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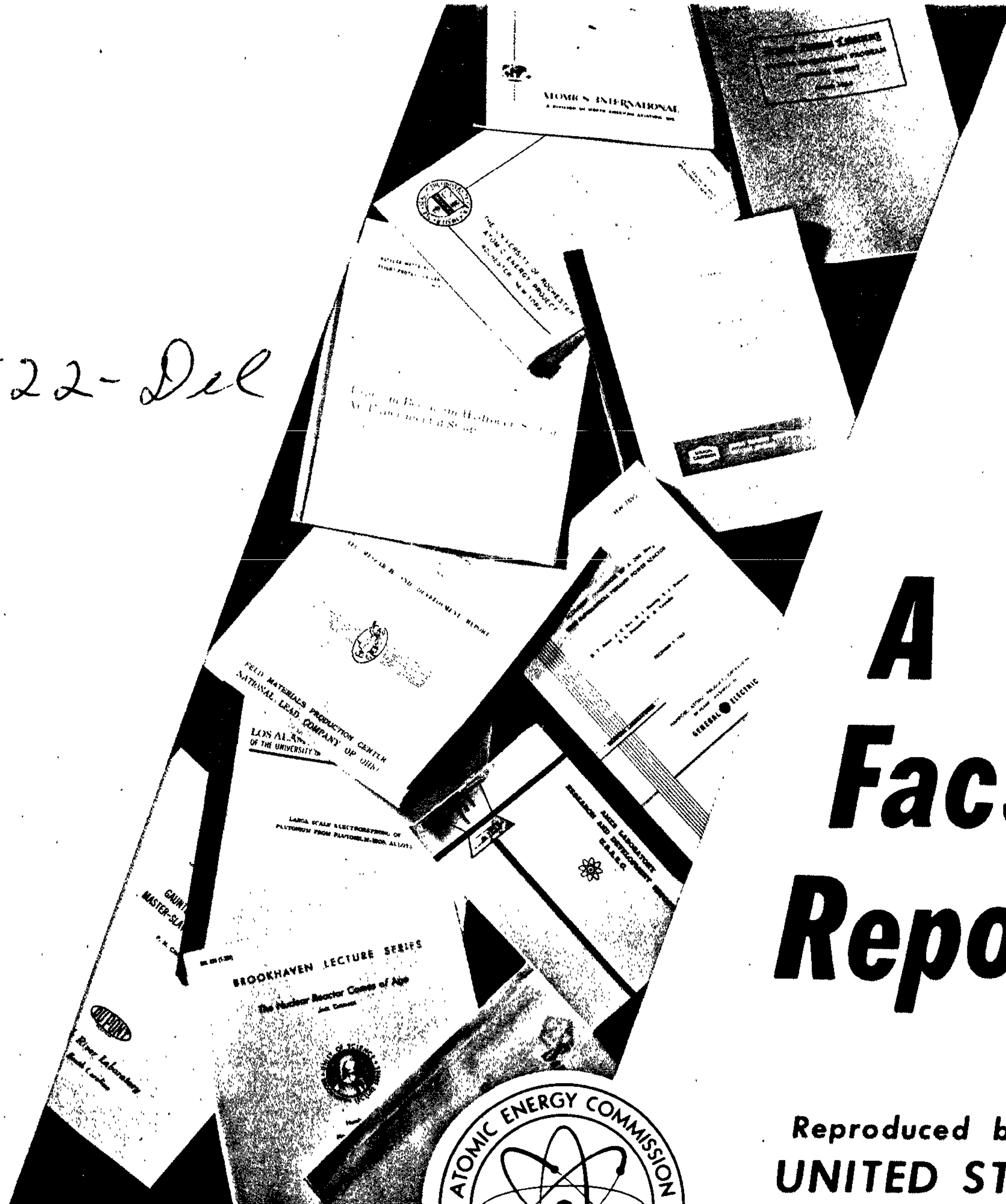

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NYO-4522 (DEL.)
Effects of Atomic Weapons

UNITED STATES ATOMIC ENERGY COMMISSION
New York Operations Office

RADIOACTIVE DEBRIS FROM OPERATION IVY

Prepared by the Staff,
Health and Safety Division
Merril Eisenbud, Director

Photostat Price $ 6.30
Microfilm Price $ 3.00

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Washington 25, D. C.

April 28, 1953

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FOREWORD

The worldwide fallout monitoring program for Operation IVY was coordinated by the New York Operations Office at the request of the Division of Biology and Medicine. When the plan was originally devised, in the Summer of 1952, only the area beyond 500 miles from Eniwetok was assigned to NYOO. It was contemplated that Joint Task Force 132 would monitor the islands within this distance. In early September, the NYOO assignment was extended to include all of the islands of the Trust Territory except Eniwetok itself.

The monitoring program employed a worldwide network of 111 stations located on all continents but concentrated in the northern hemisphere, and a system for aerial monitoring of the western Pacific. The latter feature of the program was devised to meet the requirement for quick and reliable radiation measurements of the islands. It was necessary to design special monitoring instruments of a type which were not anywhere available in September, 1952, when the mission was assigned to NYOO.

The program has required the cooperation of a diverse list of organizations which, in addition to the Division of Biology and Medicine and Joint Task Force 132, includes the Weather Bureau, the Air Force, Navy and Coast Guard, the Canadian Weather Service and the Atomic Bomb Casualty Commission. Most of these organizations have provided and manned the sampling stations at which our data were obtained. The Navy provided aircraft for aerial monitoring and arranged for quarters and other courtesies for Health and Safety Division personnel in the Pacific.

The Special Projects Section, U. S. Weather Bureau, furnished cloud trajectory information and forecasts as a part of our joint assistance to the photographic industry. They are analyzing the monitoring data and their findings will be reported separately.

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ABSTRACT

During the Fall, 1952 atomic weapons tests (Operation IVY), data for evaluating the effects of radioactive debris on health and sensitive industry were obtained by radiological counting of daily settled dust samples from a worldwide network of 107 stations, and by radiation measurements with specially designed instruments, in flights over the north Pacific islands.

The maximum aerial reading, equivalent to 1.5 mr/hr three feet above ground and to a cumulative dose of 500 milli-roentgens, was obtained over Agrihan in the Marianas, on the third day after MIKE shot.

The highest 24 hour fallout was 3,600,000 d/m/sq ft at Iwo Jima on M + 4.

Cumulative fallout, extrapolated to January 1, 1953, is shown on maps for the first and second 15 day periods after MIKE and for the next 31 days. Dispersion of the radioactive cloud throughout the world atmosphere appears to have been essentially completed during the second two weeks.

Cumulative fallout to January 1, 1953, exceeded 10,000 d/m/sq ft at five locations and was in the hundreds or low thousands at nearly every remaining station.

Concentrations of radioactive dust, measured in air samples from 18 stations, were insignificant compared with similar data from previous surveys.

Decay rates were approximately proportional to the 1.4 power of the age of the activity, instead of the 1.2 power found during earlier series.

CHAPTER 1

PLAN AND ORGANIZATION

1.1 THE WORLDWIDE SAMPLING NETWORK

1.1.1 Selection of Stations

Sampling stations were selected according to the principles followed in previous surveys (1,2), modified by the location of the weapons tests and the possibility that significant fallout might occur in any part of the world. Less coverage was provided for the United States than during recent weapons test series but many more off-continent stations were set up. The domestic stations are listed in Table 2.4, Chapter 2, and those outside of the continental United States are given in Table 2.5.

1.1.2 Sampling

At each station, 24 hour samples of settled dust were collected by exposing one foot squares of gummed paper in the manner described previously (1). The standard sampling period began at 1830 GCT. Collections were in duplicate except that in some cities two stations, some distance apart, were maintained and a single daily sample was collected at each.

Filtered samples (2) of airborne dust were collected at Honolulu, Guam, Ponape, Truk, Midway, and a few large cities in the United States, where local interest in the results was anticipated. This type of sample was collected over the standard 24 hour period and was supplemented by sampling for shorter periods at special stations set up at Kwajalein, Guam, Midway, and Barber's Point, Honolulu, during the time when the cloud was known to be in the vicinity of the stations. Automatic units for sampling airborne dust were set up for MIKE shot at Kusaie, Ujelang, Bikini, Majuro and Kwajalein. The equipment was designed to trigger at 0.5 mr/hr but this level was not reached. The units were not reset for KING shot.

At three of the four special stations, dust was also sampled with the cascade impactor (1,2), but the activities proved to be too low to permit accurate analysis of the particle size distribution.

1.1.3 Analysis of Samples

All samples were mailed to the Health and Safety Division laboratory for analysis, where they were ashed and counted by automatic beta counters (1).

A new feature was the utilization of IBM cards in place of the keysort system used in the earlier test series.

1.2 AERIAL MONITORING

1.2.1 Flights

From bases at Kwajalein, Guam, and Barber's Point, Honolulu, flights after MIKE were made over the Hawaiian Islands, the Marshalls, the Carolines, the Marianas, the Japanese Islands of Honshu, Shikoku and Kyushu, and the islands extending southwest from Japan to the archipelago of Mansei Shoto. This was the coverage provided for in the original survey design (3) plus additional flights to the north and northwest of the Marianas. The latter flights were undertaken on the basis of measurements made in the northern Marianas and the need to delineate the northern edge of the fallout zone. The reconnaissance in this area on M plus 6 and M plus 7 accomplished this purpose.

Following KING, a less extensive survey, limited to the Marshalls, the eastern Carolines and the Marianas was made.

Charts of the above flights are deferred to Chapter 2, so that the monitoring results, which form part of the subject matter of that chapter, may be presented on the same maps (Figures 2.1 and 2.2).

1.2.2 Survey Instruments

The aerial survey instrument illustrated in Figure 1.1, consisting of a gamma detector and a recording unit, was designed and fabricated within the Health and Safety Division.

