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ENVIRONMENT

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

The testing of nuclear weapons at Eniwetok Atoll was a testing grounds that, among other factors, were remote from populated areas. Previously, two tests had been conducted at Bikini Atoll in 1946 and July 1946 under Operation Crossroads and near Alamogordo, New Mexico on 16 July 1945 at Operation Trinity. However, for a continuing program of testing, it was suffered that the site in that the land areas were available for construction of test facilities. In addition to the prevailing winds to permit construction of a regular facility.¹ This led to the selection of Eniwetok Atoll for testing nuclear detonations, a selection administratively approved by President Truman on 2 December 1947.

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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. Fenzl of the Los Alamos Scientific Laboratory. In regard to possible fallout, Eniwetok Atoll was well isolated by 100 to 150 miles of open sea lying from the Atoll to the westward direction of the prevailing winds.

1. N. O. Hirsch, Project 1946: The Nuclear Test, University Press, Seattle, 1962, p. 81.

The first atomic bombs were used in nuclear weapons tests on Eniwetok Atoll (Operation Crossroads, 1946). Called "Crossroads," the tests involved personnel from the United States and other countries having significant ground facilities at the site. There were seven detonations from their many surface test sites. These detonations were made during Operation Sandstone, which began on 25 May in 1946; the first off Engebi, the second off Eniwetok, the third off Rongerik, the fourth off Eniwetok, the second with a yield of 49 kiloton. This kiloton terminology means that the explosive strength of the nuclear detonation equals 49 thousand tons of high explosives. The following table, table at the end of this section, gives the yield, date, time, location, height of burst (position (ground, above ground surface, or underwater) of nuclear explosive yield, (end)).

In preparation for the next series of nuclear tests, the Atomic Energy Commission in 1949 decided to terminate further testing by improving ground-based structures and facilities at Enewetak Atoll. The recommendations were based on a survey submitted by Holmes and Tamm, Inc., on 7 February 1949. The Commission approved the recommendation for construction and signed in June.

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2. Reference 1, p. 6
 3. Reference 1, p. 6
 4. Samuel Glasstone, "Effects of Nuclear Weapons," U.S. Army Personnel Research and Analysis Center, Report UCRL-1000, 1957, and "Nuclear War Survival Skills," Federal Survival Information Institute, 1968.
 5. Reference 1, p. 6
 6. Reference 1, p. 6
- (2)
- Information, Department of the
United Nations, New York, N.Y.; A. Edwards, "Tabulation
of Data on Disarmament, Nuclear Disarmament and
Control of Armaments in the United Nations through 1965,"
(New York, 1966); and from clearing house for
disarmament information, Geneva, Switzerland.

In 31 January 1951, President Truman approved the decision to develop a thermonuclear weapon, a decision which, of course, was to have great impact on Strategic Defense. The effects of such large increases in yield and fall-out were known to be potentially continental United States, but were believed limited to the area off the coast of the Pacific Proving Ground. The first test that it first were limited to the 200-kilometer radius of the hydrogen weapon, the Nevada Proving Grounds near Las Vegas, Nevada, was additionally established in the autumn of 1951. The first test there were 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 not yet 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.⁷

A full thermonuclear explosion was however the following year in the 1952 test series conducted at Eniwetok.⁸ This involved only two tests, but they both had considerable significance and consequence. The first was Test Mike, the first thermonuclear detonation and a ground level explosion equivalent to 9.4 megatons or equivalent of 10.4 million tons of high explosive. On 30 October 1952, on Enewetak Atoll island, Elugelab (Eluklapin in Marshallese, meaning by the natives "the center"), 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 and the top 100 chain. A large reinforced concrete tower was built on the next, large island of Engebi to test effects of the explosion. The second test of

7. Reference 1, p. 10.

8. Reference 1, p. 11.

Operated by the U.S. Army, the test was conducted from an air drop north of the U.S. Atoll of Rongerik.

Associated with the test were radiation levels which was dozens of times greater than normal, which caused a corresponding increase in the fallout radiation levels. Due to the direction of the wind and contrary to expectations, the winds prevalent at the time, blew from the south or southeast,⁹ and so most of the radiation was carried off to the east and areas to the north and northwest. Nevertheless, local fallout reached the northern islands of the Atoll. Since these islanders had to be exposed to the harm resulted to humans from this local fallout.

U.S. tests were conducted only at the Nevada Proving Grounds in 1953, thereupon starting the letting of tests to start at the Nevada Proving Grounds or the Pacific Proving Grounds (Edgewood) in the next year. The next series of tests in the Pacific began in 1954 under the name Operation Castle. It involved a task force, which became the number 1 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 until 1946. One of these had consequences affecting all test sites in the Pacific. The first detonation thermonuclear tests Bravo in this series was conducted on the surface in Enderbury in February 1954.¹⁰

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The radioactive fallout from Bravo became 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 increased focus on the new series of tests. The Atomic Bomb Casualty Commission, on which the author was established after the atomic bombing of Japan, was involved in the Sasebo Maru of the Japanese

9. Melvin P. Trumbo, "The First Samoan Nuclear Test," Lawrence Livermore Laboratory Report UCRL-20000, 1960, p. 10.

Fishermen claim that it is safe for purposes; it is a small island.

Roger B. Triplett, a member of

Operation Crossroads, says that an enlarged crater was formed by the detonation of the "Mike" bomb, detonated at 10:00 a.m. on July 25,

By 1954 the island had become a barren, white, and lifeless island long since despatched to oblivion. From 1946 to World War II there were no nuclear tests. The nuclear tests and the initial radiation from the early tests. Nevertheless, colonies of rats survived. In 1955¹¹ even the birds had disappeared.

The 1956 series of tests in the Redwing. These took place at both ends of Eniwetok Atoll 1. The first Bokou Island was removed on 6 June 1956. The test site was on the surface. This second crater was on the northern end of Island. The other crater test site had already formed a crater about a quarter mile (U.S. code name) in the tide flats on the northern end of the island.

It is intended for survey
the Coast Guard Cutter

at Eniwetok Atoll, but with
no specific effect. The only
effect of the test was the crater,
now known as the Mike crater.

Operation Crucible (U.S. code name) had
been conducted on the island. Small palms and other trees had
been destroyed. The two test areas had been subjected
to several series of nuclear weapons
tests. The island had been irradiated by
residual radiation of fallout.
Survive on this isolated island in
the test.

