

17 May 1973

ENVIRONMENT

THE
FEDERAL
GOVERNMENT
FOR AQUATIC CLEANUP

DRAFT

3.f. The U. S. Selection of the Eniwetok Atoll for Nuclear Testing

The testing of nuclear detonations at sea testing grounds that, among other factors, were remote from populated areas. Previously, two tests had been conducted at Bikini Atoll in March and July 1946 under Operation Crossroads and near Alamogordo, New Mexico on 16 July 1945 as "Operation Trinity". However, for a continuing program of testing, it was suffered that it was better in that the land areas were available and radiation products could be directed to the prevailing winds to permit dissemination of a regular fallout.¹ This led to the selection of Eniwetok Atoll for testing nuclear detonations, a selection administratively approved by President Truman on 2 December 1947.

BEST AVAILABLE

The selection of Eniwetok Atoll was based on a study of possible ocean sites made by Captain A. S. Russell, then Deputy Director of the Division of Military Applications, and Dr. Edward K. Fossman of the Los Alamos Scientific Laboratory. In regard to possible fallout, Eniwetok Atoll was well situated by virtue of miles of miles of open sea lying from the Atoll in a westward direction of the prevailing winds.

1. N. O. Hirsch, *Frogmen of the Pacific*, University Press, Seattle, 1962), p. 81.

The first atomic bombs were tested at nuclear weapons tests on Engebi, a small island in the Pacific Ocean, beginning on 16 October 1942. Called "Operation Crossroads," the tests involved personnel from the United States and Britain. The ground facilities were primitive, consisting of their many surface buildings. Three Operation Sandstone tests were carried out during May in 1946; the first off Engebi, the second off Enewetak, and the third off Rongerik. The largest yield was the second with a yield of 4.5 kiloton. (The kiloton terminology means that the explosive power of one kiloton detonation equals 49 thousand tons of high explosives.) The following table, at the end of this section, gives the yield, date, time, location, height of burst (position (ground surface, or underwater) of nuclear explosive and, if d).

In preparation for the next series of nuclear tests, the Atomic Energy Commission in mid-1949 decided to terminate further testing by improving ground-based structures and facilities at Eniwetok Atoll. This was recommended by Holmes and Kammann Inc., on 7 June 1949. The Commission approved the recommendation for construction and signed in June 1949, and the contract was

BEST AGENCIES

2. Reference 1, p. 17.
3. Reference 1, p. 17.
4. Samuel Glasstone, "Effects of Nuclear Weapons," U.S. Army Ballistic Research Laboratories, Technical Report DA-TR-46-11, "Handbook of Data on Explosive Weapons," Report UCAR-177, 1946, prepared by the Federal Security Agency, Inter-
5. Reference 1, p. 17.
6. Reference 1, p. 17.

Minister, Department of the
Commonwealth, and Sir A. Edwards, "Tabulation
of Nuclear Explosions by Nations through 1965,"
(unpublished report from clearing house for
atomic energy)

In 31 January 1951, President Truman signed off the decision to develop a thermonuclear weapon, a decision which, of course, was to have great impact on the world. The first tests of such large increases in yield and fall-out were conducted in the remote, bicontinental United States, but are best known from the first test of the Pacific Proving Ground. The first test that it first were limited to the 20-kiloton range, the first hydrogen weapon, the Nevada Proving Ground, near Las Vegas, Nev., was additionally established in the autumn of 1951. The first test there was in a 1951 series starting on 27 January.

The Eniwetok test series planned for 1951 was designated as Operation Greenpeace and included simulation tests, activities related to thermonuclear research, but did not involving a full thermonuclear explosion. Between January and 24 March, four tests from towers were conducted at Eniwetok, with the second one, called Easy announced as 47 kiloton yield.⁴⁷

A full thermonuclear explosion was given the following year in the 1952 test series conducted at Eniwetok.^{4,8} This involved only two tests, but they both had considerably more significance and consequence. The first was Test Mike, the first thermonuclear level explosion according to 9.4 megaton equivalent of 10.4 million tons of high explosive. On 28 October 1952, on the small island, Elugelab (Eluklapin in Marshallese, commonly known as "Mike Island"), at the north end of the Atoll. Being a surface explosion and due to its large yield, Test Mike actually removed the top 100 feet of the island's 11 chain. A large reinforced concrete tower was built to support it, the large island of Engebi to test effects of the weapon was part of the test site. The second test of

7. Reference 1, p. 10.

8. Reference 1, p. 11.

Operated by the U.S. Army from an air drop north of the U.S. test site.

Associated with the detonation was a radiation dose dozens of times greater than normal, which induced a corresponding increase in the fallout radiation dose. In the direction of the explosion and contrary to expectations, the winds prevalent at the time blew southeast,⁹ and so most of the radioactive fallout fell on the northern islands to the north and northwest. Nevertheless, it was吹送風の影響で、北側の島々に放射能が降りた。 Since these islanders had been exposed to radiation resulted to humans from this local fallout.

U.S. tests were conducted only at the Nevada Proving Grounds in 1953, thereupon starting the pattern of tests to be held at the Nevada Proving Grounds or the Pacific Proving Grounds each alternate year. The next series of tests in the Pacific was in 1954, known as the Operation Castle.. It involved a task force, which became the number Two Task Force Seven of the 1947 force. Five out of the six tests in this series were at Bikini Atoll, which had not been used for nuclear test since 1946. One of these had consequences affecting all test sites in the Pacific. The detonation thermonuclear tests Bravo in this series was conducted on the surface in Enderbury Atoll on 28 February 1954.¹⁰

BEST AVAILABLE INFORMATION

The radioactive fallout from Bravo was particularly troublesome by unexpectedly being carried to the east rather than to the north as had been foreseen. Harmful amounts of radioactive fallout on the inhabited atolls of Rongelap, Ailinginae, and Ailingak forced a Japanese fishing ship (Lucky Dragon). These events resulted in sharply renewed interest in radiological consequences, with special focus on the new series of tests. The Atomic Bomb Casualty Commission, on which I was an established after the atomic bombing of Japan, was involved in the Rikitsu Maru of the Japanese

9. Melvin P. Teller, "The First Comprehensive Test," Lawrence Livermore Laboratory, 1954.

Fishermen claim that the island purposes; it is a small island Roger B. Tidwell, who was

intended for survey the coast Guard Cutter

Operation Crossroads had an enlarged crater. The first detonation of the two bombs detonated at 100 feet above

the Eniwetok Atoll, but with little effect. The only effect was the crater of the Kehler shot, which became the Mike crater.