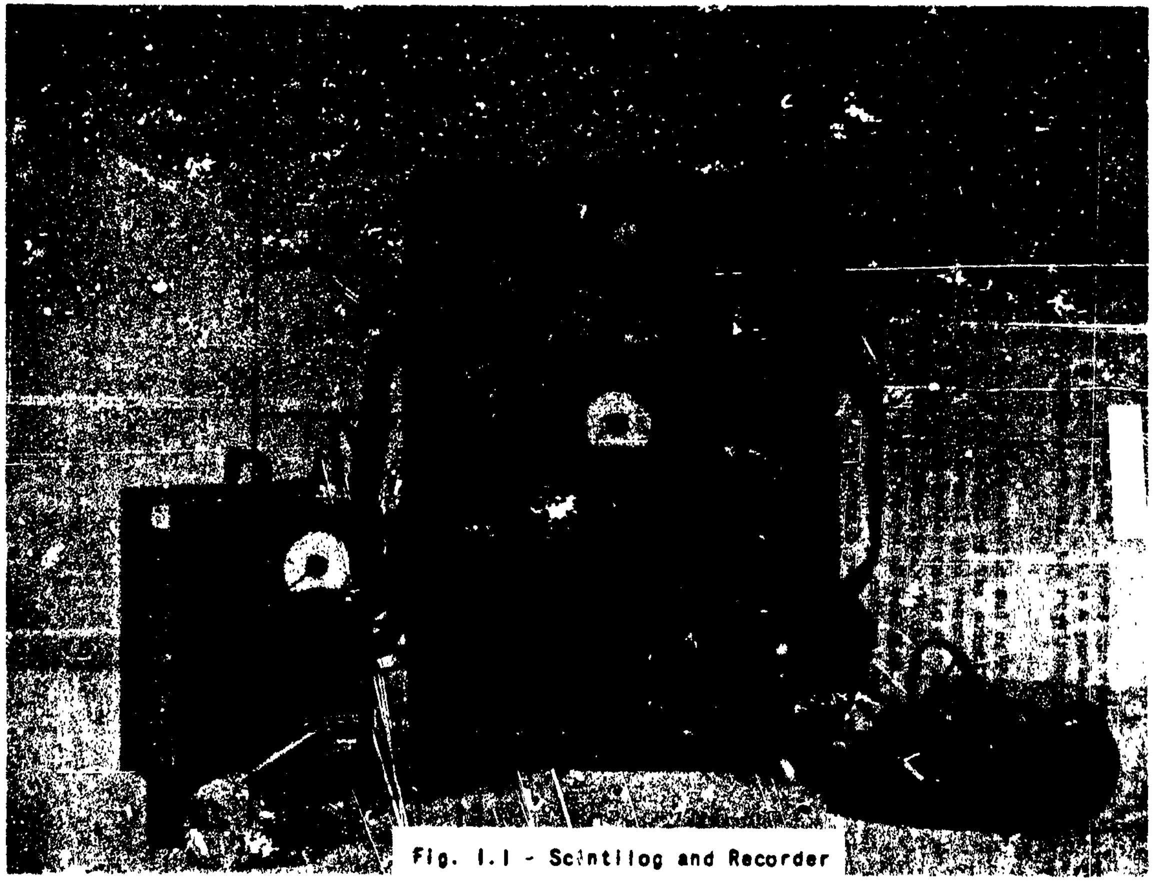


Fig. 1.1 - Scintilog and Recorder

The gamma detector, "Scintilog," covers the range of 0.01 to 1000 mr/hr in a single scale. It is a portable instrument, weighing 17 pounds 14 ounces, and requiring no external source of power.

The recording unit is also portable and self-powered. An audio signal, modulated by the output of the scintilog, is recorded on one channel of a two channel tape recorder. The modulation is between 600 and 3,000 cycles and is proportional to the logarithm of the radiation intensity. On the second channel, the operator makes a vocal record of position, altitude, etc. By means of a playback attachment, the audio signal can be converted to a voltage which actuates a pen type recorder, converting the radiation intensities to a graphic record (Figure 1.2).

A preliminary survey at the Nevada Proving Grounds yielded calibration factors of 4 and 10 for converting readings at 200' and 500' altitudes respectively to intensity 3 feet above the ground. These factors were checked in flights over the islands of Engebi, Runit and Kwajalein. Ground level radiation intensities, obtained by direct measurement and by computation from aerial readings, are listed in Table 1.1.

TABLE 1.1

Radiation 3 Feet above Ground (mr/hr) From Readings at 3 Altitudes			
Altitude	Engebi	Runit	Kwajalein
3'	0.8	2.1	0.75
200'	0.6	2.7	0.40
500'	0.6	3.3	—

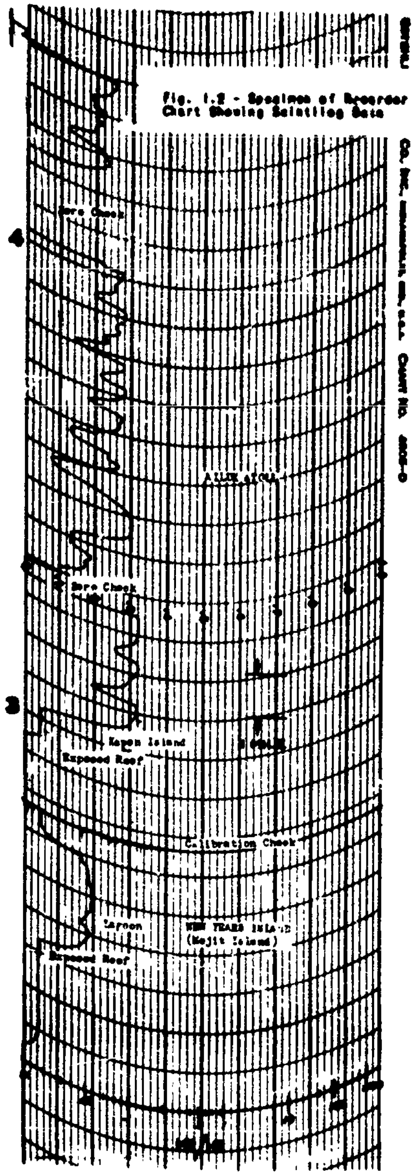


Fig. 1.2 - Specimen of Recorder Chart Showing Scintilog Data

CHAPTER 2

FINDINGS

2.1 AERIAL MONITORING

The flights made according to the plan described in Chapter 1 are mapped in Figures 2.1 and 2.2. The radiation intensities are shown on the maps and also, to permit identification of the islands, in Tables 2.2 and 2.3. At places where no data are given the rates are less than 0.05 mr/hr. The highest value was 1.5 mr/hr on M plus 3 at Agrihan in the Marianas. On the basis of the decay law usually assumed, with an exponent of minus 1.2, the cumulative dose to the population of this island was estimated at 500 milliroentgens, neglecting the possibility that rain might wash away the active dust or concentrate it onto limited areas. The amount washed off cannot be guessed but the process must certainly occur and the estimate of the dose to the general population is therefore conservative. Some such process evidently reduced the radiation level on a number of islands in the lower Marianas from 0.5 mr/hr on M plus 3 to an undetectable amount on M plus 5.

Settled dust sampling stations had been established at some of the islands included in the aerial survey. There were two such stations on Guam, an island on which relatively high radiation intensities were found during the week after MIKE shot. The aerial monitoring results and the duplicate settled dust data for this period at Guam are listed in Table 2.1.

TABLE 2.1

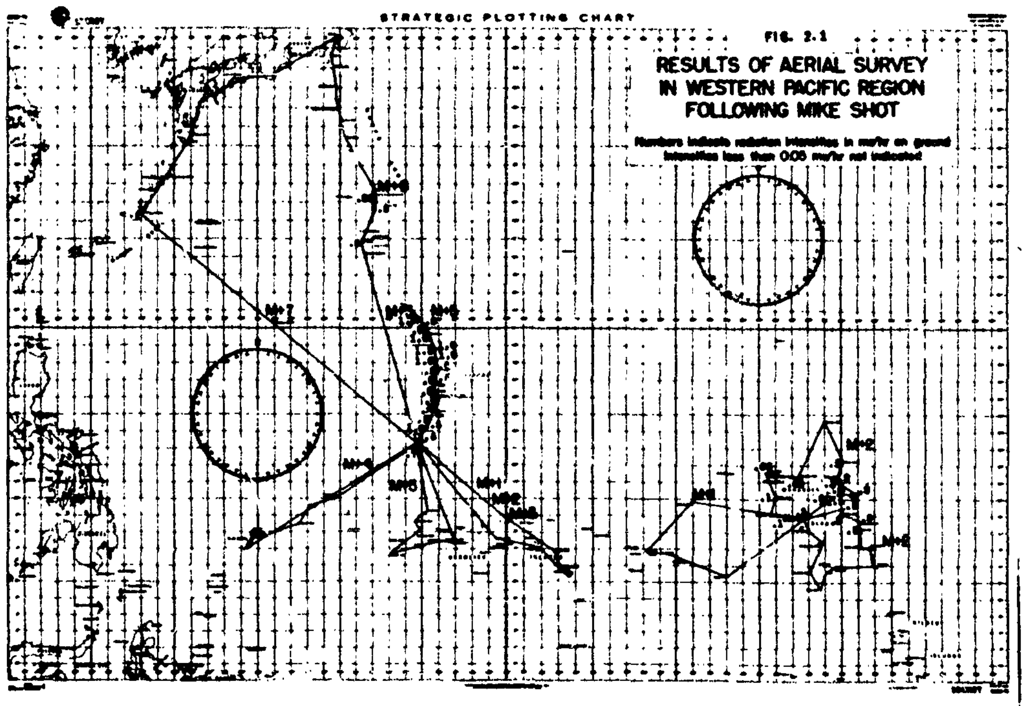
RADIATION INTENSITY AND SETTLED ACTIVITY AT GUAM

Day	Gamma (mr/hr)	Settled Dust Activity (d/m/sq.ft.)*			
		Anderson AFB		Naval Station	
M + 1	--	0	4	0	0
M + 2	--	5800	1400	4400	9200
M + 3	1.0	310000	320000	120000 (6 hrs) ** (10 hrs) 100000 (12 hrs)	83000 (6 hrs) ** (10 hrs) 69000 (12 hrs)
M + 4	0.7	280000	27000		
M + 5	0.5	14000	11000		
M + 6	--	6000	8500		
M + 7	0.1	1600	0		

*Sampling period was 24 hours, except where noted. Data are extrapolated to the day of sampling.

