to the people a basic understanding of their situation. It is, after all, a widespread practice in the medical profession to explain to the patient what is going to take place to ease the patient's mind. Unfortunately, this has never been done to the Rongelapese. It has effectively produced a situation analogous to that of a teenager whose parents avoid telling him about sexual matters, only to have the son or daughter pick up his needed information by rumor, heresay, and innuendo. In either case, such information does not produce a healthy

state of mind. In terms of the irradiation of the Marshallese, this has been especially true with two groups of people: the Utirikese, and those Rongelapese and Utirikese who are used as control, or comparison groups.

This fact is illustrated by the question posed during the public meeting at Utirik. The question was, "How do we compare with the people of Rongelap?" One would imagine that after nearly two decades, these people would have some understanding of their exposure and how it differed from their neighbors. Apparently, this is not the case. This uncertainty despite the annual reassurances of the team that the people are in good health (except for those who are operated on for thyroid nodules) has resulted in mixed feelings in the people of the islands. These general feelings of insecurity can be roughly grouped into three catagories:

1. Rongelapese exposed. Perhaps because of the visible effects of their exposure, these people seem to have the best understanding in certain areas of their situation. It was this group of people who generally expressed a desire for additional medical attention ranging from having Dr. Knudsen stationed on the island to having more frequent medical examinations. However, these people still need to have explained to them in their language at their level of understanding the circumstances of their exposure and its past and possible effects. This is clearly shown by a passage in the seven year report which notes that the health aide "admitted that some of the people at times had eaten coconut crabs in spite of the fact they

had been requested not to." (p. 14) It is further evidenced by statements in the reports and by Dr. Conard himself to the effect that some of the people who must take Thyroxine regularly for the rest of their lives, often are inconsistent in taking this medicine. The Committee declares itself amazed at such findings and very disturbed at the apparent lack of understanding by the people concerning prescribed measures which are so vital to their future health and welfare. It, in short, represents a problem which should have been corrected long ago and one which should not be allowed to exist in the future.

2. The exposed Utirikese. Amongst these people there appear to exist two lines of thought. Either the annual examinations should be discontinued because Dr. Conard keeps telling them they are healthy and were not exposed to a large amount of radiation as were the Rongelapese, or, they should receive treatment equal to that of the Rongelapese since their case appears to be important enough for the team to continue returning. These feelings are compounded by several influences. One is the fact that the Rongelapese were compensated by the United States Government but the people of Utirik have not, a subject to be considered in the next report. The other is the knowledge that they were irradiated and, like the Rongelapese, were removed from the island. They continually hear about the many Rongelapese who go to the United States for thyroid surgery and thus wonder if they might not in the future suffer the same fate. This is further compounded by the fact that one woman from Utirik was taken to the U.S. for a thyroid operation. Upon removal the thyroid was found to

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contain malignancy, and, while all reported evidence would suggest that this single case from Utirik may have been the only "normal" case of thyroid cancer, it is difficult for the people to believe this while they are aware of what happened on Rongelap. Again, misunderstanding resulting from poor communication and explanations persists in the minds of the people, together with the general uncertainty about their future because of their exposure.

3. The unexposed Rongelapese and Utirikese. One of the necessities in the examinations and studies carried out by the team is to have a group of persons who are of similar background, age, and sex but not exposed to the fallout radiation of 1954. These people represent what is known in medical parlance as a "control" or "comparison" group. In laboratory experiments with rats, mice, guinea pigs or flies there are usually two groups. One group is exposed to a chemical or other influencing agent, while the other "control" group is not. By studying both groups, scientists can tell what specific effects the influencing agent has had on the group experimented upon. In a similar fashion, those Rongelapese and Utirikese who are examined and give blood and urine samples, provide a group which the doctors can use in comparison with the exposed people. It was this group which was the most vocal in expressing dislike of the examinations. They indicated that they resented being examined and, in many cases, if such examinations were to be continued in the future they should be compensated for them. While the Committee can understand such a request, its major concern is that the people do not understand how their role as a control group is helpful to their exposed brethren. Again, it is due to a lack of

information--a situation which must be corrected.

Cultural Aspects

As it will be recalled, Dr. Conard remarked that perhaps the team had failed in communicating to the people their special situation and the certain procedures and limitations they must accept. The Committee believes that this results for a number of reasons.

First, it should be remembered that the March 1st event involved a great number of military personnel. This also included the later examinations in which Dr. Conard as a Navy Captain (and later Commander) in the Medical Corps participated. The memory of the Japanese military was undoubtedly strong in the minds of the Rongelapese and Utirikese and the examinations were accepted as a matter of course in the beginning and as a matter of habit later on, even though the emphasis gradually shifted from a military to civilian representation in the teams. Thus, while Dr. Conard appears to be a kindly and considerate man, the examinations as observed by the Committee are initiated in a military manner ("they act as though they own the island") and carried out with an almost military precision and efficiency.

Second, the short amount of time of the visits coupled with their annual occurance leaves little time for consultation with the people. Also, it should be noted that the results of the examinations may not be ready for dissemination for several months after the exam has taken place.

Lastly, the Committee would like to call attention to cultural differences which have a great influence on this miscommunication.

While this may seem superfluous to Micronesian readers of this report, it is mentioned here for the edification of those uninformed or unaware non-Micronesians who are connected with the activities described in this report, or who simply may read it. It is a generally practiced Micronesian custom, like that of people in Asia in general, not to give offense when directly confronted by a person or a situation. This results in situations where Micronesians will give a positive answer to a question in order to avoid giving offense to the questioner; or will avoid directly making an immediate decision concerning a problem either to avoid possible conflict, or in hopes that the problem will resolve itself without personal involvement. Non-Micronesians, especially Americans, are wont to ask questions which to Micronesians already indicate the kind of answer expected. Questions like "Isn't it a nice day?", or "Don't you think this is a good idea?", are invariably met with an affirmative, "Yes," regardless of the true feelings of the person being querried. Thus while it is customary not to give offense by contradicting the views of another person, it is also customary to express one's views either indirectly or directly concerning a person or activity after the questioner has left, or the activity ceased. Thus, a non-Micronesian in dealing with Micronesians may leave with the impression that he made quite a hit with the people, that he was well liked and his ideas well received and accepted. He may be quite amazed to learn later that they are actually in opposition to his ideas, that the people did not like him or the manner in which he conducted himself. To the American, it may appear that the people are "two-faced" or have "talked about him behind his back"

or have "stabbed him in the back." This, of course, is nonesense. It results from a lack of understanding and sensitivity to another person's cultural attitudes. Americans are direct and like direct answers. Micronesians are more discreet and subtle and appreciate behavior in accordance with those desirable qualities. Often, however, these differences are not recognized and lead to serious problems in communication. The Committee believes that this has been true in the case of the team's handling of the annual visits to Rongelap and Utirik, and is an important factor in causing other problems in communication and information. Because the Committee believes it to be an important aspect of the problem, it will be included in the next section under recommendations.

RECOMMENDATIONS

General Statement

At the outset the Committee wishes to state emphatically one point concerning its approach to this report which has influenced the recommendations it will subsequently make. The United States of America, either through the Department of Defense and its instrumentalities, the Atomic Energy Commission and the Department of the Interior and its instrumentality, the Trust Territory of the Pacific Islands, is directly responsible and accountable for the actual injury and suffering, disease and possible death experienced by the Marshallese exposed to the fallout from the March 1, 1954 "Bravo" shot. Furthermore, whether or not any fiduciary relationship had existed at the time, the United States of America is also directly responsible and accountable for bearing any and all burdens connected with the welfare of these people since that time and until lack of the need for such can be clearly established.

Several times during the existence of this Committee, it has, through written communications or verbal exchanges, been apprised of the opinions of certain people, who shall go unnamed, connected with the annual surveys that the Marshallese examined should be grateful for the examinations since similar services rendered in the United States would cost in the neighborhood of $200 per examination or more. A corollary argument posed by one concerned, but possibly misinformed individual, was that the Congress of Micronesia should bear the expense of these annual surveys estimated to cost from $100,000 to $125,000 per trip. The Committee wishes to state that it vehemently rejects and opposes such specious reasoning. Did the Rongelapese and Utirikese invite the United States to conduct nuclear tests

in their islands? Did the Rongelapese and Utirikese ask for the bomb to be detonated and to be irradiated? Did they request skin burns, thyroid nodules and cancer and possibly leukemia be given to them as a gift from the United States? Did these people ask to suffer in silence for more than ten years before receiving any compensation? Did these people ask to be deprived of their ancestral homes and to have them irradiated, too? Did these people ask to inherit an anxious and uncertain future for themselves and their children? Most certainly not. Furthermore, the Committee wishes to make known its feelings that while the United States of America is primarily responsible for this situation, such burden must also be shared equally on a moral level with the Trust Territory of the Pacific Islands Government, if it is, in fact, possible to separate the United States of America from the Trust Territory Administration. As a consequence, the Committee is of the opinion that not one penny of revenues collected by the Congress should be spent for the care and welfare of these people and similarly not one penny should be diverted from the U.S. Federal Grant funds for the purposes of funding an obligation incurred by other agencies and instrumentalities of the United States Government.

The Committee would also like to comment briefly on the nature and intent of its recommendations. Through its studies and investigations the Committee has discovered that exposure to radiation such as that experienced by the Rongelapese and Utirikese has long range implications. It is a sad but true fact that nothing can be said with certainty about the condition of the people except that they face an uncertain future. Some effects may not develop for thirty or forty years after exposure. As Dr. Darling commented about the Japan studies, "This is really a 50 year ball game."

Other effects may not appear until a second or third generation. Thus the Committee has made recommendations, the intent of which is to provide for care and treatment for an indefinite period of time.

Secondly, the Committee is aware that of the many reports issued from the Congress in the past, often their recommendations were not carried out or they were ignored. There have been failures on the part of the executive branch and the Congress in this respect. With this in mind, the Committee has made recommendations which it feels are realistic and practical; that should meet with no objections from any of the parties concerned, and which can be implemented in a relatively short period of time to the benefit of the people involved. The Committee is also recommending that its life be extended officially until January, 1975, so that it can monitor the action taken on its recommendations to insure that all of them are carried out to the most feasible extent possible. This extension will also allow the Committee to study the subject area of compensation more thoroughly before presenting its report on that subject to the Congress.

Finally, the Committee wishes to note that this Committee and this report would not have been necessary had certain persons, both Americans and Micronesians, carried out their responsibilities. The Committee finds the AEC and BNL guilty of allowing the people involved to remain in virtual ignorance for nearly twenty years. The Committee also notes that many Marshallese in government service have participated in these examinations for nearly eighteen years and while they must have been aware of the complaints of the people and their need for information, never took the initiative to correct this situation. The Committee also expresses its concern that the Marshall Islands District Legislature has apparently

never taken positive action regarding this matter which is, essentially, a situation unique to the Marshall Islands District. This statement, however, should not be construed to imply that district problems should only be handled at the district level. The Committee is only too happy to carry out the requirements of its mandate where local remedy has failed to rectify a local problem. The Committee also wishes to note its displeasure with actions by certain non-Micronesians at the Headquarters Administration level. Specifically, the Committee notes that the expulsion of the Japanese survey team by the Trust Territory Administration in December of 1971 may have ultimately resulted in the delay of the annual survey scheduled three months later. While a paranoid interpretation of the possible propaganda use of the visit by certain Japanese in the group may have been a consideration, the expulsion not only was an affront to the people of Rongelap and Utirik, but also a shameful and embarrassing, experience fo Dr. Haruo Ezaki, one of the foremost Japanese surgeons with impeccable credentials in the field of radiation-induced effects on the thyroid. The Committee is also displeased to note certain actions and allegations made by the Trust Territory Administration in connection with the aborted March, 1972, survey. The one Japanese doctor who did arrive in time to join the team in March was an "unknown." No one in Japan--including such people as Dr. Darling, Dr. Kumatori and Dr. Ezaki--had ever heard of him. This doctor himself told members of the Committee that he had little background in thyroid and radiation and that he was not particularly interested in the peoples' problems. Rather, he was interested in writing something about the case. The executive branch has charged that Dr. Ezaki was persuaded by an "outside influence" not to come on the March survey. The Committee has questioned this "outside influence" and he has stated that during his meeting with the doctor, he tried to encourage him to go on the trip

and did not discourage him. These points noted, the Committee would also like to commend the executive branch, including High Commissioner Johnston, Deputy High Commissioner Peter T. Coleman, Dr. William Peck and Dr. Masao Kumangai for their excellent cooperation, help and assistance to the Committee since its creation.

The Committee would like to make one last point before proceeding to the recommendations, which has oftentimes clouded the issue connected with the people of Rongelap and Utirik. This is the often heard complaint or charge by persons in the Administration or persons connected with the annual surveys that it is unfortunate that political issues are being injected into what is a purely medical and scientific matter. The Committee does not agree with this attitude. The Committee would like to remind those who hold this attitude of the origins and connotations of the word "political." The original Greek root word and suffix, and the present day connotations of the word"politic"relate to the citizens of a governmental state and the enforcement of laws and regulations for their benefit. A political action is any action which takes place in the public realm of the polis. Thus, virtually any action is a political action which affects or influences other people. In a more general sense then, by both strict definition and because of other considerations, the annual surveys are political actions. As it pertains to the Special Joint Committee or the elected representatives of the Rongelapese and Utirikese, their actions have been committed in the interest of their constituents with the intent of improving their health and welfare. Certain actions of the Administration, in the past, however, appear to be more defensive and retaliatory in nature and more concerned with the image of the Trust Territory Government than they

are with the welfare of the people involved. The Committee notes that, as with the issue of Rongelap, the Administration many times in the past has reacted defensively concerning certain issues raised, or to criticisms about existing problems instead of sitting down with those who raised the issues or made criticisms and trying to find out just what was wrong or how the situation could be corrected. Relative to this, the Committee is pleased to note the excellent cooperation of the executive branch with this committee of the Congress which has perhaps, in part, resulted from a greater understanding by the executive branch of the perplexing problems and difficult issues involving the people of Rongelap and Utirik. The Committee is happy to note this apparent change and hopes that it presages increasing cooperation between the executive and legislative branches of the Trust Territory Government in the future, concerning the subject matter of this report, as well as other considerations affecting the interests and well-being of the people of Micronesia.

RECOMMENDATIONS

United Nations

The Committee recommends that the United Nations Scientific Committee on Radiation issue an annual report of the findings of surveys on the Marshallese, Americans, and Japanese exposed to the March 1, 1954, fallout from the "Bravo" test and that scientific meetings on the subject be held, as suggested by Dr. Kumatori.

Atomic Energy Commission

1. The Committee believes that because of psychological implications, new thyroid nodule findings, and the unprecedented case of leukemia, it strongly recommends that the AEC recruit and fund a doctor like Dr. Knudsen--on a one or two year contract basis to visit the Rongelapese and Utirikese during the time between the yearly examinations. The Committee has been advised that finding someone to do this is very difficult. The Committee believes this is not a valid consideration. The former Surgeon General of the United States informed the Committee that the U.S. Public Health Service has about 40,000 employees, 12,000 of them in professional occupations. Also, the Committee does not believe that the matter of funding should stand in the way of this proposal since the AEC's annual budget exceeds by several times the annual budget for the Trust Territory of the Pacific Islands. Arrangements for such a service on a continuing basis can be made through the Department of the Interior and the Trust Territory Government.

As an alternate proposal, should the above proposal be impossible to fulfill--which the Committee doubts--the Committee then would favor the recommendation of two of its consultants to have a hospital ship visit the island regularly, the cost of which would also be borne by the AEC.

2. It is also recommended by the Committee that the Atomic Energy Commission provide funds in addition to regular Grant Funds for any new hospital facility on Majuro and Ebeye for the purposes of constructing additional rooms and providing equipment particularly relevant to the examinations of the Rongelapese and Utirikese.

The Committee further recommends that the Atomic Energy Commission increase its funding under contractual obligations to Brookhaven National

Laboratory so that Dr. Conard may be able to meet some of the recommendations made by this report and/or carry out such additional work or studies as he may feel will be beneficial to the people involved.

Brookhaven National Laboratory

In order to convey to the people of Rongelap and Utirik the sense that the BNL team is truly interested in not only the health of the people but is also respectful of customs and of their counsel and advice in these matters which directly affect them, it is recommended that:

1. Prior to the survey, through the District Administrator of the Marshall Islands District, the BNL team should ask the permission of the people of the islands to make the examination.

2. Permission by the magistrates and councils of the islands should be asked in order to hold an island meeting for the purposes of explaining results from the last visit and to answer questions.

3. During such a meeting, the BNL team should ask the people if they would like to have an island party. Assuming that the people want to have the party, they should be encouraged to provide some local food (like fish and breadfruit). Conversely, it is recommended that in addition to such food as hot dogs and beans, that the team provide pigs and chickens for the people to prepare for the party.

4. The Committee also strongly recommends that Brookhaven give serious and careful consideration to the recommendations made by consultants Ezaki, Kumatori, Cole, and Pochin and that it report to the Committee what action it proposes to take concerning them.

5. The Committee recommends that during the forthcoming March, 1973, survey, as an interim measure, the Brookhaven team give each person examined

a written statement in Marshallese of their general findings from 1972 and 1973. Upon the publication of the booklets for exposed, children of exposed and control persons, which hopefully will be ready by the March, 1974, survey, these written comments in Marshallese will be included in the booklets.