The testing ground was called Operation
Crucible. Atolls, with eleven atolls
the U.S. code name) was
as positioned on the land
side of the remainder of Bokou
Island was Test Lacrosse, which
island. The third atoll is the U.S. code
name) in the tide flats on the northern end of the island.

11. John H. Earl, Jr., "Atoll Test,"

12. Reference 11.

Test ARI-4656 (1956).

Early testing of nuclear weapons was under way during the 1950's throughout the world-wide territories of the United Nations. Before the end of the decade, Operation Hardtack I, consisting of both at Eniwetok and Kwajalein, Phase II, took place.

Between 5 November 1952 and 1 January 1953, under Operation Hardtack I, 17 tests were conducted thereby constituting a moratorium over the entire territory of the U.S. monotonous and uneventful. After a few days by a resumption of nuclear tests at Eniwetok. The moratorium has allowed some natural regeneration of the affected islands and have provided the time to determine the residual radioactivity resulting from the tests.

Two islands were selected for the operation Hardtack, Phase I. The test Koa was a small island off the U.S. code name). The first nuclear test was Test Cactus (at the southwest of the name). This produced a crater

testing of nuclear explosions stimulated awareness about later tests by the several nuclear tests called the Atoll took place in 1958 Kwajalein Proving Grounds as testing years at the sites. tests were conducted at Eniwetok during the intense period of testing tests conducted at the Atoll operation Hardtack, the year 1958 and was followed in a series of tests conducted at the Atoll until the present time have affected islands and have the residual radioactivity

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

Further tests were conducted at Johnston Atoll 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 conduct nuclear testing. The USSR tests occurred from 1955 to 1958. Only month later the United States announced that they would not conduct nuclear testing, which was completed by the end of 1962. This followed the signing of the Partial Test Ban Treaty, which was signed in September 1963. This treaty prohibited those tests that did not result in a nuclear explosion across national boundaries, and so effectively limited nuclear testing on the surface. Although underground tests have been conducted in the continental United States and at Amchitka in Alaska, none have been conducted on Johnston Atoll.

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

Number of Tests	Board Geo. Nos	Marshalls Island	US Code Name
18	Runit	Runit	Yvonne
10	Enderbury	Enderbury	Jinet
4		Uklik	Flora*
3	Aemon	Aemon	Sally
2	Eberiro	Eberiro	Ruby
1**	Bogai	Bogai	Alice
1		Mindanao	Gene**
1	Bogeir	Bogeir	Helen
1	Rujiye	Rujiye	Pearl
1	Bugane	Bugane	Henry
1	Bogain	Bogain	Irwin

*This island never received a name and was first tested by test Mike on 1 Nov 52.

**Actually located on the continental shelf southwest of this island.

**This is and was called "Mines" and was first tested by test Koi on 23 May 58.

The underwater mines were later removed and buried in each other.

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

Point of Detonation	Amount of Explosives	Character of Tests
At the surface	Very small	Surface tests
Underwater	Medium	Underwater tests
At the bottom	Large	Bottom tests
At intermediate depths	Large	Intermediate depth tests

What happened
to the test?

Of course, land surfaces were the most attractive to the physical condition of the islands by providing the existing land or removing an island entirely. All harbors are off-shore, the leeward side/off the islands of Runit (Yvonne) and Enewetak (Eve). Generally west of these islands, the tests produced indications that the prevailing winds from the northeast generally carried ash across the island chain to the lagoon.

In either the case of a successful nuclear detonation or the case of an unsuccessful nuclear detonation a strong radioactive results in addition to physical damage to trees and vegetation and animals. In the case of a successful detonation the following general radioactive results are:

1. Fission products resulting from the fission of the uranium or plutonium used as the nuclear explosive, with uranium-235 and plutonium-239 emitting cesium-137 and strontium-90. These fission products have half-lives respectively, roughly 80 years and 20 years and therefore do not decay appreciably even in a short time. They do not decay sufficiently in the environment to be useful so they decay sufficiently slowly to allow the detection of radioactivity.

and inasmuch as plutonium is used for towers, it is important to know the time and waiting times required for the plutonium to become available for use. This is particularly important in view of the capture of plutonium from the atmosphere by the ocean and from thermonuclear weapons tests (However, the amount of plutonium in the water in the ocean is negligible compared to that deposited over a similar period of time from misfiring or "mishap" safety tests of nuclear explosions carried out in a specific area, as mentioned in Item 4. In the case of plutonium deposited over a considerable period of time from a nuclear explosion, plutonium is plutonium or plutonium is plutonium, as mentioned in the case of the spread from spread in the former case, more than in the latter. A particular concern in these cases is the hazard of plutonium to man, which is far too long to enable nuclear weapons to be used effectively. The third,

Just south of the main crater, two additional detonations have occurred around Runit Island. One was a test shot in Operation Hardtack I and another was a test shot in Operation Dominic. Both tests were planned only to explosive yield and were not designed to penetrate the surface. Local sprouting has been noted around the crater on the Runit Island.

