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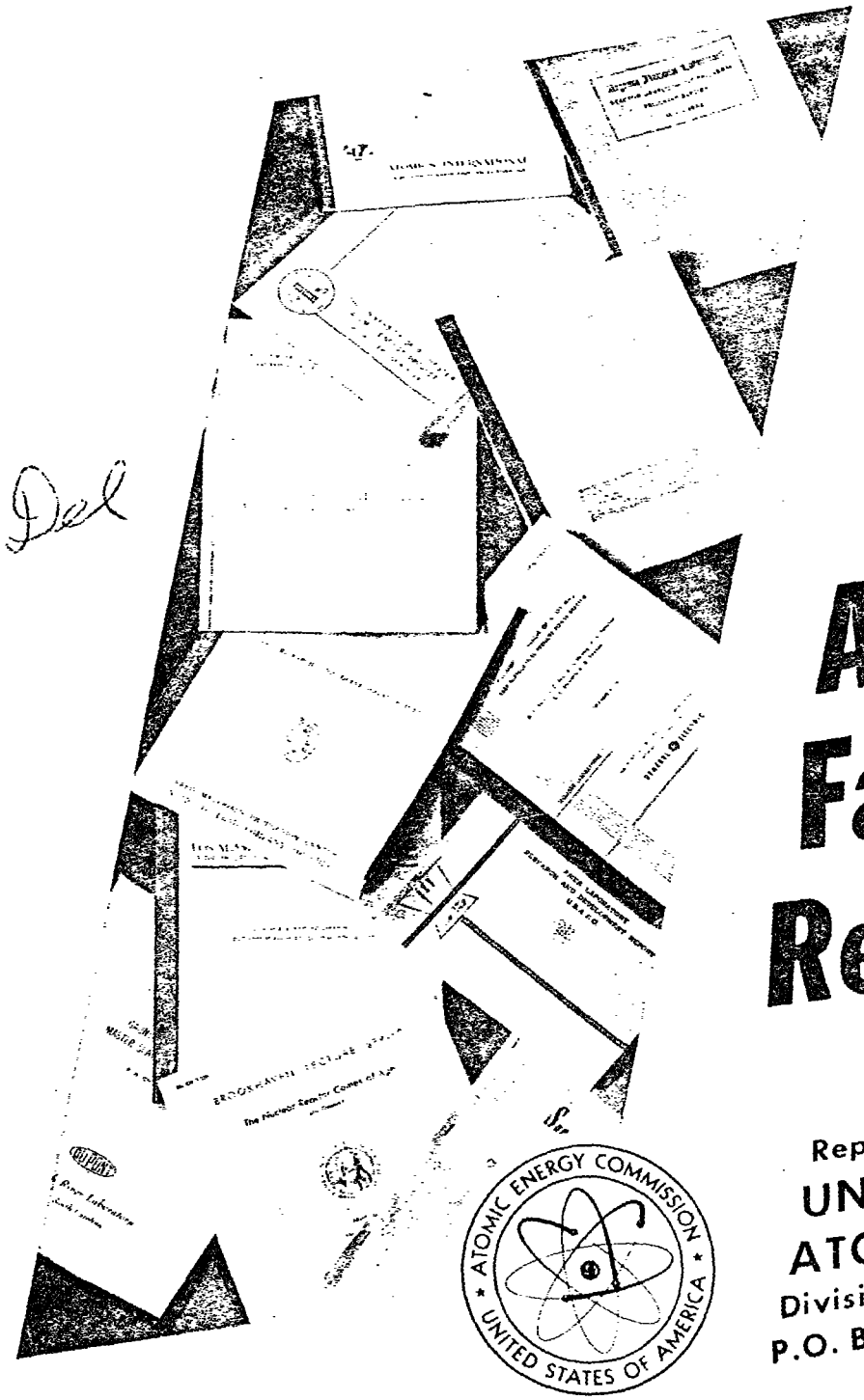

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Effects of Atomic Weapons

RADIOACTIVE DEBRIS FROM OPERATION CASTLE: WORLDWIDE FALLOUT

by

D. E. Lynch
UNITED STATES ATOMIC ENERGY COMMISSION
New York Operations Office
Health and Safety Laboratory

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Abstract

Data on worldwide fallout of radioactive debris from the Castle series of weapons tests conducted in the Spring of 1954 are summarized.

Total world fallout of Beta activity to August 31, excluding the vicinity of the test site, is estimated at 7.1 megacuries, extrapolated to [illegible]. During March, April and May the average monthly fallout was 1.5 megacuries. During June and July it was at about half this level but in August it increased to 1.2 megacuries.

NYOO 4621

WORLDWIDE FALLOUT FROM OPERATION CASTLE

1. Introduction

During Operation Castle, the atomic weapons tests held in the Spring of 1954 at the Eniwetok Proving Grounds, fallout monitoring was conducted by the A.E.C. Health and Safety Laboratory (New York Operations Office) and the same agencies which had cooperated in earlier surveys.

The work was done in these phases:

a. Collection of fallout samples at fixed stations comprising a worldwide network and analysis of the samples at the Health and Safety Laboratory.

b. Similar sampling and analysis of fallout on Navy ships in the Pacific.

c. Assistance to the task force by the installation and maintenance of automatic radiation and airborne dust monitors on Pacific Islands, furnishing instruments for aerial monitoring of the islands and providing technical instruction and guidance in the operation of the aerial and ground instruments.

d. Investigation of the feasibility of measuring fallout over the open sea.

This summary presents the results of fallout sampling at fixed stations. The work referred to in "c" and "d" above will be reported separately. The fixed station data in greater detail and an analysis of it in relation to meteorology will be reported by the Weather Bureau.

To simplify data handling, the ship samples were assumed to represent areas into which the ocean was divided for convenience and in which the ships happened to be when the samples were taken. The number of samples in each area varied from day to day and the number of days represented by samples was different for each area. For these reasons the ship data are not suitable for reporting in summary form. They are best studied in detail as a part of the general study being made by the Weather Bureau.

The ships were used in the sampling program to augment the fixed stations in case a specific question might require dense coverage in some area of the ocean.

2. Sampling

Observers at each typical fixed station collected 24 hour samples by exposing duplicate one foot squares of gummed film. One hundred twenty such stations throughout the world mailed samples daily to the Health and Safety Laboratory where the activity was measured. The program began February 1954 and is still in effect as this is written, except that a few stations which were manned only temporarily during the weapons tests have dropped out.

Sampling and analysis techniques were the same as those used during Operation Upshot-Knothole and other test series and they are described in earlier reports 1,2,3.

3. Results

The maps, Figures 1 to 18, show the total fallout of beta activity at the fixed stations for each of six periods, the five between consecutive explosions and the sixth beginning the day of the last explosion and ending 18 days later. Each period begins on the day of a burst. Figures 19 to 21 show the totals for all six periods. Fallout for June, July and August is shown in Figures 22 to 30.

The data are in millicuries per square mile extrapolated to January 1, 1955. For the purpose of extrapolation the activity was attributed to test explosions according to an arbitrary rule adopted in advance. Fallout at stations in the 900 series, the nearest to the proving grounds, and fallout on ships was attributed to the latest burst preceding sampling. Fallout at other stations was attributed to the burst before the latest one so that all fallout between the first and second bursts was assumed to be the first. Beginning in August the activity was assumed to have originated on April 10th, about the midpoint of the series.

As usual the activity was assumed inversely proportional to the 1.2 power of the age.

Total world fallout, excluding the vicinity of the test site, from the beginning of the series until 18 days after the last burst, is about 4.4 megacuries.

In the vicinity of the tests the network was not dense enough to give an estimate of fallout. Measurements of radiation from the ships reported elsewhere, however, demonstrated that activity of a higher order fell out over small spots in the ocean.

Estimated world fallout is 0.7 and 0.8 megacuries for June and July. The estimate for August is 1.2 megacuries, an increase of 50% over July. The average monthly fallout for the three months of the weapons tests was only slightly greater, 1.5 megacuries.

The radioactive debris dispersed quickly throughout the world and all but a few stations experienced measurable fallout at some time during the series.

Examination of the daily results showed spread in time also. When fallout occurred at a station it usually lasted for several days, a fact tending to improve the reliability of the station totals. It was demonstrated during continental tests that most of the fallout of a period occurred on a single day or two days. During the recent series this pattern was less common.