The Trust Territory Government

1. The Committee recommends that the Trust Territory Government construct, on municipal land after consultation with the people, a dispensary and other dual purpose buildings such as classrooms, which will enable the medical survey team to house all of its equipment and personnel and in which to perform their examinations. The cost of such shall be borne by the Atomic Energy Commission.

2. In connection with this recommendation, the Committee noted the deteriorating condition of a former observation tower at the Radsafe site. The Committee recommends that Public Works personnel, after consultation with the landowner, dismantle said tower before it collapses and injures one of the inhabitants of the island.

3. In conjunction with the AEC and Brookhaven, it is recommended that the Trust Territory Department of Health Services formulate an education program which will satisfactorily explain to the Rongelapese and Utirikese the circumstances of their exposure and illnesses. It should be thorough and should be conducted for as long as it takes to satisfy the curiosity of the people involved, so that the same questions are not asked of the BNL team every year. It should also include the fact which the Committee has been made aware of by Dr. Darling, various Japanese experts, and testimony in the U.S. Congressional hearings, that such

examinations may go on for 25 years or more.

4. As provided for by law (introduced by the Committee during the First Regular Session of the Fifth Congress) the Trust Territory will provide free transportation, housing and per diem to those Rongelap and Utirik survivors, their descendants, and those who agree to act as members of a control group if they wish to go to Majuro for a health examination. The Trust Territory, under this law, will also be responsible for keeping track of all survivors and descendants, and control persons and arrange to see that they are all in places available to the BNL team during its visits.

5. It is recommended, in conjunction with BNL and the AEC, that health aides on Rongelap and Utirik should be given additional training in record keeping and certain methods of examination (palpation of the thyroid, for example). They should also be required to send in a monthly report by radio to Majuro and written monthly reports (vital statistics) on every field trip vessel.

6. It is also recommended that the Division of Community Development encourage self-help programs in the areas of agriculture, fisheries, and handicraft production on the islands of Rongelap and Utirik.

Congress of Micronesia

1. It is recommended that the Congress of Micronesia pass the law introduced by the Committee which will provide for free transportation, housing, and per diem for exposed, descendants of exposed, and control persons.

2. The Committee also recommends that the Congress, through its Special Joint Committee shall, in conjunction with the Department of Health Services, cause to be printed survivors and control persons booklets in Marshallese and English with the name, case number, name of island, etc., as described in

the public law. To this end, the Committee offers to the Department of Health Services the assistance of its staff members.

3. It is recommended that the Congress, through its Special Joint Committee, cause to be printed a summary of this report and its recommendations in the Marshallese language and that such report be distributed to the people of Rongelap and Utirik.

4. The Committee recommends that due to the unique nature of the effects of radiation and the special situation of the affected Marshallese, that members of the Special Joint Committee accompany the annual examinations to assure that its recommendations are carried out and that at the same time, it encourage further involvement of the Nitijela (Marshall Islands District Legislature) by sending two members to accompany those from the Joint Committee.

5. The Committee recommends that its mandate be enlarged in scope and that its life be extended to January, 1975.

The People of Rongelap and Utirik

1. To the people of Rongelap and Utirik, the Special Joint Committee recommends that they form Fallout Survivors Councils, composed of members of the regular island municipal council, plus senior exposed persons. This is a common practice in Japan, and the Committee feels that through groups like these, the people involved might better be able to express their concerns or agitate for correction of what they consider to be problems.

ACKNOWLEDGEMENTS

First of all, the Committee would like to give its thanks and appreciation to the magistrates, municipal councils, and the people of Rongelap and Utirik for their cooperation and assistance to the Committee. It is for these people that the Committee has traveled and studied and it is hoped that this report and its recommendations will help rectify some of their problems so that they may face the future, certain in the knowledge that the people and the government of Micronesia are concerned about them and are mindful of their special circumstances.

The Committee is also grateful to the following persons or agencies for their assistance to the Committee during its work. They are listed below in alphabetical order, according to country or jurisdiction.

ENGLAND

The Committee wishes to extend its deep appreciation to E. Eric Pochin, M.D., CBE, FRCP, Director of the British Medical Research Council's Department of Clinical Research at the University College Hospital Medical School, London, England. Also the Committee is grateful to the World Health Organization for recommending Dr. Pochin to the Committee.

JAPAN

Tokyo

We are also indebted to Ambassador Ingersoll, and Mr. David Brown, Second Secretary, Political Section of the United States Embassy in Tokyo; and in the government of Japan to Mr. Mamoru Tsunashima,

Director of the International Affairs Division of the Ministry of Health and Welfare, Dr. Tomokazu Kato, head of the Planning Section of the Bureau of Public Health, Mr. Sapuro Ishikawa, legal counsel, Mr. Watanabe, interpreter, and Mr. Tosikaya Takeuchi, assistant Chief of the Seamen's Insurance Section of the Bureau within the Division of the Ministry.

The Committee would also like to note its special thanks to Dr. Toshiyuki Kumatori, who heads the Clinical Research Division of the Japanese National Institute for Radiological Sciences for his acting as a consultant to the Committee, and is thus also grateful to Dr. Keisuke Misono, Director of the Institute for allowing Dr. Kumatori to participate in the Committee's work. The Committee is especially appreciative of having the opportunity to meet and talk with Mr. Matashigi Oshi a former crewmember of the Lucky Dragon.

The Committee wishes to also note its appreciation to Mr. Warren Elsner, Mr. John Krimsky, Mr. David Jones, and Mrs. Toshiko Saito of Pan American World Airways for their invaluable assistance to the Committee during its stay in Japan.

Hiroshima

The Committee would like to extend its sincere appreciation to the Honorable Istuo Nagano, Governor of Hiroshima Prefecture, and the Honorable Setsuo Yamada, Mayor of Hiroshima City and to his Foreign Affairs Chief, Mr. Kaoru Ogura.

A note of appreciation is also due to the staff of the Atomic Bomb Casualty Commission in Hiroshima including Dr. George B. Darling,

former Director, and the present Director Dr. LeRoy Allen, Dr. Maki, Associate Director, and to doctors Kato, Steer, Belsky, and Wada.

Also in Hiroshima the Committee wishes to thank Dr. Fumio Shigeto, Director of the Hiroshima Atomic Bomb Hospital, Dr. Yutaka Mizuno, Countermeasure Section Chief at the Hiroshima Survivors Welfare Center, Mr. Hiroshi Suzuki, Vice Director of the Hiroshima A-bomb Aid Home, Mr. Kazuharu Hamasaki, Director of the Hiroshima Peace Memorial Museum, and Dr. Tomin Harada, Director of the Harada Hospital.

Our special thanks is also hereby recorded for Dr. Haruo Ezaki, now Professor in the Second Surgery Department of the Hiroshima University School of Medicine, for his participation as a consultant to the Committee. We are especially grateful to Dr. Ezaki's former supervisor, Dr. Naomasa Okamoto, Director of the Research Institute for Nuclear Medicine and Biology of Hiroshima for allowing Dr. Ezaki to take leave from the Institute to work with the Committee.

Nagasaki

The Committee would like to extend its gratitude to the Honorable Yoshitake Murotani, Mayor of Nagasaki City and to his Deputy Mayor Soichi Urabe for his kindness to the Committee, and for the assistance in arranging the Committee's schedule. We are also grateful to Dr. Sadahisa Kawamoto of the Department of Medicine, Atomic Bomb Casualty Commission, Dr. Yoshimasa Matsuzaka, Assistant Director of the Nagasaki Survivors Welfare Center, to the directors of the Nagasaki A-bomb Hospital, the Old Age A-bomb Survivors Home,

the Nagasaki A-bomb Museum, and to Dr. Shunzo Okajima, Director of the Atomic Disease Institute of the Nagasaki University School of Medicine.

UNITED STATES OF AMERICA

The Committee acknowledges with appreciation the efforts of the Department of State, and the assistance of Deputy Assistant Secretary for Territorial Affairs, Mr. Stanley S. Carpenter, and the Department of the Interior for assistance rendered to the Committee in coordinating the participation of the doctors from Japan and England with the Brookhaven survey team.

Deserving special thanks is Jesse L. Steinfeld, M.D., former Surgeon General of the United States Public Health Service for his offers of assistance to the Committee. Special thanks are also due to Dr. William S. Cole, Associate Director of the Bureau of Radiological Health who was assigned to work with the Committee as consultant by Dr. Steinfeld. The Committee is also indebted to Dr. Cole and the U.S. Public Health Service for its assistance in having certain materials of the Committee translated from Japanese into English, and for the pamphlets and publications made available to the Committee through the kindness of Dr. Cole.

The Committee would like here to acknowledge its disappointment with two agencies of the United States Government; namely the Department of Defense and the Atomic Energy Commission for their apparent lack of cooperation and interest in the Committee's work. While it should be stated that the AEC has been cooperative to some extent

concerning certain aspects of compensation concerning the people of Utirik, it, along with the Department of Defense have unaccountably failed to respond to a request for certain information and materials in a letter dated April 5, 1972, which was routed through the Office of the High Commissioner. Whether this lack of response is due to bureaucratic lethargy or reluctance on the part of the agencies named is not known. In either case, the Committee wishes to note for the record its extreme displeasure at this apparent lack of assistance and expresses its hopes that this situation will be rectified in the future.

The Committee would like to extend its appreciation to Dr. Cronkite and Dr. Robert A. Conard of the Brookhaven National Laboratory of Long Island, New York for their assistance and cooperativeness. We are especially grateful for Dr. Conard's efforts to respond to the Committee's many requests for information and for his hospitality during the September survey. Also due a note of appreciation are the medical and support staff of the Brookhaven team including: doctors Lowery, Larsen, Sutow, and Knudsen, and Brookhaven staff members William Scott, Douglas Clareus, and Mike Maker.

THE U.S. TERRITORY OF GUAM

The Committee is also indebted to Dr. William Vitarelli, Vice President for Research and Development of the University of Guam, for his advice and comments, and also for his assistance in obtaining material from the University of Guam Library which has been invaluable to the writing of this report.

TRUST TERRITORY OF THE PACIFIC ISLANDS

Saipan

As noted elsewhere, the Committee tenders its thanks to High Commissioner Edward E. Johnston, Deputy High Commissioner Peter T. Coleman, and former Director of Health Services Dr. William Peck. Special note is due to present Director of the Department of Health Services Dr. Masao Kumangai, for his work with the Committee in Japan as liaison from the executive branch and for his assistance and advice thereafter. Also deserving of thanks is Mr. Kosang Mizutani, Assistant Medical Repair Specialist, who participated in the September examinations. Also providing assistance to the Committee was Mr. Bert Ogata of the Agriculture Division of the Department of Resources and Development, for which the Committee is thankful to Resources and Development Director Wyman X. Zachary, Deputy Director Eusabio Rechucher, and Agriculture Division Chief Mr. Bermin Weilbacher.

Marshall Islands District

The Committee wishes to thank the following people for their help and assistance during its two visits to the Marshall Islands District: District Administrator Oscar de Brum; Deputy District Administrator Edmund Gilmar; Mr. Henry Moses, now with the Legislative Liaison Division; Mr. Tony de Brum, Public Affairs Officer; Mr. Jack Tobin, Community Development Advisor; Mr. Philip K. Kabua, Administrative Officer; Speaker of the Nitijela, the Honorable Atlan Anien; the members of the district delegation of the Congress of

Micronesia; Mr. Murphy Ownbey, Distad Representative, Kwajalein; Captain Willie M. Poznanski, Master of the M/V Militobi during the September survey; Dr. Ezra Riklon, Assistant District Director of Health Services; Mr. Sebio Shoniber, Supervisory Laboratory Technician; Mr. Nelson Zetika, Laboratory Technician; Dr. Jetton Anjain; Mr. Kimura Riklon, Dental Aide; and Mr. Joe Saul, Health Aide.

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Appendix No. 1

Memorandum of Understanding and Reports of Consultants

CONGRESS OF MICRONESIA
SAIPAN, MARIANA ISLANDS, 96950

SPECIAL JOINT COMMITTEE
CONCERNING RONGELAP &
UTIRIK ATOLLS
(Public Law 4C-33)

Senator Olympio T. Borja, Chairman
Representative Timothy Olkeriil
Representative Hans Williander

September 21, 1972

Memorandum of Understanding

To : Medical Consultant to Special Joint Committee Concerning Rongelap and Utirik Atolls, Congress of Micronesia

From : Vice Chairman, Special Joint Committee

Subject: Submission of Report

As per the Special Joint Committee's Interim Report of May 16, 1972, the Committee would like to request that you submit a report to it discussing the following areas of concern:

1. Method of examination of people of Rongelap and Utirik used by members of Brookhaven National Laboratory medical team including:

a. you (sic) indication as to whether you feel examination on a once-a-year basis is justifiable in an island situation; and

b. whether you feel the present examination methods are adequate to protect the health of those examined, including whether you feel certain tests should be added, or if certain tests being now conducted are not necessary; and

c. your discussion on the doctor-patient relationship between the team and the people being examined and also any observable problems in communication evident to you; and

d. any other comment you care to make in this area.

2. Relative to the area of treatment, the Committee requests that you:

a. comment based upon your observations of this particular

survey, whether you feel that present treatment (surgery, medicine, etc.) is adequate, could be improved, or is inadequate and your reasons for such opinion; and

b. from your knowledge, experience and review of pertinent literature, discuss the adequacy or inadequacy of past medical treatment.

Additionally, the Committee would like to request comments on:

1. The advisability of returning the Rongelapese and Utirikese to their islands before testing in that area had ceased and their consequent exposure to higher-than-normal levels of residual background radiation; and

2. Any other comments or suggestions relating to professional medical aspects of the team's work, either of a general or specific nature, or any information comparing the medical examination and treatment of these groups with those you may be familiar with; and

3. Your professional opinion based on Brookhaven-AEC reports as to the validity of the original amounts of radiation exposure, and residual amounts both whole-body and internal.

The Committee asks that you prepare your report separately, upon return to your present place of work and that it be written without soliciting the opinions of the other consultants to the Committee or doctors connected with the AEC or Brookhaven other than for informational purposes and that this report be submitted to the Committee no later than 50 days after your departure from the Marshall Islands District.

It is agreed that all reports, information and correspondence between the Special Joint Committee and its consultants will be treated confidentially as in a normal medico-legal, doctor-client relationship: provided, however, that the Special Joint Committee may, upon its discretion, make public, any and all information received from said consultants without naming them unless they so agree and that such publication will release the consultant from any restriction on using said information for his personal use as he sees fit. It is furthermore, provided that those consultants who are required by their supervisors or superiors to do so will make available copies of their reports with the understanding that the information contained therein is confidential in nature. The reports, when completed, should be sent to Chairman Olympio T. Borja, c/o Congress of Micronesia, Saipan, Mariana Islands, 96950. Any expenses connected with the work of the consultants will be reimbursed or defrayed by funds of the Special Joint Committee Concerning Rongelap and Utirik Atolls or by the Trust Territory Government.

[redacted] 5010463

/s/
Hans Wiliander, Vice Chairman
Special Joint Committee Concerning
Rongelap and Utirik Atolls
Congress of Micronesia

Concurrence by consultants to
Special Joint Committee:

/s/
Dr. William S. Cole

/s/
Dr. Haruo Ezaki

/s/
Dr. Toshiyuki Kumatori

/s/
Dr. E. E. Pochin

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
ROCKVILLE, MARYLAND 20852

OCT 24 1972

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

Dear Senator Borja:

It is my pleasure to submit my report (Attachment No. 1) as a Consultant to your Committee in accordance with the Memorandum of Understanding of September 21, 1972, (Attachment No. 2).

I have combined portions of my response to the multiple questions in an attempt to more concisely state my observations on the methods of examination of the exposed persons of Rongelap and Utirik, as well as on the delivery of health care to the entire population of those atolls. The latter observation is made in response to the verbal request of Mr. Hans Wiliander, Vice Chairman of the Special Joint Committee.

I trust my report will be of assistance to your Committee in its continuing deliberations concerning Rongelap and Utirik Atolls.

As requested by you, I have attached a resume of my professional background.

With best personal regards, I remain

Sincerely yours,

William S. Cole, M.D.
Associate Director
Bureau of Radiological Health

3 Enclosures

[redacted]

5010465

Attachment No. 1

REPORT OF WILLIAM S. COLE, M.D., MEDICAL CONSULTANT TO THE SPECIAL JOINT COMMITTEE CONCERNING RONGELAP AND UTIRIK ATOLLS, CONGRESS OF MICRONESIA, FROM THE U.S. PUBLIC HEALTH SERVICE, BUREAU OF RADIOLOGICAL HEALTH, FOOD AND DRUG ADMINISTRATION, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

In accordance with the Memorandum of Understanding, dated September 21, 1972, I submit this report. The observations and opinions expressed are the result of my visits to Ebeye Island, Rongelap Atoll, Utirik Atoll, and Majuro Island, Marshall Islands, Trust Territory of the Pacific Islands, from September 5, 1972, to September 23, 1972, with the Brookhaven National Laboratory Medical Team. During this interval the following Marshallese were examined:

Exposed persons	- Rongelapese	32
	- Utirikese	76
Unexposed Rongelapese Control Group		16
Children of exposed Rongelapese		30
Children of unexposed Rongelapese		10

In addition, approximately 100 men, women, and children were examined and treated for diseases not related to radiation exposure. For example, more than 60 pairs of charity-donated eyeglasses were dispensed to the people of Rongelap and Utirik.