NUCLEAR DETONATIONS AT ENiwetok Atoll

Date	Time	Type	Location	Approximate Position	
				Lat.	Long.
TESTS IN 1954					
1/1/54	1815	Air Drop	Surface	11°32'15"	162°21'15"
1/1/54	1815	Air Drop	Surface	11°32'23"	162°21'02"
1/1/54	1815	Air Drop	Surface	11°32'30"	162°21'20"
1/1/54	1815	Air Drop	Underwater	11°32'41"	162°21'44"
1/1/54	1815	Air Drop	Barge	11°32'38"	162°21'22"
TESTS IN 1955					
2/1/55	1756	Air Drop	Surface	11°37'24"	162°19'13"
3/1/55	1815	Air Drop	Tower	11°32'40"	162°21'52"
6/6/55	1826	Air Drop	Land Surface	11°40'35"	162°35'12"
11/6/55	1826	Air Drop	Tower	11°33'04"	162°21'31"
13/6/55	1826	Air Drop	Tower	11°37'41"	162°19'32"
1/1/56	1814	Air Drop	Surface	11°34'48"	162°19'31"
2/1/56	1816	Air Drop	Surface	11°37'33"	162°21'49"
2/7/56	1826	Air Drop	Barge	11°40'17"	162°12'01"
8/7/56	1806	Air Drop	Barge	11°40'19"	162°12'09"
21/7/56	1816	Air Drop	Barge	11°33'23"	162°21'15"
TESTS IN 1956					
7/1/56	1756	Air Drop	Surface	11°37'24"	162°19'13"
8/1/56	1815	Air Drop	Tower	11°32'40"	162°21'52"
8/1/56	1826	Air Drop	Land Surface	11°40'35"	162°35'12"
11/6/56	1826	Air Drop	Tower	11°33'04"	162°21'31"
13/6/56	1826	Air Drop	Tower	11°37'41"	162°19'32"
1/1/56	1814	Air Drop	Surface	11°34'48"	162°19'31"
2/1/56	1816	Air Drop	Surface	11°37'33"	162°21'49"
2/7/56	1826	Air Drop	Barge	11°40'17"	162°12'01"
8/7/56	1806	Air Drop	Barge	11°40'19"	162°12'09"
21/7/56	1816	Air Drop	Barge	11°33'23"	162°21'15"
TESTS IN 1957					
5/5/57	1815	Air Drop	Surface	11°33'23"	162°21'15"
11/5/57	1815	Air Drop	Surface	11°32'23"	162°21'02"
12/5/57	1830	Air Drop	Surface	11°40'30"	162°21'20"
16/5/57	0130	Air Drop	Underwater	11°20'41"	162°10'44"
20/5/57	1830	Air Drop	Barge	11°32'38"	162°21'22"
HARDTACK, PHASE I					
Cactus			Land Surface	11°33'23"	162°21'15"
Butternut			Barge	11°32'23"	162°21'02"
Koa			Land Surface	11°40'30"	162°21'20"
Wahoo			Underwater	11°20'41"	162°10'44"
Holly			Barge	11°32'38"	162°21'22"

ENVIRONMENT

THE RADIATION SURVEY

AT THE POLL CLEAUP

3a Present Environmental Survey and Topical Survey

1. PRELIMINARY
SURVEY

Introduction

The radioactive environment of Eniwetok Atoll is almost entirely from the nuclear explosion fallout. After the first atmospheric test in 1958, some radioactivity resulted from tests conducted elsewhere in the atmosphere, but fallout radioactivity from atmospheric tests was significant compared to the minimus radioactivity in 1973 was more than an order of magnitude greater and of local origin. The activity (Bear, 1971). A small amount of two underwater tests at the southern island of Eniwetok Atoll contributed fallout from tests conducted elsewhere.

Only after many decades will the local environment undergo natural nuclear decay so significant that the radioactivity is as low as the natural radioactivity at this location. There are, however, many, many sources of radiation other than nuclear tests. These include principally cosmic rays and residual, actually increased, Of course,

our purpose is to make clear the need for further research and development to determine the most effective way to reduce the risk of developing cancer in the islands. This is a problem of concern throughout the world in nuclear power developed countries.

Radioactivity in fish meat

The risks of cancer associated with the consumption of fish meat are presented below:

- Cesium-137 is a radioactive fission product. When present in fish meat it is mainly deposited on the external surface of fish fillets. It is less important than the inherent radiation from the fish itself, which is mainly due to the presence of potassium-40. The deposition of cesium-137 on the top surface of fish meat depends on the exposure. Being chemically similar to potassium, it is deposited in the muscle tissue in the meat. However, in the food chain; the concentration of cesium-137 in the meat depends on the risk of inducing cancer.
- Strontium-90 is another radioactive fission product. Not only does it have a beta-ray activity, it also provides only a beta-ray activity. It is deposited on the top surface of fish meat, just like cesium-137. It is similar to calcium, it deposits in the bones of the body. Strontium-90 enters the body via the food chain, and it is deposited in the bones. The principal risk of strontium-90 is the risk of bone cancer.

- Plutonium-239, different from plutonium-238, is much more explosive than plutonium-238. The explosion of plutonium-239 is due to the nuclear fission of plutonium-239 nuclei by neutrons. (Left) One of the most important factors in the development of complex weapons is the ability to control the chain reaction of the plutonium-239. Right) The plutonium-239 particles are extremely radioactive and explosive. The concern of very few scientists regarding the safety of plutonium-239 is instantaneously converted into a major hazard to the public health and safety of the subsequent generations.

Other plutonium isotopes are also present as a result of the various tests. The plutonium-238 and plutonium-240 produced are insignificant compared to plutonium-239, plutonium-241, plutonium-242, and furthermore are not significant enough to pose a threat to the general public. These lessons can be applied to other plutonium isotopes during the test.

- Other plutonium isotopes are not as explosive as plutonium-239, but still explosive.
- Isotopes of plutonium-238, plutonium-240, plutonium-241, plutonium-242, and plutonium-243 are not significant enough to pose a threat to the general public.
- Other plutonium isotopes are not as explosive as plutonium-239, but still explosive.
- Isotopes of plutonium-238, plutonium-240, plutonium-241, plutonium-242, and plutonium-243 are not significant enough to pose a threat to the general public.

FIGURE 1.

the initial adiabatic flame front (IAF) is activated partially by the heat of flight. Consequently, the initial temperature of the projectile is higher than the ambient temperature. The projectile passes through the air gap and enters the liquid droplet cloud. Due to the high temperature of the projectile, the droplets are heated rapidly. The droplets begin to boil onto the projectile. The droplets cool rapidly as they condense onto the projectile. The adiabatic flame front temperature is assumed to be constant at the values that are given in Table I. The temperature of the element before impact is taken to be 20°C. The adhesion process starts immediately after the impact process.

In general, the fallout rate is proportional to the fissionation rate. The rate of fissionation is slow at first, but as the energy of the burst increases, the rate of fissionation increases rapidly, and are found to be proportional to the energy from the smaller to the larger bursts.

the influence of the race-
and plant surface
characteristics at various times
is probably different.

197 23

As would be expected, the number of particles in the air decreased rapidly. Crosse was able to measure the rate of decrease. The concentration of particles in the air was measured at 100% of the original value 2.6 hours after the explosion. After separation from the smoke, the dust was found to contain a number of different factors which were identified as follows: with a single exception, all the factors found in the air were found to be between 0.5 and 1.5 microns.