4. Acknowledgment

The sampling network included weather stations of the U. S. and Canadian Weather Bureaus, the Army, the Navy, the Air Force and the Coast Guard. Most of the military stations were operated by Air Weather Service personnel.

Two stations in Japan were manned by the Atomic Bomb Casualty Commission and one in Canada was provided by the Chalk River Atomic Energy Installation.

The armed forces and the Weather Bureau cooperated also in other ways and the Weather Bureau is studying the data and will issue a report.

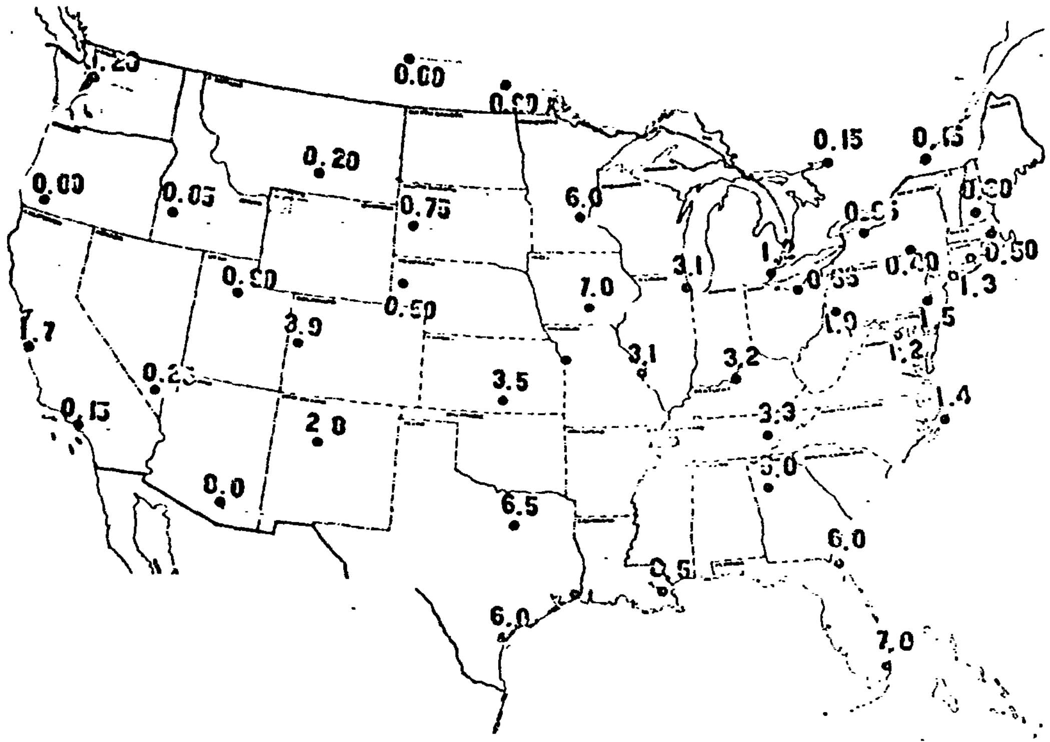
Phases of the survey to be reported separately were accomplished in cooperation with Joint Task Force Seven and the Navy.

List of Sampling Stations

101	Detroit, Mich.	219	Des Moines, Iowa
102	Louisville, Ky.	221	St. Louis, Mo.
103	Knoxville, Tenn.	222	Chicago, Ill.
105	Memphis, Tenn.	225	New Orleans, La.
108	Atlanta, Ga.	304	Boise, Idaho
115	Philadelphia, Pa.	309	Billings, Montana
116	Pittsburgh, Pa.	310	Salt Lake City, Utah
117	New York (La Guardia), N. Y.	314	Tucson, Arizona
118	Binghamton, N. Y.	321	Grand Junction, Colo.
122	Rochester, N. Y.	323	Albuquerque, N. M.
127	New Haven, Conn.	326	Las Vegas, Nevada
132	Jacksonville, Fla.	401	Seattle, Wash.
133	Miami, Fla.	404	Medford, Oregon
134	Washington, D. C.	407	San Francisco, Calif.
137	Cleveland, Ohio	410	Los Angeles, Calif.
138	Cape Hatteras, N. C.	501	Anchorage, Alaska
139	Concord, New Hampshire	502	North Bay, Ontario
141	Boston, Massachusetts	503	Moosonee, Ontario
204	Corpus Christi, Texas	504	Moncton, N. B.
206	Dallas, Texas	505	Montreal, Quebec
209	Wichita, Kansas	507	Seven Islands, Quebec
211	Scottsbluff, Nebraska	508	Winnipeg, Manitoba
212	Rapid City, S. D.	509	Churchill, Manitoba
216	Minneapolis, Minn.	510	Regina, Saskatchewan

[illegible]	Edmonton, Alberta	701	Prestwick, Scotland
[illegible]	Deep River, Ontario	702	Rhein Main, Germany
[illegible]	Goose Bay, Labrador	703	Pretoria, South Africa
[illegible]	Stephenville, Newfoundland	704	Dakar, Fr. West Africa
519	Thule, Greenland	705	Dhahran, Saudi Arabia
520	Keflavik, Iceland	706	Sidi Slimane, Fr. Morocco
520	Shemya, Alaska	707	Beirut, Lebanon
521	Adak, Alaska	708	Oslo, Norway
522	Nome, Alaska	709	Leopoldville, Belgian Congo
523	Fairbanks, Alaska	710	Wheelus A. F. B., Tripoli
524	Juneau, Alaska	711	Lagos, Nigeria
525	San Juan, P. R.	713	Durban, Natal, U. of S. Africa
601	Canal Zone	714	Monrovia, Liberia
602	Bermuda	717	Addis Ababa, Ethiopia
603	Lima, Peru	801	Hiroshima
604	San Jose, Costa Rica	802	Nagasaki
605	Lagens A. F. B., Azores	803	Hong Kong
606	Buenos Aires, Argentina	804	Tai Pei, Formosa
608	Sao Paulo, Brazil	805	Tokyo, Japan
611	Belem, Brazil	806	Misawa A. B., Japan
612	La Paz, Bolivia	807	Kadena, Okinawa
613	Quito, Ecuador	808	Bangkok, Siam
614	Mexico City	809	Bombay, India
615	Bogota, Columbia	810	Melbourne, Australia

811	Wellington, New Zealand	908	Wake
813	Columbo, Ceylon	909	Canton Island
814	Singapore	910	Ponape
815	Sydney, Australia	911	Truk
816	Calcutta, India	912	Yap
817	Noumea, New Caledonia	913	Koror
901	Guam	914	Lihue
903	Iwo Jima	915	Honolulu, Hawaii
904	Clarke A. F. B., P. I.	916	Hilo, Hawaii
905	Johnston Island	920	Kusaie
906	French Frigate Shoals	921	Majuro
907	Midway	922	Kwajalein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0.75
6.0
0.15
0.50
0.90
0.50
7.0
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1.3
1.5
3.9
3.1
3.2
1.2
0.25
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1.4
0.15
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3.3
0.0
6.5
5.0
6.0
6.0
7.0

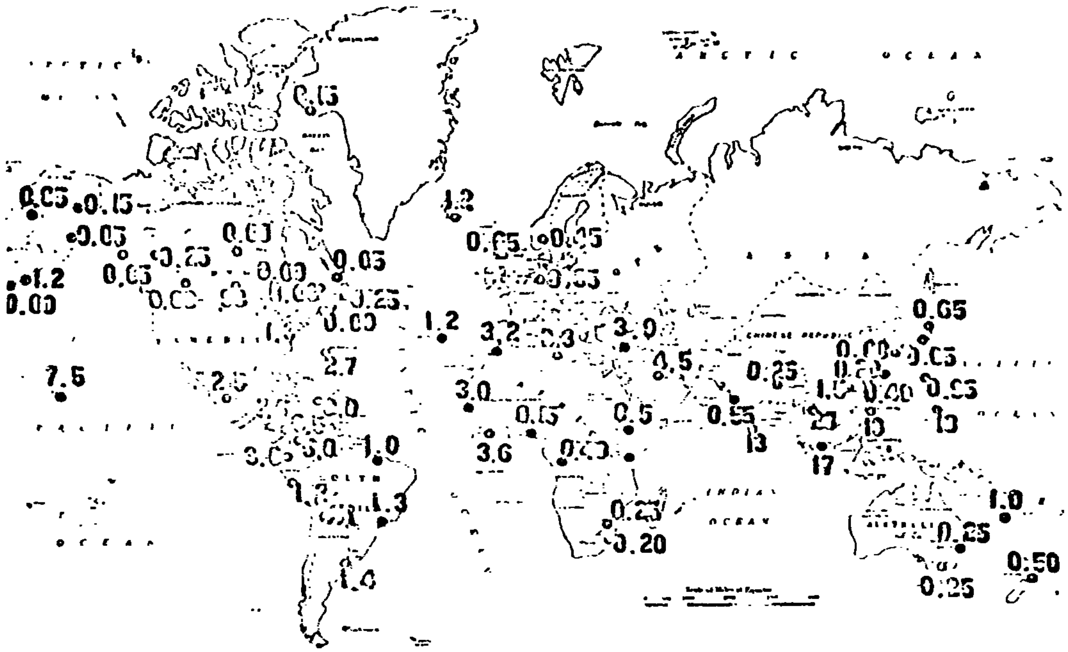


Fig. 2 - Radioactive Fallout, 4/13 - 3/25/54, worldwide
mc/mi^2, extrapolated to 1/1/55