The visit of the Medical Team coincided with a serious outbreak of upper respiratory diseases and an acute gastro-enteritis infection on both Rongelap and Utirik. In addition, a localized epidemic of influenza occurred among those people and the personnel of the Medical Team, resulting in a quarantine of the involved islands. This proved to be an additional handicap in the conduct of the examinations by the Medical Team when it arrived at the Majuro Memorial Hospital, Majuro Atoll.

1. METHOD OF EXAMINATION OF THE PEOPLE OF RONGELAP AND UTIRIK ATOLLS BY THE BROOKHAVEN NATIONAL LABORATORY MEDICAL TEAM

The annual examination of the exposed people of Rongelap and Utirik Atolls is considered adequate for the detection of radiation-induced diseases, the result of fallout exposure in March 1954. This method of examination has detected serious thyroid abnormalities in 21 Marshallese in the past and resulted in the discovery of two additional cases at this most recent examination. The first case of acute myelogenous leukemia was discovered at this examination and the patient taken to the Hospital of the Medical Research Center at Brookhaven National Laboratory, Upton, New York, and subsequently transferred to the National Institutes of Health, Department of Health, Education, and Welfare, for observation and treatment.

Examinations performed by the Brookhaven National Laboratory Medical Team are considered technically adequate for its purpose. The history and physical examinations are performed under difficult circumstances on the islands with the lack of any facilities on Utirik compounding the problem. The permanent facilities available in the trailers on Rongelap are much more adequate for the examinations. The blood and urine tests performed by the American and Marshallese technicians are adequate and accurate. Additional examinations not related to radiation-induced disease could be added as clinically indicated. In regard to the treatment of radiation-induced disease and, in particular, the thyroid abnormalities occurring in exposed persons who were under the age of 10 at exposure, all available records indicate the treatment to have been excellent. The surgical care rendered to these individuals in Guam, Hawaii, and the United States is comparable to the best afforded in this country.

An annual medical examination with diagnosis and treatment of diseases endemic to the Marshall Islands not related to radiation is inadequate to protect the health of the people. Much more medical training of the Trust Territory Health Aides with standardization of the facility, surgical supplies, and medications is necessary before much improvement is to be expected. Frequent visits by Medical Officers of the District Headquarters are imperative.

There is difficulty in communication with the people on the purpose of the annual examination for the detection of radiation-induced disease. The facilities available on both Rongelap and Utirik do not afford the opportunity for a good physician-patient relationship and, until this situation is improved, misunderstanding and mistrust by the people will continue. This was more evident when I visited the Marshall Islands with members of the Special Joint Committee in July 1972. The language barrier increases the difficulty for both patient and examining physician as the physical examination is conducted.

2. OBSERVATIONS RELATIVE TO THE TREATMENT OF PAST AND PRESENT DISEASES

In regard to the diagnosis and treatment of disease endemic to the Marshall Islands visited and not related to radiation, the methods for delivery of good health care are totally inadequate. The difficulty in transporting heavy diagnostic medical equipment ashore at Rongelap and Utirik precludes examination using, for example, modern x-ray machines. In view of this, consideration should be given to the procurement of a "hospital" ship with such equipment permanently installed. This method would also allow additional clinical examinations to be performed as well as treatment of surgical problems. Such a facility would afford visiting medical personnel clean living accomodations not now available. This method of delivery of good health care has been adopted and proven highly successful in other developing countries.

The medical record system observed is totally unsatisfactory. A medical record should be established for all persons, both exposed and non-exposed. That information pertinent to the exposed population should be part of such a record and available for the visiting Medical Officers of the Trust Territory. An upgraded record of immunizations should be maintained to prevent outbreaks of diseases which could be prevented by early childhood immunizations. The tragic poliomyelitis epidemic of 1963-64 is an example of the necessity of such a program.

Consideration should be given to the preparation of a document in Marshallese on the purpose of the annual examination by the Brookhaven National Laboratory Medical

Team for distribution to the people prior to the visit of the physicians. I am not aware that such written information is presently available. Such a document may alleviate misunderstandings now in existence.

The dispensaries on Rongelap and Utirik should be upgraded with standardization of surgical supplies and medications. The hospital on Ebeye is inadequate to deliver good health care to the 5,000 residents of that island. The construction of the new hospital should be expedited as rapidly as possible. Additional medical training of the Health Aides on Rongelap and Utirik is a necessity. In my opinion, without it, even the scheduled visits by the Medical Officers from the District Headquarters will not prevent possible serious or fatal illnesses in the outer islands.

3. OPINION ON THE REPORTED ACUTE AND LATE RADIATION EFFECTS ON THE PEOPLE OF RONGELAP AND UTIRIK ATOLLS

The Bravo thermonuclear device of the Operation Castle test series was detonated on a coral reef on Bikini Atoll on March 1, 1954. This produced a yield of 15 megatons TNT equivalent and contaminated an area approximately 330 miles by 60 miles with radioactive debris. This large area included Rongelap and Utirik Atolls. The reported exposures to the people on those islands released by the U.S. Atomic Energy Commission in July 1956 were as follows:

Rongelap	175 rads whole body gamma	
Ailingnae	69 rads " " "	
Rongerik	78 rads " " "	(USAF Personnel)
Utirik	14 rads " " "	

The people of Rongelap received a skin exposure to such a degree to produce burns and partial epilation of the scalp, the result of a significant beta dose. The external beta dose was the result of direct skin contamination by fallout material. The presence of clothing and partial shielding by trees or houses resulted in spotty skin contamination.

In addition to the whole body gamma exposure and beta burns of the skin, a significant amount of radionuclides was absorbed by ingestion and inhalation. The dose calculations were begun at Kwajalein about two weeks after the detonation by determination of radioactivity within pooled urine samples. Such samples were returned to the United States for radiochemical analysis. Such analyses were continued and, at six months following the exposure, only minute amounts of radioactivity were detectable in the urine. Radioactive iodine was the most hazardous of the absorbed isotopes and, by extrapolation, a dose of 160 rads to the thyroid gland of the exposed adult and a range of 700-1400 rads to the exposed child's thyroid gland was received. In addition, both groups received 175 rads from external gamma irradiation.

Articles on this subject, published by the U.S. Atomic Energy Commission, the Brookhaven National Laboratory, the Department of Defense, and testimony before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Congress of the United States, were carefully reviewed with particular attention to methods used in dose calculations. Granted that much of the data were determined by post-detonation calculations and extrapolations, one must conclude that the published figures are reasonably accurate. It may be possible to reevaluate the data but this would be a formidable procedure.

By the Spring of 1957, ten surveys of Rongelap Atoll had been made by the Applied Fisheries Laboratory of the University of Washington and U.S. Naval Radiological Defense Laboratory. A decision was made to allow the people to return to their island on June 29, 1957, with the belief that permanent residence would not be detrimental to their health. The last nuclear device of the Operation Hardtack Tests was detonated on Eniwetok on July 26, 1958. Published data indicates that only a small and insignificant increase in background levels occurred on Rongelap as a result of this test.

In early 1958, a joint field trip was made by the Laboratory of Radiation Biology of the University of Washington and the Brookhaven National Laboratory Medical Team. Subsequently, three additional radiation surveys were conducted by the Laboratory of Radiation Biology prior to 1960. The maximum gamma dose level in September of 1959 was recorded as 0.04 mrads per hour, or approximately 350 mrads per year, well within the accepted maximum permissible dose of 500 mrads

per year to an individual. It was recommended to the people that land and coconut crabs not be consumed because of their selective absorption of strontium-90 and cesium-137.

It is accepted that the radioisotopes of iodine I-131, I-132, I-133, and I-135 contributed to the total dose to the thyroid gland, resulting in the development of nodules in the thyroid gland in 19 of 82 exposed people on Rongelap, with the preponderance in individuals who were less than 10 years of age at the time of exposure. The first thyroid abnormality was discovered nine years after exposure. Subsequent surgical exploration was carried out in Guam, Hawaii, and the United States on 18 of the victims, revealing three to have cancer of the thyroid gland. In addition, two boys were found to have developed total atrophy of the gland resulting in hypothyroidism. In an effort to prevent the development of thyroid nodules, the exposed people were administered thyroxine on a continuing basis. In my opinion, the surgical and medical treatment of the thyroid abnormalities afforded was comparable to the best available in the United States.

The long term or delayed effects of radiation are in the main the result of the radioactive isotopes strontium-90 and cesium-137. These two isotopes were plentiful in the fission products and have relatively long half-lives. Body burdens for cesium-137 and strontium-90 by radiochemical assay of the exposed Rongelapese in 1969 indicated no increase since similar evaluations in 1965. In addition, there was no significant difference in the body burdens of the exposed and unexposed persons living on Rongelap, indicating an equilibrium had been reached. It is difficult if not impossible to predict the ultimate result of this increased body burden of potentially carcinogenic substances. It is generally considered that the biological hazard from cesium-137 is not as great as strontium-90, a beta emitter that is selectively deposited in bone. There are animal experiments which indicate that strontium-90 in sufficient quantities may produce bone cancer and possibly leukemia. Pathological effects of cesium-137 in the muscle mass of the body are not definitely known at the present time.

At this examination, a nodular thyroid gland was detected in a Rongelapese girl who was 12 years of age at exposure and the first nodular thyroid in a woman exposed on Ailingnae when she was less than 10 years of age. Unfortunately, the first case of acute myelogenous leukemia among the exposed

Rongelapese was discovered at this examination. This case of leukemia occurred well beyond the peak incidence expected as the result of radiation exposure but radiation cannot be dismissed as the causative agent. In my opinion, the discovery of this disease in an exposed person on Rongelap is an extremely disturbing event at this late date following the acute radiation exposure. One of the most difficult problems at the moment is determining the effect of continued low dose irradiation of a given population. It is prudent to assume that there is no level below which some damage may be produced. Although I am not able to conclude with certainty that this case of leukemia resulted from radiation, it would appear that this is the case. Certainly it demands the continued annual examination of all exposed Marshallese for the forseeable future.

William S. Cole, M.D.

Submitted: October 18, 1972

CURRICULUM VITAE

WILLIAM S. COLE, M.D.

BIRTHDATE:

October 18, 1912, Norfolk, Virginia

MEDICAL EDUCATION:

University of Virginia Medical School - Doctor of Medicine, 1937

INTERNSHIP AND RESIDENCIES:

Virginia Mason Hospital, Seattle, Washington, 1937-1938
Resident on Internal Medicine, The Mason Clinic, Seattle, Washington, 1938-1939
Fellowship in Radiology, Mayo Clinic, Rochester, Minnesota, 1947-1948-1949

CIVILIAN PRACTICE OF MEDICINE:

General Practice: Taylor-Richardson Clinic, Ellensburg, Washington, 1939-1942
Chief of Radiology, Washington Clinic, Washington, D.C., 1954-1968
Assistant Professor of Radiology, Johns Hopkins University, Baltimore, Maryland, 1968-1973
Staff Radiologist, Johns Hopkins Hospital, Baltimore, Maryland, 1969-1973

MILITARY SERVICE:

U.S. Navy Medical Corps, 1942-1954
Rank: Commander, MC-USN (ret.), 1954
Last duty station: Chief of Radiology, U.S. Naval Hospital, Bethesda, Maryland, 1953-1954
Retired from the U.S. Navy as a result of injuries received in combat in the South Pacific Theater.

SCHOLARSHIPS AND HONORARY MEDICAL SOCIETIES:

E. I. DuPont Scholarship, 1932-1933-1934, University of Virginia
Richard Henry Whitehead Scholarship, 1935-1936-1937, University of Virginia Medical School
Alpha Omega Alpha Honor Medical Society, 1937

ALUMNI ASSOCIATIONS AND SOCIAL CLUBS:

Mayo Foundation Alumni Association
University of Virginia Medical Alumni Association
President, Manor Country Club Community Association, 1966
Board of Governors, Manor Country Club, 1967-1968
Executive Committee, Manor Country Club Board of Governors, 1968
Advisory Committee, Manor Country Club Board of Governors, 1969-1972

SEMINARS AND LECTURES:

Radiology Representative, Tumor Board Seminars, U.S. National Naval Medical Center, Bethesda, Maryland, 1950-1954
American Cancer Society Speakers Bureau, Washington, D.C. Chapter, 1964-1965-1966

PROFESSIONAL AND SCIENTIFIC SOCIETIES:

American Medical Association - 1941-1972
American College of Radiology - 1949-1972
- Executive Committee of the Council ACR, 1968
- Councilor from the Washington Chapter of ACR, 1965-1968
- Committee on Radiological Units, Standards and Protection, 1970-1972
- Councilor from U.S. Public Health Service - 1970-1972
- Member, Task Force on Pneumoconiosis of ACR - 1970-1972
- Member, American College of Radiology Residents Workshop, Washington, D.C. - 1965
- Chairman, American College of Radiology Residents Workshop, Johns Hopkins Hospital, 1970
- Fellow, ACR, 1969

Diplomate of the American Board of Radiology, 1949
District of Columbia Medical Society
- Chairman, Committee on Licensure, 1967-1968
- Vice-Chairman, Committee on Credentials, 1967-1968
- Chairman, Annual Scientific Assembly, 1966
- Chairman, Committee on Hospital Utilization, 1966

New York Academy of Sciences, 1968
Eastern Radiological Society, 1968-1972
Louis MacKall Medical Society, Washington, D.C., President, 1967-1968
Advisory Committee Chairman, Mid-Eastern Conference of X-ray Technicians, 1967-1968
Honorary Member, District of Columbia Society of Radiological Technicians, 1968
Radiological Society of North America - 1949-1972
- Committee on Audio-visual Aids, 1970

American Roentgen Ray Society - 1971

[redacted]

PRESENT POSITION:

Associate Director
Bureau of Radiological Health, USPHS

Executive Secretary, Medical Radiation Advisory Committee
Bureau of Radiological Health, USPHS

ARTICLES, BOOKS, REPORTS:

"Macrocytic Anemia in Association with Esophagitis"; William S. Cole, M.D.; Clinics of the Virginia Mason Hospital; 16:2:1937.

"Tabes Dorsalis Simulating Disease of the Gastro-Intestinal Tract"; William S. Cole, M.D.; Clinics of the Virginia Mason Hospital; 16:3:1937.

"The Plasma Proteins Following Partial Hepatectomy"; Alfred Chanutin, J. C. Hortenstine, and William S. Cole - J. Biol. Chem., p. 123-247, 1938.

"Massive Hemorrhage from Peptic Ulcer"; John M. Blackford, M.D., and William S. Cole, M.D.; Am. J. Dig. Dis.; 6:637:1939.

"Peptic Ulcer: A Review of 1,033 Cases"; John M. Blackford, M.D., M. F. Dwyer, M.D., Robert H. Williams, M.D., and William S. Cole, M.D.; Radiology; 36:217:1941.

"A Manual of Radiation Therapy"; William S. Cole, M.D.; Mayo Clinic Press, Rochester, Minnesota, 1949.

"Carcinoma of the Larynx Occurring in a Patient Receiving Therapeutic Doses of I-131"; E. R. King, M.D., William S. Cole, M.D., Alec Horwitz, M.D., Calvin T. Klopp, M.D.; Archives of Otolaryngology; 59:333; March 1954.

"Opportunities and Problems in the Clinic Practice of Radiology"; American College of Radiology Workshop, Washington, D.C., Nov. 13, 1965.

"Aggressive Approach to Metastatic Testicular Teratocarcinoma"; Theodore H. Wilson, Capt. MC-USN; David P. Osborne, Capt. MC-USN, William S. Cole, M.D.; The Journal of Urology, Vol. 96, August 1966.

"The Judicious Use of Radiation in the Healing Arts"; William S. Cole, M.D.; (Presentation at APHA, November 1968). American Journal of Public Health, Vol. 59, No. 7, July 1969.

[redacted]

HIROSHIMA UNIVERSITY SCHOOL OF MEDICINE
Kasumi-cho Hiroshima Japan

October 18, 1972

Senator Olympio T. Borja
Chairman
Special Joint Committee
Concerning Rongelap and Utrik Atolls
Congress of Micronesia
Saipan, Mariana Islands 96950

Dear Senator Borja:

Thank you very much for the kindness extended to me during my recent visit to Micronesia. I greatly appreciated all your assistance.

Enclosed is a copy of my report of my visit to Rongelap and Utrik. As for the report on the two new cases of thyroid nodules, I will submit my report as soon as I hear from Doctor Conard on the details of these cases.

If you and the committee have any questions, please do not hesitate and let me know.

Thank you again.

Sincerely,

H. Ezaki

Haruo Ezaki, M.D.
Professor
Department of Surgery

Enclosure:
Report on Visit to Rongelap and Utirik Atolls

HE:amk

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REPORT ON VISIT TO RONGELAP AND UTIRIK ATOLLS

At the request of the Special Joint Committee Concerning Rongelap and Utirik Atolls, Congress of Micronesia, I participated as an observer of the Brookhaven National Laboratory - AEC Medical Survey Team and made observations at Ebeye Island (8 September), Rongelap Island (11-13 September) and Utirik Island (16 and 18 September). In the following, I wish to report my findings in sequence by item of the questions put to me by the Committee.