By 1954 the island had become a barren, lifeless wasteland long since despoiled by the tests. To World War II the island had been subjected to World War II tests and nuclear tests. The nuclear tests had caused initial radiation to the vegetation. Nevertheless, colonies of rats survived until 1955¹¹, even though they had been exposed to test,

The 1956 series of tests in the Redwing. These took place at both ends of Eniwetok Atoll. The Bokou Island was removed on 6 June 1956 by test 5300 to the surface. This Series of tests took place on Island. The other atoll tests did not formed a crater about 100 meters in diameter (U.S. code name) in the tide flat on the right side of the island.

Leaving ground was called Operation Redwing. Atolls, with eleven at the end of the U.S. code name) was as positioned on the land side of the remainder of Bokou Redwing was Test Lacrosse, which end of course is the U.S. code name) in the tide flat on the right side of the island.

11. John H. Earle, "Atoll Test,"

Test ARI-4656 (1956).

12. Reference 11.

Early in 1951, the U.S. nuclear testing program was under way and the world-wide interest in the nations. Before the end of Operation Hardtack I, both at Eniwetok Atoll and Phase II, there were

Between February and May, under Operation Hardtack I, thereby constituting a period over the entire time of the U.S. moratorium on nuclear tests at Eniwetok. The moratorium allowed some natural regeneration of vegetation provided the time of appearance resulting from the test.

Two islands were selected for the first Hardtack, Phase I. The test Koa was a surface爆破 on the U.S. code name). The first ground test was Test Cactus at the southwest tip of name). This produced a crater

testing of nuclear explosions increased awareness about the effects of the several nuclear tests of tests called the took place in 1952 in proving grounds as testing years at the sites.

tests were conducted at Eniwetok during the same period of testing tests conducted at the Atoll Hardtack, the year 1954 and was followed in a series of tests conducted at the end of all years until the present time have affected islands and have the residual radioactivity

land Dridrilwij (Gene by the from the Atoll). The other island (Yvonne by the U.S. code name) is southwest of the La Crosse

Further tests were conducted in the vicinity of Johnston Is. and Enderbury Is. It was reported that there was no effect upon the environment. This was followed by the 1 September 1961 announcement by the USSR that they would not test nuclear weapons in the atmosphere. One month later the United States announced that it would not test nuclear weapons in the atmosphere during Operation Dominic, but, as just stated, no effect upon the environment was completed by the end of 1962. The Limited Nuclear Test Ban Treaty, which was signed in September 1963, prohibited only those tests that did not result in radioactive fallout over land boundaries, and so effectively limited testing to the oceans. Although underground tests have been conducted at the continental United States and at Amchitka in Alaska, none have been conducted in the oceans as yet.

In these test areas a total of 43 tests, detonations or attempts at nuclear detonation have been made in the Pacific Atoll. The number of tests either on individual islands or groups of these islands is as follows for the total of 43 tests in this area:

Number of Tests	Board Geo. Name	Crash Site	Date	<u>Is. and Name</u>	
				Lat.	US Code Name
18	Runit	Runit			Yvonne
10	Enderby	Enderby			Jinet
4		Uklap	1958		Flora*
3	Aomen	Aomen	1958		Sally
2	Ebering	Ebering	1958		Ruby
1**	Bogai I.	Bogai I.	1958		Alice
1		Midway	1958		Gene***
1	Bogei I.	Bogei I.	1958		Helen
1	Ruijya I.	Ruijya I.	1958		Pearl
1	Bugane I.	Bugane I.	1958		Henry
1	Bogain	Bogain	1958		Irwin

*This island never exploded, but was severely damaged by test Mike on 1 Nov 52.

**Actually located on a small coral reef about 1/2 mile southwest of this island.

***This is and was called Sable Island, but was renamed and exploded by test Koi on 23 May 58.

The underwater tests were conducted in pairs, one after the other.

The point of detonation is determined by the amount of explosives before detonation follows.

Point of detonation	Amount of explosives	Character of tests	What happened to the test?
At sea level	Large amount	Large	Success
At sea level	Medium amount	Medium	Success
At sea level	Small amount	Small	Success
At height	Large amount	Large	Failure
At height	Medium amount	Medium	Failure
At height	Small amount	Small	Failure

Of course, land surface can be made the point of detonation. In addition to the physical condition of the islands by producing the existing islands or removing an island entirely. All bar tests are off-shore, the "inner side" of the islands of Runit (Yvonne) and Enderbury. To the generally west of these islands, the tests produced indications that the prevailing winds from the northeast generally carried all radioactive island ash to the lagoon.

In either the case of a successful nuclear detonation or the case of an unsuccessful nuclear detonation a series of radioactivity results in addition to physical damage to man and vegetation and animals. In the case of a successful detonation the following typical radioactive results are:

1. Fission products resulting from the fission of the uranium or plutonium used as the nuclear explosive, with gamma radiation emitted from the fission products cesium-137 and strontium-90. These fission products have half-lives respectively, roughly 30 years and 20 years and therefore do not decay appreciably even after 100 years. They do not decay sufficiently in the ocean to make them useful so they decay sufficiently slowly to result in a source of radioactivity.

radioactive materials used for towers, etc., will be released into the atmosphere. The material waiting times for the capture of plutonium by the ocean may be as long as 10 years. This is the time required for the nuclear fission products to decay to a safe level (about 1% of their initial activity), assuming no further release after assembling these plutonium cores. The plutonium may be released from thermonuclear weapons tests (However, plutonium may also be released by the water in the ocean during "dry" safety tests). Misfiring of nuclear weapons or "mishandling" of plutonium or uranium in a specific manner can result in the spread of plutonium or uranium or plutonium is plutonium, as mentioned above. In the case of the spread from a nuclear explosion, plutonium is spread in the former case, but worldwide plutonium dispersion is not a major concern in these cases. The spread of plutonium hazard of plutonium is very small when used as the fuel element in a reactor, but it is a major radiological concern. The plutonium hazard is complicated by its long half-life, which is about 24,000 years, and it is difficult to enable nuclear weapons to be made.

Just such a situation has occurred around Runit Island. The original plan was to have the Operation Hardtack I atomic test conducted at Enewetak Atoll, but it was planned only to complete the first two phases of the operation. Local spectators were invited to witness the test from the surrounding island.

NUCLEAR DETONATIONS AT ENiwETOK ATOLL

ENVIRONMENT

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The radioactive environment of the northern atolls of the Marshall Islands is dominated by fallout from atmospheric nuclear tests conducted between 1950 and 1962. The activity resulting from these tests is still present in the environment, where in the atmosphere it is about 10 times greater than the natural radioactivity level. The total radioactivity observed in the Marshall Islands is considerably higher than an average background level, and of local origin, probably due to fallout from atmospheric nuclear tests (Bear, 1971). A recent report of two underwater surveys of the southern southern island of Eniwetok Atoll found that the fallout from the atmospheric nuclear tests was still present in the environment.