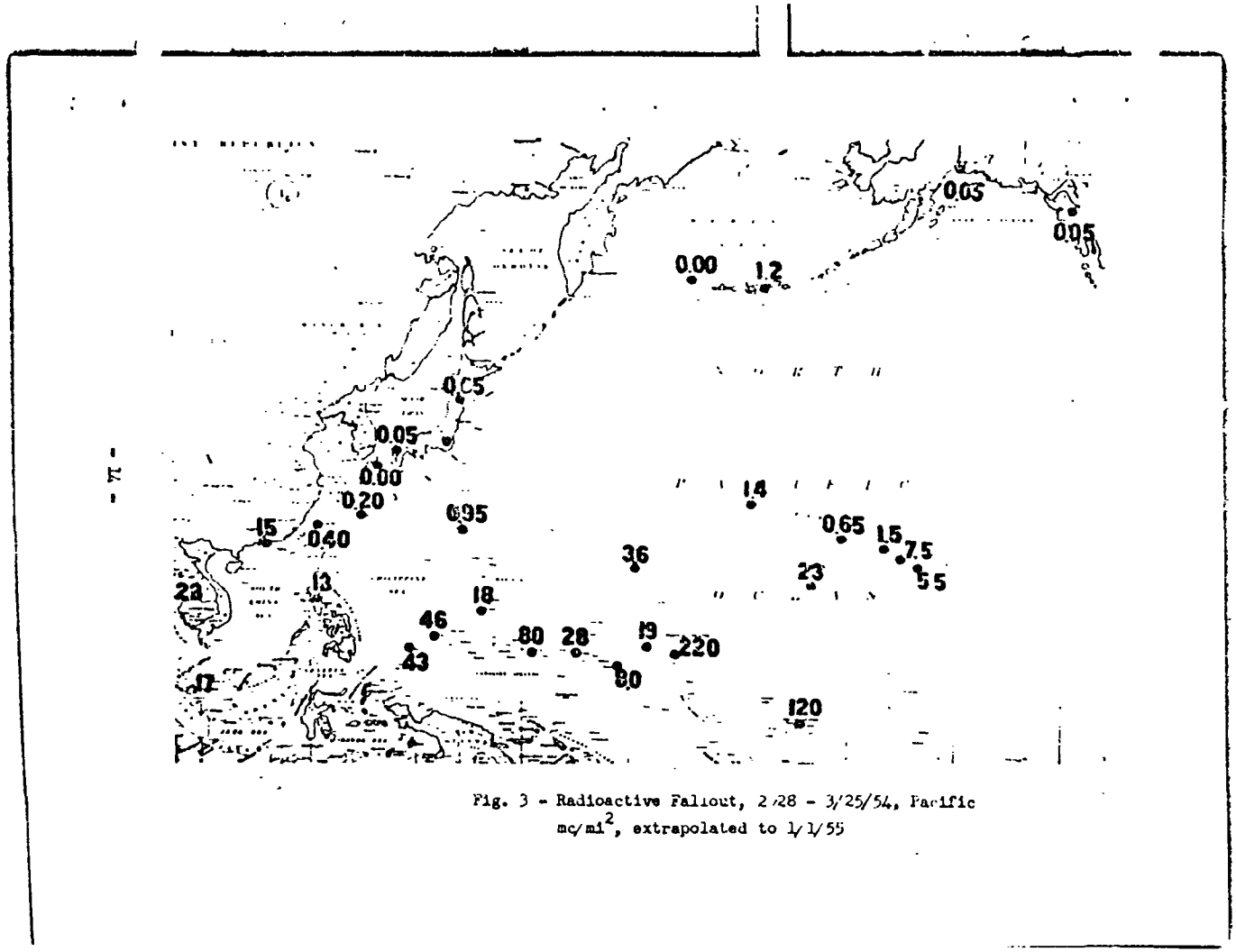


Fig. 3 - Radioactive Fallout, 2/28 - 3/25/54, Pacific
mc/mi^2, extrapolated to 1/1/55

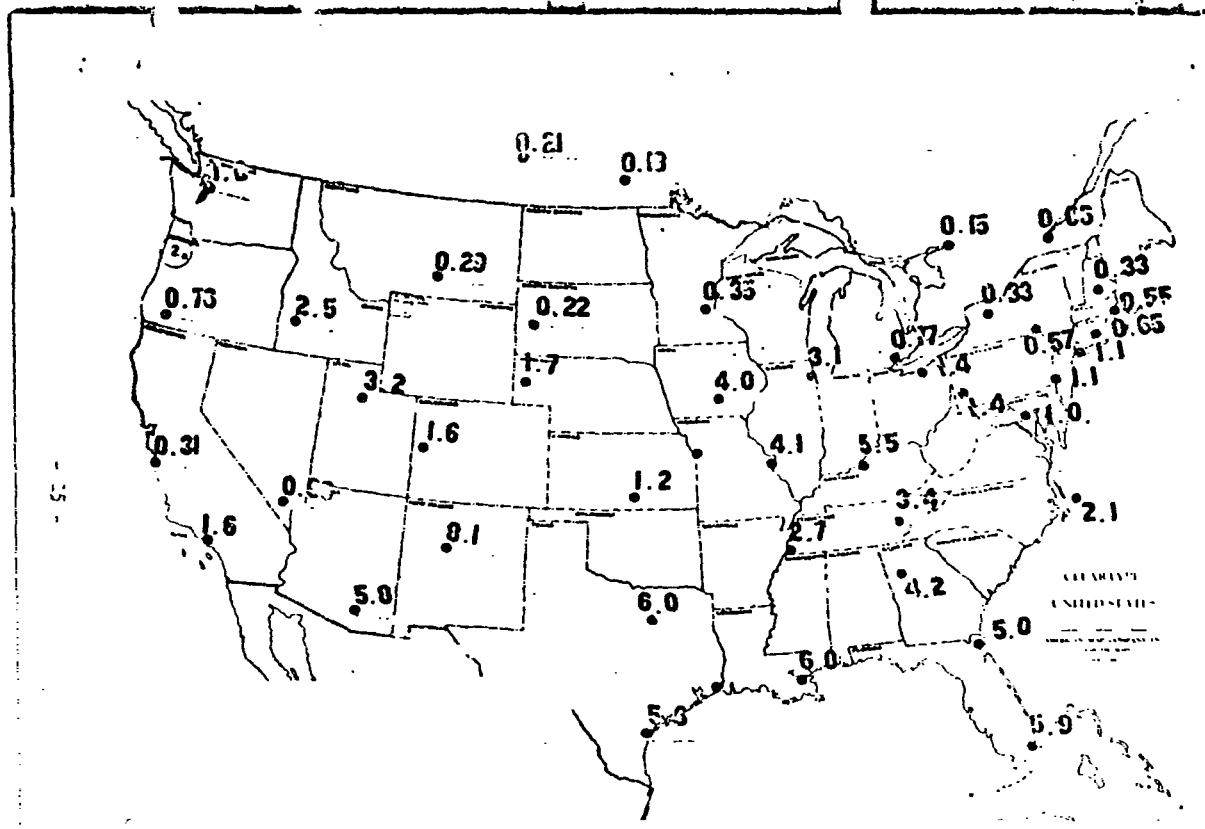


Fig. 4 - Radioactive Fallout, 2/26 - 4/4/54, U. S.
mc/mi^2, extrapolated to 4/7/55