As I stated at the meeting with the congressmen held on board the Militobi on the morning of 10 September, I would like to limit my opinions mainly to thyroid diseases which is my specialty, and not attempt to answer items outside of my specialty. Further, as I do not have the results on the specimens obtained during the survey, it is requested that it be understood I shall present my opinions on the basis of past medical literature and my current observations on these islands.

1. a. Detailed physical examination as is being held on an annual basis is appropriate. However, on such remote islands with limited hygiene facilities, it is desirable to conduct in addition 3 to 4 physical examinations per year for health consultation. At the same time, it is necessary to strengthen the health and hygienic facilities for the local residents, independent of the H-bomb casualty survey.

b. The contents of the past surveys have been modified slightly in accordance with special requirements. The present policy is considered satisfactory, except for one grave defect. This is that almost no autopsies are performed. Autopsy is one of the most effective methods to detect the effects of the H-bomb. Though there may be technical difficulties involved in performing such in this remote district and difficulties in securing the consent of the local people, it is hoped that the medical survey team and the Government of Micronesia can cooperate in overcoming these difficulties. If it is not possible to perform autopsy on the whole body, I strongly recommend study be made of the thyroid glands at least, where disturbances are most obviously present.

c. The examinees willingly underwent physical examinations and their attitude was friendly. It was observed that members of the medical survey team were making efforts to explain the results of examination in full detail so that they might be easily understood. However, when the opinions of those examined were sought later, I received the impression that some of them did not seem to have a complete comprehension of the results. This is considered not due to inadequate efforts on the part of the medical survey team, but due to the problem of language and lack of knowledge by the examinees. It is necessary to devise a mechanism whereby the results of examinations can be fully utilized for the health preservation of the examinees.

d. From the above point of view, the following countermeasure can be considered. A mechanism whereby a medical record containing the contents

of laboratory test results with the doctor's opinion is prepared for each individual and arrangements be made for one copy to be retained by the Government of Micronesia so that it can be referred to at any time as required by doctors or a person of similar qualifications. I recommend also that more highly trained health aids be stationed on the islands and have doctors visit the island 3-4 times a year for examination and consultation, and that both the doctors and health aids cooperate in maintaining the health of the residents.

2. a. I shall limit my report to thyroid diseases.

Surgical Treatment:

The operations for thyroid cancer that have been conducted are appropriate. It is usually the case with adenomatous goiter that operation is performed only after the tumor becomes enlarged causing disturbances. Therefore, for small adenomatous goiters as seen in many of the exposed, total thyroidectomy or similar operations are not required. It is enough to closely follow the course and perform an operation only when cancer is strongly suspected. However, for the following reasons, the treatment given in the past is considered to have been inevitable.

(1) Under the present system where one examination is made per year, it is not possible to make detailed follow-up observations. Therefore, it is safer to perform such operations on cases with even the slightest suspicion.

(2) From the biopsy specimens prepared from surgical material, I received the impression that some parts showed severe cell abnormality. Considerations must be given to the possibility of such areas developing into cancer in the future. From the standpoint of preventing radiation induced cancer from occurring, it is safer to perform such operations.

Medical Treatment:

(1) Treatment with Synthyroid after operation of the thyroid is considered as having been properly administered in view of the fact that the patients failed to show symptoms considered as due to hypothyroidism.

(2) Administration of Synthyroid for prevention of thyroid diseases is also considered as being properly handled, though some patients were found not to be taking the medicine as instructed by the doctor. This is considered due to the reason stated in 1-c, and the necessity for a means to more effectively utilize the results of examinations as stated in 1-d was keenly felt.

b. The above stated opinions are presented on the basis of my knowledge, experience and reference from medical literature.

3. Additional Comments

Item 1. This is beyond the realm of my specialty.

Item 2. All of my opinions have been stated above.

Item 3. This is beyond the realm of my specialty.

NOTE: The Medical Survey Team of Brookhaven National Laboratory - AEC is conducting the survey with a sincere attitude in a way considered appropriate from the medical point of view and is not only contributing much to the treatment and prevention of diseases among the exposed people, but also is providing service to the health preservation of the local people in general. I am deeply impressed by the great effort being devoted to this difficult work which is being carried out in the inconveniently located areas. It shall make me very happy if what I have stated will serve as some reference in achieving even better accomplishments.

H. Ezaki

Haruo Ezaki, M.D.
Professor
Department of Surgery
Hiroshima University
School of Medicine

[redacted]

CURRICULUM VITAE

Name: Haruo Ezaki

Date of Birth: December 7, 1921

Present Address: 17-38, Yoshijima Higashi 2-chome, Hiroshima-shi

Permanent Address: 115, Miyama-mura, Yamagata-gun, Gifu-ken

Education:

October 1945	Graduated from Tokyo Imperial University School of Medicine

Positions Held:

October 1945	Assistant, Nagoya Imperial University School of Medicine (1st Surgery Department)
December 1949	Lecturer, Hiroshima University School of Medicine (2nd Surgery Department)
October 1951	Assistant Professor, Hiroshima University School of Medicine (2nd Surgery Department)
April 1962	Professor, Hiroshima University Research Institute for Nuclear Medicine and Biology (Surgery)
October 1972	Professor, Hiroshima University School of Medicine (2nd Surgery Department)

NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES

9-1, 4-chome, Anagawa, Chiba-shi, Japan

Senator Olympio T. Borja
Congress of Micronesia
Saipan, Mariana Islands, 96950

October 27, 1972

Dear Senator Borja;

I have the honor to submit the report concerning the medical examination of exposed Marshallese. Also enclosed please find our short communication as a reference for the additional comments, paragraph 2.

I appreciate your kind information. Dr. Conard also informed me of the results of the survey. I regret the occurrence of a leukemia.

With the understanding that the information contained is confidential in nature, a copy of this report was given to Dr. K. Misono, Director of our Institute, by his request.

I hope this report will be of use for the future medical examinations.

Respectfully submitted,

Yours sincerely,

Toshiyuki Kumatori

Toshiyuki Kumatori, M. D.
Head, Division of Radiation Health

Encl.
Tk:tk

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Report to the Special Joint Committee Concerning
Rongelap and Utirik Atolls, Congress of Micronesia

This report was preapred in response to the request from the Special Joint Committee. The comments in this report are arranged in the same order of the subjects of discussion in Memorandum of Understanding which I received on September 21, 1972.

Comments on:

1-a. I think that medical examination of the exposed Marshallese on once a year basis is justifiable considering an island situation. However, since the immigration into other islands of the Rongelapese and Utirikese is unexpectedly frequent, I feel that it is necessary to take firm hold of actual circumstances. For this purpose, those who bear the responsibility of health control of the Rongelapese and Utirikese should inform the Trust Territory Government and Dr. Conard of these circumstances periodically. These actions will be very useful for the following examinations.

1-b. The present AEC team's examination methods which seem to attach importance to thyroid function are adequate to protect the health of exposed people. However, when we consider that the radiation health control forms a link in the chain of general health control and that detection of subtle late effects in the exposed people is necessary,

it is desirable, as an ideal, to add some other examinations to the present ones, f. e. chest X-ray examination to all residents, liver function tests, more detailed hematological examinations, cytogenetical study, etc.. Without saying, expensive equipments and man power will be required to perform such examinations. Moreover, closer co-operation of Marshallese is inevitable, because more frequent blood sampling and other procedures can not be avoided.

1-c. This time, the AEC team and the observers had meetings to discuss several problems with the Rongelapese and Utirikese before the beginning of the examinations. I think that these meetings were helpful to carry out the examinations smoothly. Nevertheless, I still feel that the difference of languages is the biggest obstacle which may sometimes disturb mutual understandings.

In general, personnels who are engaged in health control of the Rongelapese and Utirikese should be more trained. With the help of these personnels doctor-patient relationship between the AEC team and the people being examined will be much more improved.

1-d. As mentioned in the comment on paragraph 1-b, more detailed examinations are desirable as far as possible. I propose that Trust Territory Government own a ship which has enough rooms to complete the examinations. The ship should be equipped with an automatic

blood analyser, an automatic blood cell counter and other small examination rooms including a culture room and a dark room. With the use of the ship most of the results of examinations will be available more quickly than at present.

2-a. I feel that the present treatment of AEC team is adequate. Most remarkable late effects of the exposed Marshallese were thyroid abnormalities. The methods of the treatment of these abnormalities are quite adequate according to the Brookhaven National Laboratory Report.

2-b. The Rongelapese were irradiated by following three ways; external irradiation by γ-ray, β-radiation to skin, and internal irradiation. The treatments of the injuries due to γ-ray and β-ray irradiation were reasonable.

According to the present knowledge, when the uptake of radioactive iodine is suspected, inorganic iodine, f. e. NaI should be given to the suspicious patients as soon after irradiation as possible. The Rongelapese were evacuated about 2 days after the initial exposure. Even if these people had been given a dose of NaI containing 200 mg of stable iodine at that time, uptake of radioactive iodine might not have been much reduced.

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Furthermore, considering that the rescue operation was done 18 years ago, I don't think that the treatment without giving them inorganic iodine was inadequate.

Additional comments on:

1. The body burden of the Rongelapese and Utirikese is considered to have been increased by the fallout due to the following test explosion after their return to Rongelap and Utirik. However, the amount of fallout was not so much to injure them. At that time, namely in 1954 and 1957, if they found some benefit in returning to their home islands and wished to live there, I feel that it was not necessarily wrong to have made them return.

2. On the exposed Japanese fishermen the cytogenetical studies have been continued since 1964 by the staffs of our Division. The chromosome analyses are done by 2 day culture of peripheral lymphocytes. Some of the results are summarized in the attached paper. We found intimate correlation between the frequency of stable chromosome aberrations and estimated external dose or minimum value of neutrophils which indicates the severity of early radiation syndrome.

According to the report by Lisco and Conard (BNL 50029, p. 137), correlation of chromosomal aberrations and severity of early radiation

syndrome was not apparent. However, Dr. M. S. Sasaki, Dept. of Human Cytogenetics, Tokyo Medical and Dental University, has found a difference between the 175-rad group and the 70-rad group of the exposed Marshallese (Radiation Biology Research Communication 3: 3-21, 1968, in Japanese) from the data of Lisco and Conard (Science 157: 445-447, 1967) using the method with which the estimate for atomic bomb survivors was made 22 years after exposure (Nature 220: 1189-1193, 1968).

Taking above mentioned facts into consideration, I would like to suggest that cytogenetical examination be done on the selected cases in near future. This study is considered to be important to detect the late effects.

3. Since I am not a specialist in the field of radiation dosimetry, I asked an authority of our Institute. According to his opinion, the ways of estimation described in BNL report are reasonable.

In addition to these comments, I would like to make a proposal that Trust Territory Government request the United Nations to have an international scientific meeting on the effects of radiation-exposed people including the Marshallese. I believe that such a meeting is useful to dispel several misunderstandings.

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Lastly I would like to take this opportunity to express my great admiration for the excellent results which have been obtained under the co-operation of AEC team, Trust Territory Government and many other authorities after overcoming many difficulties.

Toshiyuki Kumatori

Toshiyuki Kumatori, M. D.

NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES

9-1, 4-chome, Anagawa, Chiba-shi, Japan

Résumé of Professional Background

I was graduated from School of Medicine, Tokyo University in 1945 and received a degree of Doctor of Medicine. After the graduation I entered the 3rd Department of Internal Medicine, Tokyo University as a research fellow. In October 1945 I went to Hiroshima for the survey and treatment of A-bomb victims and spent about two months. I practiced hematology. From 1948 to 1950 I was also a lecturer of Tokyo Medical and Dental College.

In 1952 I moved to First National Hospital of Tokyo. When Bikini radiation accident occured I took charge of the treatment of Japanese fishermen exposed to fallout radiation in March 1954. In 1956 I got the scholarship of Japanese Government and studied radiation hematology for about a year mainly in Oxford University, England. I also visited other European countries and U. S. A. for the study until October in 1957.

In 1959 I was appointed to Chief of 1st Laboratory of Clinical Investigation at National Institute of Radiological Sciences. In October, 1962, I was invited to the scientific meeting on "Diagnosis and Treatment of Radioactive Poisoning" by the International Atomic Energy Agency. In March, 1964, I went to the Marshall Islands to observe the examinations of the exposed Marshallese with U. S. AEC team. In 1965 I was appointed to Head of Division of Radiation Health at National Institute of Radiological Sciences. In June, 1966, I went to U. S. A. and several European countries as a leader of a party of investigation on "Medical Supervision of Plutonium Operator". In August, 1970, I attended to the 13th International Congress of Hematology which was held in Munich. Since 1954, I have continued the follow-up studies on above mentioned Japanese fishermen. I have published many papers on the subjects of hematology and radiation effects on human being.

Toshiyuki Kumatori

Toshiyuki Kumatori, M. D.

stored in the punched paper tape for retrospective studies. The original image stored in the disc is then processed into an intelligent pattern for visual interpretation by means of smoothing and restoration, and displayed on CRT, line printer or curve plotter (Fig. 8). The above procedures are also programmed in an on-line mode so that all instructions are initiated at the keyboard of the input-output typewriter equipped in the scanning room. The viewer is allowed to choose any image processing technique employed in program and to repeat the display until he finds the best one to be photographed for diagnosis. These highspeed versatile functions offer the physicians many additional diagnostic information which cannot be obtained by the conventional methods. Details will be soon published.

Chromosome Abnormalities of Japanese Fishermen Exposed to Fallout Radiation in 1954

Toshiyuki Kumatori, Takaaki Ishihara, Sei-ichi Kohno and Machiko Inaba

Twentythree Japanese fishermen were exposed to fallout radiation in the Pacific Ocean on March 1, 1954. The fishermen were irradiated externally from the radioactive materials deposited on the boat, internally from those materials which entered various organs and by those that adhered to the body surface. Although the estimation of exposed dose was very difficult, the external gamma radiation dose of each person was inferred as 170–690 R for 14 days, nearly 60% of which was received on the first day. The external irradiation seems to have taken an important role in their radiation syndrome.

Follow-up studies on the fishermen have been performed on an annual basis by the authors. Number of persons examined in each year were 15–18, which corresponded to about 70–80% of exposed fishermen.

The cytogenetical studies have been continued since 1964. The chromosome analyses were done by the culture method of peripheral blood. At first we did 72 hrs. culture, but since the 1966 examinations, 2 days culture has been adopted. The results of chromosome analyses are summarized as follows; 1. The frequency of aneuploid cells was 2–3%, which was not so high compared with that of a normal person.

2. The frequency of stable and unstable chromosome abnormalities was remarkable high. Compared with that of a normal person, the frequency of stable cells was 10–20 times higher, and fairly constant in each annual examination.

According to these results it was suggested that an intimate correlation might exist between chromosome aberration rate and the externally irradiated dose of each person. This correlation was examined on the findings of 1969 survey. The aberration rate used was that of the stable cells. 300 cells on an average were observed in each case for the calculation of the rate. As shown in Fig. 9 the close correlation between stable cells percentage and external doses were proved ($P<0.01$). In addition a similar close relationship existed between these aberration rates and minimum values of neutrophils, which were observed at the critical stage (4–7 weeks after exposure) and almost corresponded to the severity of acute radiation syndrome of each fishermen. Fig. 10 shows this relationship ($P<0.01$).

Although the significance of chromosome abnormalities should be elucidated by further follow-up studies, it is noted that the examination of chromosome abnormalities is valuable for the risk estimation of radiation exposed persons.

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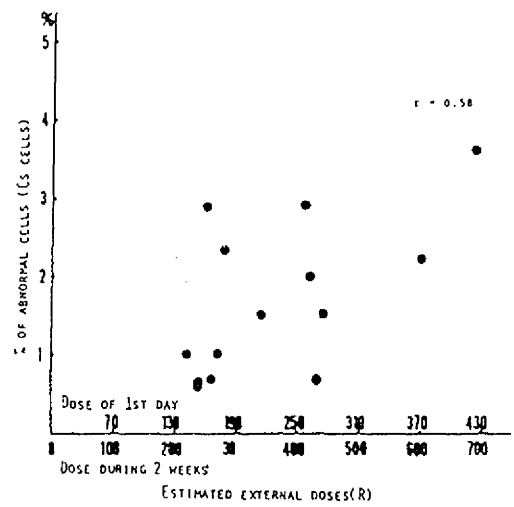

Fig. 9. Correlation between chromosome aberrations (Cs cells) and estimated external doses.

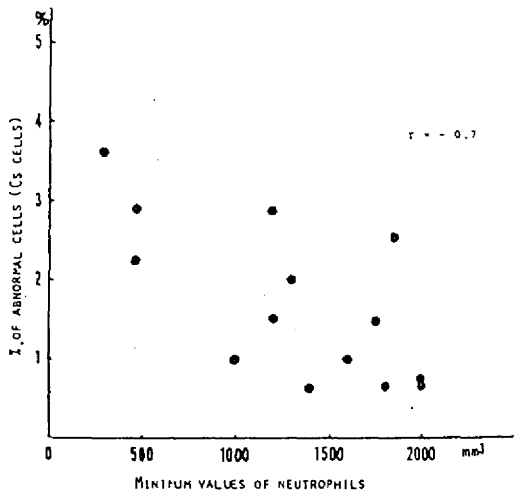

Fig. 10. Correlation between chromosome aberrations (Cs cells)and minimum values of neutrophils.