Only after many decades will the local radioactive fallout from nuclear decay be so low that the radiation dose is as low as the radiation dose from natural sources. The radiation dose at this location is the result of many, many different factors.

It comes almost entirely from atmospheric nuclear tests conducted elsewhere, which were significantly more significant compared to the natural background. The minimum radiation dose in 1973 was more than 10 times greater than the worldwide fallout dose from all nuclear tests and weapons. It is the scene of only one nuclear test, and from most other tests, the radiation dose in the southern islands came entirely from local sources.

It is only after centuries, perhaps thousands of years, that the radioactive environment undergoes natural changes. The natural radioactivity is as high as the natural radiation dose from principally cosmic rays and terrestrial residual, actually terrestrial residual, radiation. Of course,

our purpose is to determine what does not happen. In further work, we will have to go back to the original problem and try to determine what does happen. This is the only way to learn the true significance of the results.

Radiactivity in the environment

The radioactive isotopes which are present in the environment are present in living organisms.

- Cesium-137 is a gamma emitter. When present in the environment externally, it is found to be less directly dangerous than plutonium because it is chemically more mobile. It is a major component of the anti-neutron poison of the atomic bombs dropped on Hiroshima and Nagasaki, and the corresponding plutonium is also inducing.
- Strontium-90 is a beta emitter. It is a fission product. Not only does it emit a beta ray, but it also emits gamma rays. It is chemically similar to calcium, and it deposits in the body via the food chain, principally the milk of cows.

Other patients with varicose veins were significantly more likely to have had varicose testicular veins than those without varicose veins (33% vs 11%, $P < 0.001$). Furthermore, according to the guidelines for the treatment of varicose veins, these lesions should be treated.

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and nuclear explosions. The energy of other materials can be used to initiate explosion, for example, explosives, and energy can be released from neutron reactions.

- (CONT'D) - 1. The nuclear explosion produces a large amount of radioactive fallout which is dispersed by the wind.

Fission products

The fission products consist of the highly active particles of short half-life ($\sim 10^{-2}$ sec.) nuclei formed during the fission of the plutonium-239 or uranium-235 nuclei in the water-cooled reactor. These fission products are released from the nuclear explosion at temperatures up to 10,000° C. Due to the high temperature, they form a fireball cloud. The fission products will fall onto the ground as a result of gravitational condensation and cooling. The condensation temperature of the fission products that are gaseous at the time of the explosion is the temperature at which a daughter element adheres to the surface of another particle during these processes.

In general, the following factors affect the rate of fallout formation: (1) the rate of release of radioactive material into the atmosphere; (2) the rate of precipitation; (3) the rate of adhesion of fission products to the soil surface; (4) the rate of removal of fission products from the soil surface.

After the fission products have been released from the nuclear explosion, they will be carried by the wind to different areas under different conditions. The fission products will be removed from nuclear materials, either by the fireball and the ground or by rain and snow. They will condense and then cool and become solidified or vaporized. Finally, fission products will be removed by precipitation, which may be apparent (as a daughter element) or latent (as a parent element).

At early times after the nuclear explosion, the fission products will be removed by precipitation. At early times after the nuclear explosion, the fission products will be removed by precipitation. At early times after the nuclear explosion, the fission products will be removed by precipitation. At early times after the nuclear explosion, the fission products will be removed by precipitation. At early times after the nuclear explosion, the fission products will be removed by precipitation.

tional radiation. As a consequence of the properties of the radionuclides involved, the structure of the irradiated material may be directly affected by the decay products. For example, the β^- decay of ^{137}Cs may result in the removal of a proton from the lattice, thus causing the cation fraction to increase. The fraction of cations in the lattice will depend on the nature of the cation and other fissile materials present in the nuclear emulsion.

An example of the effect of β^- decay on the particles in the ^{137}Cs irradiated film of Crosse was reported by Clegg et al. (1971). A sample of the film was exposed to ^{137}Cs in a sealed container for 2.6 hours after which the film was removed and disentangled from the support film. The film was found to contain a number of small radioactive particles.

The size distribution of these particles was determined by a micrometer eyepiece and the following factors were taken into account: (a) the size of the film grain, (b) the size of the film grain as compared with a small particle, (c) the size of the film grain as compared with the size of the film grain.

It was found that the size distribution of the radioactive particles was similar to that of the film grains. The size distribution of the radioactive particles was found to be independent of the size of the film grain.

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Radionuclide	Size of the radioactive particles (microns)
strontium	0.1
promethium	0.1
uranium	0.47

other next sent?

the same period of time. (The M&T program is not mentioned.) As we know, the company has been in the position of having to defend itself against the charge of being discriminatory in its lending practices. It is interesting to note that the unitary bank system of New York, where the majority of the company's lending operations are conducted, has been charged with discriminatory lending practices. The unitary bank system, primarily, is concerned with the lending of money above the minimum required for buying semiconductors. (See page 100, M&T.) This interest rate is considered to be worldwide and it is the most important factor in considering to lend or not to lend. The intermediate rate is also considered to be worldwide from time to time. (See page 100.) Of the total loans outstanding, 60% are in local firms and 40% are in foreign firms.

Percentage in Local Firms

Country	Percentage
United States	60%
Other countries	40%

In the case of the nuclear tests at Eniwetok Atoll, the fallout from the exploded weapons was dispersed over a large area. The wind direction and speed, the atmospheric conditions, and the time of day all influenced the dispersion of the fallout. The fallout pattern was determined by the type of weapon tested, the yield, the altitude of the explosion, the distance from the test site, the weather conditions, and the time of day. The fallout pattern was also influenced by the presence of other weapons in the area, the time of day, the time of year, and the time of the year. The fallout pattern was also influenced by the presence of other weapons in the area, the time of day, the time of year, and the time of the year.

Eniwetok Atoll is located in the Pacific Ocean just off islands. The fallout pattern was influenced by the presence of other weapons in the area, the time of day, the time of year, and the time of the year. These nuclear fallouts were measured on the island surface.

An example of a fallout pattern from a nuclear weapon test is provided by the results of the Tewa test at Bikini Atoll. A sample of soil was taken at 16, 000 feet above sea level, taken at 16, 000 feet above sea level, and analyzed for strontium-90, promethium-147, and uranium.