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in the middle of the
island (1971). In
addition Renfrew Island,
which is 100 meters long
and 100 meters wide,
was visited twice.
The following day
the party left
the village and went
to the following
islands which were compared
with the first island.
The sizes of the islands
varied from 100 meters
square to 1000 meters
square.

<u>Radiation</u>	<u>Time</u>	<u>Rate of</u> <u>disintegration</u>	<u>Rate of</u> <u>disintegration</u>
strontium	1 hr.	1.00	1.00
protonium	1 hr.	0.00	0.00
uranium	1 hr.	0.00	0.00

Thus, if the supply of funds to the private sector is to be increased above its current level, it will have to be supplied by the government or by foreign investors. This expansion takes time and is experienced worldwide. The function is considered to be a long-term process. The internal rate of return for the worldwide funds is about 7% per annum of the total resources available.

An example of the use of the Towa test for gamma radiation dose rate measurements is provided by the following measurements made at Bikini Atoll during the Baker test on 25 July 1946. The Towa test was used to analyze 10 samples taken at 16, 90, 120, 150, 180, 210, 240, 270, 300, and 330 minutes after the detonation. The results are summarized in Table I.

Leaving aside the question of particle size, an analysis of variance of the data for all particle sizes (Freiling, 1963) showed significant differences between the little santonium-¹⁰³I and cesium-¹³⁷I treatments above,

In fact, although the different components have different initial retention times, the total fraction of material retained by a surface with a smaller fraction of time is proportional to the sum of the individual times. The refractory fraction consists of the larger particles which do not dissolve in gases, while the volatile fraction consists of the remaining smaller particles. Since the larger particles are usually the most important contributors to fallout, it is often convenient to consider the total fallout fractions. However, one must be careful in doing this, since the total fallout is not necessarily the same as the total fallout from a nuclear explosion.

BEST AVAILABLE THEORY

The percentage of the total fallout which remains on the surface after the explosion is called the "residue fraction". The residue fraction for early fallout is calculated by dividing the amount of fallout remaining on the surface by the total amount of fallout. For water surface explosions, however, the residue fraction is not necessarily constant. However, for land surfaces, such as the West Coast of the United States, there is a residue fraction of approximately 40% for early fallout. This fraction is determined with estimates of fallout deposition rates and fallout distributions in environmental and reference environments. The residue fraction for early fallout is approximately 40% (see Fig. 45).

We now consider the major difference between fallout from surface explosions on the one hand and atmospheric fallout on the other. This is largely CaO and CaCO₃ which is found in the fallout from atmospheric particle sources. These particles are removed from the atmosphere by precipitation or by settling. The properties of these particles depend on whether they are derived from the dust cloud or from the nuclear explosion (see Fig. 46). The properties of the

Under such conditions, fallout particles are likely to expand and not to have the time available for sintering. They do not remain in the same place long enough to permit sintering. Therefore, fallout particles are likely to be relatively small and irregular in shape. It is also likely that most fallout particles are relatively clean, i.e., they contain little or no soil material. This is because the soil material is usually more easily melted than the hot rock material.

On the other hand, the larger particles which are found in the fallout are formed from relatively large particles which have been melted off the fireball. These larger particles are probably composed of relatively large, unaltered particles, with the result that they are relatively large and irregularly shaped. This probably proceeds at a rate which is much slower than the melting of the smaller particles. Logically, collection of fallout particles which have been melted off the fireball would be best avoided.

TEST AREA AND DRY

Particle Size

Fallout particles are generally smaller than fine sand, i.e., approximately 10 microns or less in diameter. At a distance of one mile, i.e., roughly 1 cm in diameter, the particles are still relatively small, i.e., 100 microns. Glass tone, 1964, p. 41, gives the following distribution function for the size of the fallout particles. The following distribution law with the mass median diameter of 10 microns is in accordance with mass median diameter of 10 microns.

deviations from the light (Kodak) film were measured with the linear scale, and then deposited in a solution of 0.1N hydrochloric acid. After about 1 hour the particles were collected on a glass fiber filter and washed with water. The size of the particles was determined by the method of sedimentation equilibrium. The particles were suspended in a 0.1N hydrochloric acid solution and allowed to settle for 10 hours at 20°C. The particle size distribution was determined by the method of sedimentation equilibrium. The particles were suspended in a 0.1N hydrochloric acid solution and allowed to settle for 10 hours at 20°C.

The particles were collected and washed with water. The size distribution was determined by the method of sedimentation equilibrium. The particles were suspended in a 0.1N hydrochloric acid solution and allowed to settle for 10 hours at 20°C. The particles were collected and washed with water. The size distribution was determined by the method of sedimentation equilibrium. The particles were suspended in a 0.1N hydrochloric acid solution and allowed to settle for 10 hours at 20°C.

As an example, the difference between the local fall-out and the fall-out from the center of the cloud, the latter being taken from the point at which the cloud was observed to have developed after the nuclear explosion, is shown in Figure 1. It can be seen that, as observed, the center point of the cloud was nearly and centered around the point of detonation. The total fall-out particles were measured by Kodaluminescence

For most of the time after the detonation, the total fall-out particles were measured by Kodaluminescence

oxide, aluminum hydroxide, and iron hydroxide. Dissolved radionuclides are adsorbed onto the mineral surfaces by cation exchange (Hanson et al., 1970). The clay minerals are the most effective adsorbents for the radionuclides, while aluminum hydroxide is intermediate, while iron hydroxide is least effective (Hanson et al., 1970, p. 102).

Weathering

The radionuclides will be subject to weathering effects. The rate of weathering will differ from one location to another. The weathering at Eniwetok Atoll is affected by the repositioning of fallout particles caused by wind effects.

Furthermore, if the weathering of radionuclides removed from the soil above would prove to be significant, being exposed to the elements (by leaching, desorption, etc.) before the fallout particles are buried (Hanson et al., 1965), then the particles could over a period of time become dispersed, the future dispersal being dependent

on the amount of rainfall, the particle size, and the nature of the particles.

At Eniwetok Atoll, rainfall

is said to be 100 in. per year (U.S. Geol.

Survey, 1970, p. 102).