Common Clone Cells with Structural Chromosome Aberrations in Peripheral Lymphocytes and in Bone Marrow of Irradiated Humans

Takaaki Ishihara, Sei-ichi Kohno
and Toshiyuki Kumatori

The Ph^1 chromosome in chronic granulocytic leukemia is known to be present in granulocytic, erythrocytic and megakaryocytic cells in bone marrow, but not in peripheral lymphocytes which are stimulated to divide in culture responding to PHA. The evidence has led to an idea that those lymphocytes might be developed from a separate line while the former three cell series are derived from a common stem cell. In mice and rats, on the other hand, the presence of multipotent lympho-hematopoietic stem cells has been suggested.

As a means of approaching the problem on the derivation of lymphocytes in their relation to bone marrow cells in humans, three radiation-exposed individuals who showed presence of distinct clones with structural chromosome abnormalities in bone marrow were studied in order to find out whether or not clone cells common to peripheral lymphocytes and bone marrow are present.

The results of the chromosome analysis both in the bone marrow and in the cultured lymphocytes of the three cases are presented in Table 2. As seen in the table, common clone cells in the two tissues did exist in cases B-17 and Th-3.

In case B-17, one of the fishermen exposed to fallout radiation at Bikini in 1954, a clone with a karyotype of 47, XY, mar+ occurred in the bone marrow with a frequency of about 10%. In the blood cultures four of the 690 cells (0.58%) showed the karyotype of this clone.

In case Th-3, a man injected with Thorotrast in 1945, 21 of the 519 cells (4%) in the bone marrow and 70 of the 3,398 cells (2%) in the blood cultures showed an identical karyotype of 46, XY, Gq-?, t(2p-Gp+)

In case RT-1, a cervic cancer with hypoplastic anemia received radio-therapy, nearly 100% of the cells in the bone marrow were members of a single clone showing a karyotype of 46, XX, t(Bp+;Cq−) and the derivatives, but none of the 273 cells snalyzed in the blood cultures showed this karyotype.

The identification of cells with the same radiation-induced markers among the dividing cells in PHA-stimulated lymphocytes and in bone marrow in cases B-17 and Th-3 seems to be conclusive evidence for the presence of a lympho-hematopoietic stem cell in man yielding both lymphoid and bone marrow descendants.

The present data from irradiated humans clearly demonstrated that PHA-responsive peripheral lymphocytes are the progeny of the same stem cell for bone marrow cells, but they do not explain the reason for the absence in peripheral lymphocytes of cells with the Ph^1 chromosome in chronic granulocytic leukemia or of the clone cells of case RT-1, which are observed as the majority of the cells in bone marrow. This is a serious problem to be solved in future.

(Unpublished)

IN CONFIDENCE

MRC Department of Clinical Research
University College Hospital Medical School
University Street, London WC1E 6JJ

MRC
Medical Research Council

telephone 01 - 387 9300 ext 188

reference

6th November 1972

TO: The Chairman
The Special Joint Committee Concerning
Rongelap and Utirik Atolls
Congress of Micronesia

Sir,

I have pleasure in reporting to you on the medical examinations made during September 1972 by the Brookhaven U.S. National Laboratory team and their consultants, and on the subjects specified in the Memorandum of Understanding between Representative Hans Wiliander and the consultants to your Committee.

I accompanied the team from September 6th to 23rd, and either observed or took part in examinations, including that of the thyroid gland, of most of the people seen on Rongelap and Utirik, and of about 60 of the 80 people to be seen on Majuro. I also examined microscopic sections of thyroid glands removed at operations on these people, and have studied reports of previous surveys and estimates of radiation dose.

I will comment on the lines indicated in the Memorandum of Agreement but think it may be useful to the Committee if I refer first to the aims of these surveys as I observed them.

It seems to me that the surveys have, and have had, three aims which are to a large extent interdependent.

(a) As a primary purpose, to detect at an early stage any radiation-induced abnormality, so that early treatment can be given, e.g. by removal of benign nodules to prevent malignant development, and of malignant nodules to prevent their spread beyond the thyroid or the neck; or to start or supervise treatment designed to prevent such changes occurring (e.g. by giving "Synthroid").

(b) In addition, to maintain a record of the frequency of any observed thyroid or other changes, in relation to the radiation exposure of thyroid glands. When detailed examinations need to be made anyhow as under (a), this record involves no additional examination or study except of the normal frequency of changes occurring in people who have not been exposed, and of the radiation dose likely to have been received by those exposed. It is however of very considerable importance in the proper planning of radiation protection measures, to know the changes that may

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occur after a given exposure and the frequency with which they occur. This incidental information therefore has widely recognized importance, for example in the International Commission on Radiological Protection, and in the United Nations Scientific Committee on the Effects of Atomic Radiation, particularly in view of the careful clinical examinations that are made on the Marshallese people.

(c) To offer any treatment, or advice about treatment, for any condition detected by the general medical examinations, although unrelated to radiation. It is obvious that if a strongly qualified and equipped medical team is making rather extensive examinations in any case to detect and treat any radiation induced condition, the team would wish to offer treatment of any other condition as well. In fact I think that this general and nonradiation aspect of the visit clearly occupied a major proportion of the team's effort. A general "sick-call" for any ill member of the community was announced and held on each day (in Rongelap and Utirik), and each patient so seen was discussed in detail by the whole group in the light of the different findings (clinical examination, blood count, X-ray etc.). The rather full clinical examination of the radiation exposed people was also supplemented by eye examinations and by electrocardiographic, blood and chest X-ray and urine examinations in many cases, and these were of evident value in general medical surveillance, as judged by conditions detected which were unrelated to radiation but which required treatment.

Coming to the points raised in our memorandum of agreement,

1(a). It is difficult to say at all exactly what interval is necessary, but new nodules have been detected on this visit in two people, and possibly a further instance of depression of thyroid function (the latter diagnosis depended partly on later chemical analysis of the blood sample). Both these conditions call for rather prompt action: for the nodules, to establish by surgical removal that they are benign and that they cannot become malignant, or to plan appropriate operation if either should prove to be malignant; and for the depression of thyroid function, if confirmed, to start or increase thyroxine ("Synthroid") dosage.

I understand that one radiation exposed person has been found to have a significantly low white blood cell count, and this will require immediate investigation and probably treatment.

The thyroid tumours of the type liable to follow radiation are relatively slow growing, even if malignant, and the apparently successful complete removal of all that have previously occurred is reassuring. Whether this would have been the case with less frequent examinations is uncertain. There would clearly be greater risk, however, even at this stage after exposure, in widening the interval considerably, since annual thyroid examinations help in ensuring that a malignant nodule is detected early enough for it to be completely removed before it has spread too far

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to be removable.

1(b). Present examination methods appeared to me to be extensive, detailed and careful. In particular, the clinical examination of the thyroid was ordinarily done by one of the team and one observer, with two others of the team and two other observers also in any case of doubt. The laboratory tests used highly sensitive modern methods of detecting any threatened, as well as any actual, depression of thyroid function (by measuring the blood concentration of the thyroid stimulating hormone as well as of the thyroid hormone itself). They are in general of the same type and range as those that I use in my own work in excluding depression of thyroid activity. Apart from additional tests that were made occasionally of the reserve of thyroid function (by injection of thyroid stimulating hormone in a few cases), these are the orthodox routine tests ordinarily done in sound advanced thyroid clinics - given that thyroid scans need to be specially arranged outside the Trust Territories if shown to be required.

I therefore do not see other thyroid tests which should be added, or any present ones deleted. Nor do I see any tests for radiation effects which should be added or deleted. It is a matter of opinion whether any tests carried out as part of general medical care and surveillance, and presumably irrelevant to radiation effects, for example by electrocardiograms or tests on the urine, should be deleted. If an expert team with the necessary facilities is on these islands in any case, and if these tests detect treatable disease that had not otherwise been detected, I think it would not be appropriate to delete them, even though from the narrower point of view their deletion would probably not impair the necessary care of these peoples in regard to purely radiation induced effects. Unless equally detailed medical examination is available to these (and other) islanders from other sources, therefore, it would seem to me wrong to diminish this general health protection, even though the size of the team could be reduced if its work were confined to radiation effects alone and if "sick calls" and general surveillance were excluded. As it stands, I think it could in fact even be held that the exposed islanders may actually have had better health than other islanders - by virtue of non-radiation diseases detected and treated and despite the radiation induced thyroid conditions that have required treatment.

1(c). With so little common language between most members of the team and the people examined, an impression of brusqueness could easily be created, but I did not consider that the many examinations that I saw were inconsiderate. It was particularly obvious that Dr. Conard was being greeted as an old friend, and Dr. Sutow's gentleness and charm in dealing with children and young people were very evident. In general the difficulties seemed to be only those that, for example, I find in London in examining a patient with whom I have no common language: namely that one cannot verbally express reassurance, cannot indicate in detail

what examinations one is about to make, and cannot explain the purpose or results of each.

It was of outstanding value that Dr. Ezra Riklon first obtained from all who were being examined, an account of any sympotoms they had, and then explained the nature of the intended examinations. In addition, if any abnormality was detected or suspected from the examination, he asked, or interpreted, additional questions to amplify the "history" and to make sure that the individual understood the position and any necessary action. I understand that this arrangement was introduced on this 1972 visit and I would expect that difficulties in communication will have been much reduced by this, particularly in view of his sympathy and his deeply humane and positive personality.

On this general point, I understand that unirradiated people had questioned why they also should be examined and should be exposed to blood sampling and other tests. I was concerned to hear this since, if so, it would imply that their help had not been clearly asked for, or understood to be, on the voluntary basis that such help would be valuable, or essential, to the proper care of their irradiated fellow people. The point here is that if, for example, thyroid nodules were common in unirradiated islanders and did not progress to malignant forms, the proper management of nodules appearing in the exposed people might be quite different from that if such nodules were rarely seen in the unexposed. It would certainly suggest a failure of communication if the co-operation of unexposed people had not been asked for and interpreted as an offer of their help.

1(d). I examined microscopic sections of nodules removed at operation and see no grounds for disagreeing with the diagnoses - of benign or malignant forms - that have been made. The pathologists who have examined and reported on these sections include men who are internationally accepted as expert in thyroid pathology.

2(a). Past medical treatment seems to me to have been on normal and orthodox lines, and appears appropriate.

In particular,

(i) The treatment of any significant depression of thyroid activity by a synthetic thyroxine preparation - in this case "Synthroid" - is a routine, and the regular blood tests (for protein bound iodine and, when the test became available, for the thyroid stimulating hormone) enable deficiencies to be detected early. Taking the whole weekly dose of Synthroid at one time once a week is reasonable, given the slow utilisation of this hormone, and makes it more likely that the appropriate average will be maintained than if doses are to be given daily. It is of course important that Medical Aides should check that correct supplies of tablets are in fact collected regularly.

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(ii) A temporary cessation of this administration of Synthroid is necessary when tests for remaining activity are needed in patients who have been treated for thyroid cancer, as was done in the four affected patients in 1968. The period of withdrawal then used was in my view longer than needed and I have discussed this point with Dr. Conard. I find that 1 month is needed, whereas 3 months were used (1 of which apparently arose from delay in travel of patients for the tests). The effect of this would not be, and evidently was not, substantial in causing return of any severe hypothyroid symptoms, and at least it will have made tests to exclude the persistence of tumour tissue more rigorous.

(iii) The administration of thyroxine preparations to decrease the likelihood of nodules developing is also generally accepted practice, and the dosages used are normal ones. The basis for this practice is a theoretical one (to avoid stimulation of the thyroid cells by the body's own production of thyroid stimulating hormone) and it is not known by experience how fully effective it is. It cannot be completely effective, since a nodule has appeared this year in a young woman who was receiving this treatment.

(iv) The removal of "solitary" nodules is normal medical practice if they arise spontaneously, particularly in younger people and often also in older people if they do not decrease after thyroxine administration. When they arise after thyroid irradiation, and if only occurring rarely in unirradiated people of the same race and way of life, there is a much stronger case for removal to exclude possible malignancy.

2(b). Present and proposed treatments continuing on these lines appear appropriate and adequate. I agree with the opinion in the team that the nodules newly detected in two young people (by the time of my leaving Majuro) should be removed surgically, with whatever removal of thyroid tissue or local lymph nodes is indicated by their histological nature (benign or malignant).

A particular problem comes up in testing for the completeness of removal of any malignant thyroid tissue. All the four people from whom thyroid cancers have been removed were examined in detail at the time of operation, and by clinical examinations since, to exclude any remaining tumour tissue, and no evidence has been found of any. They have in addition had scans in 1968 which are reported as showing no concentration of radioiodine in any position which would necessarily indicate tumour tissue to be remaining, no uptake having apparently been found except in positions consistent with remaining normal tissue. I have discussed in detail with Dr. Conard certain additional and sensitive tests that we currently use in this situation, but these might present greater difficulties than those already used, either because of the high concentrations of a characteristic iodoprotein which is present normally in the blood

of many of the islanders, or because the further tests would themselves involve appreciable additional radiation, or specialized linear scanning equipment which is not available in many centres.

On the three additional points on which the Committee requests comment:

1. It is inevitably difficult to assess the likelihood that further tests, after the return of the Rongelapese and Utirikese, might have added substantially to their radiation exposure, if only because this assessment would depend upon the detailed planning arrangements laid down for conducting these tests in the light of current meteorological reports, height and power of detonation, fission/fusion yield, etc. In retrospect, however, the measurements of background radiation and body burden of radionuclides appear to indicate that in fact the amount of whole body radiation was little increased, probably by less than 3% of that initially received, following the return, either from a raised background or from subsequent tests. The percentage increase in thyroid radiation is likely to have been even smaller. I have not attempted to make any exact determination of this increase, but the above estimate shows that the decision did not increase substantially the exposures received.

2. The team's general medical examinations, both of the exposed people and of the unexposed people attending "sick call" illustrated the value that periodic medical examinations always have for people living in relatively isolated small communities in any part of the world. Your present practice and development of periodic medical visits to the Marshallese and other islands is thus of obvious importance in detection and treatment of chronic illnesses. I was impressed however by the frequency of recent or "acute" illnesses or minor epidemics, the management of some of which would be beyond the facilities of Health Aides. This point is not strictly within my remit as your consultant. I wondered however whether the development of simple and reliable radio links, and appropriate arrangements for discussion when necessary between dispensaries and hospitals in the area, might not give help which could be economically practicable and rapidly introduced, and which would not only allow discussion of difficult problems, but might also provide a valuable form of continuing training and stimulus, particularly for Health Aides in the more isolated situations. I appreciate, however, the problems of supplying and maintaining equipment, and of implementing advice that might be given by hospitals, and that questions of this type will certainly have been reviewed already by your Congress.

3. I cannot comment as an expert on the purely physical estimate of external radiation exposure or the data from which they are derived. These dose estimates, however, appear to have been reliably based on early and subsequent readings, on conventional calculations as to the decrease in fallout radioactivity with time, and on reasonable estimates

of the relevant period of exposure.

The estimates of internal exposure in the initial phases depend upon three types of assumption:

(i) The size of the thyroid glands into which the radioactive iodine was concentrated, and the way in which gland size varies with age. Estimates of gland size made in different countries do not vary greatly, and the sizes assumed for the Marshallese children, in the absence of direct data, are typical average values.

(ii) The types of radioiodine taken into the body, and whether by inhalation, drinking water or food (since this affects the time and duration of exposure). The types of radioiodine present at any time since nuclear fission are well established on physical grounds, and the assumed modes and durations of intake seem reasonable.

(iii) The amount of these radioiodines incorporated in the thyroid and hence the radiation exposure of glands of any given size. Here the estimate has to be based on measurements of the amounts excreted in pooled urine specimens taken 15 days after exposure, and on assumptions as to the proportion of the initial uptake that will be excreted during this 15th day. The original assumption was that 0.05 to 0.2% of the initial uptake would be excreted on that day. I have recalculated this figure on the basis of the best later estimates of which I am aware for the speed of discharge of iodine from the normal thyroid and its appearance in the urine, and obtain a figure of 0.09%, in good agreement with the central value for the original assumptions. I have also seen a calculation by Dr. Rall and Dr. Berman based directly on measurements of iodine turnover in five Marshallese people. This gives a higher percentage, and therefore a lower estimate of radiation exposure as based on the measured urinary excretion. It should also be added that, if the thyroid radiation itself altered any of these (normal) values, it would do so by accelerating the discharge of iodine from the gland, and perhaps also by increasing the proportion excreted in the urine. Both these changes would thus lower the estimate of thyroid dose. The average thyroid dose may thus have been lower than estimated, and it seems unlikely to have been higher. It must be emphasized however that these are estimates of the likely <u>average</u> dose from internal radiation. Doses received by different children are likely to have differed considerably from the average appropriate for their age, owing to individual variations in size of gland, in amount of contaminated water drunk, or air inhaled, and in the discharge rate of iodine from the thyroid gland.

I apologize for the considerable length of this report and recognize that much of it deals with minor points of technical or medical detail. I felt however that, on questions of the type which your Committee has raised and with which it must be concerned, it was

preferable to state the basis for opinions, even if the detail is technical, rather than to give general conclusions without supporting reasons. I hope that my comments deal adequately with the information and opinions that you require, and that you will not hesitate to raise with me any other questions that your Committee may wish.

Yours sincerely,

E. Eric Pochin CBE MD FRCP.

Dr. E. Eric POCHIN, CBE MD FRCP

Director of the (British) Medical Research Council's Department of Clinical Research, in University College Hospital Medical School, London; and Consultant Physician in University College Hospital, and Honorary Lecturer in the Medical School.