**No sampling during this 10 hour period.

The similarity of the trends of radiation intensity and settled dust activity is obvious from the table. Gamma intensity should be roughly proportioned to cumulative settled activity, on the premise that the Scintilog readings were due entirely to radiation from the ground surface, but we have no adequate basis for predicting radiation intensities from fallout data.


STRATEGIC PLOTTING CHART
FIG. 2.1
RESULTS OF AERIAL SURVEY
IN WESTERN PACIFIC REGION
FOLLOWING MIKE SHOT

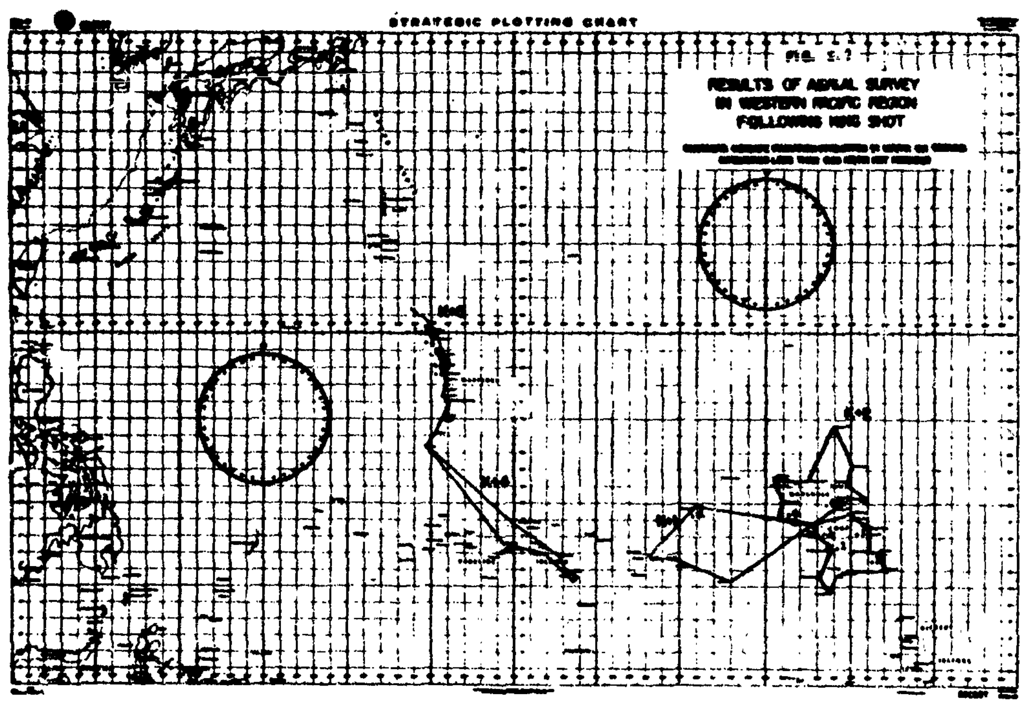
See Expanded Table AT END of DOCUMENT

Table 2.2

RESULTS OF AERIAL SURVEY FOLLOWING MIKE SHOT (mr/hr)

Days after MIKE:	2		2		3	5		4		6
Likiep	0.5	Namu	0	Farallonde			Ulithi	0	Iwo Jima	0.5
Jemo	0.5	Ailing-		Pajaros	1.0	0	Yap	0	Hahashima	0.5
Ailuk	0.5	lapalap	0	Maug	0.5	0.5	Ngulu	0	Chichishima	0.25
Mejit	0.2	Namorik	0	Asuncion	1.0	0	Babel-		Tori Shima	0
Taka	0.3	Ebon	0	Agrihan	1.5	1.0	thuap	0.05	Aoga Shima	0
Utirik	0.2	Kili	0	Pagan	1.0	1.0	Koror	0	Hachigo Shima	0
Bikar	0.2	Jaluit	0	Alamagan	0.5	0.5	Peleliu	0	Miyake Shima	0
Taongi	0	Mili	0	Guguan	0.5	0.5	Guam	0.7	O Shima	0
Rongerik	0.05	Arno	0	Sarigan	0.5	0				
Rongelap	0	Majuro	0	Anatahan	0	0				
Bikini	0.05	Maloelap		Farallonde						
Wotho	0.1	& Aur	0.5	Medinilla	0.5	0				
Ujae	0	Erikub	0.2	Saipan	0.5	0				
Lae	0.1	Wotje	0.5	Tinian	0.5	0				
Kwajalein	0.3			Rota	0	0.5				
				Guam	1.0	0.5				

Days after MIKE:	1		1,2,5		5		5,6		7		8
Kusaie	0	Namonuito	0	Gafernut	0	Oahu	0	Oahu	0	Honshu	0
Pingelap	0	Truk	0	Faraulep	0	Kauai	0	Lanai	0	Shikoku	0
Mokil	0	Losap	0	W. Fayu	0	Niihau	0	Kahoolawe	0	Kyushu	0
Ponape	0	Namoluk	0	Woleai	0	Necker	0	Hawaii	0	Tanega Shima	0
Ujelang	0	Lukunor	0	Ifalik	0	Laysan	0	Maui	0	Amami O Shima	0
		Satawan	0	Eauripik	0	Midway	0	Molokai	0	Okinawa	0
		Kuop	0	Elato	0					Guam	0.1
		Pulap	0	Lamotrek	0						
				Satawal	0						


STRATEGIC PLOTTING CHART
RESULTS OF AERIAL SURVEY
IN WESTERN PACIFIC REGION
FOLLOWING KING SHOT

SEE EXPANDED TABLE AT END OF DOCUMENT

Table 2.3

RESULTS OF AERIAL SURVEY FOLLOWING KING
(mr/hr)

Days after KING:	2		1		5		1		4
Likiep	0.[illegible]	Namu	0.1	Farallon de Pajaros	0	Kusaie	0	Namonuito	[illegible]
Jemo	0	Ailinglapalap	0.[illegible]	Maug	0.1	Pingelap	0	Truk	[illegible]
Ailuk	0	Namorik	0	Asuncion	0.1	Mokil	0	Losap	0
Mejit	0	Ebon	0	Agrihan	0.5	Ponape	0	Namoluk	[illegible]
Taka	0	Kili	0	Pagan	0.1	Ujelang	0.3	Lukunor	0
Utirik	0	Jaluit	0	Alamagan	0.1			Satawan	0
Bikar	0	Mili	0	Guguan	0			Kuop	0
Taongi	0	Arno	0.1	Sarigan	0			Pulap	0
Rongerik	0	Majuro	0	Anatahan	0				
Rongelap	0	Maloelap & Aur	0.1	Farallon de Medinilla	0				
Bikini	0	Erikub	0	Saipan	0				
Wotho	0	Wotje	0	Tinian	0				
Ujae	0			Rota	0				
Lae	0.4			Guam	0				
Kwajalein	0								

2.2 WORLDWIDE NETWORK

As a first step in summarizing the activity data, the age was standardized by extrapolating to January 1st, 1953. Since the standardized activities are additive, the results for a series of days may be totaled and this was done for each station. The maps, Figures 2.3 to 2.10 show the activity on January 1st, by station, due to fallout occurring during the 61 days from MIKE shot to the end of the year and during each of three periods into which the 61 days were divided. The density of the network in the United States required separate maps for domestic and foreign data.

To facilitate identification of the stations the data are also listed in Tables 2.4 and 2.5.

The spread of fallout around the globe was followed by observing the time of the first appearance at each station of activity clearly greater than normal. The dates, mapped in Figure 2.11, show how the debris spread around the world. Fig. 2.12 follows the movement of radioactive debris within the United States.

2.2.1 Fallout during the First Fifteen Days after MIKE

The average fallout in the United States during this period was 290 d/m/sq ft (extrapolated to January 1st) and the worldwide average excluding the United States was 8100 d/m/sq ft. Most of the activity contributing to the latter figure fell at Iwo Jima on the third, fourth and fifth days after MIKE. The fallout on this island was found to be 83,000 d/m/sq ft on the 3rd day, 165,000 on the 4th and 57,000 on the 5th. The figure of 165,000 d/m/sq ft on January 1st, due to fallout on the 4th day after MIKE, corresponds to 3,600,000 d/m/sq ft extrapolated to the day the fallout occurred.

2.2.2 Fallout during the Second Fifteen Days

Maximum fallout in the United States occurred during this period. The average (extrapolated to January 1st) was 910 d/m/sq ft, while stations outside the United States averaged 1600. The drop in the worldwide average is due almost entirely to decreased fallout at Iwo Jima. If this island had not been included, the average for the first fifteen days would have been only 2300 d/m/sq ft instead of 8100.