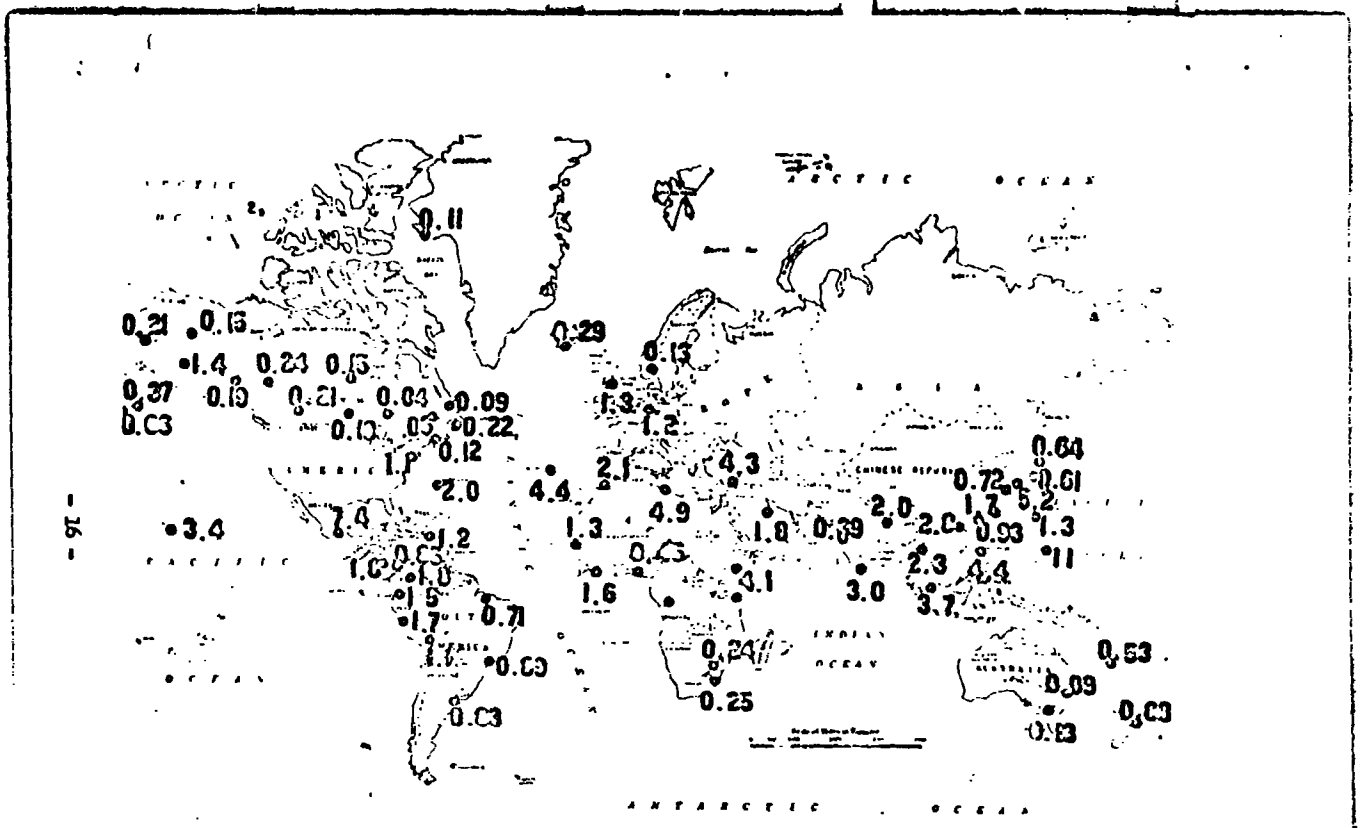
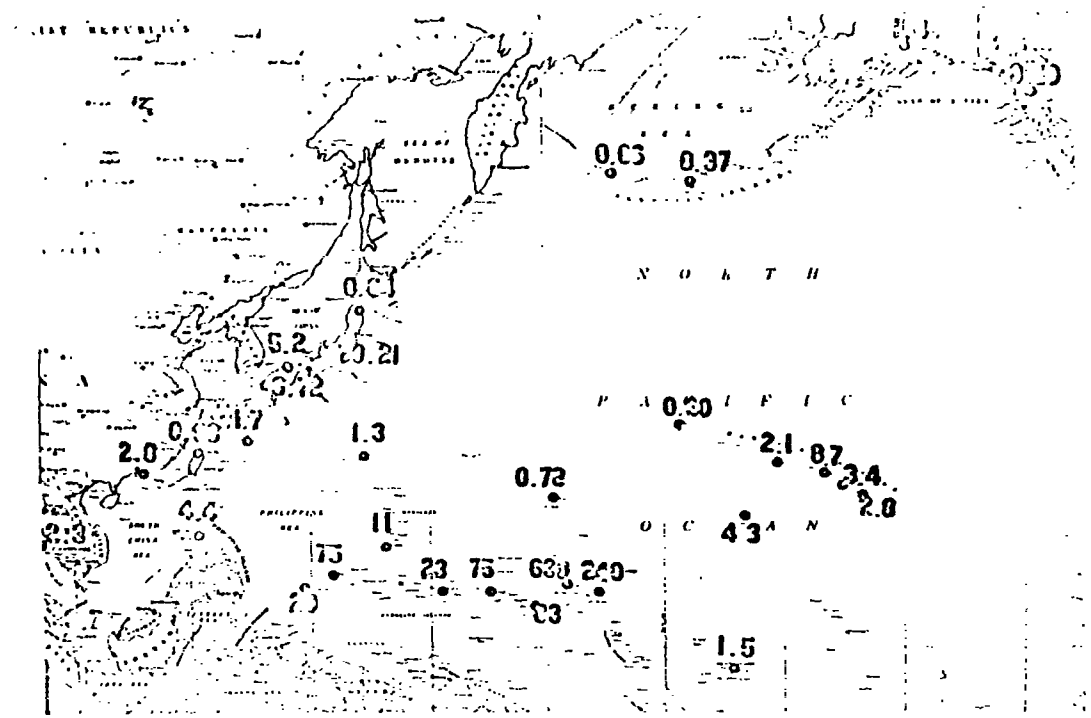


Fig. 5 - Radioactive Fallout, 3/26 - 4/5/54, Worldwide
mc/mi^2, extrapolated to 1/1/55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0.72
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2.8
4.3
23
75
63
1.5

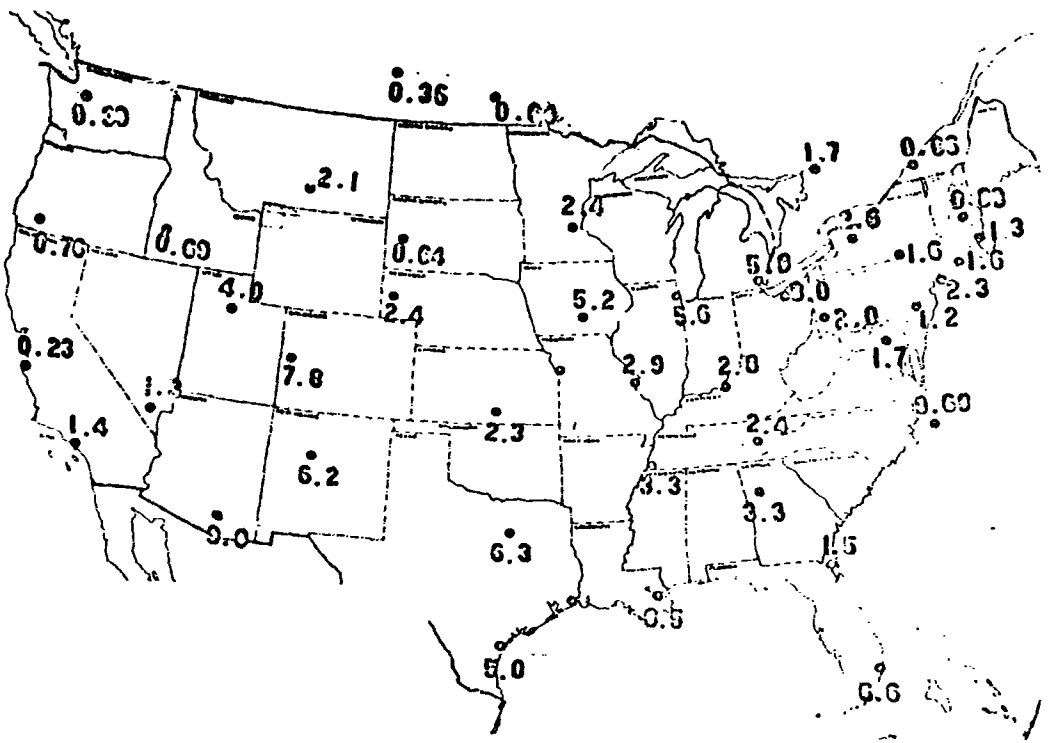

Fig. 7 - Radioactive Fallout, 4/6 - [illegible], U. S.
mc/mi^2, extrapolated to 1/1/[illegible]