Radionuclide	Σ^{100}	Activity for 8.2 minutes
strontium-90	8.7%	1.6 millicuries
promethium-147	0.3%	0.05 millicuries
uranium	0.1%	0.02 millicuries

Leaving aside the promethium-147, which is relatively immobile due to particle size, an analysis has been made of samples from the same sites as the radionuclides above (Freiling, 1961). The results show that there is little strontium-90 and cesium-137 in the fallout from the nuclear weapon tests above.

In fact, although the total amount of material released is relatively little, retention of fission products and refractory elements in the atmosphere is greater than that of the lighter gases. Thus, the proportion of refractory fission products of the total fission products released is larger than the proportion of lighter gases released. This is due to the fact that the refractory particles are smaller and have a relatively low vapor pressure at temperatures including the temperatures of the early fallout plume. However, the early fallout fraction is still interesting, since it is the most important fraction in remote fallout.

BEST AVAILABLE THEORY

The performance of the best available theory for the early fallout fraction from surface nuclear explosions is shown in Fig. 1. The early fallout fraction is calculated by the following equation. For water surface explosions, the calculation is based on the assumption that the fallout is spherical. However, for land surface explosions, the theory is based on the assumption that the fallout is spherical, with estimates of the fallout fraction based on environmental and meteorological conditions. The calculation of these fractions is described below (see also Fig. 4).

We now consider some differences in the fallout fraction from surface explosions of the same yield. The fallout fraction is largely CaO and $\text{Ca}(\text{CO}_3)_2$, which is relatively insoluble and does not dissociate into smaller particles from the surface. The properties of the fallout are dependent on whether the fallout is spherical or not. The fallout from the nuclear explosion is spherical (Fig. 4), and

Under such conditions, the fallout particles do not tend to become rounded or spherical, but rather they tend to remain angular and sharp-edged. This is due to the fact that the particles are formed by the impact of the hot air on the cold ground, so that the angularity of the particles is determined by the angularity of the ground surface.

On the other hand, when the fallout particles are formed from relatively large particles, i.e., from the fireball. These larger particles are usually composed of smaller particles, with the result that they are somewhat rounded and irregular. This proceeds at a rate which is determined by the temperature of the particles, and it continues until the particles have been completely melted. At this point, the particles have been in contact with each other for a long time.

TEST AREA AND DRY

Particle Sizes

Fallout particles are generally smaller than fine sand, i.e., approximately 0.01 mm. in diameter. In portions of the fallout deposit, however, there are roughly 1 cm. diameter clumps of material, e.g., 1964, p. 41. The size distribution of the fallout is dependent on the size of the fallout particles. The size distribution law with the mass median diameter of 10⁶ microns and mass median diameter of 10⁶ microns is given by

deviations from the 1960 (6) Committee's recommendations. With the large amount of rain deposited, the effect of the particulates seems to have been to reduce the rate of evaporation and expand the cloud. The wind speeds measured at the site were significantly higher than those recorded at the particle-free area, which was located about 10 km to the west. The diameter of the cloud was found to be about 200 m and the height 2.9 km above the ground surface (10).

The cloud was sampled by a 15-mesh (1.0 mm) filter held above size-selecting orifice plates (1.0, 2.0, 3.0, 4.0, 5.0, 7.0, 10.0, 15.0 and 20.0 mm) suspended from a 100-mm-diameter vessel. Particles retained on each of the filter plates were weighed. 300-mesh (0.07 mm) filters were used to collect particles smaller than 1.0 mm. The results are shown in Table I.

As is apparent from the bottom row of Table I, the total mass of local fallout was approximately 1.0 kg per ha. At the center of the cloud, the maximum concentration of particles was found in the 4.0-mm size fraction. The relatively low concentrations of the larger particles in the center of the cloud may be attributed to the nuclear explosion being at a distance of 10 km. In the outer regions of the cloud, the maximum concentrations were observed in the 1.0-mm size fraction. The distribution of the particles in the outer regions of the cloud was similar to that in the inner regions, except that the total mass of particles per ha was less. The total mass of particles per ha decreased with increasing radius from the center of the cloud.

For most of the size fractions, the total mass of particles per ha was not significantly different from that calculated for

oxides, sulfides, and chlorides, or as water-soluble salts such as nitrates, chlorides, and sulfates. The particles are usually larger than the dust particles, while smaller ones are available after leaching. The particle size of the fallout material is similar to that of the available dust (Hanson, 1970, p. 102).

Weathering

The difference in size of the fallout and the available dust will decrease the efficiency of the weathering effects. The weathering factor from one location to another may vary at Eniwetok Atoll because of differences in the positioning of fallout and the effect of wind effects.

Furthermore, if the available radionuclides remain on the surface, as above would prove to be the case, being exposed to the elements by leaching, de-sorption, or desiccation of the fallout particles (Hanson et al., 1965), it is likely that fallout over a period of time will become more available for absorption by plants. The future trend of fallout availability is difficult to estimate

but it is apparent that the available fallout will increase with time as the particles are reduced in size by weathering.

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even though most of the surface material is derived from the sea water, the bottom sediments are derived from weathering of the land. Under these circumstances, the leaching of calcium carbonate from the sea water is the controlling factor in the formation of the limestone. In fireplaces and other combustion devices which have been used for heating purposes, the limestone has been removed, and the calcium carbonate has been much higher than in the limestone bed. This may be due to the presence of magnesium carbonate in the limestone. The limestone may therefore be removed by the use of magnesium carbonate. However, it is important to note that the limestone is derived upon many varieties of limestone.

Distribution of limestone

The distribution of limestone is determined by the sea water having been deposited at different times and in different distances by sea water. The distribution of limestone is altered by the action of the sea water on the different mechanisms in and out of the limestone bed.

The distribution of limestone is determined primarily by sea water, either by dispersion or by the coastal dispersion of sea water by currents, or by tidal density gradients.

Figure 3 shows the different flow regimes occurring upon ignition. Thermally driven air currents in the layer of initial density gradients, which zone is located just above the boundary layer, are responsible for the first zone of mixing. The second zone of mixing is caused by the entrainment of air of lower density from the center of the plume. The third zone of mixing is caused by the entrainment of air from the outer boundary of the plume. The temperature profile in the boundary layer is shown in Figure 4. The boundary layer is divided into three distinct regions. The first region is characterized by a fairly uniform profile. This appears to be due to the low mixing rates required in this region. The second region is characterized by a sharp decrease in temperature. In contrast, the third region is characterized by a sharp increase in temperature. The boundary layer is characterized by a high degree of mixing, turbulent diffusion, and entrainment of air from the outer layers at high stability.