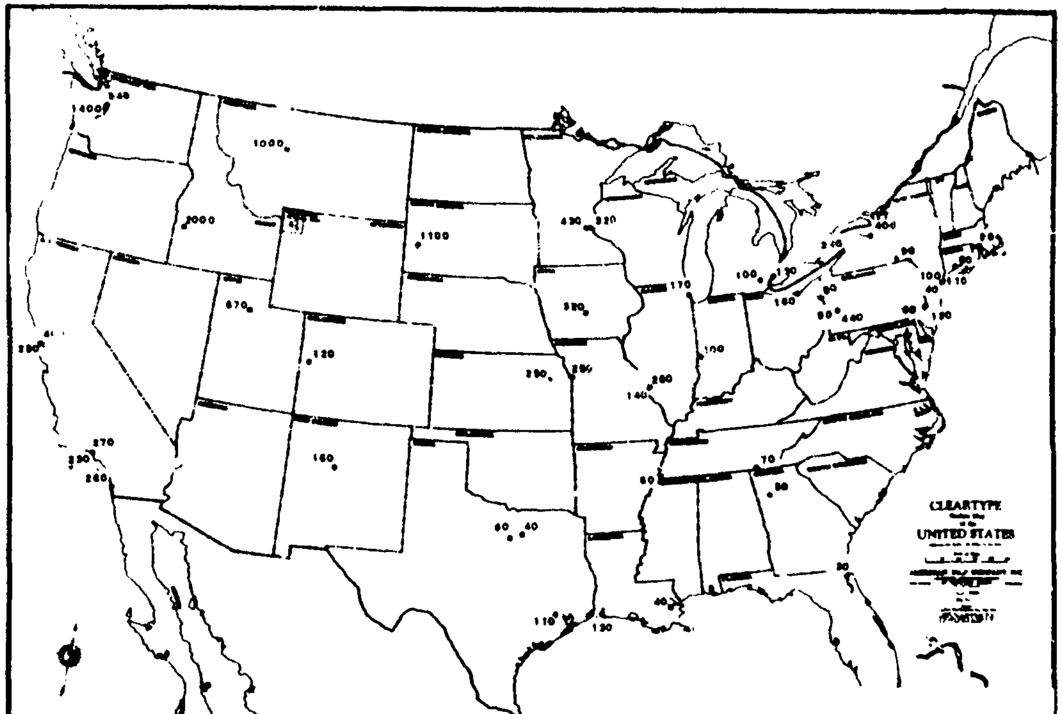


FIG. 2.3 - FALLOUT IN UNITED STATES THROUGH H+15.
Disintegrations per minute per square foot extrapolated to January 1, 1959.

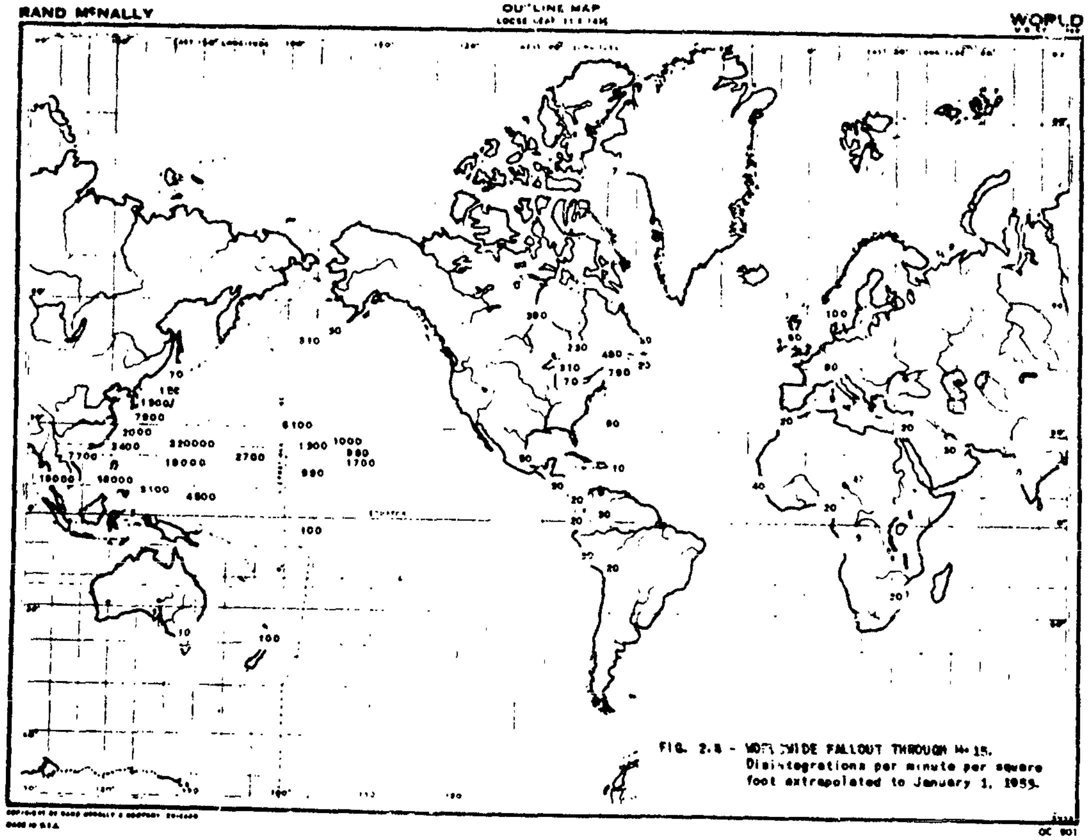


FIG. 2.8 - WORLDWIDE FALLOUT THROUGH H+15.
Disintegrations per minute per square foot extrapolated to January 1, 1955.

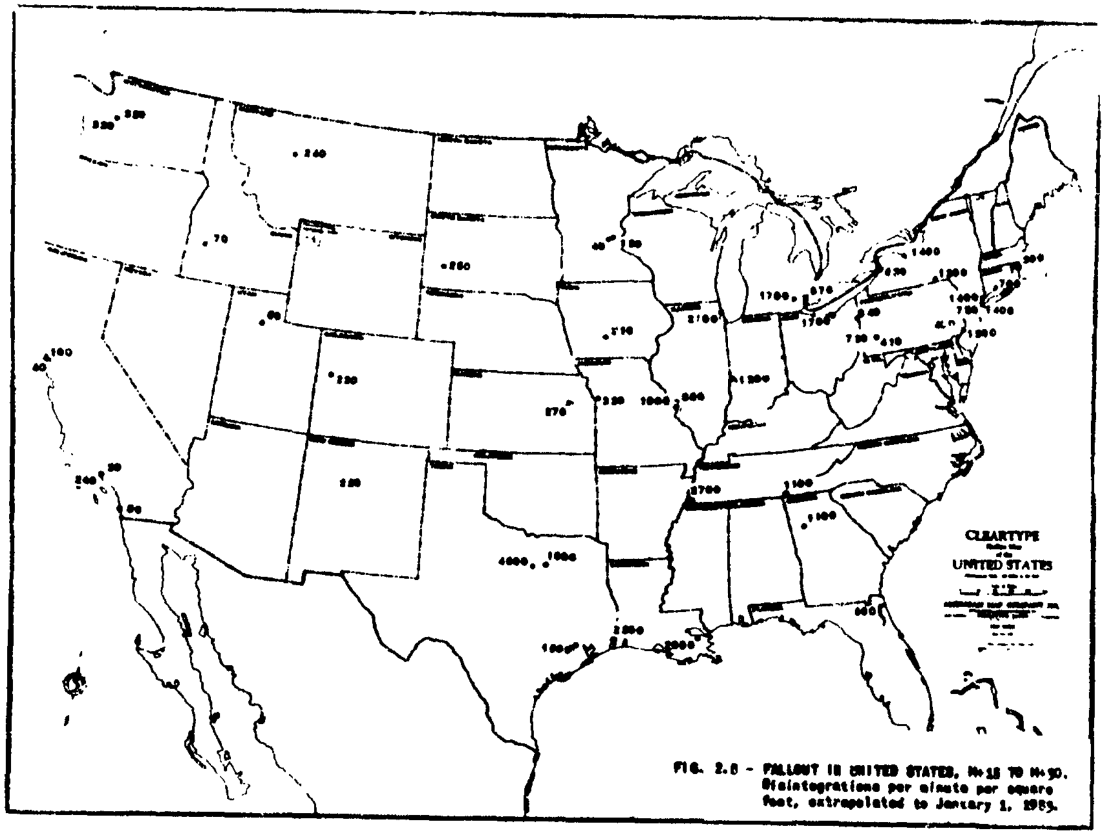


FIG. 2.5 - FALLOUT IN UNITED STATES, N+18 TO N+30. Disintegrations per minute per square foot, extrapolated to January 1, 1953.