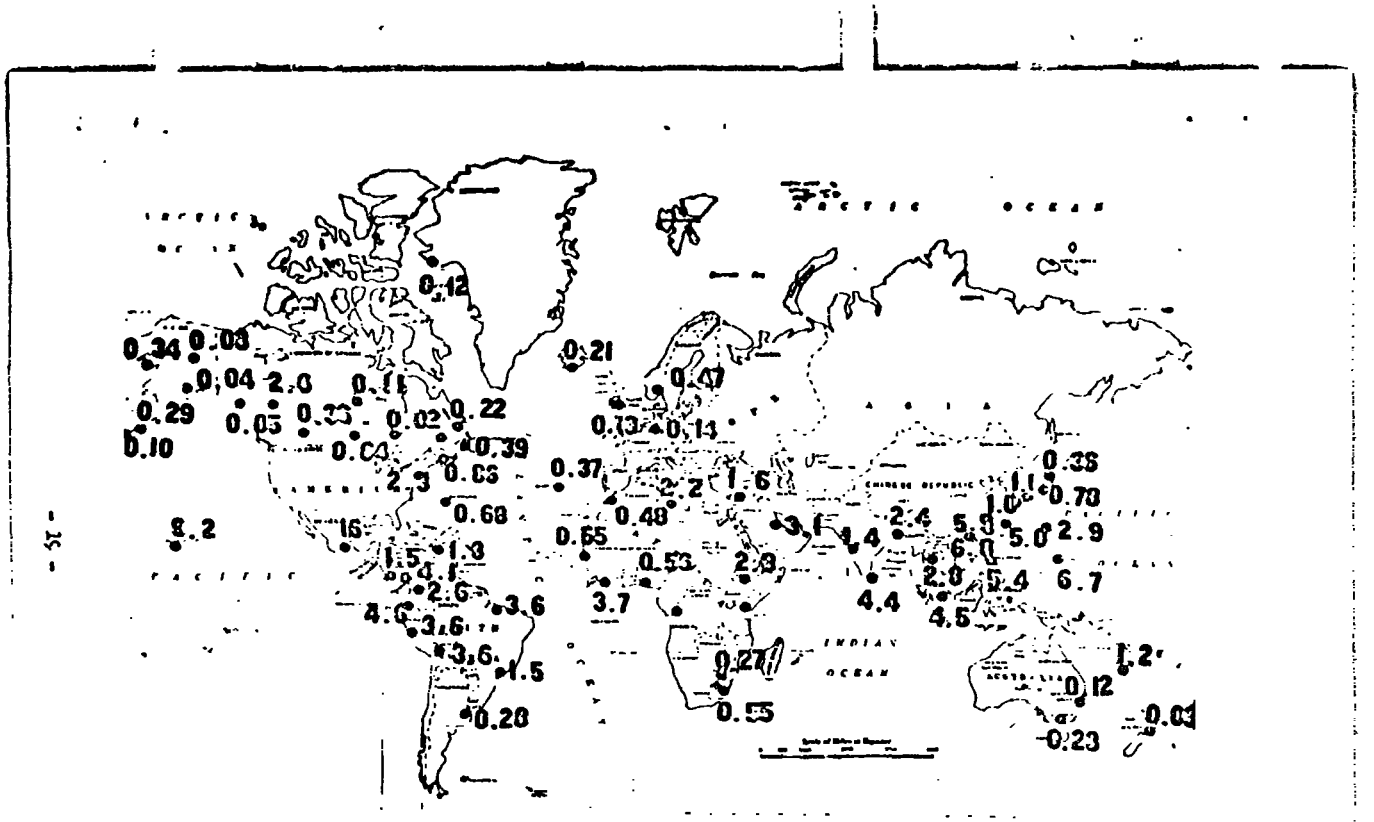

Fig. 8 - Radioactive Fallout, 4/6 - 4/24/54, Worldwide
mc/mi^2, extrapolated to 1/1/55

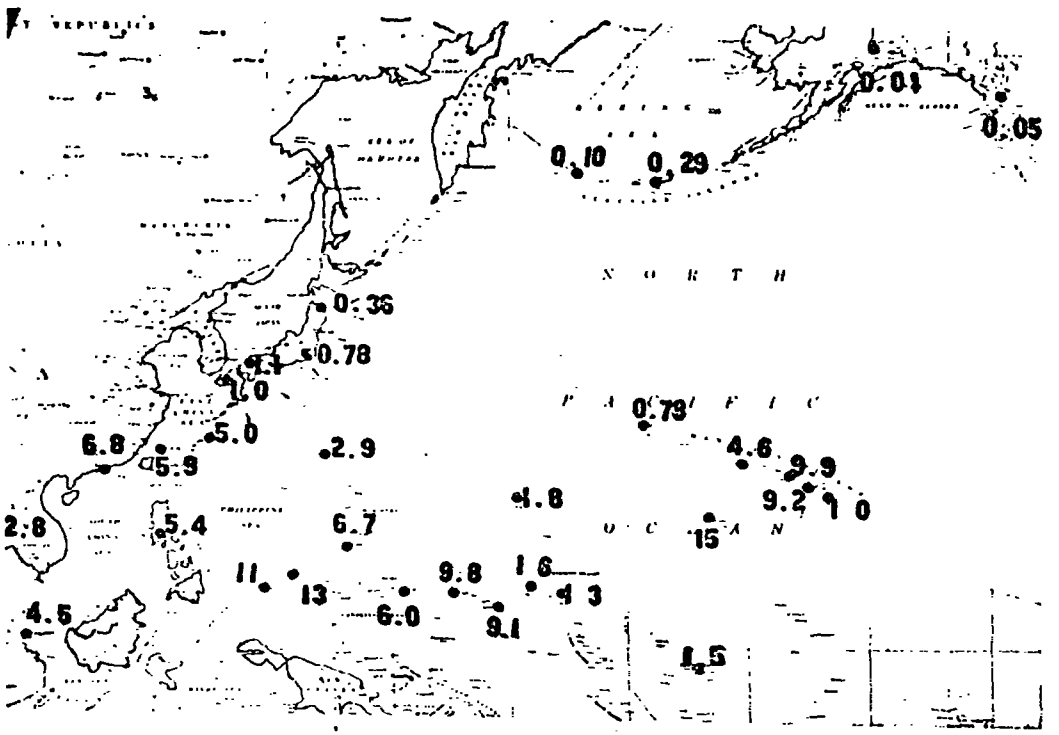

Fig. 9 - Radioactive Fallout, 4/6 - 4/24/54, Pacific
mc/mi^2, extrapolated to 1/1/55