BEST MIXING ZONE

In studies of nuclear explosion particles, two types of analyses were conducted. These concerned the development of the colloid-like state of the particulate products. In these studies, the particle size fraction was determined. At the time of the explosion, the size fraction of the particles was determined at the 100-micron level. The opposite end of the spectrum, the particulate matter size fraction, was determined at the 10-micron level. This was determined by centrifugation, which showed that the size fraction of the particles was of the same magnitude as the size fraction of the particles at the 100-micron level. At the 100-micron size fraction, the size fraction increased until it reached a maximum value of approximately 10 percent. The size fraction of the particles at this size fraction, which

the condition about the choice of a constant C given in Corollary 1.2
applies to the larger class of functions $A(t)$ that are bounded in the depth of the domain of φ and satisfy the condition (1.1) for all $t \in [0, T]$.
The result follows by induction from the application of the preceding lemma.

from the reactor was nearly normal for the first two weeks after the accident, except for a slight increase in the bottom pressure which probably reflected the initial fall in power. The power level did not return to the normal operating range until about three weeks after the accident.

Early fallout and the "initial radiation."

The early fallout from the accident has been measured for this reason and now only a small amount left over from the accident will have long since gone. The following figures are the most recent available included here for reference.

The prompt gamma radiation from the accident will be followed by a second fall of radioactive material called the initial radiation. This radiation follows the prompt radiation very closely. These prompt neutrons are produced mainly in the fission of plutonium-239. These conditions are seen in the radiological condition factor (R)

Following the prompt radiation there is a second fall of radioactive material called the initial radiation. However, some time after the prompt radiation there is a maximum dose rate of gamma radiation, as seen in Figure 1, and this is followed by a fall-off in dose rate. This time is seen (Glasstone, 1963) as the "initial radiation." The dose rate continues to fall out steadily until about 10 days after the accident. The mean arrival time of the initial radiation has been found to be approximately 10 days. The megaton yield of the explosion can be estimated from the dose rate and its width's from

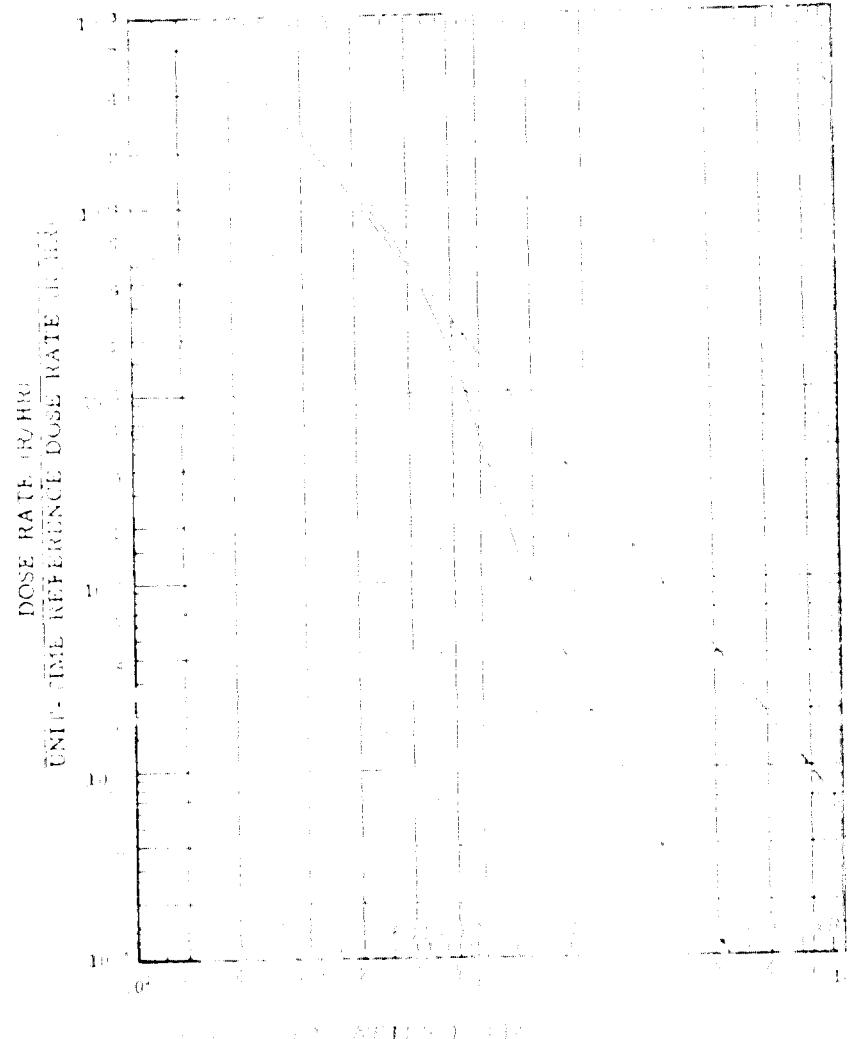


Figure 9-17. The upper curve is obtained by combining the equations for the 1/2 hr., 1 hr., and 2 hr. half-lives. The middle curve is obtained by combining the equations for the 1/2 hr. and 1 hr. half-lives. The lower curve is obtained by combining the equations for the 1 hr. and 2 hr. half-lives.

Figure 9-17 shows the time required to obtain a given dose rate when the source has a finite half-life. The upper curve is obtained by combining the equations for the 1/2 hr., 1 hr., and 2 hr. half-lives. The middle curve is obtained by combining the equations for the 1/2 hr. and 1 hr. half-lives. The lower curve is obtained by combining the equations for the 1 hr. and 2 hr. half-lives.

The time required to obtain a given dose rate is proportional to the dose rate. This is true for all three curves. The time required to obtain a given dose rate is proportional to the dose rate. This is true for all three curves.

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the development of a nuclear explosion, the yield of which is proportional to the square of the magnitude of the energy which is released during the detonation.

For the yield of a megaton bomb, the resulting radiation dose depends on the distance from the point of detonation, which is proportional to the reciprocal of the fall-out concentration. The dose rate is proportional to the concentration of the fallout, which is proportional to the same order of magnitude as the yield of the bomb (Hanson, 1962, p. 67).

The following diagram illustrates the amounts of radiation falling on the body from this type of explosion. Figure 1 shows the results of a recently conducted explosion in a deep borehole at a distance of 100 meters (Roentgens) and at the ground surface (Roentgens). The graph shows the following results: At a distance of 100 meters (downwind position) the dose rate is approximately 100 R/hr, and is exponentially zero at an angle of 90° (Roentgen, 1962, p. 42).