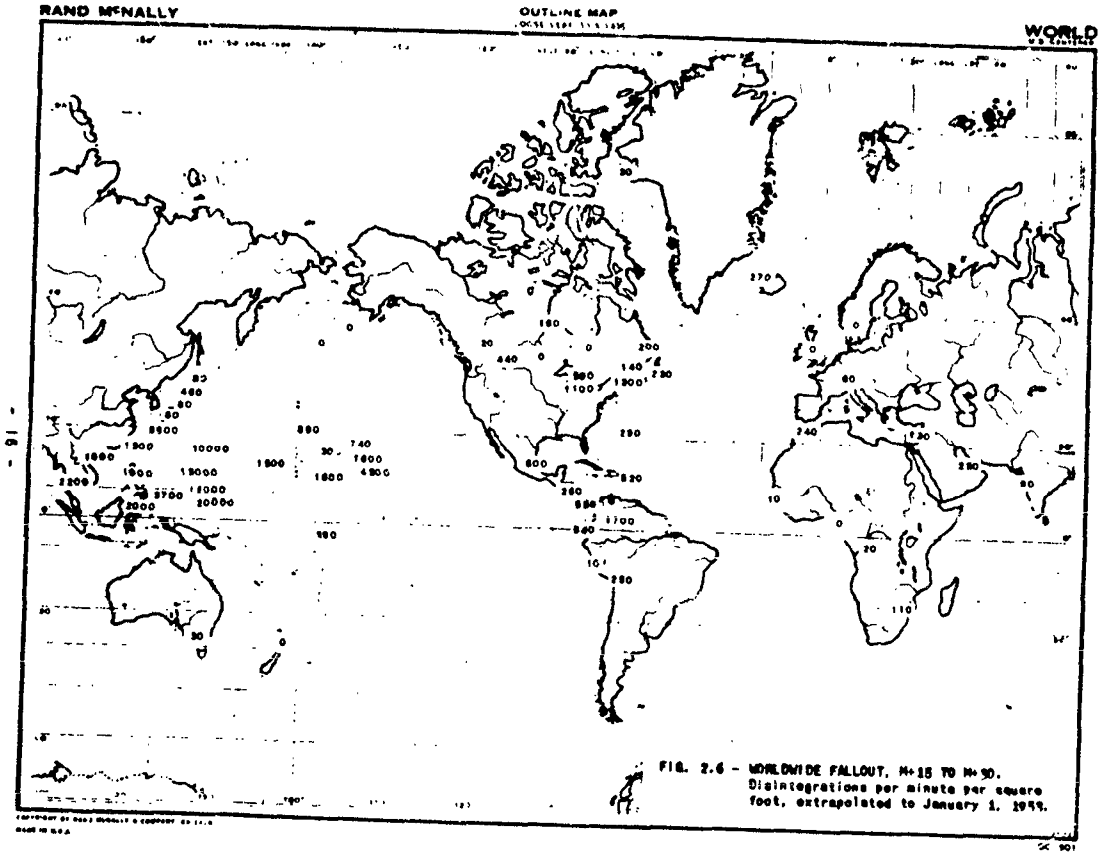


FIG. 2.6 - WORLDWIDE FALLOUT, H+15 TO H+30.
Disintegrations per minute per square foot, extrapolated to January 1, 1959.

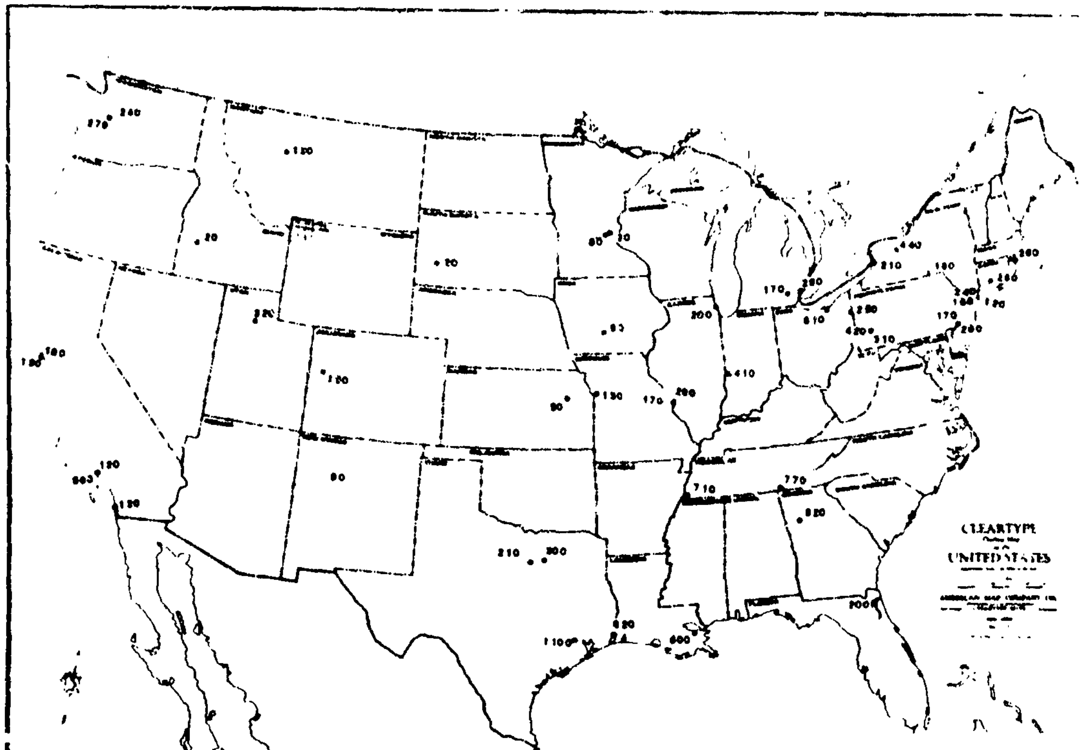


FIG. 7.7 - FALLOUT IN UNITED STATES, H+90 TO H+61.
Disintegrations per minute per square foot, extrapolated to January 1, 1955.

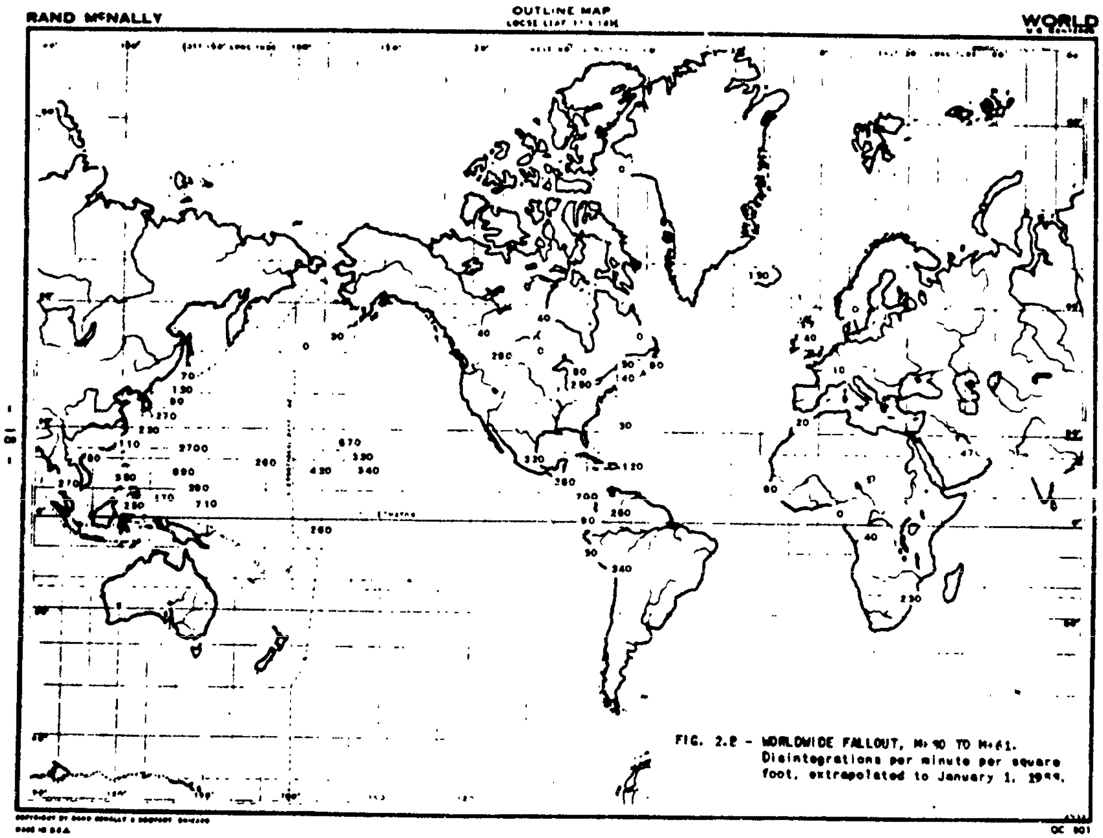


FIG. 2.2 - WORLDWIDE FALLOUT, M+90 TO M+61.
Disintegrations per minute per square foot, extrapolated to January 1, 1955.

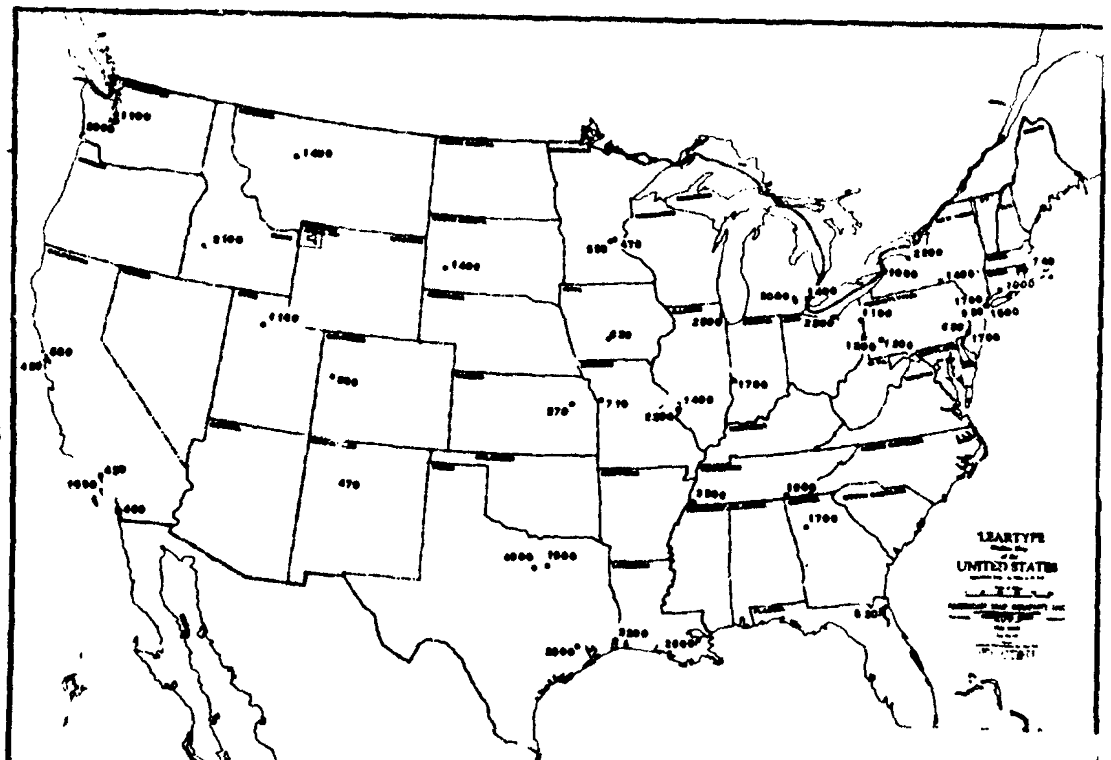


FIG. 2.9 – FALLOUT IN UNITED STATES THROUGH M-61. Disintegrations per minute per square foot, extrapolated to January 1, 1953.