Fellow of the Royal College of Physicians since 1946, and member of its Council from 1966 to 1968. Member of the Association of Physicians of Gt. Britain and N. Ireland, of the Royal Society of Medicine, and of the British Medical Association. Member of the Ethics Committee of the School and Hospital.

Engaged since appointment as Director of the Department in 1946 in clinical work in thyroid and other diseases, in medical teaching, and in research, particularly into the investigation and treatment of thyroid disease, the treatment of thyroid over-activity, and the study of the diagnosis, metabolism and therapy of thyroid cancer; and author of various papers on thyroid cancer and disease.

Member of the European Thyroid Association, the Thyroid Club of London, and (corresponding member) of the American Thyroid Association.

Member of the International Commission on Radiological Protection, formerly Vice Chairman (1959-62) and Chairman (1962-69) of this Commission and member of its Committee on Internal Dose.

Member, formerly Chairman, of the British Medical Research Council's Committee on Protection against Ionising Radiation and member of its Committee on Internal Dose.

Member of the British Institute of Radiology, and Honorary Member of the Faculty of Radiologists, British Radiation Protection Association and the Japanese Radiological Society.

UK Representative on United Nations Scientific Committee on the effects of Atomic Radiation since 1956, and formerly Chairman of its Biological Section.

Appendix No. 2

Preliminary Report of 1972 Examination
by Dr. R.A. Conard

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BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC., UPTON, L.I., N.Y. 11973

MEDICAL DEPARTMENT

TELEPHONE: (516) 345- 3577

October 13, 1972

Senator Olympio T. Borja
Chairman, Special Joint Committee
Concerning Rongelap & Utirik Atolls
Congress of Micronesia
Saipan, Mariana Islands 96950

Dear Senator Borja:

Thank you for your letter of October 4, 1972. I was glad we were able to successfully complete the medical examinations of the Rongelap and Utirik people. I am sorry you were not able to be with us. Please extend to Vice-Chairman Wiliander and other members of the Committee that were with us our appreciation for their efforts in helping make for a successful survey. I am also most grateful for the help of the distinguished physicians of the medical observing group who participated actively in the medical examinations and contributed a great deal to the success of the survey.

I am enclosing a copy of my answer to Mr. Farley's letter summarizing in a preliminary way results of the examinations. I am most regretful about the leukemia case and can only assure you that everything possible is being done for him.

With regard to your return visit to Rongelap and Utirik, I would like very much to send along a brief statement to the peoples of these two islands concerning the results of our examinations in September. I will have the statement translated into Marshallese and will send you both versions prior to your departure. Please let me know when you expect to leave.

If I can be of any further help, please let me know.

Sincerely,

Robert A. Conard

Robert A. Conard, M. D.

RAC:ls

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BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC., UPTON, L.I., N.Y. 11973

MEDICAL DEPARTMENT

TELEPHONE: (516) 345-3577

October 13, 1972

Mr. Brian Farley
Staff Member
Special Joint Committee Concerning
Rongelap and Utirik Atolls
Congress of Micronesia
Saipan, Mariana Islands 96950

Dear Mr. Farley:

Thank you for your letter of October 4, 1972. You requested a rough summary of the survey. The following summary must be considered preliminary in nature. The medical records and equipment have not yet arrived from the islands. I understand that the quarantine due to the influenza epidemic held up the Militobi departure for Kwajalein, where our material was to be airshipped from.

You will remember that in the March survey we were able to complete the examinations on the Rongelap and Utirik people at Ebeye. Therefore, the following examinations were performed at Rongelap, Utirik and Majuro atolls:

Group	Rongelap	Utirik	Majuro
Rongelap exposed	23	-	9
Children of exposed	16	-	14
Utirik	-	46	30
Rongelap unexposed	6	2	8
Children of unexposed	4	-	6
Total	49	48	67

In addition, a large number of other people were examined and treated for routine ailments during sick call each morning at Rongelap and Utirik. At Rongelap an epidemic of severe gastrointestinal infection, frequently complicated by upper respiratory infection and, in some cases, by pneumonitis, were treated. At least a dozen children were involved. A total of some 40-50 people were treated at sick call at Rongelap. At Utirik also a large number of children (26 in one morning) and some 20-30 adults were treated for various ailments. At

Majuro also treatment was recommended on some of the people examined to the local medical officers. In the interest of trying to promote a better communication between the examining doctors and the Marshallese examined, an attempt was made at the completion of each examination to explain to the person through an interpreter the general results of the examination and possible treatment recommended.

At each island clinical conferences were held by the physicians, including the medical observers, Dr. Riklon and the health aide, to evaluate all cases examined and to recommend treatment and disposition. In some cases, the health aide was advised as to further treatment. In other cases, Dr. Knudsen was asked to see certain cases on his return visit to the islands. In other cases transfer to the Majuro hospital were recommended for further evaluation and treatment. At Rongelap there were two hospital cases and at Utirik five cases. We took them with us on the Militobi to Majuro. None of these people appeared to have conditions related to radiation exposure. When we left Majuro at the end of the survey, the two Rongelap women were being further examined. Four of the five Utirik cases were found to have conditions that could be treated on their home island and they were to be returned. The other case from Utirik needed further consultation.

There were important findings in three exposed people who lived at Majuro. Two young exposed girls had developed thyroid nodules since last examined in 1971. They were Billiam Jabwe (female, age 19) who had been exposed at one year of age at Ailingnae. The other girl was Rokko Iso (female, 29) who had been exposed on Rongelap at age 12. Surgical removal of these nodules is of course necessary. Dr. Brown Dobyns at the Cleveland Metropolitan General Hospital, who operated on many of the other Marshallese thyroid cases, has agreed to operate on these as soon as it is possible to arrange transportation of the patients to Cleveland. Preliminary arrangements have already been started for this.

The third case is more serious. Lekoj Anjain, male, age 19, who was exposed at one year of age on Rongelap was found to have a low white blood cell count during the survey. A repeat count later in the survey was even lower. This boy had previously had thyroid surgery for removal of benign nodules of that gland in 1968 and when last examined in March 1971 he was found to be healthy. In view of the alarmingly low blood count and after consultation with his father, we took Lekoj with us to Tripler Army Hospital in Honolulu. They were unable, however, to get a successful bone marrow examination and we decided to take him back to Brookhaven National Laboratory. I am sorry to report that the diagnosis of acute myelogenous leukemia was

established. In view of the extensive treatment that would be needed for this patient, we arranged to have him admitted to the National Cancer Institute, Clinical Center, in Bethesda, Maryland. This is the leading hospital in the United States for treatment of such cases. On October 3, I took the patient down by hospital plane to Maryland. Cablegrams were sent requesting that the mother and father of Lekoj be sent to Washington, D. C. as soon as possible at AEC expense. Also, Sebeo Shoniber, a health aide at Majuro was requested as interpreter. The father, John Anjain and Sebeo, arrived Friday, October 6 and are with the patient. We have not yet been notified of the arrangements for the mother's travel.

Examination of the Utirik people did not reveal any unusual or unexpected conditions that might be related to radiation exposure. The incidence of thyroid abnormalities was quite low and not different from that to be expected in any island group.

At both Rongelap and Utirik, recommendations were made to the Trust Territory health services personnel concerning requisition of certain additional drugs and equipment and checking of drugs and so on. A better arrangement for local record-keeping on the islands was discussed including data from our medical examinations, thyroid treatment and transfer of such information when individuals move to another island. These matters are still under discussion.

After our records have arrived and analyses of blood data have been made we will be in a position to report more comprehensively on findings of the past survey. If I can be of any further help at this time please let me know.

With best regards,

Sincerely,

Robert A. Conard, M. D.

RAC:ls
P. S.: I am enclosing an updated table of thyroid lesions to include the latest two cases.

THYROID LESIONS IN MARSHALLESE EXPOSED TO FALLOUT
(AS OF SEPT. 1972)[6]

Marshall Island group (radiation dose-gamma)	Age at exposure	Estimated thyroid dose-rads[1]	Thyroid lesions percent[2]	Thyroid surgery	Malignant lesions percent[2]
Rongelap (175 rads gamma exposure)	< 10	500-1400	89.5 (17/19)	15	5.3 (1/19)
	11-20	335-500	12.5 (1/8)	0	-
	> 20	335	16.5 (3/26)	2	7.7 (2/26)
	all	-	39.6 (21/53)	17	5.7 (3/53)
Rongelap (on Ailingnae Island-69 rads gamma exposure)	< 10	200-500	16.6 (1/6)	0	-
	> 10	132[3]	12.5 (1/8)	1	-
	all	-	14.3 (2/14)	1	-
Utirik[5] (14 rads gamma exposure)	< 10	40-80	0.0 (0/55)	0	-
	> 10	22[4]	5.8 (4/69)	1	1.4 (1/69)
	all	-	3.2 (4/124)	1	0.8 (1/124)
Rongelap unexposed	< 10	-	0.0 (0/61)	0	-
	> 10	-	3.8 (5/133)	1	-
	all	-	2.6 (5/194)	1	-
Likiep unexposed	< 10	-	0.0 (0/31)	0	-
	> 10	-	4.7 (5/106)	0	-
	all	-	3.6 (5/137)	0	-

[1] Dose from ^{131}, ^{132}, ^{133}, ^{135}I plus gamma dose

[2] Based on number living. In parentheses number of cases/total number in group.

[3] One child 10-17 years of age at exposure received estimated thyroid doses between 132 and 200 rads.

[4] Fifteen children 10-17 years of age at exposure in this group received estimated thyroid doses between 22 and 40 rads.

[5] The more energetic shorter-lived isotopes of iodine contributed less to the total thyroid dose in the Utirik people due to later fallout. One might surmise therefore that the biological effectiveness of the thyroid dose per rad would be less in that group.

[6] In addition to thyroid lesions, one case of acute myelogenous leukemia was discovered in a 19-year-old Rongelap boy who had received 175 rad gamma radiation at 1 year of age.

[redacted] 5010505

Appendix No. 3

Initial Report to Committee
by Dr. W.S. Cole

[redacted] 5010506

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
WASHINGTON, D.C. 20201

August 2, 1972

SURGEON GENERAL
OF THE
PUBLIC HEALTH SERVICE

Senator Olympio T. Borja
Chairman, Special Joint Committee
Concerning Rongelap and Utirik Atolls
Congress of Micronesia
Saipan, Marianna Islands 96950

Dear Senator Borja:

Enclosed is the report of Dr. William S. Cole, summarizing his recent visit to the Trust Territory.

I hope this report and Dr. Cole's attendance at your recent Subcommittee's investigation will be useful to you. We, of course, continue to be available to assist the High Commissioner and the Congress of Micronesia in whatever ways may be appropriate.

Sincerely yours,

Jesse L. Steinfeld, M.D.
Surgeon General

Enclosure

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
ROCKVILLE, MARYLAND 20852

July 31, 1972

Senator Olympio T. Borja
Chairman, Special Joint Committee
Concerning Rongelap and Utirik Atolls
Congress of Micronesia
Saipan, Marianna Islands 96950

Dear Senator Borja:

The attached document represents my report to you as an invited radiological consultant from the United States Public Health Service during the visits of your Committee to Majuro, Utirik, Rongelap, and Kwajalein (Ebeye) Atolls on July 16-20, 1972.

In order to condense the subject matter, I have made my observations and recommendations on the findings on Rongelap and Utirik although we interviewed some of these people on Majuro and Ebeye.

My report will be released to you through the office of Surgeon General Jesse L. Steinfeld, U.S. Public Health Service, as you requested at the Executive Session of your Committee on July 20, 1972.

I trust my report will be of assistance in the preparation of your official report to the Special Session of the Congress of Micronesia on August 15, 1972.

Sincerely yours,

William S. Cole, M.D.
Associate Director
Bureau of Radiological Health

Enclosure

REPORT OF FIELD TRIP TO THE MARSHALL ISLANDS, TRUST TERRITORY OF THE PACIFIC ISLANDS, AS A RADIOLOGICAL CONSULTANT TO THE SPECIAL COMMITTEE CONCERNING RONGELAP AND UTIRIK ATOLLS, CONGRESS OF MICRONESIA, ON JULY 16-20, 1972

Introduction

This is a report of my observations and recommendations based on a field trip in the Marshall Islands, Trust Territory of the Pacific Islands, with the Special Committee composed of the following individuals:

Senator Olympio T. Borja, Chairman
Representative Timothy Olkeriil, Member
Representative Hans Wiliander, Member
Representative Ataji Balos, Interpreter
Dr. Masao Kumangai, Deputy Director of Health, Trust Territory
Mr. Brian M. Farley, Researcher, Trust Territory
Dr. William S. Cole, Radiological Consultant
Mr. Henry Moses, Majuro Atoll, Interpreter

The purpose of the visit to Rongelap and Utirik Atolls was to interview those people living on those Islands at the time of the detonation of the thermonuclear device at Bikini Atoll on March 1, 1954. This resulted in exposure to fallout radiation of those people due to an unpredicted shift in winds at the time of the explosion. Sixty-four persons on Rongelap received an estimated 175 rads of whole-body radiation and severe contamination of the skin; an additional 18 Rongelap people on a fishing trip received an estimated 69 rads of whole-body radiation; and 157 people on Utirik received an estimated 14 rads of whole-body radiation. Twenty-three Japanese fishermen aboard the vessel, the Lucky Dragon, also received significant whole-body radiation. These data are reported by the Brookhaven National Laboratory Medical Survey Team.

In the 18 years following the radiation exposure, an undetermined number of the exposed persons have died and others have moved to different atolls. The Committee for this reason interviewed people on Majuro and Ebeye. The four sessions were attended by approximately 300 people including exposed persons, families of deceased exposed persons, and numerous persons in the control groups. Although the interviews were carried out through Marshallese interpreters, there was little difficulty in following the proceedings.

The Chairman of the Committee, Senator Olympio T. Borja, presided at each of the four sessions. At the onset of each session, he stated the purpose of the visit of the Committee was as follows:

1. To determine the extent of personal injury to the people of Rongelap and Utirik Atolls as a result of the radiation exposure.

2. To determine the extent of the damage to the land and trees.

3. To obtain additional medical examinations and treatment.

4. To obtain reasonable and just compensation for personal injury and damage to the land and trees of Rongelap and Utirik Atolls.

Observations

A. Medical Problems:

The examinations conducted by the medical team from the Brookhaven National Laboratory are now resented by the involved people, both exposed and control groups. I am deeply concerned that the Marshallese have apparently lost confidence in the medical examinations and the aborted effort in March 1972 did little to restore it. I am of the opinion that a major source of trouble has been a lack of understanding by the people of the purpose of the examinations. At all four sessions, it was repeatedly asserted by the people that they were not informed of the findings and that treatment and medications were not available. The people attribute any and all sickness to the effects of the radiation and believe that the medical team should treat them. The control groups appear to most resent the examination because of the lack of understanding as to its purpose. For example, the people from Utirik asserted they were told they were not injured and therefore not entitled to compensation, yet were forced to submit to the examinations. As a result, many refused to be examined. They resent the taking of large samples of blood and feel that they should receive compensation for this procedure.

I repeatedly heard that the involved people will submit to additional examinations in September or October only if independent physicians from Japan, WHO, and the U.S. Public Health Service accompany the team.

The Health Aides of Rongelap and Utirik have difficulty in administering the prescribed thyroid medication due to the lack of written records on the patients. The Aide on Rongelap stated he thought the records were in the trailers but were not available to him. There are apparently no records in Marshallese for the use of the Health Aides or Medical Practitioners that periodically visit the Atolls.

At all four sessions, the women repeatedly stated that there have been more miscarriages and abnormal babies on both Utirik and Rongelap since the explosion. Those from Utirik stated this occurred during the first year after the return to their Island. Specific dates and instances could not be determined. Apparently there were four abnormal babies born to the exposed women of Rongelap who were not pregnant at the time of exposure. After much discussion among themselves, the spokesman for the women stated that there continues to be an increase in the number of miscarriages on Rongelap.

According to statements made at the sessions, approximately 19 exposed persons living on Rongelap at the time of the explosion, who were under the age of 10, have developed thyroid nodules requiring surgery. Although biopsy reports indicate only 2-3 of these to be malignant, the involved patients believe that all have cancer. They are not able to distinguish between benign and malignant lesions. It is apparent that some of these patients are not taking thyroxine as instructed. I emphasized at all four sessions that the prescribed medication was necessary for their health and welfare.

In summary, the apparent lack of communication and understanding between the people and the medical team has been a major problem. There have been difficulties with interpretation between English and Marshallese in the past but it is not a major factor.

B. Compensation:

Although I did not actively participate in the sessions devoted to compensation, the following complaints were registered:

1. The exposed people of Utirik Atoll believe that they have sustained physical injury from the radiation and are entitled to just compensation. Those now living on Majuro and Ebeye stated they wanted to return to their home but were afraid of the radioactivity that remains.

2. The exposed people of Rongelap do not believe that the compensation paid to them in 1964 was adequate because of the thyroid abnormalities that have developed since that time. The Rongelapese now living on Majuro and Ebeye will not return to their home because of the residual radioactivity and the fear of related sickness.

3. The people of both Atolls believe the land and trees were damaged by the radiation and that they should receive just compensation for this damage. They would agree to have such compensation placed in trust funds for the good of both groups.