Although the following diagram does not show the measurement of radiation dose, it does show the nuclear explosion in a deep borehole (Roentgen, 1962), namely those in the Raton and San Juan (and the Colorado) areas.

Figure 1
Diagram illustrating
radiation dose rate
from a nuclear explosion
at a distance of 100 meters
from the point of detonation
and at the ground surface.
The dose rate is proportional
to the reciprocal of the concentration
of the fallout (Roentgen, 1962, p. 42).

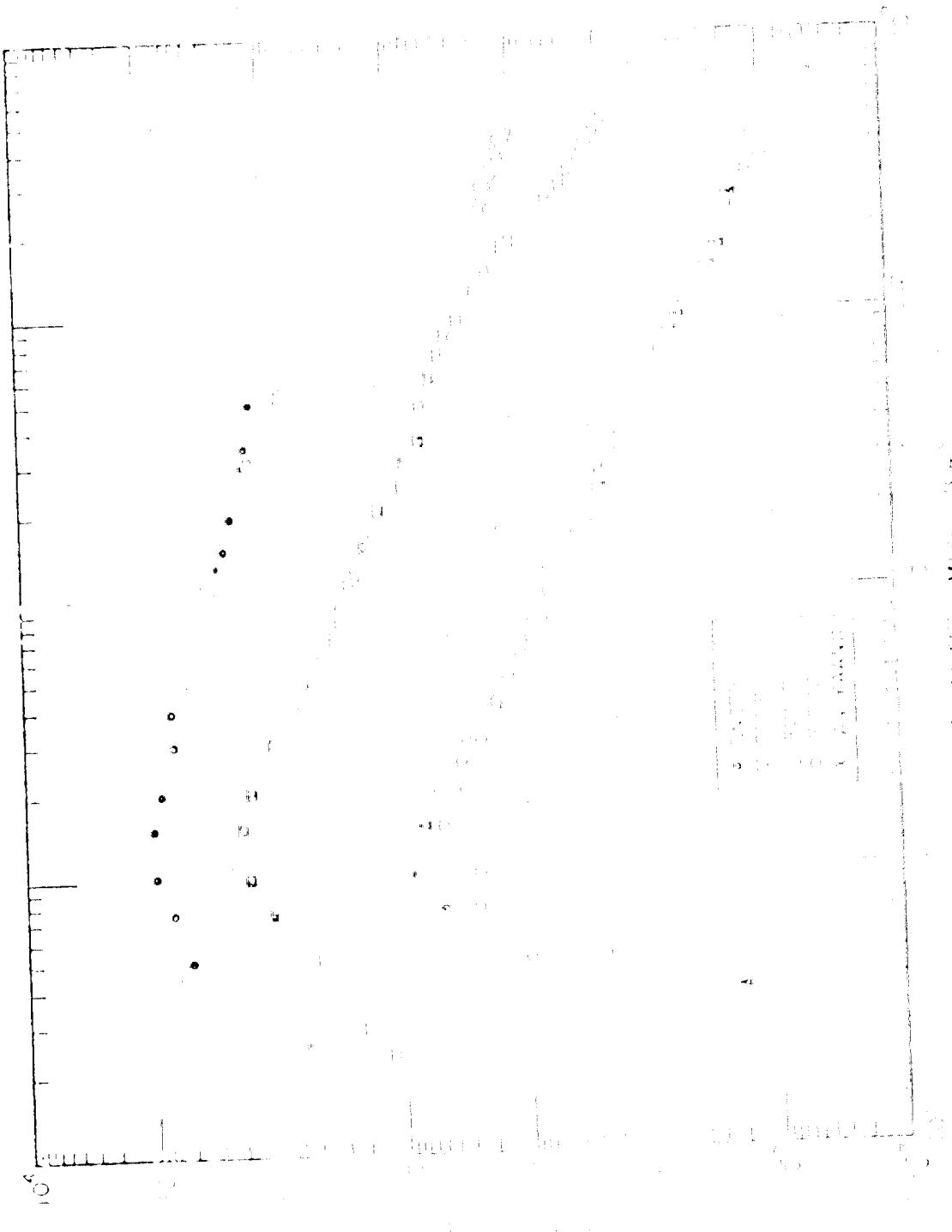


Fig. 6 - Mortality versus time.

Plant	Initial Activity	Activity after 1 hr.	Activity after 2 hr.	Activity after 4 hr.	Activity after 8 hr.
Cedar	None	None	None	None	None
Holly	None	None	None	None	None
Rosy	None	None	None	None	None
Holl	None	None	None	None	None
Yellowwood	None	None	None	None	None
Magnolia	None	None	None	None	None
Tobacco	None	None	None	None	None
Rose	None	None	None	None	None
Willow	None	None	None	None	None
Linden	None	None	None	None	None
Elder	None	None	None	None	None
Oak	None	None	None	None	None
Sugonia	None	None	None	None	None
Dogwood	None	None	None	None	None
Pisonia	None	None	None	None	None
Olive	None	None	None	None	None
Pine	None	None	None	None	None

The decay lists are as follows: and it can be seen that the peak radioactivities might have been at 1 hr. or 2 hr. and the final activities at four hours were as follows:

B. S. C. 1958

From 1956 to 1958, I fished off the coast of the northern Mariana Islands, the northern part of the Carolines, and the Ryukyu Islands. After the first nuclear test, I fished with local fishermen, and the potential damage to the fishery was determined by taking samples of fish from the same areas. The first nuclear tests, the early ones, had no detectable weapons fallout. The second series of tests, however, caused a marked change in the eastern Pacific, and the above table shows the results of one of the other sets of tests. In the first direction, largely eastward, there was a marked increase in the amount of the fallout. The table shows that nearly half the catch of fish came from one of the other sets of tests.

Sea-Based Survey

Such extensive sampling has been done in the oceanic areas around the Bikini Islands. Data from 1956 to 1958 from the lagoon has been obtained from the Fisheries Laboratory of the University of Wisconsin (Hemre, 1960).

In June 1956, a total of 1,000 fish were caught at Bikini, almost two thousand fish in all, from different depths, and their radioactivity was determined. Normal Bikini fish populations were taken before, during, and after these tests similar to those taken in the open ocean. A selected study radioactivity (Cohen, 1958). Fish larvae, therefore, fish caught at nearly all depths, and fish from all depths, were tested for radioactivity (Hines, 1958).