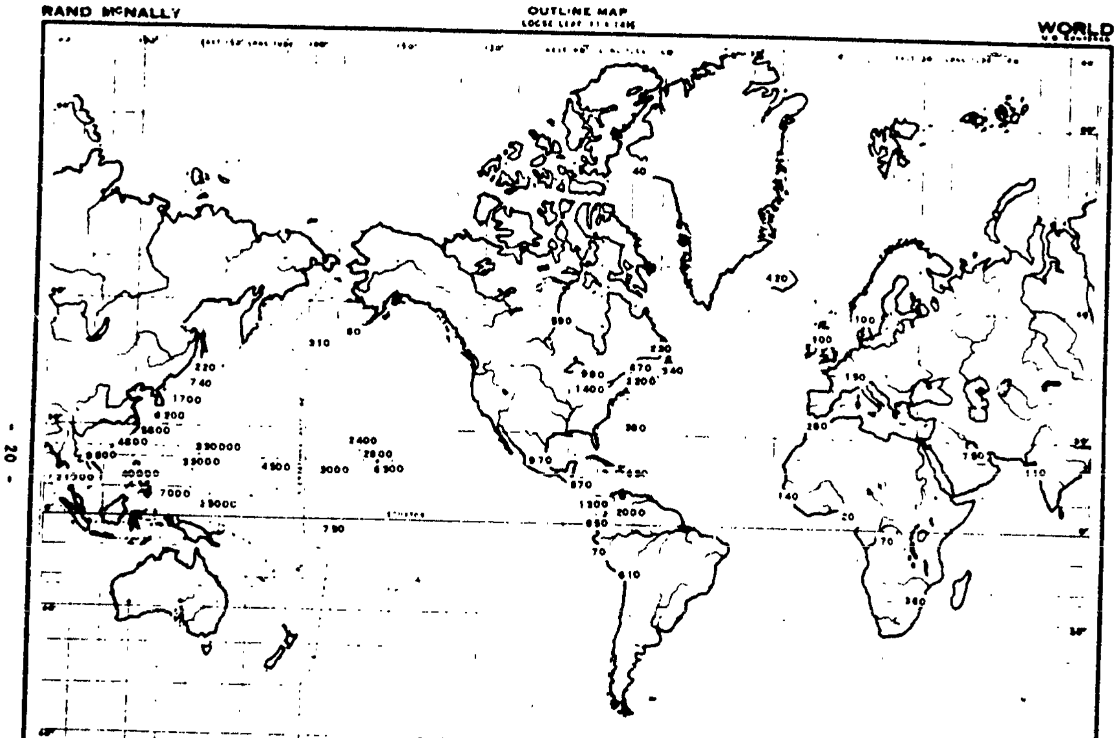


FIG. 7.10 - WORLDWIDE FALLOUT THROUGH M+61.
Disintegrations per minute per square foot, extrapolated to January 1, 1953.

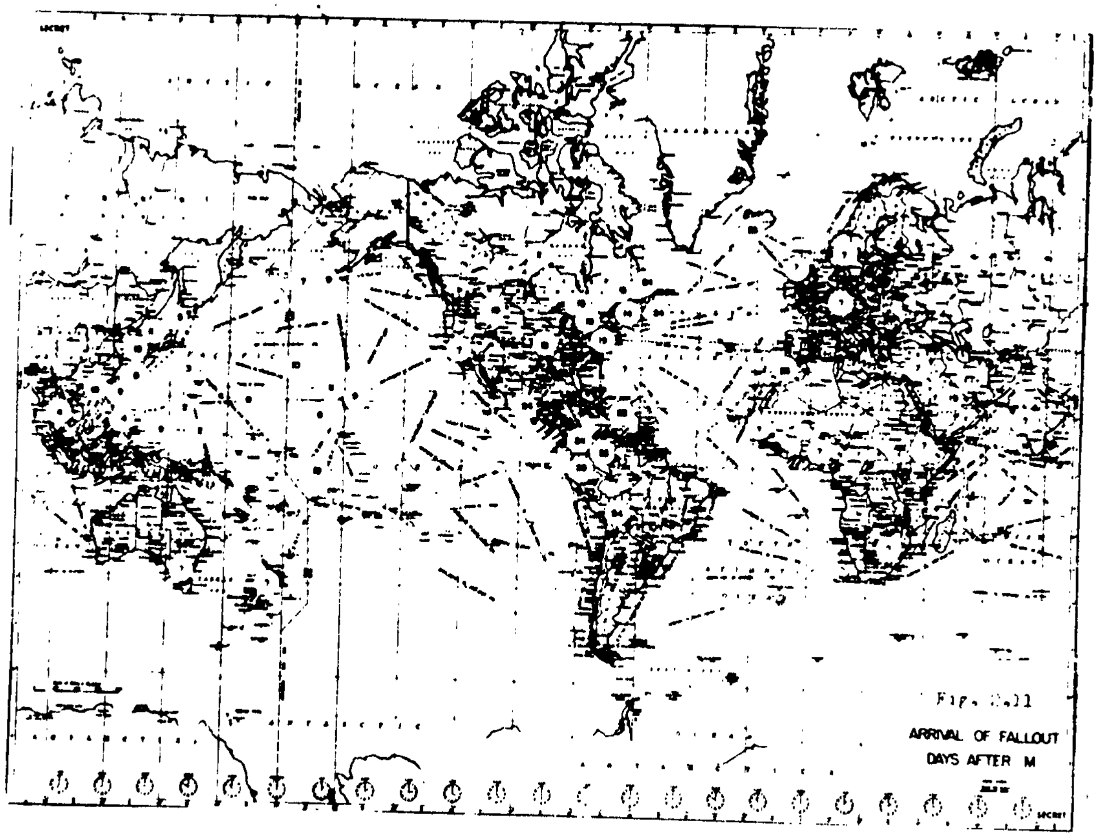


Fig. C.11

ARRIVAL OF FALLOUT
DAYS AFTER M

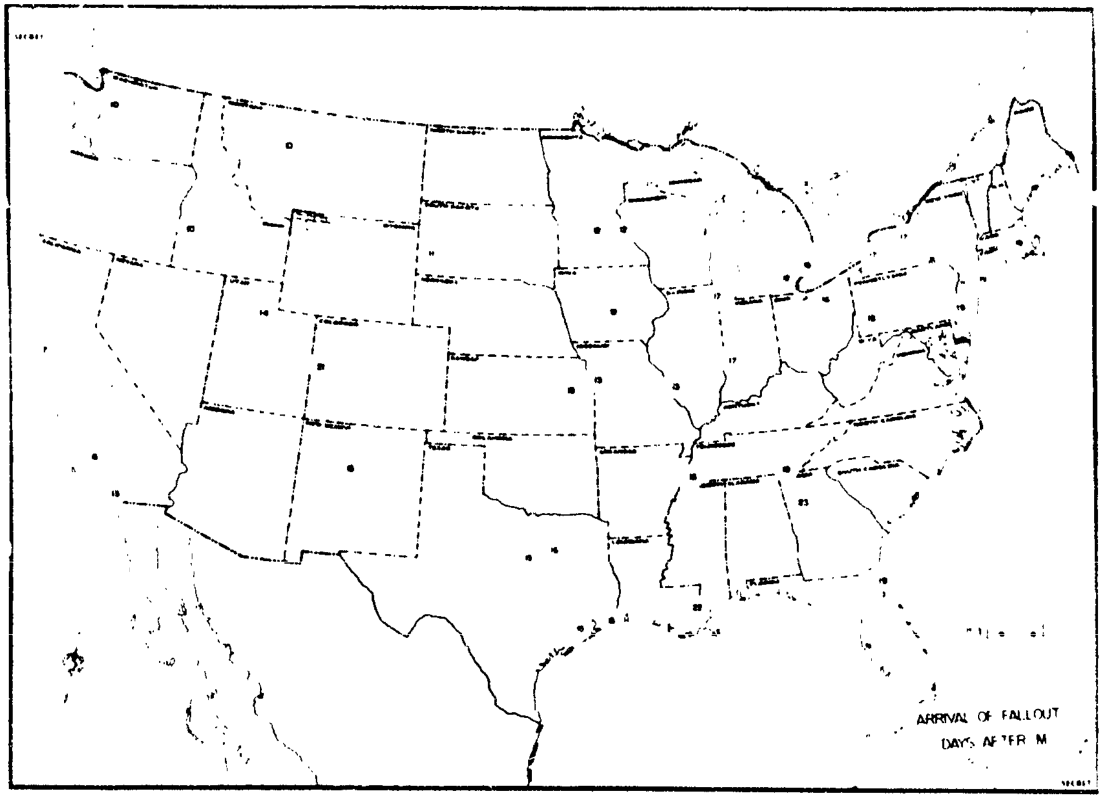

ARRIVAL OF FALLOUT
DAYS AFTER M

TABLE 2.4

CUMULATIVE FALLOUT, U.S.- EXTRAPOLATED TO JAN. 1, 1953, (d/m/sq.ft.)