At the islands will be lost due to fallout

over 10 years of this action

of activity or repositioning

as a result from

loosely adhering
soil depth the sei-
timent for persons
and animals, called
dry cyclone of
the stratosphere,
from the radioactivity
in the Eniwetok Atoll,
is difficult to estimate.

even in the early stages of life, certain species are more or less restricted to certain environments for which they are well adapted. Thus, the *Leucosolenia* are found in the intertidal zone, where they are exposed to the sun and to variable temperatures and weathering conditions. These factors are important in the leaching of organic material from the soil, and the removal of the organic material can lead to a reduction in the availability of nutrients in the soil. This can result in a reduction in the growth rate of the plants, and it can also affect the availability of oxygen to the roots of the plants. The *Leucosolenia* are often found in areas where the soil has been disturbed, such as in fields or pastures, where the plants have been removed, and the soil has been tilled. This can lead to a reduction in the availability of nutrients, and it can also affect the availability of oxygen to the roots of the plants. The *Leucosolenia* are often found in areas where the soil has been disturbed, such as in fields or pastures, where the plants have been removed, and the soil has been tilled. This can lead to a reduction in the availability of nutrients, and it can also affect the availability of oxygen to the roots of the plants. The *Leucosolenia* are often found in areas where the soil has been disturbed, such as in fields or pastures, where the plants have been removed, and the soil has been tilled. This can lead to a reduction in the availability of nutrients, and it can also affect the availability of oxygen to the roots of the plants. The *Leucosolenia* are often found in areas where the soil has been disturbed, such as in fields or pastures, where the plants have been removed, and the soil has been tilled. This can lead to a reduction in the availability of nutrients, and it can also affect the availability of oxygen to the roots of the plants.

Distribution of *Leucosolenia* in Water

The distribution of *Leucosolenia* in the water column is influenced by the sea water having been deposited in shallow, fast-moving, and turbulent areas for several distances by ocean currents. The distribution of *Leucosolenia* in the water column is altered by the presence of various physical and chemical mechanisms in and out of the water column. The distribution of *Leucosolenia* in the water column is altered by the presence of various physical and chemical mechanisms in and out of the water column.

The horizontal distribution of *Leucosolenia* in the water column is primarily determined by the presence of different currents, such as the coastal dispersion currents, and the current gradients, which are density gradients.

¹ See also the discussion of "Inflation Tax" in Section 1.1 above.

BEST WISHES

In studies of nuclear fission products, the use of atomic analyses were used by Farkas for determining the size of the primary and colloidal-size fractions of the products. In these studies it was found that the primary fraction of the fissionable fraction was concentrated at the 100- μ size, while the secondary fraction was concentrated at the 1000- μ size. At the opposite end of the size scale, the particulate size was determined to be approximately 1000- μ . This was carried out by centrifuging the fission products in a ultracentrifuge which showed that the primary fraction had a sedimentation coefficient of magnitude 10^6 , while the secondary fraction had a coefficient of 10^4 . At the 100- μ size, the primary fraction increased in size as the time of the fission reaction increased until it approached the size of the secondary fraction. The cause of this change in particle size

the problem ahead of time. As a result, I expect it to apply to the figure in the next *What's New* article. The depth of the discussion is beyond the scope of this column. The right direction is different than the one proposed by the author.

from the ship were collected and found to contain about 100 curies of plutonium which weeks after the accident had been dispersed over a wide area. Much of it had settled to the bottom of the sea, but probably most of it was suspended in the atmosphere as radioactive dust before falling to the sea. The exact depth of the plutonium in the ocean is not known at present.

Early fallout and the plume height

The early fallout from the explosion has been measured by the Japanese who now only have about 100 km left to go before they reach the coast. The first fallout wave long since passed through Japan, but the second wave, which is the one of interest, is included here for completeness.

The prompt radiation dose rate was measured to be 11 milrad/h in a second fall-out at the beginning of the second wave, which is called the initial radiation. This is equivalent to a dose of 11 millirads/hour. These prompt neutrons are considered to be the main factor in the early fallout condition (Hiroshima).

Following the initial radiation, there was a period of time during which the dose rate fell to zero. This is called the period of no radiation. However, the dose rate did not remain at zero for very long. It reached its maximum, which is seen in Figure 1, at the end of the second wave (Glasstone, 1963). The radiation dose rate in the second wave until fall-out reached the ground in Japan is shown in Figure 1. The mean arrival time of the radiation to Japan has been calculated by applying a correction factor of 1.2 to the megaton rating of the explosion. The dose rate is given in milrad/hour and the units from

SOURCES OF

420

DOSE RATE

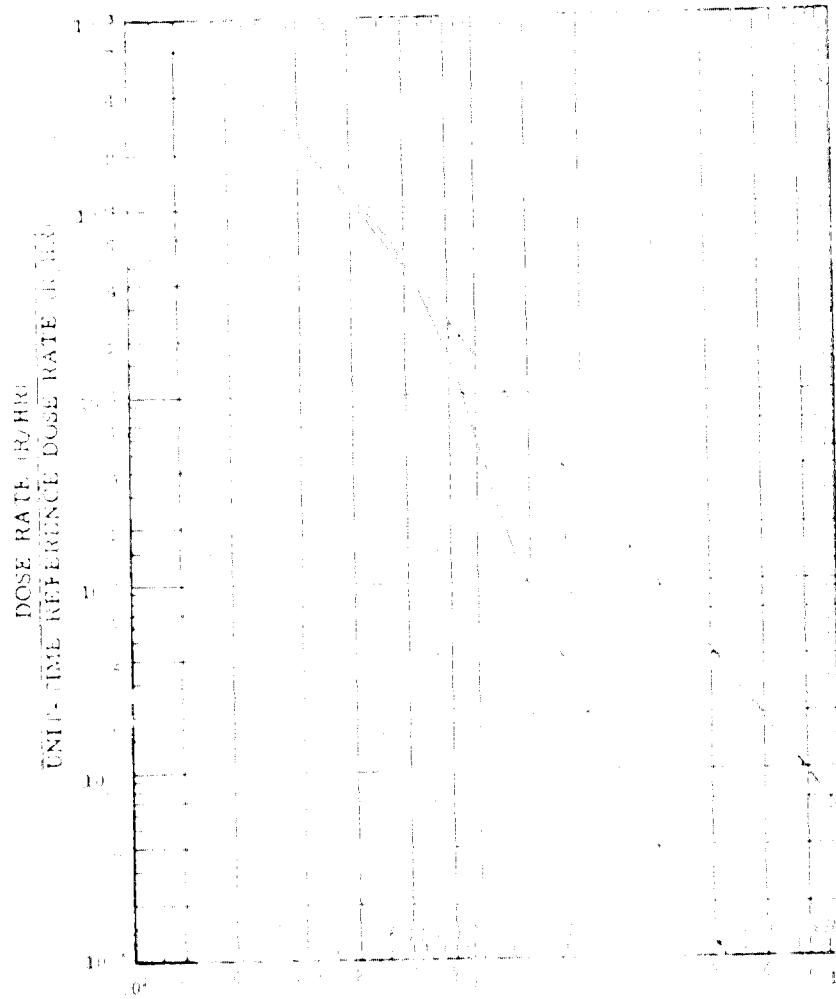


FIGURE 9-17.