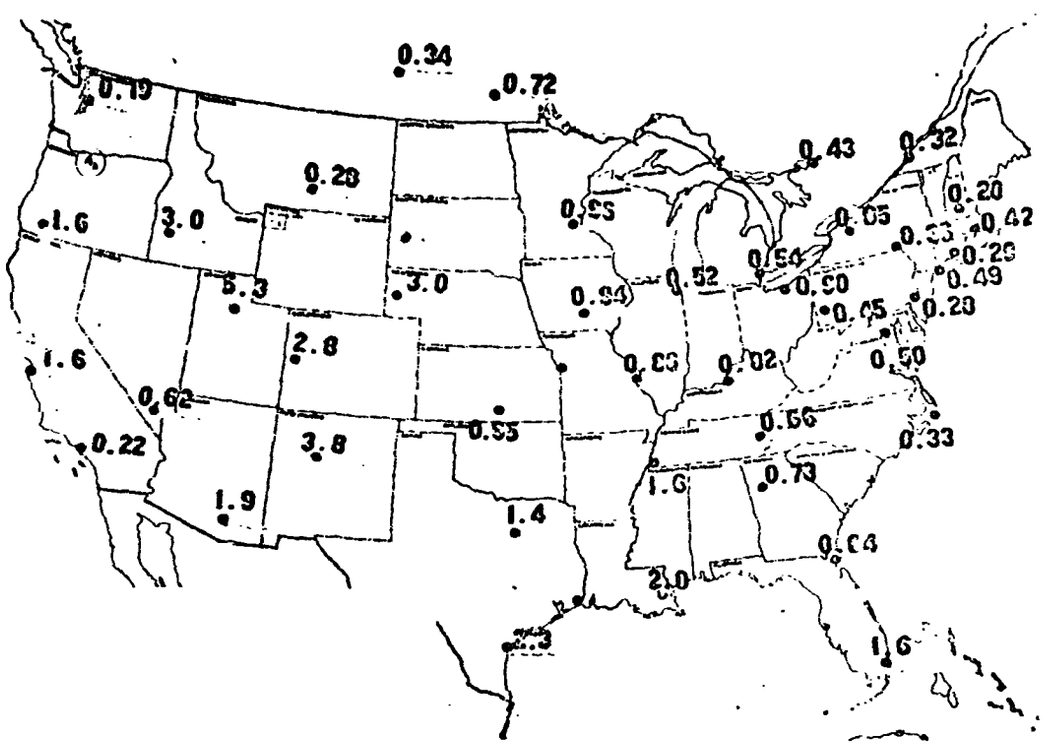

Fig. 10 - Radioactive Fallout, 4/25 - 5/3/54, U. S.
mc/mi^2, extrapolated to 1/1/55

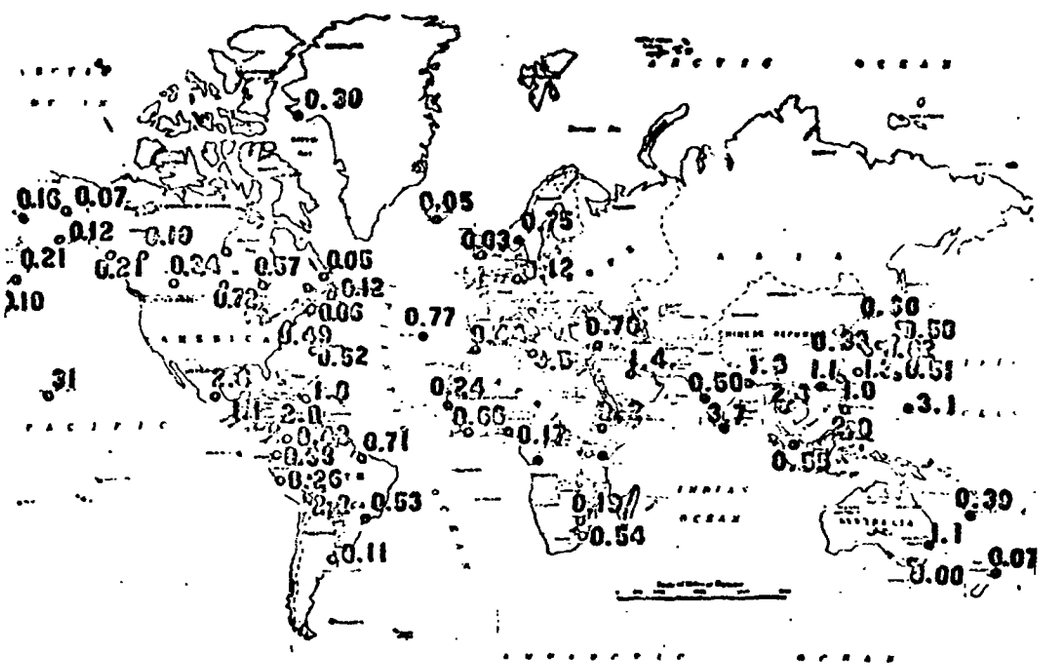

Fig. 11 - Radioactive Fallout, 4/25 - 5/3/54, Worldwide mc/mi^2, extrapolated to 1/1/55

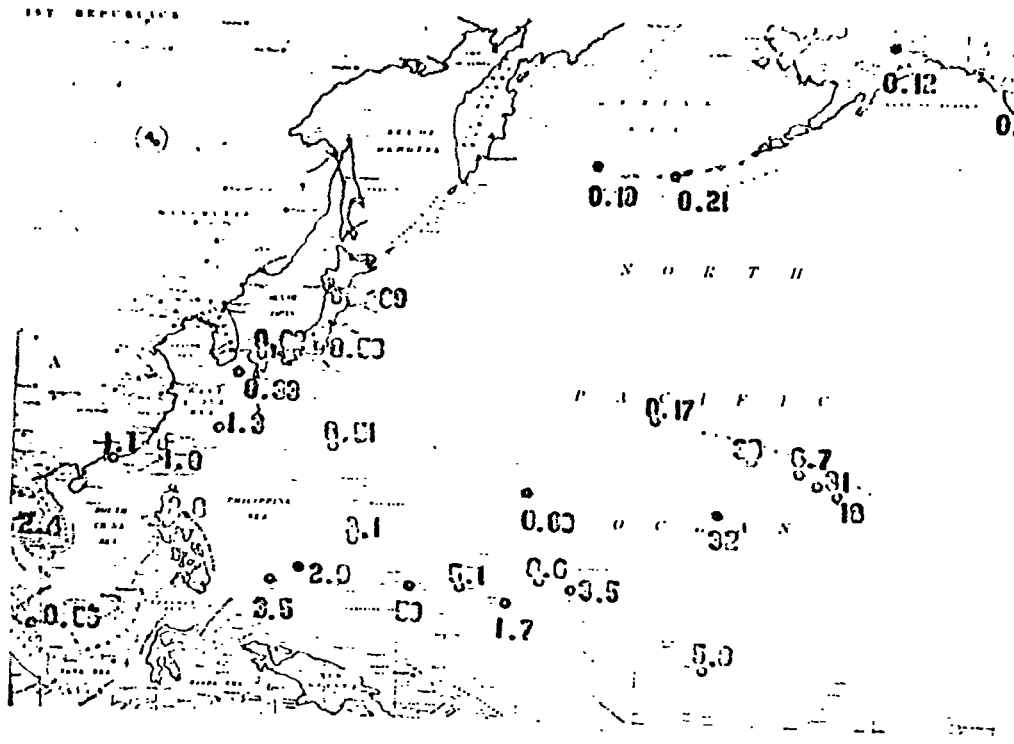

Fig. 12 - Radioactive Fallout, 4/25 - 5/3/54, Pacific
mc/mi^2, extrapolated to 1/1/55