From: / To:	M / M + 15	M + 15 / M + 30	M + 30 / M + 60	M / M + 60
Cleveland, Ohio	160	1700	610	2500
Youngstown, Ohio	50	840	250	1100
Pittsburgh, Pa.*	440	410	310	1200
Pittsburgh, Pa.**	90	720	420	1200
Philadelphia, Pa.*	120	1300	280	1700
Philadelphia, Pa.**	60	400	170	630
New York, N.Y.**	100	1400	240	1700
New York, N.Y.*	40	750	160	950
New York, AEC	110	1400	120	1600
Providence, R.I.	90	390	260	740
Binghamton, N.Y.	90	1200	160	1400
Rochester, N.Y.	400	1400	440	2200
Buffalo, N.Y.	210	630	210	1000
New Haven, Conn.	50	700	260	1000
Dallas, Texas	40	1600	300	1900
Fort Worth, Texas	80	4600	210	4900
Port Arthur, Texas	130	2300	820	3200
Houston, Texas	110	1600	1100	2800
New Orleans, La.	40	2000	600	2600
Memphis, Tenn.	80	2700	710	3500
Chattanooga, Tenn.	70	1100	770	1900
Jacksonville, Fla.	30	600	200	830
Atlanta, Ga.	50	1100	520	1700
Albuquerque, N.M.	160	220	90	470
Kansas City, Mo.	250	330	130	710
Topeka, Kansas	250	270	50	570
Minneapolis, Minn.	430	40	80	550
St. Paul, Minn.	320	130	20	470
Chicago, Ill.	170	2100	200	2500
Detroit, Michigan	130	970	280	1400
Ypsilanti, Michigan	100	1700	170	2000
Des Moines, Iowa	320	210	90	620
Rapid City, S.D.	1100	260	20	1400
Grand Junction, Colo.	120	230	150	500
Terre Haute, Ind.	100	1200	410	1700
St. Louis, Mo.*	260	880	290	1400
St. Louis, Mo.**	140	1900	170	2200
Seattle, Wash.*	540	320	240	1100
Seattle, Wash.**	1400	330	270	2000
San Francisco, Calif.*	400	100	180	680
San Francisco, Calif.**	250	40	130	420
Los Angeles, Calif.*	270	30	120	420
Los Angeles, Calif.**	230	240	560	1000
San Diego, Calif.	260	80	120	460
Boise, Idaho	2000	70	20	2100
Salt Lake City, Utah	670	60	320	1100
Great Falls, Mont.	1000	240	130	1400

*City Station **Airport Station

TABLE 2.5

CUMULATIVE FALLOUT WORLDWIDE EXCEPT U.S., (d/m/sq.ft. on January 1, 1953)

From: / To:	M / M + 15	M + 15 / M + 30	M + 30 / M + 61	M / M + 61
North Bay, Ont.	310	590	80	980
Moosoonee, Ont.	230	0	--	---
Moncton, N.B.	790	1300	140	[illegible]
Deep River, Ont.	70	1100	250	1400
Seven Islands, Que.	480	140	50	670
Winnepeg, Man.	---	0	0	---
Churchill, Man.	390	160	40	590
Regina, Saskatchewan	---	440	270	---
Edmonton, Alberta	---	20	[illegible]	---
Shemya, Alaska	310	0	0	310
Adak, Alaska	30	0	30	60
Canal Zone	20	550	700	1300
Stephenville, Newfoundland	20	230	90	340
Goose Bay, Labrador	30	200	0	230
La Paz, Bolivia	20	250	340	610
Quito, Ecuador	20	540	90	650
Mexico City, Mex.	50	600	320	970
Bogota, Colombia	30	1700	260	2000
Lima, Peru	30	10	30	70
San Jose, Costa Rica	30	260	280	570
San Juan, P.R.	10	520	120	650
Keflavik, Iceland	20	270	130	420
Thule, Greenland	7	30	0	40
Dhahran, Saudi Arabia	30	250	470	750
Sidi Slimane, French Morocco	20	240	20	280
Bermuda	60	290	30	380
Prestwick, Scotland	60	0	40	100
Rhein Main, Germany	80	60	10	150
Praetoria, South Africa	20	110	230	360
Beirut, Lebanon	20	130	---	---
Oslo, Norway	100	0	0	100
Dakar, Fr. West Africa	40	10	90	140
Leopoldville, Belgian Congo	8	20	40	70
Lagos, Nigeria	20	0	0	20
Tokyo, Japan	150	460	130	740
Misawa, A.B., Japan	70	80	70	220
Kadena, Okinawa	2000	3600	230	5800
Hiroshima, Japan	1500	80	90	1700
Nagasaki, Japan	7900	80	270	8200
Bangkok, Siam	19000	2200	270	21000

TABLE 2.5 (Continued)

From: To:	M M + 15	M + 15 M + 30	M + 30 M + 61	M M + 61
Bombay, India	0	90	20	110
Melbourne, Australia	10	30	--	---
Wellington, New Zealand	100	0	--	---
Hongkong	7700	1800	80	9600
Tai Pei, Formosa	3400	1300	110	4800
Iwo Jima	320000	10000	2700	330000
Clark A.F.B., P.I.	38000	1900	350	40000
Guam	19000	13000	890	33000
Johnston Island	990	1600	430	3000
French Frigate Shoals	1300	300	--	---
Midway	6100	890	--	---
Wake Island	2700	1500	260	4500
Canton Island	100	390	260	750
Ponape	--	15000	390	---
Truk Island	4500	20000	710	25000
Yap	3100	3700	170	7000
Korea	--	2000	250	---
Lihue	1000	740	670	2400
Honolulu	960	1600	330	2900
Hilo	1700	4300	340	6300

For the purpose of extrapolation the activity of all samples collected during the survey was arbitrarily attributed to MIKE. Data based on samples collected after the 15th day therefore contain an element of uncertainty because of the possibility that a significant portion of the activity was due to KING.

2.2.3 Fallout after the First Thirty Days

Figures 2.7 and 2.8 show the fallout from M + 30 to M + 61. In the United States the average was 280 d/m/sq ft and in the rest of the world the average was 240. The close agreement appears to be consistent with the idea that the active particles had been dispersed throughout the world atmosphere. The impression of dispersion is reinforced by the small range of total fallout, from M to M + 61, over the United States (Figure 2.9), and by the fact that measurable fallout occurred, sooner or later, at every domestic station and nearly every foreign station (Figure 2.10).

2.2.4 Sampling Precision

The error in estimating fallout at a collection station from an individual sample, as measured by the coefficient of variation (ratio of standard deviation to mean), computed from the first 250 pairs of settled dust samples, is approximately 30%. Studies of data from an earlier survey (4) indicated that the finding may be applied to a large region surrounding the station without serious loss of precision. The figure of 30% includes no allowance for the efficiency of the collection method or for other sources of systematic error.

Although the totals shown on the maps are more precise than the data of individual samples, they may be influenced greatly by exceptional results, such as the maximum daily fallout at Iwo Jima, discussed in Section 2.2.1, above.

2.2.5 Radioactive Dust Concentration of the Air at Ground Level

The concentration of radioactive dust in the atmosphere, as measured by counts of filtered samples, was negligible compared to the results of surveys made during continental tests. The maximum for each station is given in Table 2.6.

TABLE 2.6

MAXIMUM RADIOACTIVE DUST CONCENTRATIONS EXTRAPOLATED TO SAMPLING DATE (d/m/M³)

Station	Days after MIKE	Sampling Period (Min.)	Activity
Honolulu			
Airport	23	1440	6
Special	6	120	14
Guam			
Air Base	5	1440	8
Special	3	480	100
Midway	0.7	120	50
Kwajalein	3	180	700
Truk	5	175	60
Ponape	19	1440	17
Rochester, N.Y.	13	1440	2
New York			
Airport	-	--	0
City	24	1440	1
Chicago	15	1440	3
Detroit	16	1440	1
Ypsilanti	15	1440	2
San Francisco			
Airport	-	--	0
City	11	1440	[illegible]
Los Angeles			
Airport	12	1440	1
City	12	1440	1

2.2.6 Decay Rate

Decay rate data for 23 gummed paper samples yielded an average value for the exponent of the time of - 1.37. The values of the decay slope calculated from counts of two filtered dust samples were - 1.19 and - 0.95.

In Figure 2.13 the activities of typical samples are plotted against the age of the material (days after MIKE). We have not discovered the cause of the regular fluctuations. We are unable to rule out the possibility that it is due to some unknown bias in the counting procedure.

The value of the decay rate exponent was the last piece of information obtained. It was not used for extrapolation which was based, instead, on the conventional exponent of - 1.2.

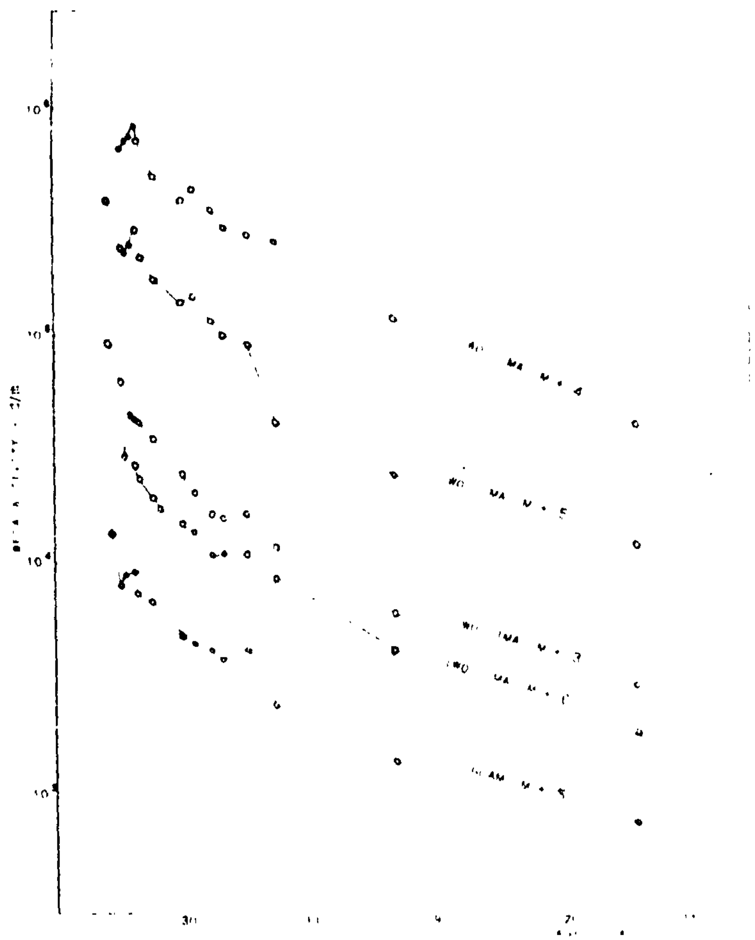


Fig. 2.13 [illegible]