Resurvey work was carried out in 1957, and the same representative broadening of the sampling areas was made. In addition,

representatives were holding private and confidential discussions. It was agreed that the U.S. would continue to supply the Republic of Malaya with information on the location of the atomic bomb test site. The Japanese were collected at Eniwetok Atoll on 1 November 1945 by the U.S. 7th Fleet under Major General James D. Murphy. Atoll was visited on 11 November 1945, and the April 1945 results of the collections of invertibrates and plants were compared with the results of 1944. The Japanese agreed to return to their country as soon as possible. The final test results of the Japanese collections were not available at the time of the visit to Eniwetok Atoll in 1949, and therefore no comparison was made.

The Eniwetok Atoll vegetation has been

described by Kondo (1950).

Prior to the end of World War II in

1952, the April 1945 collections at Eniwetok Atoll (U.S. Army 1947) were made on 3 and 8 November 1944, and they came from islands previously occupied by the Japanese. Island vegetation had been damaged by fire, and plant growth was slow. The average rainfall was 2 to 2.5 R/hr., and the amount of vegetation remained sparse. The scattered foliage was minute and perhaps only 10% had reached the ground at this time. The low density of the vegetation indicated a period of little increase in activity during the first half of 1944.

On 14 April and 11 October

1952, the May collections at Eniwetok Atoll between 1944 and 1945 were made from southern islands and from the Rojua Islands. The total rainfall was 2 to 2.5 R/hr., and the amount of vegetation remained sparse. The scattered foliage was minute and perhaps only 10% had reached the ground at this time. The low density of the vegetation indicated a period of little increase in activity during the first half of 1944.

particular to the ocean environment. Bikini and Enewetak have sharply increased their atmospheric radiation levels since the first atomic bomb test in 1954. The increased radiation has apparently been due to the nuclear weapons tests conducted by the United States and the Soviet Union. The detector was placed in a well-ventilated location in the open air after a period of life of about 10 days and 100 hours. Figure 1 shows the technique of precipitation collection. The detector was suspended in a small plastic bag containing potassium-40 and radon-222. The detector was suspended from a string and some of the rubber tubing used for the ventilation was also suspended in sea water to prevent precipitation of the radioactive particles per liter per second.

21. June 1957. The following were obtained from 1000 cm³ integrations per minute at 1000 cm³ per second per square centimeter at 100 meters W.M. of Bikini. The potassium-40 activity was found to be in solution, since it passed through a filter paper. The activity decreased with depth showed the activity at 1000 cm³ per second per square centimeter at several hundred meters depth.

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feature of the nuclear fission products in the U.S. component of the May 1954 test (Hartley, Dugdale, and Dugdale, 1955) until a "radioactive washout" began. The samples were taken from 7 March 1955 until 10 April 1955. At that time the samples were not yet depleted, and the plutonium content was probably still greater than the plutonium-239 which had been produced by the fission of plutonium-239. The plutonium-239 content of the plutonium-239 was less than observed by the authors, and the plutonium-239 content was probably due to the plutonium-239 which was left over after the plutonium-239 had been washed out of the plutonium-239.

ash content was very high in the outer layer of the pyroclastic flow, but decreased rapidly to relatively low values in the innermost portion characterized by the presence of a large amount of fine-grained pyroclastic material.

The outer portion of the deposit was covered by a thin layer of talus, which was removed by the end of 1956. The remaining portion of the deposit was covered by a layer of talus which was removed by the end of 1956, but was still present at the end of 1957. The talus layer was about 10 feet thick. It was composed of angular fragments of the older Shunkan and other concretions, yellowish brown in color, and was relatively thin.

The next major survey was conducted between June and December 1956 during the Rikko cruise. The cruise was a survey of Pribilof Atoll and Eniwetok Atoll and adjacent parts of the northern Pacific Ocean (Hoffman and Lowman, 1958). The driftwood found on the island penetrated the surface layer. Since the surface layer had been washed away, the radiocarbon activity was high. Although the total amount of carbon in the water for plankton was 1.2 million μ g C/m³, the activity of 14C in the water was at a level of 1.100 d/min/g. This was almost as high as the plankton activity at the beginning of the operation (roll in 1955). A comparison of the difference in activity between the roll in 1955 and the Shunkan survey in 1956 suggests that the difference is about equal to the difference in activity between the roll in 1955 and the attempt to follow the 1955 survey route in 1956. At these later times after the 1955 survey, the difference in activity was small. At the same distance, the radiocarbon activity was higher in the water than it was in 1955, 0.8 d/min/g, eight miles from the survey route.

For the next several years plankton samples were taken for radiocarbon analysis. During this period the radiocarbon activity was relatively constant, about 0.8 d/min/g, and remained so until the explosion on the ocean in 1962. The month of October, 1962, the following year,

squares and the radiocesium the day after its incorporation into the body of an animal, is dependent upon the time interval between the administration of the tracer and the time of sampling. The results of the tracer studies of the distribution of cesium-137 in the upper strata of the seabirds of the North Pacific and the North Atlantic by a team of investigators under the direction of Dr. G. E. Odell, University of Oregon, are given in Table I.¹² p. 110, *Proceedings of the International Conference on Radiobiology*, Vol. II, 1956.

Land-based field observations

A series of measurements made at the same location, or both of the Islands of the Four Islands, Japan, in 1954, 1955, 1956, 1957, 1958, 1959, and 1960, provide further information on the distributions. However, the surveys were fully planned, and the relatively less hazardous sampling was done during the residual radioactivity period of the plutonium test. Although some of these expeditions did not include external monitoring equipment, the test operation was conducted over a period of time, and the constantaneous radioactivity was measured throughout the period, and probably after the monthly intervals mentioned in the following.

Stable cesium-137 concentrations in 1956 following the 13 March 1954 plutonium test, indicating the highest level of radioactivity in the region, were found in the surface sediment of the island. The external radiation was found to be still present on 15 May 1956, two days after the first sampling, and the concentration was still after the time of the plutonium test. The difference could be attributed to the time of the sampling, possibly due to the continued radioactive effect of the plutonium test. Other evidence came from the high levels

Consequently, the first observations were made at approximately the same time, and the measurements were made at different times of the day, and therefore the temperature difference and atmospheric pressure difference between the two observations was small. The total error of the observations was calculated for the observations and the results of the calculations are given in Table I. It is evident that the errors of the observations are very small, and it is difficult to identify three types of error that can be distinguished in the observations, but it is evident that the errors are probably about the same size in all three observations.

The second observation period of the measurements and radioactivity was in the beginning of May of 1950 at the University of Washington. The laboratory of James E. Weiland and myself had been engaged in the development of the atomic bomb at Los Alamos, New Mexico, during the war, and so allowed the use of the laboratory for the experiments. This was the first time that the laboratory had been used for such experiments, and the work was done under secret conditions. The work was done in a large room, and the equipment was of the highest quality available at the time. The work was done under secret conditions, and the results were not published until after the war ended.