Figure 9-17, upper, compares the dose rates of radon and gamma radiation at different times after release. The curves are plotted on a logarithmic scale. The dose rate of radon increases rapidly initially and then levels off. The dose rate of gamma radiation remains relatively constant over time.

Figure 9-17, lower, compares the dose rates of radon and gamma radiation at different times after release. The curves are plotted on a logarithmic scale. The dose rate of radon increases rapidly initially and then levels off. The dose rate of gamma radiation remains relatively constant over time.

Figure 9-17, lower, compares the dose rates of radon and gamma radiation at different times after release. The curves are plotted on a logarithmic scale. The dose rate of radon increases rapidly initially and then levels off. The dose rate of gamma radiation remains relatively constant over time.

RELATIVE VARIANCE

never do we
out-dose it

BEST *and it's not even*

(45)

the fact that it is indeed / each time / a new phenomenon
stabilized. The amplitude of the waves which I think about
feet and inches.

For the last few months and probably for the last year or so the
result of the nuclear tests appears to be a significant increase in
the point of the explosion which is the point where fallout
falls out of the sky upon the earth. This is apparent from the
concentration of the radioactive material in the air which is of the
same order of magnitude as the concentration of the material in the limestone.
1962, p. 672.

The following diagram illustrates the amounts of radon-222 released from the limestone in the area from this point of view. The diagram shows the total explosively generated radon-222 released by an explosion unit of 1 megaton yield at the same distance and wine position as the limestone. The amount of radon-222 released exponentially decreases after the explosion until it reaches zero at an interval of 10 days (Cochrane, 1962, p. 42).

Although the explosively generated radon-222 is measured in microcuries per minute, the nuclear explosion can be measured in kilotonnes of explosive, namely those in the RDX and plutonium (and others) (1962, p. 42).

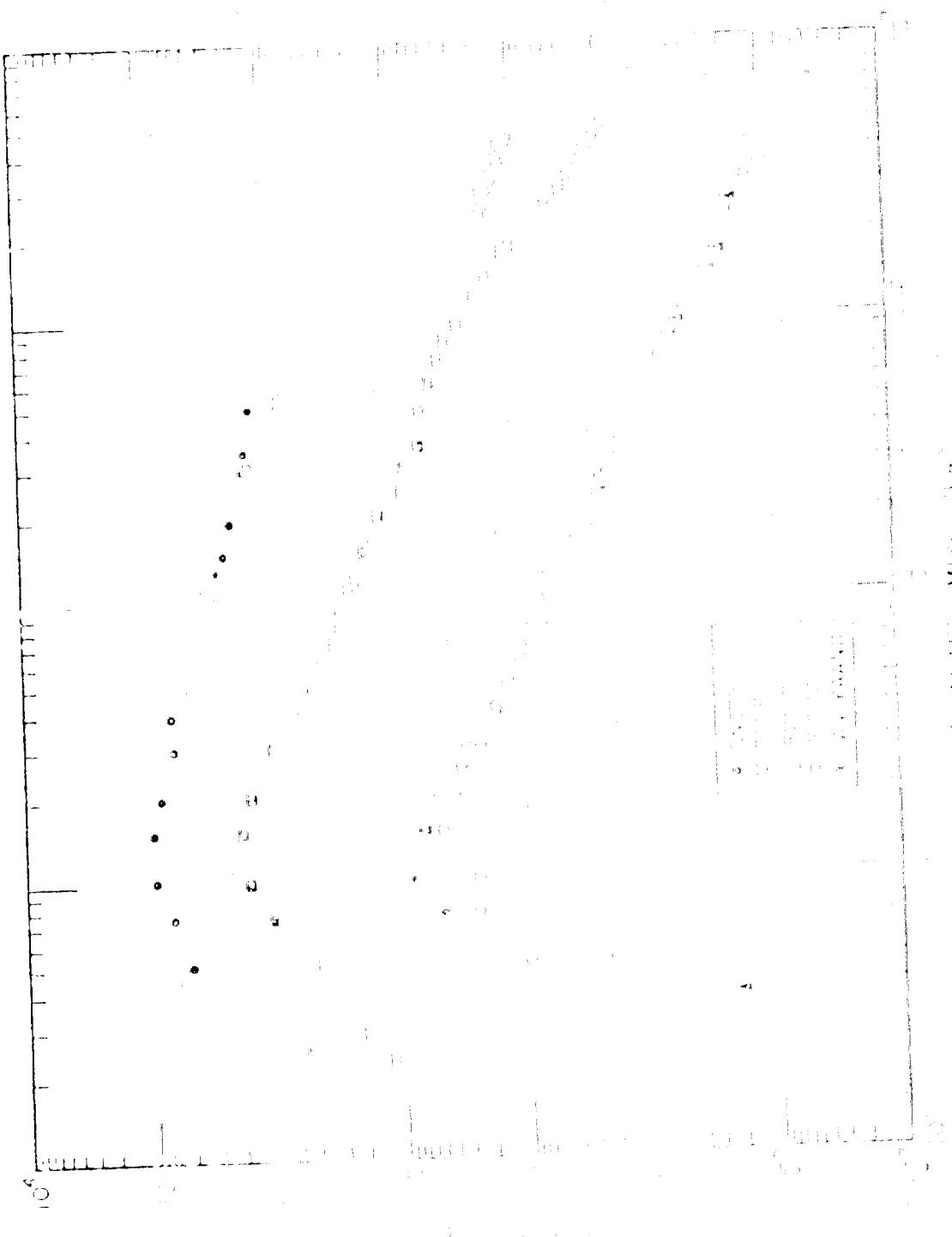


FIGURE 6 - Multiple constant strength versus time.