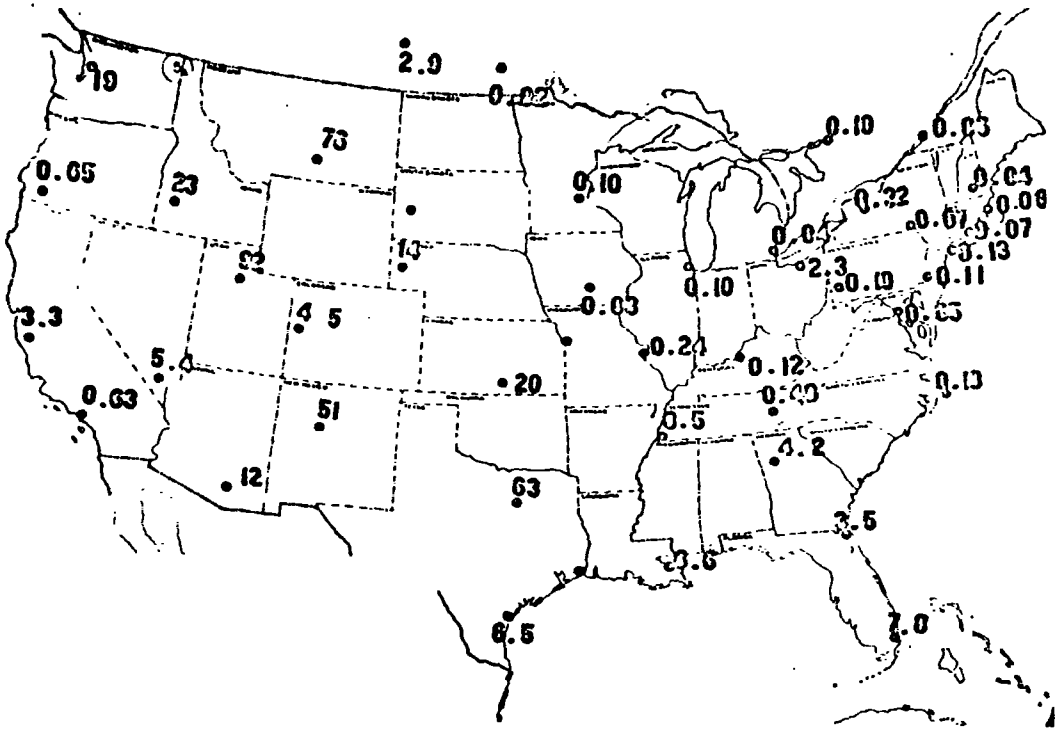

Fig. 13 - Radioactive Fallout, 5/4 - 5/12/54, U. S.
mc/mi^2, extrapolated to 1/1/55

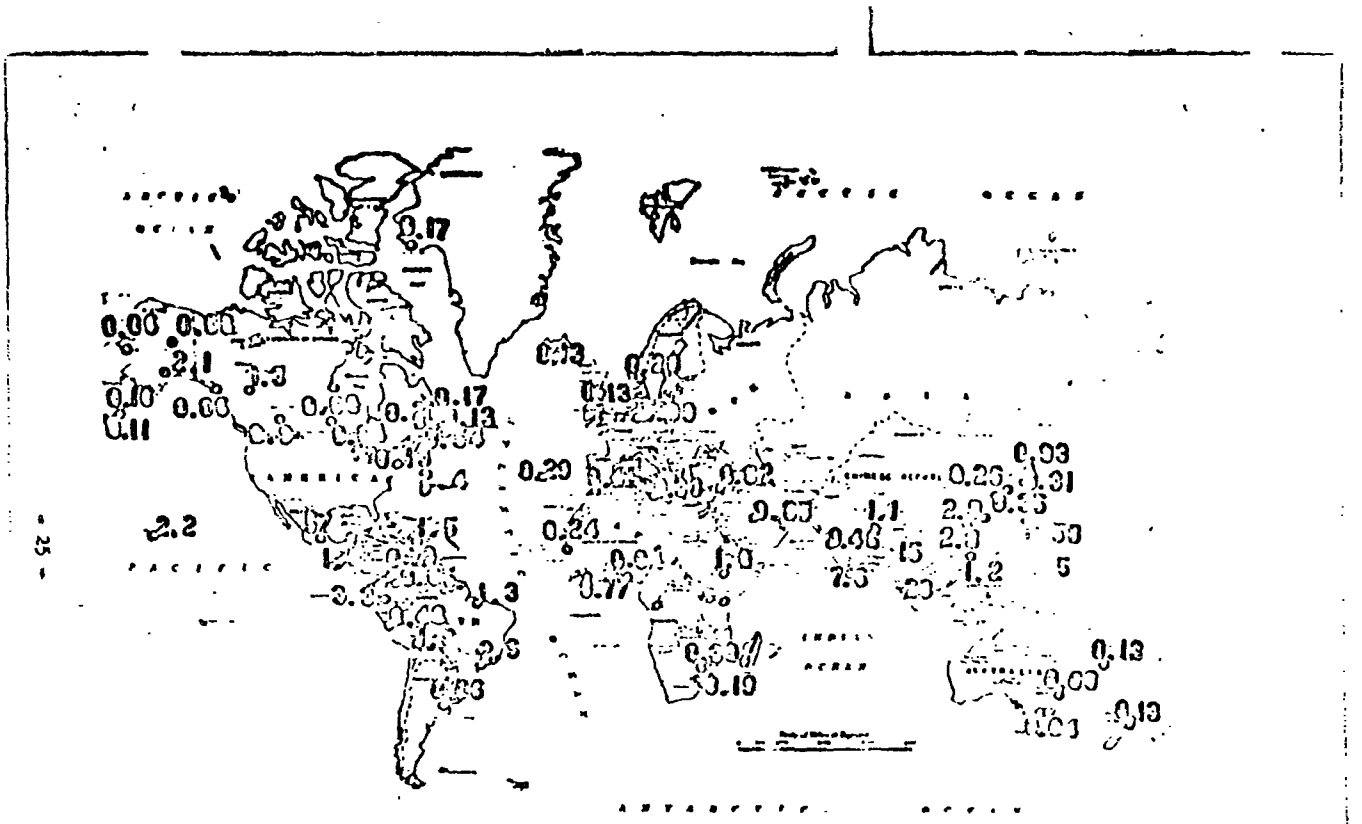

Fig. 14 - Radioactive Fallout, 5/4 - 5/12/54, Worldwide
mc/mi^2, extrapolated to 1/1/55