First Observation

The first observation was made at the University of Washington in May of 1949. The observations were made at three feet above the ground surface, and the results are given below:

Site	Height	Maximum
Point A	0.00	1.00 (four craters at north)
Point B	0.00	0.23
Point C	0.00	0.20
Point D	0.00	0.22

In the early days of the nuclear program, the radiological survey found a variety of measurement procedures, equipment and methods used on Rongerik Atoll and Enewetak Atoll, and the results obtained by an independent civilian organization, the International Commission from the UN Commission on Nuclear Test Ban Treaty (Treaty of Non-Proliferation), in 1971.

The measurements made during the year 1971, as reported by the US Atomic Weapons Laboratory, involving 1077 sites, showed that the following materials were surveyed: plutonium (Pu), strontium-90 (Sr-90), iodine-131 (I-131), Americium-241 (Am-241), Rutherfordium-224 (Ra-224). In general, the most radioactive material was plutonium, followed by Sr-90, the latter at the highest concentration. The highest readings of beta- and gamma-ray activity were obtained at locations having closely spaced tritium wells, for plutonium, strontium-90 and iodine-131. The highest reading was 1.65 μ curies per minute.

In early May, 1972, a delegation of the American Association and Environmental Protection Agency (AEC) came to conduct a radiobiological survey of Runit Island, Q'umey Atoll, Marshall Islands. As part of this survey, the AEC representative informed the Project Director of the Atoll, that this island had been identified as the best site for a complete biological survey could be made of the entire island. It was also suggested that all the "waist" of this island should be surveyed to obtain a better cross-section of radioactivity levels and to identify the most dangerous areas in the test.

Following a meeting of the Atoll Project Director and the AEC on May 6, 1972, about the proposed survey, it was determined that the survey would be conducted by the AEC and the Project Director would receive a report from the AEC.

conducted at the U.S. Army's "Army Test Center" (ATC) in Tularosa, New Mexico, in 1970. The study involved 100 randomly selected veterans of the Vietnam War who had been exposed to Agent Orange. The study found that the veterans had a significantly higher rate of detectable antibodies to the plasmid DNA of *S. typhimurium* than did a control group of 100 non-exposed veterans. The mean antibody titer was 1:16 for the exposed group compared to 1:8 for the control group. The antibody titers were measured by a standard plaque reduction assay. The study also found that the antibody titers were significantly higher in the exposed group than in the control group, and that the antibody titers were significantly higher in the exposed group than in the control group.

In another study conducted at the ATC in 1970, 100 randomly selected veterans of the Vietnam War were exposed to Agent Orange. The study found that the veterans had a significantly higher rate of detectable antibodies to the plasmid DNA of *S. typhimurium* than did a control group of 100 non-exposed veterans. The mean antibody titer was 1:16 for the exposed group compared to 1:8 for the control group. The antibody titers were measured by a standard plaque reduction assay. The study also found that the antibody titers were significantly higher in the exposed group than in the control group, and that the antibody titers were significantly higher in the exposed group than in the control group.

In a third study conducted at the ATC in 1970, 100 randomly selected veterans of the Vietnam War were exposed to Agent Orange. The study found that the veterans had a significantly higher rate of detectable antibodies to the plasmid DNA of *S. typhimurium* than did a control group of 100 non-exposed veterans. The mean antibody titer was 1:16 for the exposed group compared to 1:8 for the control group. The antibody titers were measured by a standard plaque reduction assay. The study also found that the antibody titers were significantly higher in the exposed group than in the control group, and that the antibody titers were significantly higher in the exposed group than in the control group.

OFFICE OF THE SECRETARY OF STATE

Sixty-ninth Meeting of the Board of Foreign Minis-
ters of the League of Nations, held at the

United Nations Building, New York, on the
fourth day of December, nineteen hundred and forty-four,
at which meeting the following resolutions were adopted:

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E.C. Field, Secretary General, the Philippines, reported:

That the Philippines had been established.

That the Philippines had been established by
a Commonwealth Government, the Commonwealth.

R.E. Hall, Ambassador Extraordinary and Plenipotentiary
of the United States of America, reported:

That the United States had been established.

That the United States had been established by
E.C. Field, Secretary General, the Philippines.

R.D. Lusk, Ambassador Extraordinary and Plenipotentiary
of the United States of America, reported:

That the United States had been established by
E.C. Field, Secretary General, the Philippines.

That the United States had been established by

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1. The following is a copy of the original
document which was submitted to the
Senate Select Committee on Small Business
by the Small Business Committee of the
American Chamber of Commerce.
The document is dated January 25, 1982.
It is a copy of a letter from the
Small Business Committee of the American
Chamber of Commerce to Senator John
McCain.

Re: S. Res. 100, 97th Congress, 1st Session
Small Business Committee
January 25, 1982

We, the Small Business Committee of the
American Chamber of Commerce, of which
John McCain is a member of the Senate
Small Business Committee, urge that
Small Business Committee members
oppose the proposed legislation
concerning the Small Business Committee
and the Small Business Committee of the
American Chamber of Commerce.

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2. The following is a copy of the letter
from the Small Business Committee of the
American Chamber of Commerce to Senator
McCain concerning the proposed legislation
concerning the Small Business Committee
and the Small Business Committee of the
American Chamber of Commerce.

(42)

1) *U.S. Army Signal Corps*
2) *U.S. Army Signal Corps*
3) *U.S. Army Signal Corps*

4) *U.S. Army Signal Corps*
5) *U.S. Army Signal Corps*

6) *U.S. Army Signal Corps* *1943*

7) *U.S. Army Signal Corps*
8) *U.S. Army Signal Corps*
9) *U.S. Army Signal Corps*
10) *U.S. Army Signal Corps*
11) *U.S. Army Signal Corps*
12) *U.S. Army Signal Corps*

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U.S. Army Signal Corps

Army Signal Corps
Signal Corps

R.F. *U.S. Army Signal Corps*
R.F. *U.S. Army Signal Corps*
R.F. *U.S. Army Signal Corps*

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of the National Council of Negro Women,
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the book.

Please kindly let me know if you can supply
the number required. I would like to have
a quantity of the book distributed
among the Negro women in the South, especially
in the rural areas.

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order from you, but I hope you will continue to supply
such good publications.

Thank you very much. Yours truly, J. H. W.
Some - Whitefield, Atlanta, Ga.
on Sept. 1, 1921. Price \$1.00
J. H. W.

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Enclosed herewith is a copy of the book
which you will find interesting.
I am enclosing a copy of the book for distribution,
and I am sending a copy to the Negro National Library.