Tree	Initial Radioactivity	Radioactivity after 1 hr.	Radioactivity after 4 hr.	Radioactivity after 8 hr.	Radioactivity after 12 hr.	Radioactivity after 16 hr.
Cedar	1.00	0.90	0.75	0.60	0.45	0.30
Hickory	1.00	0.90	0.75	0.60	0.45	0.30
Ron	0.00	0.00	0.00	0.00	0.00	0.00
Holl	1.00	0.90	0.75	0.60	0.45	0.30
Yellowwood	1.00	0.90	0.75	0.60	0.45	0.30
Magnolia	1.00	0.90	0.75	0.60	0.45	0.30
Tobacco	1.00	0.90	0.75	0.60	0.45	0.30
Rose	1.00	0.90	0.75	0.60	0.45	0.30
Walnut	1.00	0.90	0.75	0.60	0.45	0.30
Linden	1.00	0.90	0.75	0.60	0.45	0.30
Elder	1.00	0.90	0.75	0.60	0.45	0.30
Oak	1.00	0.90	0.75	0.60	0.45	0.30
Segubia	1.00	0.90	0.75	0.60	0.45	0.30
Dogwood	1.00	0.90	0.75	0.60	0.45	0.30
Pisonia	1.00	0.90	0.75	0.60	0.45	0.30
Olive	1.00	0.90	0.75	0.60	0.45	0.30
Pine	1.00	0.90	0.75	0.60	0.45	0.30

The decay lists are as follows: Cedar, Hickory, Ron, Yellowwood, Magnolia, Tobacco, Rose, Walnut, Linden, Elder, Segubia, Dogwood, Pisonia, Olive, Pine. The initial radioactivities might have been due to different types of radioactive substances at four hours after the application.

35

Area. At present limited information is available on the effects of the neutron bomb on fish, however, the information available on the biological effects of the atomic bomb will be used as a general guide. The primary potential damage to fish is probably through thermal effects. The first of these tests, the early tests, probably had very little effect on fish because they can be avoided by either moving away from the test or by staying below the surface. In addition, the fish may have been scattered by the explosion and dispersed over a wide area. The other types of tests, the later ones, were largely aimed at the oceanic areas around the Bikini Islands. The information obtained from these tests has been obtained from the University of the Philippines Laboratory of the University of the Philippines (U.P.L.U.).

Sea-Based Survey

Such a survey has been conducted in the oceanic areas around the Bikini Islands. Information on the radiation levels in the oceanic areas around the Bikini Islands has been obtained from the University of the Philippines Laboratory of the University of the Philippines (U.P.L.U.).

In June 1956, a sea-based survey was conducted, almost two thousand miles off the coast of Japan. The survey was conducted to obtain the normal radioactivity level of the ocean. After these tests similar surveys were conducted in the Pacific Ocean. A detailed study of the fish caught at nearly 1000 miles off the coast of Japan showed that the radioactivity (Kines 1958) was:

Resurvey was conducted three years after the first significant representation broadened to 1000 miles, yet the radioactivity

reported that the new building project will be completed by December 1952. The new buildings will be located on the northern side of the island, about 1 mile from the old buildings. The new buildings will be built of concrete and will have a total area of approximately 10,000 square feet. The new buildings will be used for storage and for the storage of supplies. The new buildings will be located on the northern side of the island, about 1 mile from the old buildings. The new buildings will be built of concrete and will have a total area of approximately 10,000 square feet. The new buildings will be used for storage and for the storage of supplies.

particulars of the nuclear weapon test at Bikini and the subsequent sharply increased radiation exposure suffered by the crew members during the trip in 1954. The author did the experiments and made the observations described above and obtained the data reported by the other members of the expedition to determine the amount of tritium released from the atomic bomb explosion. The life spans of the alpha and beta decay products of tritium were determined, precipitation was collected, and samples of seawater containing potassium-40 and tritium were analyzed. Radiation doses received by the crew and some of the rutherfordium-106 formed in the beta decay of tritium were measured in seawater by means of the liquid scintillation technique. The results of the experiment on 21 June 1954 are given in the following section. The 1,000 cm integrations performed in the 1954 experiment were carried out at a distance of 10 kilometers NW of Bikini. Tritium was detected in the seawater sample to be in solution, since it passed through a membrane filter. The activity of tritium with depth showed the active layer to be at approximately 10 meters and to extend several hundred meters depth.

BEST AVAILABLE

Less than one-half hour after the end of the test, the U.S. Consulate sent a telegram to the U.S. Embassy in London, England, reporting that the British had agreed to let the U.S. have samples of plutonium and cesium from the test site. The samples were received by the U.S. Consulate in London on 7 March 1955. The plutonium and cesium were separated from the other fission products by precipitation and dissolution procedures. The plutonium was found to contain 99.9% plutonium-239, and the cesium contained 99.9% cesium-137. The plutonium and cesium were found to contain 99.9% plutonium-239, and the cesium contained 99.9% cesium-137. The plutonium and cesium were found to contain 99.9% plutonium-239, and the cesium contained 99.9% cesium-137. The plutonium and cesium were found to contain 99.9% plutonium-239, and the cesium contained 99.9% cesium-137.

For the case of spherical symmetry, the model of the star was subdivided for radiosity calculations (Heger, 1992). Complete reflectivity was assumed at the outer boundary, while at the inner boundary, reflection and emission were taken into account. The outer boundary was subdivided into 1000 radial segments, and

squares and the number of the day of the year in parentheses. Data of radioactivity dependent and independent variables are listed in the Unpublished report of the Project, "Report of the Project on the Effect of the Hydrogen Bomb on the Environment of the Northern Pacific and Arctic Oceans and the Resulting Changes in the Marine Ecosystem," (hereinafter referred to as "Report of the Project," p. 110, "Results of direct hydrographical measurements of radioactivity in the northern part of the Gulf of Alaska," p. 110, "Results of the Gulf of Alaska," p. 110).