4. The control groups believe they should receive compensation for submitting to the medical examinations.

C. Recommendations:

As a physician concerned with the health and welfare of the exposed people, I urge that the next medical examination proceed without further delay. In order to have the examination proceed without difficulty, the following recommendations should be seriously considered by the Special Joint Committee:

1. Independent physicians from Japan, WHO, and the U.S. Public Health Service should accompany and make individual reports to the Special Committee.

2. The physicians from Japan should be -

Dr. Haruo Ezaki, University of Hiroshima
Dr. Toshiyuki Kumatori, National Institute of Radiological Sciences

The importance of the presence of these two physicians cannot be overemphasized. In my opinion, if they are not present the involved people will refuse to be examined. Due to possible complications in clearance of these physicians, the proposed date of September 7, 1972, may have to be delayed.

3. The Director of Health, Trust Territory of the Pacific Islands, should be requested to send Medical Officers with the examining team to treat local diseases. Such treatment would be advantageous from a public relations standpoint and should lead to more cooperation by all concerned.

4. Every effort must be made to improve communication between the physician and the people under study. A better understanding of the purpose of the examinations would remove an apparent major source of resentment now evident. A written translation of the major findings into Marshallese should be made for the use of the Health Aides and the Medical Practitioners.

5. The Trust Territory should provide additional medical examinations and treatment to the people of Utirik and Rongelap. This would supplement that provided by the annual surveys by the Brookhaven National Laboratory Medical Team.

APPENDIX NO. 4

Statement of Dr. E.P. Cronkite Concerning Exposure of Persons as a Result of March 1, 1954 "Bravo" Shot

(From Radioactive Fallout and Its Effects on Man, U.S. Congress, 1957)

"The estimated whole-body gamma dose to natives evacuated from the island of Utirik following the March 1, 1954, detonation at the Pacific Proving Ground was about 15 roentgens for a period of about 3 days, but no beta burns appeared. It is fair to assume here that direct contamination took place due to their mode of living, including housing that was quite open to air currents. Gamma dose rate readings were taken over the bodies of the natives at about H+78 hours both on the beach and after boarding the ship. On the beach the personnel readings averaged about 20 mr. per hour gamma (but this probably included some contribution from the ground contamination), and after wading through the surf and boarding the ship the levels averaged 7 mr. per hour gamma.

"The 18 natives on Sifo Island, Ailinginae Atoll, received an estimated whole-body gamma dose of 75 roentgens in about 2 1/4 days. Of these, 14 later experienced slight beta burns, 2, moderate burns, and none showed epilation.

"In the case of the Rongelap natives, the estimated whole-body dose was about 170 roentgens in about 2 days. All 64 natives later experienced beta burns to some degree from slight to severe, and over half of the natives showed epilation from slight to severe.

"The 16 natives from Rongelap evacuated directly by air to Kwajalein had personnel gamma dose-rate levels generally 80 to 100 mr. per hour although 1 was as high as 240 mr. per hour and 1 as low as 10 mr. per hour (at H+ about 55 hours). The remaining 48 natives evacuated by ship were reported to have personnel readings that "averaged" 60 mr. per hour before decontamination. The picture is further confused because some of the natives had bathed and some had not before the arrival of the evacuation team.

"Most of the 28 United States service personnel stationed on Eniwetok Island, Rongerik Atoll, received about 40 to 50 roentgens, based on film badge readings. Three members of the group who were located for part of the time in another section of the island were estimated to have received somewhat higher doses. Seventeen of the twenty-eight personnel showed only slight, superficial lesions with one questionable case of epilation. It should be pointed out that the personnel were in metal buildings during some of the fallout time and for most of the time thereafter until evacuation. This reduced the direct contamination as well as the whole-body gamma dose. A film badge hanging on the center pole of a tent at one end of the island read 98 roentgens. Calculations based on dose-rate readings at another part of the island indicated somewhat lower doses, if personnel had remained in the open for the period of time from fallout (about H+7.5 hours) to evacuation (at about H+34 hours). Upon arrival at Kwajalein 1 personnel gamma dose rate reading was as high as 250 mr. per hour at about H+35 hours.

"The above data do suggest that there may be possible a rough bracketing of gamma-beta doses versus beta burns. On the one hand, the natives from

Utirik received an estimated whole-body gamma dose of 15 roentgens and showed no evidence of beta burns. On the other hand, the natives on Sifo Island, Ailinginae Atoll, received about an estimated whole-body gamma dose of 75 roentgens, with 14 personnel showing slight burns, 2, moderate burns, 2, no burns, 3 with moderate epilation, and 15 with no epilation. In addition, Rongelap natives received 170 roentgens whole-body gamma dose, and about 90 percent showed some degree of lesions and 56 percent some degree of epilation.

"It is to be recalled that: (a) The natives probably were out of doors and received the full fallout; (b) the oily hair, seminaked, perspiring bodies, including bare feet, and lack of bathing for most, would tend to collect and hold the fallout material; (c) the time of delivery of essentially all of the doses was 2 to 3 days. Further, it may be speculated that the fallout on the more distant island of Utirik (about 300 statute miles) would consist of smaller particles and also perhaps lesser possibility of overlapping of radiation fields from these particles."

Appendix No. 5

"Mike" and "Bravo" Wind Charts

(From Radioactive Fallout and Its Effects on Man, U.S. Congress, 1957)

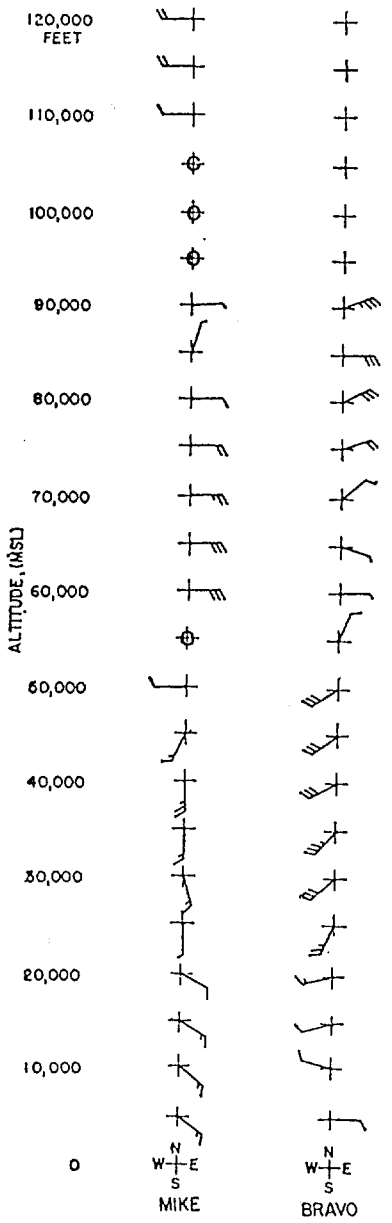

FIGURE 1.—Upper winds at shot time. Arrows blow with the winds, and barbs indicate wind speed; full barb, 10 knots; one-half barb, 5 knots.

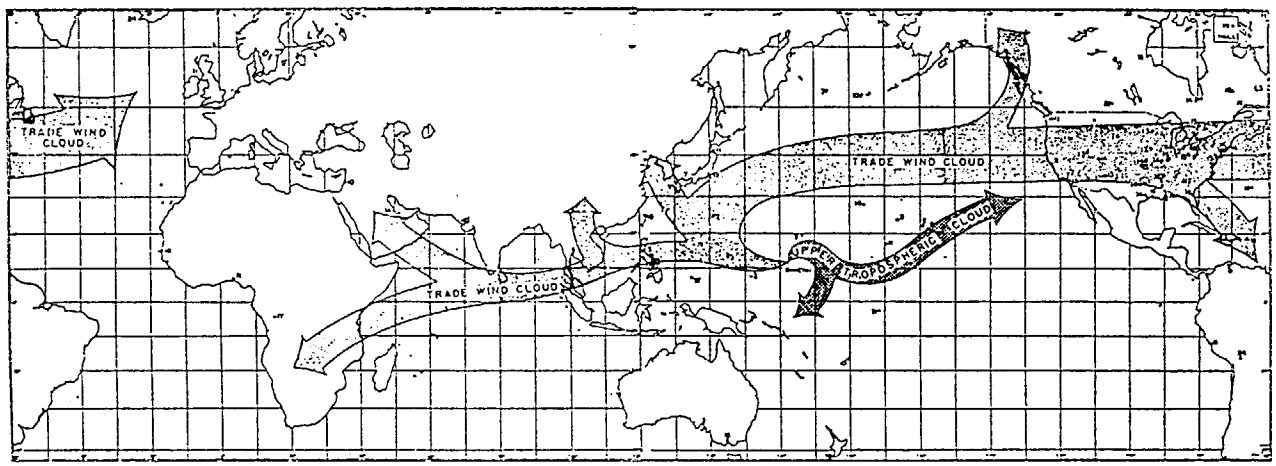

FIGURE 2.—Early history of the Mike cloud. The figures indicate the number of days between detonation and the first ground observation of fission products.

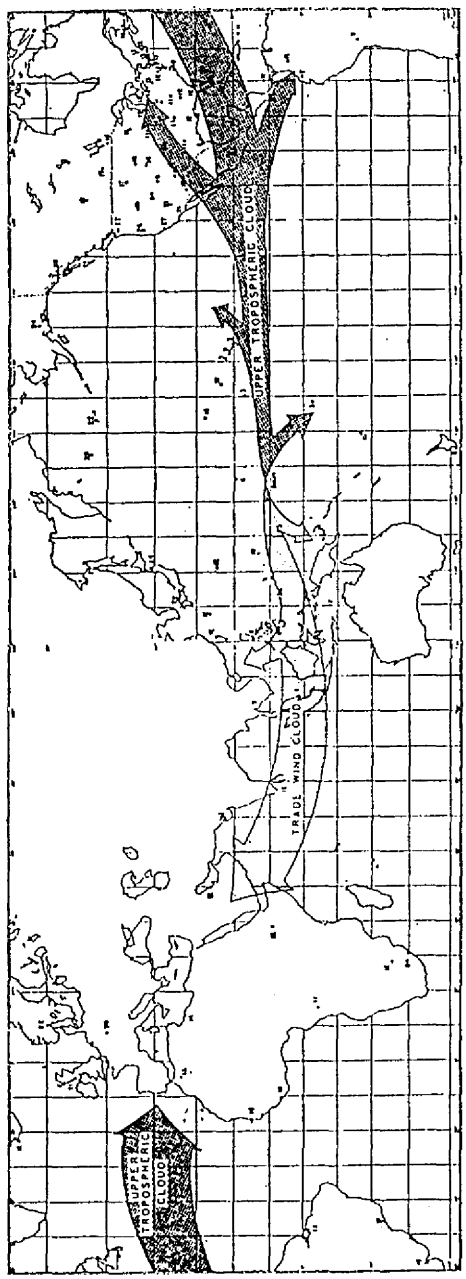

FIGURE 3.—Early history of the Bravo cloud. The figures indicate the number of days between detonation and the first ground observation of fission products.

APPENDIX NO. 6

Atomic Energy Commission Off-site Public Relations Program
for Nevada Proving Ground

(From Radioactive Fallout and Its Effects on Man, U.S. Congress 1957)

[redacted]

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"4. PUBLIC RELATIONS

"It was recognized that adequate public relations is necessary to the successful operation of the Nevada test site. The off-site program was designed to facilitate good public relations. This was accomplished by contacts and talks prior to the series, by the system of zone commanders who were largely responsible for good relations within a specified area, by following up each incident reported immediately and, of course, by the general program carried out by the Joint Office of Test Information.

"The public relations program during the operation laid the general ground work for a continuing public relations program to be carried out in the interim periods.

"In general, relations with the off-site populace were good. People were particularly appreciative of the fact that monitors were permanently stationed in their communities. Opinions expressed to monitors indicated that local populations felt more secure with this arrangement with regard to radiation hazards and that they appreciate having a local contact to go to for information or with complaints. Off-site personnel were able to carry out a continuous educational program since full advantage of their presence in the community was taken and they were asked to be on the programs of civic clubs and other organizations, to furnish material for radio programs and newspapers and to aid in school programs.

"Prior arrangements.--Prior to the start of the series, all of the large population centers in the area were visited by off-site personnel to inform people of the forthcoming tests and the manner in which off-site problems would be handled.

"Immediately before the start of the series most of these communities were revisited by a group consisting of the Test Manager, Scientific Advisor, Test Director, Support Director, Information Director, Off-Site Operations Chief, and the senior PHS officer. A series of talks were given in Caliente, Pioche, Ely, and Tonopah, Nev., and St. George and Salt Lake City, Utah. In these talks the value of continental nuclear tests to the country was stressed and the precautionary measures to be taken with regard to public safety were outlined. People were informed of the plans to station monitors in their community and that these men were expected to become a part of the community during their stay and to be of service to it in regard to public safety, information or in any other way.

"From 7 to 10 days before the initial detonation, the monitors with their equipment moved into the community, familiarized themselves with the area, made acquaintances and actively took over the job of public relations.

"Liaison activities.--Arrangements were made to keep those health officials who might be primarily concerned, informed of the activities at the test site. The States normally involved were Nevada, Utah, California, and Arizona, and the State health officers of these States were advised routinely by phone of any fallout situation that might affect areas under their jurisdiction. The personnel advised in these instances were:

Nevada: Dr. Daniel J. Hurley, State health officer.
Utah: Dr. George A. Spendlove, State health officer.
California: Dr. John M. Heslep, designate of State health officer.
Arizona: Dr. C. G. Salsbury, State health officer.

"In addition to these arrangements, contacts were made with affected USPHS officials and with local health officials.

"Activities of zone personnel.--Zone personnel conducted a public-relations program on an informal and down-to-earth basis. They formed a wide acquaintance in their respective areas, participated in local events and took their instructions to become a part of the community seriously; as for example, the monitor at Glendale who became a Sunday school teacher, or the one in Alamo who plastered a ceiling in one of the hotel rooms. Such intimate association with the people in the area was good practical public relations, and while it may not have altered completely basic public opinion regarding the tests, it at least made the explanations of zone personnel more acceptable.

RADIOACTIVE FALLOUT AND ITS EFFECTS ON MAN

"Every opportunity to reach the public through talks and film showings was accepted. Practically every person throughout the off-site area saw at least one film and listened to at least one discussion by monitors. This was accomplished through civic clubs, schools and PTA, and other groups. In this connection, it should be stated that the new film Atomic Tests in Nevada received enthusiastic reception. From the remarks made to zone personnel, it appears that general feeling was that, for the first time, the public was being shown exactly what happened during a shot.

"A complete listing of public relations contacts is not available, but the partial list of film showings tabulated in table 1 will indicate the scope of this activity:

Table 1.--Public relations--Movies

Zone	Location	Date	Film	Attendance
Alamo	Alamo	Feb. 9	Target Nevada	100
	---do	Feb. 10	Atoms in Agriculture (shown twice).	25
Caliente	Lincoln County High School.	May	Atomic Tests in Nevada, and Atoms in Agriculture	200
	Elementary school	--do	---do	80
	Lincoln County High School.	--do	Nuclear Reactors	30
	Elementary school (science and physics class)	May 12	---do	38
Cedar City			Atomic Tests in Nevada	1,180
			A Is for Atom	870
			Operation Ivy	36
			Target Nevada	36
Ely	Lions, Rotary, and Chamber of commerce.	Feb. 9	Target Nevada, and A Is for Atom.	100
	Ely Woman's Club	Feb. 10	A Is for Atom	51
	Ely Elks' Club	--do	---do	30
	Roadrunners' Motorcycle Club.	Feb. 13	Operation Ivy, and A Is for Atom.	
Ely	Ely PTA	Feb. 14	Operation Ivy, and A is for Atom.	75
	VFW and auxiliary	Feb. 17	---do	50
	Ruth-Kimberly PTA	Feb. 21	Operation Ivy	40
	Society of Professional Engineers.	Feb. 22	---do	20
	Steptoe Hospital staff	Feb. 25	---do	
	Shut-ins	Feb. 26	Operation Ivy, and A Is for Atom.	14
	Fire department	Mar. 1	---do	30
	Duckwater	Mar. 4	---do	40
	Baker PTA	Mar. 5	---do	60
	Eureka School	Mar. 11	A Is for Atom	70
	Austin School	Mar. 15	Operation Ivy	60

Table 1.--Public relations--Movies--Continued

Zone	Location	Date	Film	Attendance
Glendale	Mesquite School	Apr. 7	A Is for Atom, and Target Nevada.	60
	Bunkerville School	Apr. 8	Target Nevada	105
	Overton School	Apr. 11	Target Nevada, and Atom Tests in Nevada.	175
	Mesquite Theatre	Apr. 15	---do	150
	Overton High School	Apr. 21	A Is for Aton	40
	Overton Veterans' Club (attending: Sportsmen, firemen, and California civil defense).	Apr. 25	Atomic Tests in Nevada, and Target Nevada.	88
Lincoln Mine	Lincoln Mine Theater	Apr. 24-30	Atomic Tests in Nevada	500
Pioche	Pioche	----------	A Is for Atom	20
	Volunteer fire department	----------	---do	----------
	Pioche	----------	Operation Ivy	----------
	--do	----------	Operation Doorstep	----------
	Young women's literary club.	----------	A Is for Atom	----------
	Latter-day Saints Church	Apr. 17	Atomic Tests in Nevada	35
St. George	Glendale, Utah, PTA	Mar. 16	Target Nevada	35
	Kanab PTA	Apr. 4	Atomic Tests in Nevada	45
	Kanab High School	Apr. 5	---do	160
	Orderville PTA	Apr. 11	---do	35
	St. George firemen	--do	---do	12
	Ladies' relief society Latter-day Saints.	--do	---do	200
	---do	Apr. 12	---do	40
	Elementary school	Apr. 13	---do	230
	Dixie College	--do	---do	180
	VFW	--do	Atomic Tests in Nevada, and Target Nevada.	32