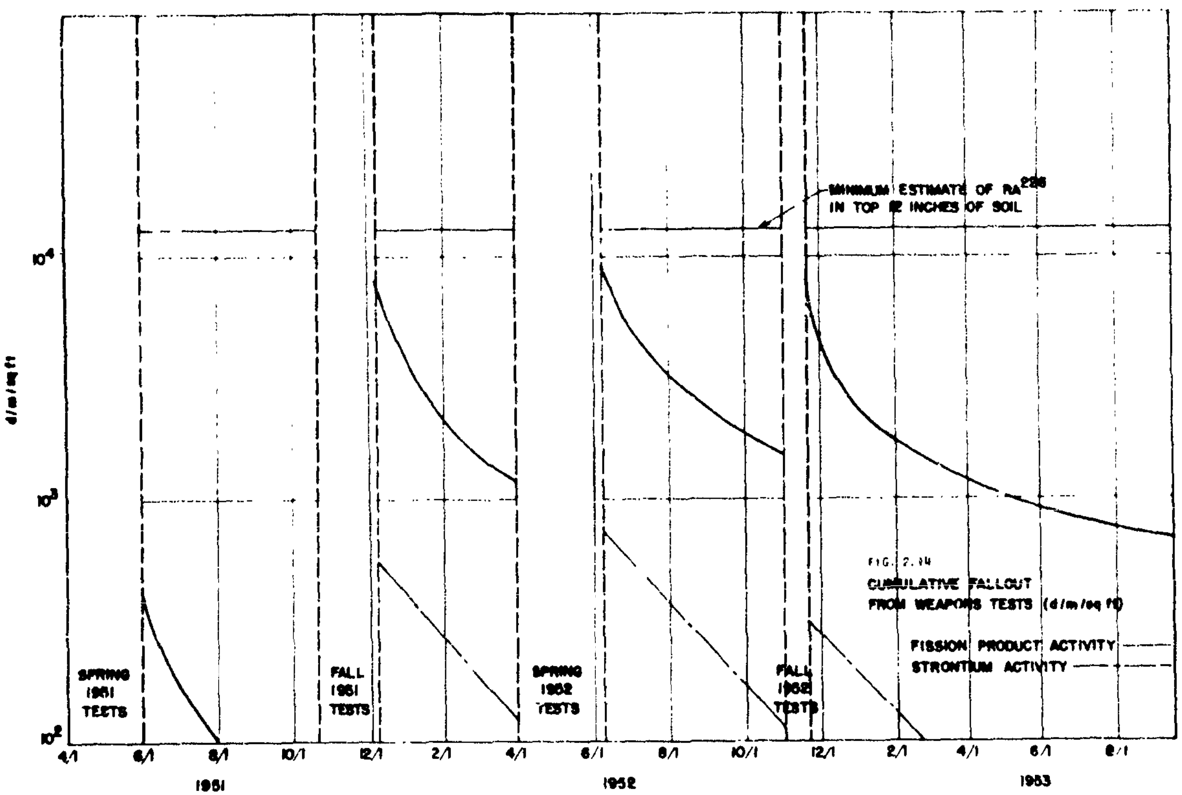


FIG. 2.14
CUMULATIVE FALLOUT
FROM WEAPONS TESTS (d/m/sq ft)

2.2.7 Cumulative Fallout in Northeastern United States from This and Previous Tests

Figure 2.14 a is cumulative graph of settled activity, plotted against time, showing the sharp rises after each weapons test series and the subsequent falling off due to decay. It is intended to show the accumulated radioactivity on the earth's surface in the northeastern United States, neglecting redistribution due to rain. The peaks would be higher if it were practical to plot the portions of the curve corresponding to the weapons test periods.

In interpreting the curve it is useful to keep in mind that the biological or industrial effect of the fallout depends on a cumulative dose which is greater for old fission products than for equal activity in the form of young, relatively unstable, fission products. Fluctuations in cumulative dose would have less amplitude than the fluctuations in activity shown in Figure 2.14.

References

1. NYO-4505 (SECRET) "Radioactive Debris from Operations Tumbler and Snapper," - Part I, Health and Safety Division, NYOO. January 12, 1953.

2. NYO-1576 (SECRET) "Radioactive Debris from Operations Buster and Jangle - January 28, 1952, Health and Safety Division, NYOO.

3. Memorandum (SECRET) "AEC Monitoring Program," - Commander Deller, September 10, 1952.

4. NYO-4512 (SECRET) "Radioactive Debris from Operations Tumbler and Snapper," - Part II, Special Projects Section, U. S. Weather Bureau, February, 1953.

END

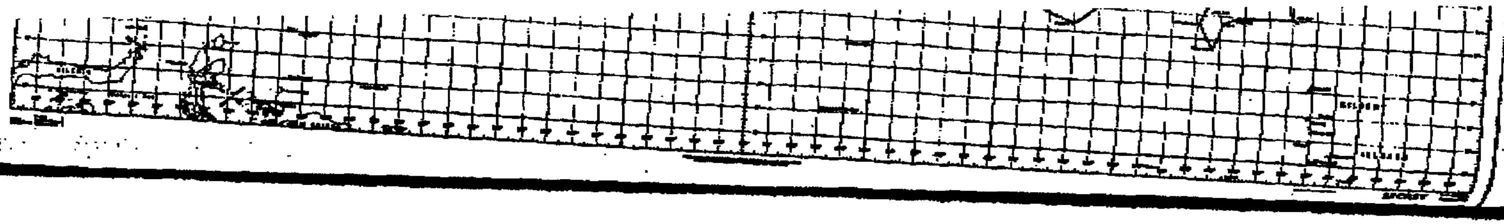


Table 2.2

RESULTS OF AERIAL SURVEY FOLLOWING MIKE SHOT (mr/hr)

Days after MIKE:	2		2		3	5		4		6
Likiep	0.5	Namu	0	Farallonde			Ulithi	0	Iwo Jima	0.5
Jemo	0.5	Ailing-		Pajaros	1.0	0	Yap	0	Hahashima	0.5
Ailuk	0.5	lapalap	0	Maug	0.5	0.5	Ngulu	0	Chichishima	0.25
Mejit	0.2	Namorik	0	Asuncion	1.0	0	Babel-		Tori Shima	0
Taka	0.3	Ebon	0	Agrihan	1.5	1.0	thuap	0.05	Aoga Shima	0
Utirik	0.2	Kili	0	Pagan	1.0	1.0	Koror	0	Hachigo Shima	0
Bikar	0.2	Jaluit	0	Alamagan	0.5	0.5	Peleliu	0	Miyake Shima	0
Taongi	0	Mili	0	Guguan	0.5	0.5	Guam	0.7	O Shima	0
Rongerik	0.05	Arno	0	Sarigan	0.5	0				
Rongelap	0	Majuro	0	Anatahan	0	0				
Bikini	0.05	Maloelap		Farallonde						
Wotho	0.1	& Aur	0.5	Medinilla	0.5	0				
Ujae	0	Erikub	0.2	Saipan	0.5	0				
Lae	0.1	Wotje	0.5	Tinian	0.5	0				
Kwajalein	0.3			Rota	0	0.5				
				Guam	1.0	0.5				

Days after MIKE:	1		1,2,5		5		5,6		7		8
Kusaie	0	Namonuito	0	Gafernut	0	Oahu	0	Oahu	0	Honshu	0
Pingelap	0	Truk	0	Faranlep	0	Kauai	0	Lanai	0	Shikoku	0
Mokil	0	Losap	0	W. Fayu	0	Niihau	0	Kahoolawe	0	Kyushu	0
Ponape	0	Namoluk	0	Woleai	0	Necker	0	Hawaii	0	Tanega Shima	0
Ujelang	0	Lukunor	0	Ifalik	0	Laysan	0	Maui	0	Amami O Shima	0
		Satawan	0	Eauripik	0	Midway	0	Molokai	0	Okinawa	0
		Kuop	0	Elato	0					Guam	0.1
		Pulap	0	Lomotrek	0						
				Satawal	0						

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Table 2.3

RESULTS OF AERIAL SURVEY FOLLOWING KING

(mr/hr)

Days after KING:	2		1		5		1		4
Likiep	0.4	Namu	0.1	Farallonde Pajaros	0	Kusaie	0	Namonuito	0
Jemo	0	Ailing-lapalap	0.1	Maug	0.1	Pingelap	0	Truk	0
Ailuk	0	Namorik	0	Asuncion	0.1	Mokil	0	Losap	0
Mejit	0	Ebon	0	Agrihan	0.5	Ponape	0	Namoluk	0
Taka	0	Kili	0	Pagan	0.1	Ujelang	0.3	Luknor	0
Utirik	0	Jaluit	0	Alamagan	0.1			Satawan	0
Bikar	0	Mili	0	Guguan	0			Kuop	0
Taongi	0	Arno	0.1	Sarigan	0			Pulap	0
Rongerik	0	Majuro	0	Anatahan	0				
Rongelap	0	Maloelap & Aur	0.1	Farallonde Medinilla	0				
Bikini	0	Erikub	0	Saipan	0				
Wotho	0	Wotje	0	Tinian	0				
Ujae	0			Rota	0				
Lae	0.4			Guam	0				
Kwajalein	0								

note: "zero" means less than 0.05 mr/hr

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