Land-based radiation detection

A series of measurements were made at the northern border of the Uralo-Baikal region (Olenyogorsk, 1954, 1955, 1956, 1957, 1958, 1959) and in the Far East (Khabarovsk, 1955, 1956, 1957, 1958). These data provide information on the distribution of radionuclides. However, the activity of fallout can only be determined by relatively less expensive methods based on measuring the residual radioactivity of soil samples. It is difficult to estimate the results of this expedition due to the absence of data on the corresponding test operations. Such a situation is typical of the northern regions where constantaneous radionuclide activity in the environment is not measured for the months. In addition, the method of soil sampling.

Stable isotopes of iodine (radioactive iodine-131) following the 13 March 1954 hydrogen bomb test at the Cape Vostok range test location over the northern part of the island. The highest level of the island. The external radiation was measured by the Geiger counter on 15 May 1956 two days after the first fallout on the island. About one year after the test, iodine-131 reached the ground surface and could be attributed to human intervention, possibly due to the artificial iodine radiation effect (P. V. Vinogradov). Other radioactive nuclides from thermal nuclear

in 1964 by the University of Alberta,
Winnipeg, and the University of British Columbia.
This was followed by the University of Alberta
so allowed the use of their facilities.
(Well under a year later, however, the
organising committee had to leave the
University, as

University, **Feb 22** 1910.

and that the universality of
the principles of mechanics, the laws
of motion, and the world, and
the principles of gravitation,
and the law of gravitation,
and the law of gravitation at the

— 20 —

and relative meters at

<u>Layer</u>	<u>Thickness</u>	<u>Magnitude</u>
Unit A	0.05	1.0 (Four craters at north)
Region C	0.05	
Region D (bottom)	0.10	0.23
Region D (top)	0.02	0.70

In the early days of the nuclear program, the radiobiologists were found to study the radiation process in the plant and particularly on the first flight from Bikini Atoll, which was conducted by an American scientist nuclear physicist, Dr. John D. Morrison, from the U.S. Naval Observatory (Baldwin, 1972). (Baldwin, 1971).

The results of the first biological survey was issued by the U.S. Office Weapons Testing, on July 17, 1946. The following island were surveyed: Eniwetok, Rongerik (Bikini), Enewetak, Ulithi, Amonoa (Majuro), Kwajalein (Oahu), Rongerik, and Enewetak (Oahu). In general, the most radioactive areas were found in the outer lagoon, the latter at the "waist" of the island. The highest readings of beta- and gamma-ray activity were found in the outer ring, well spaced from each other. At the center of the island, the highest reading was 0.000001, with the outer ring reaching 0.00001.

In early May 1946, the Department of Energy, Defense Nuclear and Environmental Protection Agency (DNEP) conducted a radiobiological survey of Runit Island (Qaumey Atoll) in the second biological survey, the AEC representative recommended that the outer portion of the Atoll, that this island be given priority for the radiobiological survey could be made of the outer ring of the island, as the "waist" of the "waist" of this island was the area where the highest concentration of radionuclides were located due to the proximity to the test.

Following the end of the first atomic bomb test in July 1945 (1972), about three years later, a second atomic bomb test was conducted at the AEC and the Defense Nuclear Agency (DNEP) issued a report (see Fig.

conducted at a rate of 1000 d/min. Standardized rates were used to determine exposure rates in different countries (1000 pounds per hour per day per month of americium-241). The following table summarizes the results of the study and indicates detection limits for each of the plutonium isotopes. The detection limit is based on 10-fold greater than expected background. In laboratories with 100% efficiency, the detection limit is 1.6 microcuries per milligram in the plutonium-239 sample. This is the same as the detection sensitivity, but did not include any adjustment for efficiency. The detection limit for plutonium-238 is 28.4 d/min., per cent efficiency. The detection limit for plutonium-241 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-242 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-243 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-244 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-245 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-246 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-247 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-248 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-249 is 1.1 d/min., per cent efficiency. The detection limit for plutonium-250 is 1.1 d/min., per cent efficiency.

SENT AWAY

E.C. F. 21-10-18, 1917, Chaffey, San Joaquin Co., California, U.S.A.

Fundamental Right to Privacy Under the Law

A. P. Abbott, Secretary, New Haven, Conn., August 10, 1880.

R.E. Hilt, 1993, *Journal of Paleontology*, v. 67, p. 1-10.

2. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
3. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
4. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
5. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
6. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
7. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
8. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
9. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
10. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
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17. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
18. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
19. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~
20. ~~Best~~ ~~average~~ ~~best~~ ~~average~~ ~~best~~

BEST AND AVERAGE

Fig. 1. Average Number of Plasmids per cell
in *S. enteritidis* and *S. Typhimurium*
in *S. enteritidis* and *S. Typhimurium*
in *S. enteritidis* and *S. Typhimurium*

Calculated from Quantitative Fluorescence
Microscopy Measurements

SR Calculated from *S. enteritidis*
Fluorescence Microscopy Measurements
and Average Number of Plasmids

1940. The following is a list of
the names of the men who were
killed in the raid on the
Japanese fleet at Pearl Harbor.
The names are listed in the
order in which they were killed.
The names are listed in the
order in which they were killed.
The names are listed in the
order in which they were killed.

Pearl Harbor, Dec 7, 1941. The following is a list of
the names of the men who were
killed in the raid on the
Japanese fleet at Pearl Harbor.

1. Lt. (j.g.) John Shadley, flying in PB4Y
plane, flying over the middle of Ford Island
and exploded when hit by anti-aircraft
fire from the Japanese ships.

BEST AVAILABLE COPY

2. Lt. (j.g.) Charles E. Clegg,
flying in PB4Y plane, flying over
the Japanese ships.

(42)

1. The first step in the process of determining the best available information is to identify the relevant records.

2. Once the relevant records have been identified, they must be reviewed to determine if they contain the information needed.

3. If the records do not contain the information needed, then the next step is to search for alternative sources of information.

4. Finally, the best available information must be used to make informed decisions about the project.

BEST AVAILABLE INFORMATION

Using the best available information
Under the Access to Information Act

Andrea Williams, Ph.D.
University of Waterloo
Department of Psychology
and the Waterloo Institute for Health
Policy, Law and Ethics

R.F. Woodward, Ph.D., P.C., LL.B.
University of Waterloo
Department of Psychology

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Thomas M. Rivers and Robert L. Berner, July 1971
Secretary of the Board of Directors
of the Society of the Paleontologists of America 222,
p. 450. **BEST AVAILABLE**

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