Table 1.--Public relations--Movies--Continued

Zone	Location	Date	Film	Attendance
St. George--Continued				
	Chamber of commerce-----	--do------	Atomic Tests in Nevada	40
	High school----------	Apr. 14---	Atomic Tests in Nevada, and Target Nevada.	400
	Ladies' relief and faculty----------	Apr. 15---	Atomic Tests in Nevada	60
	Lady Elks----------	--do------	---do----------	38
	National Guard----------	Apr. 14---	---do----------	73
	Virgin PTA----------	Apr. 21---	---do----------	60
	Community church--------	Apr. 22---	---do----------	18
Tonopah----------	High school----------	----------	Target Nevada (shown 3 times).	260
	Mizpah Hotel----------	----------	Target Nevada----------	170
	Goldfield Elks----------	Feb. 28---	---do----------	60
	Fish Lake----------	----------	---do----------	50
	Manhattan----------	Feb. 23---	---do----------	60
	Round Mountain----------	Feb. 24---	---do----------	50
	Wellington Rotary--------	----------	---do----------	50
	Tonopah (2 clubs)-------	----------	Atomic Energy----------	80
	Round Mountain----------	----------	---do----------	50
	Goldfield----------	----------	---do----------	60
	Wellington----------	----------	---do----------	50
Other:				
Beatty, Nev----------	----------	----------	Target Nevada, and Atomic Energy.	80
Do----------	----------	Apr. 11---	Atomic Tests in Nevada	60
Do----------	High school----------	Apr. 14-15	Atomic Tests in Nevada (shown twice).	175
Chattanooga, Tenn----	Division of Health and Safety, TVA.	May 9----	---do----------	60

Table 1.--Public relations--Movies--Continued

Zone	Location	Date	Film	Attendance
Other--Continued				
Fort Ogiethorpe, Ga--	Kiwanis Club----------	May 10----	Atomic Tests in Nevada	26
Florence, Ala--------	Lions' Club----------	May 16----	---do----------	45
Los Angeles, Calif---	ASCE. sanitary section--	May 25----	---do----------	50
Total people seeing films.				17,550

1 Not a full count. Conservative estimate made when attendance figure was missing.

"In addition to these semiformal contacts, a large number of individual contacts were made. One interesting example of this indicates the public relations value of the film badge program. During a routine change of a personnel film badge in Goldfield, Nev., the wearer remarked that "there must be some fine people at the test site, since they were taking such precautions even in a small place like Goldfield." It must be recognized, however, that although relations throughout the off-site area were generally good, there are some specific areas of difficulty. An example of this is the attitude of the newspaper editor in Tonapah, who contrary to editorial opinion in general, has maintained a highly critical attitude toward test activities.

"Other informational material was distributed. The news release of the Joint Office of Test Information were widely used by monitors. However, the most valuable piece of educational material was the little yellow booklet, Atomic Test Effects in the Nevada Test Site Region. Thousands of these were distributed through schools, post offices, motels, and by other means throughout southern Nevada and Utah, and in parts of Arizona and California. This was very well received. In fact, some people thought so highly of it that they requested copies to distribute on their own. Many of these booklets were picked up by tourists and were probably carried to all parts of the Nation.

"Special investigations.--It was inevitable that numerous incidents requiring investigation should arise. These were of three types, as they effected material things, people, or livestock. All that came to the attention of the off-site program were investigated and are documented in the files.

"With respect to material things, the greatest number of complaints were from prospectors. An explanation of the transient nature of radioactivity from fallout was generally acceptable. In all cases where blast damage was reported, forms for damage claims were mailed and these are being processed in the customary manner. In those cases where contamination from radiation were reported, such as on vehicles, the zone personnel investigated and were generally able to satisfy people during these visits that no hazard existed.

A number of cases of radiation damage to people were reported. These were investigated by the Cedar City Zone commander, Dr. Clinton G. Powell, who is a PHS doctor. This procedure was so useful that it became apparent that it was a mistake to require medical personnel to also act as zone commanders. In any future operation, a qualified doctor with radiation experience should be available within the off-site program for the sole purpose of investigating claims of personal radiation injury.

"Prior contacts were made with the local doctors. All investigations were made by working with local doctors. This procedure eliminated any chance of criticism about professional ethics, increased the patient's confidence in the procedure and did much to educate the local physicians in regard to radiation matters.

The general procedure was to have the patient brought to the local doctor's office. If necessary, off-site monitors provided the transportation. There both doctors examined the patient and arrived at a decision. Any costs were billed through Reynolds Electrical & Engineering, Inc.

"In no case, of those examined, were there symptoms that could be definitely attributed to radiation injury. Many cases turned out to be some common ailment, diaper rash, in one case. However, the reports of eye irritation were so persistent that this matter should be investigated in order to prove or refute the widespread belief that this is due to test activities.

"Reports of injury to livestock were reported by zone personnel and investigated during the series by veterinarians (Maj. Grant Kuhn and Col. Bernard Trum) from the AEC-University of Tennessee Agricultural Farm at Oak Ridge or by Dr. Wendell Brooksby, of the Utah State Agricultural College. There is little doubt that reputed livestock damage will continue to be reported for some time after the tests since livestock culture is such an important part of the economic life of the area. This suggests the desirability of the continuous services of a veterinarian with radiological training and of a sound investigative program."

Appendix No. 7

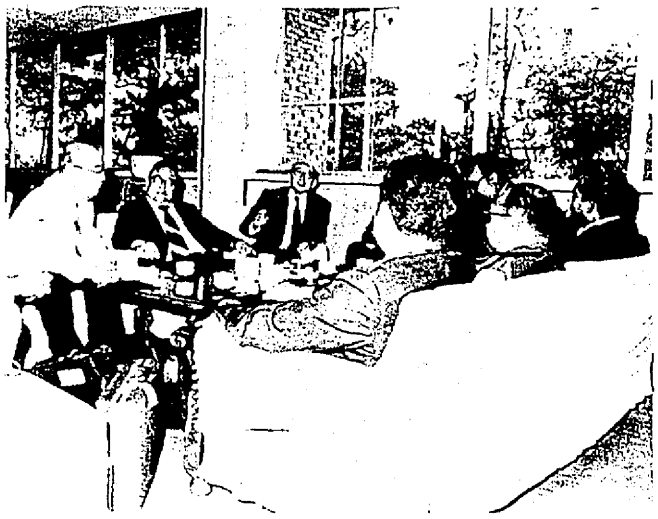
Photographs

The Committee in Tokyo during June. From left to right (l to r) are: Acting Legislative Counsel Mamoru Nakamura, Dr. Kumatori, Representative Ataji Balos, Chairman Olympio T. Borja, and Mr. Matashigi Oshi, a former crew member of the Lucky Dragon.

In Hiroshima near the Peace Park Memorial, (l to r) Representative Balos, Acting Legislative Counsel Nakamura, Chairman Borja, Representative Timothy Olkeriil, staff member Brian Farley, and Dr. Masao Kumangai.

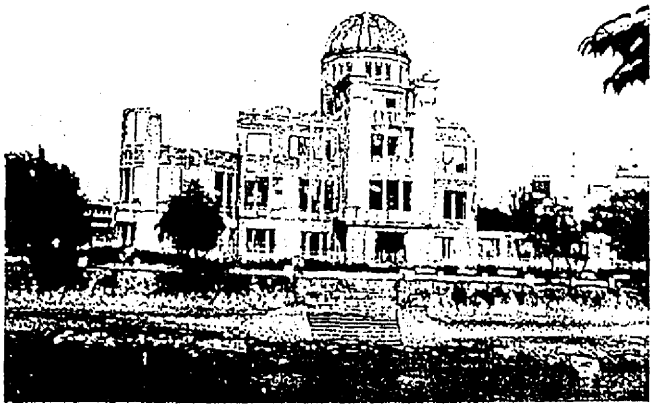
At the Office of the Governor of Hiroshima Prefecture, Chairman Borja (l) explains the Committee's mission to the Honorable Itsuo Nagano (r) while interpreter looks on (center).

The Committee poses for a picture with the staff of the Hiroshima ABCC (l to r) Dr. Kato, Dr. Maki, Dr. Steer, Chairman Borja, Dr. Allen, Representative Olkeriil, Dr. Kumangai, Dr. Belsky, Representative Balos, Acting Legislative Counsel Nakamura, Staff member Farley and Dr. Wada.



At the Hiroshima A-bomb Red Cross Hospital are: Dr. Shigeto, Chairman Borja, Foreign Affairs Chief Kaoru Ogura, and the other members of the Committee.

At the Institute for Nuclear Medicine and Biology of Hiroshima University are (l to r) two unidentified staff members, Representative Olkeriil, Staff Member Farley, Dr. Noamasa Okamoto, Director of the Institute, Representative Balos, Dr. Ezaki, Acting Legislative Counsel Nakamura, and Representative Hans Wiliander.



The remains of the Industrial Promotion Hall in Hiroshima, now preserved as a monument.

The Committee on the steps of the Nagasaki ABCC. In the center of the group wearing white is Dr. Sadahisa Kawamoto of the ABCC department of medicine.

Elderly survivors of the Nagasaki A-bomb honor the Committee with a dance at the Old Age Survivors Home in Nagasaki.

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Dr. Kumangai (l) and Chairman Borja (r) compare notes as the Committee heads back to Saipan from Japan.

At the Majuro dock prior to departing for the islands in July. In the foreground, partially facing away from the camera is the former magistrate of Rongelap, John Anjain, whose son Lekoj died of leukemia in November of 1972.

Some of the Paraphernalia of the survey team aboard the Militobi during the September survey.

Dr. Cole of the U.S. Public Health Service aboard the M/V Hafa Adai as the Committee departed for its first visit to Rongelap and Utirik.

Dr. Conard on the bridge of the Militobi, at the beginning of the September survey.

Members of the BNL team aboard the M/V Militobi (l to r) Dr. Kundsen, Dr. Sutow, Dr. Conard, Dr. Cole (consultant) and Dr. Larsen.

View of the end of Rongelap Island showing former RadSafe site constructed after the 1954 incident.

Decorations and flags were a part of the welcome the people of Rongelap gave the Committee during its July trip.

The Committee during the July trip to Rongelap (l to r) Henry Moses of the Marshall Islands District Administrator's Office, Dr. Cole, Representative Wiliander, Chairman Borja, Representative Balos, Health Aide Joe Saul, Laboratory Technician Nelson Zeti[redacted]

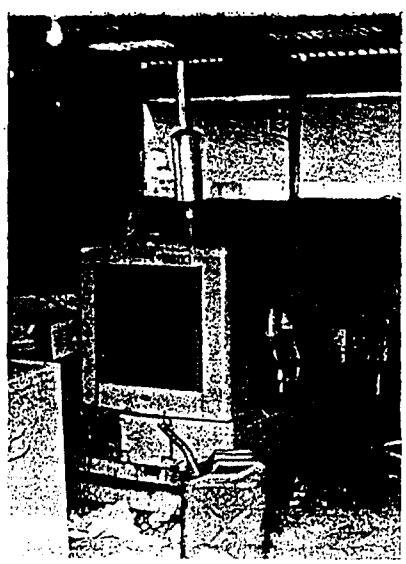
The AEC jeep and trailer on Rongelap.

The AEC deisel tractor used to load and unload equipment during the surveys on Rongelap.

The A-frame building used by the BNL team as living quarters during its stay on Rongelap.

The small trailer on Rongelap used for the taking of blood samples.

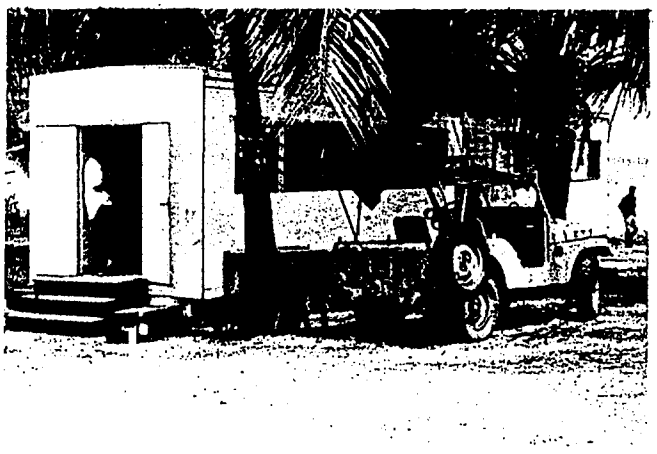
One of the two large trailers on Rongelap. This one has a room for the taking of X-ray photographs, and a section used as a mess hall.



The generator, in another building on Rongelap, which provides electricity for the team's work during the survey.

A patient giving her medical history to Dr. Ezra Riklon.

A resident of Rongelap having his X-ray photograph taken.



The other large trailer used as an examination room during the survey.

Trust Territory Laboratory Technician Seblo Shonlber taking a blood sample.

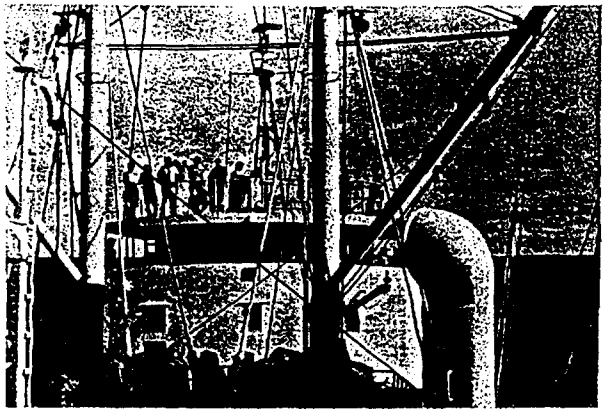
Dr. Kumatori (l) and Dr. Ezaki during the September survey.

Dr. Conard checks for thyroid nodules during examination of a resident of Rongelap.

An attentive listener at the meeting of the Committee with the people of Rongelap.

The people of Rongelap at a public meeting requested by the Committee.

Captain Willie Poznanski preparing to pilot the Militobi through the Utirik Pass.



Members of the survey team with Captain Willie on the flying bridge of the Militobj as it navigates the tricky pass at Utirik.

The village pathway at Utirik.

The Committe and the people of Utirik after an island meeting, in July.

Another view after the same meeting.

Chairman Borja and people from Rongelap and Utirik during a July meeting in Ebeye.

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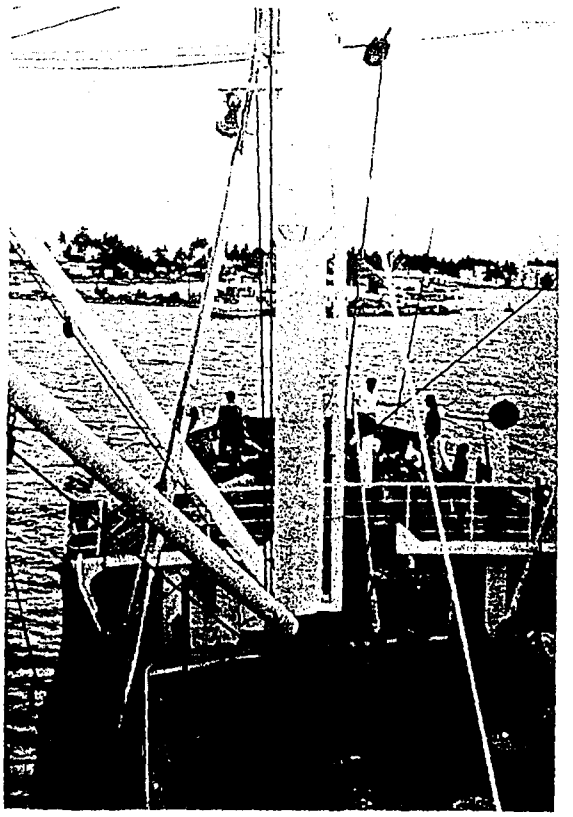
Committee member Wiliander talking with Dr. Rikon during the September survey.



The Militobi returns to Majuro after the Rongelap and Utirik survey.

The Committee's consultants: (l to r) Dr. W.S. Cole (United States), Dr. Kumatori and Dr. Ezaki (Japan), and Dr. E.E. Pochin (United Kingdom) prior to their departure from Majuro at the end of the survey.

September survey team (l to r) First Row: Dental Aide Kumura Riklon, Health Aide Joe Saul, Laboratory Technician Nelson Zetika, Dr. W.W. Sutow, Assistant Medical Equipment Repair Specialist Kosang Mizutoni, Dr. Robert A. Conard, Dr. Haruo Ezaki. Second Row, standing: Laboratory Technician Supervisor Sebio Shoniber, BNL staff member Mike Makar, Dr. Jetton Anjain, BNL staff member William Scott, Dr. Ezra Riklon, Dr. Knud Knudsen, Dr. William S. Cole, BNL staff member Doug Clareus, Dr. Austin Lowery, Dr. E.E. Pochin, Dr. Toshiyuki Kumatori, and Dr. Larsen.