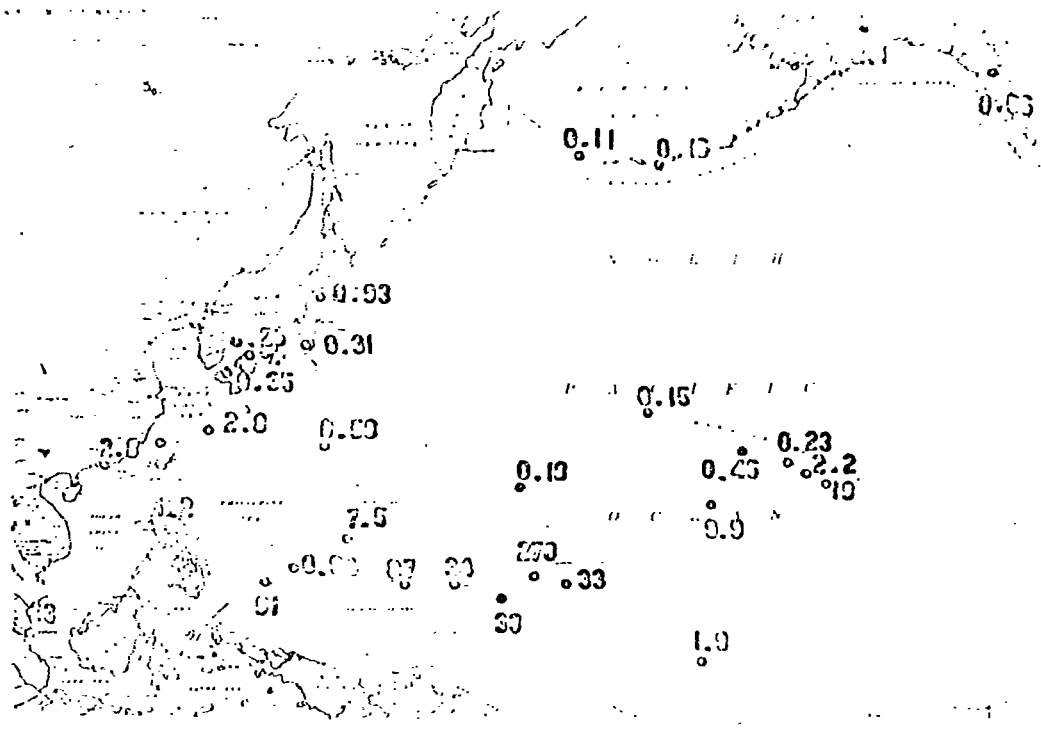

Fig. [illegible] - Radioactive Fallout, 5/4 - 5/[illegible]/54, Pacific
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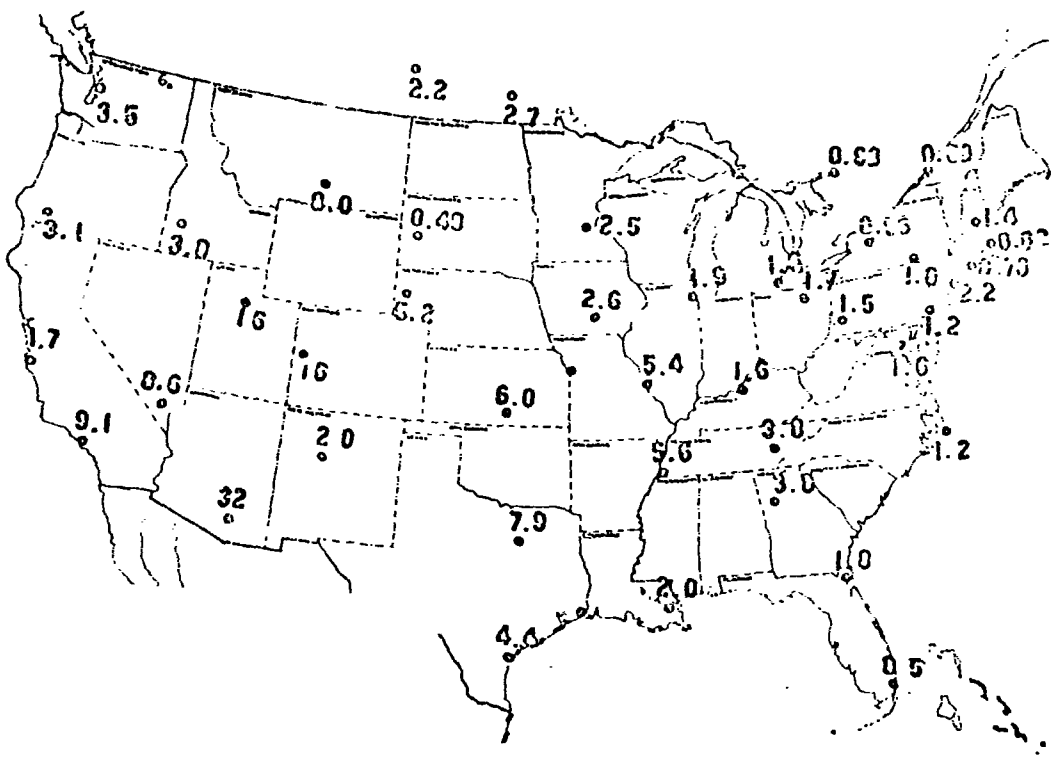


Fig. 16 - Radioactive Fallout, 5/13 - 5/31/54, U. S.
mc/mi^2, extrapolated to 1/1/55

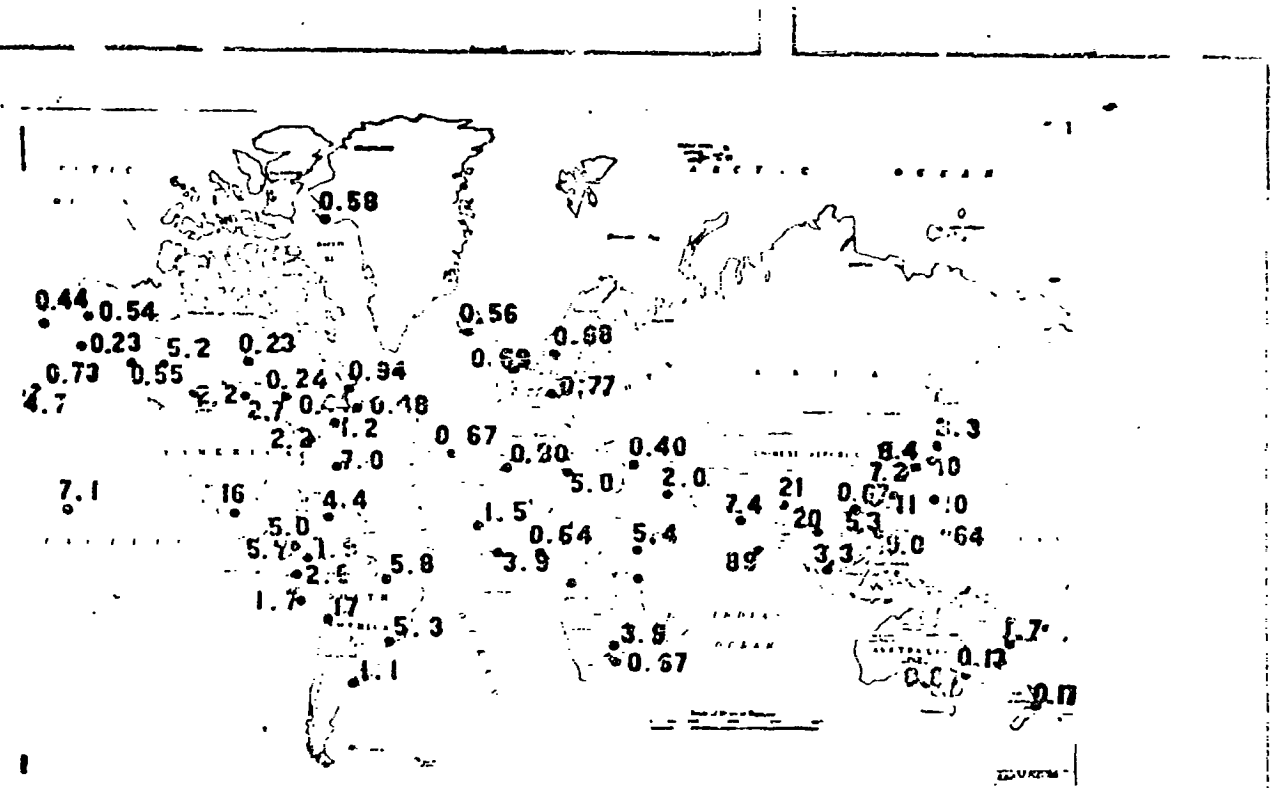


Fig. 17 - Radioactive Fallout, 5/13 - 5/31/54, Worldwide mc/mi^2, extrapolated to 1/1/55

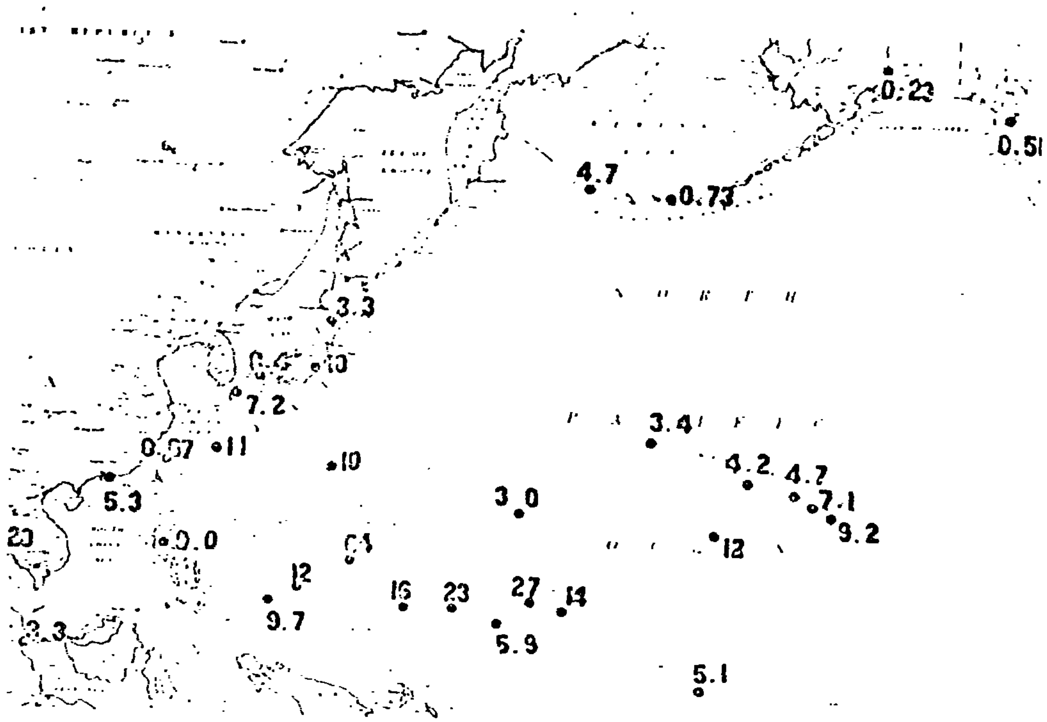


Fig. 18 - Radioactive Fall-out, 5/13 - 5/31/54, Pacific
mc/mi², extrapolated to 1/1/55

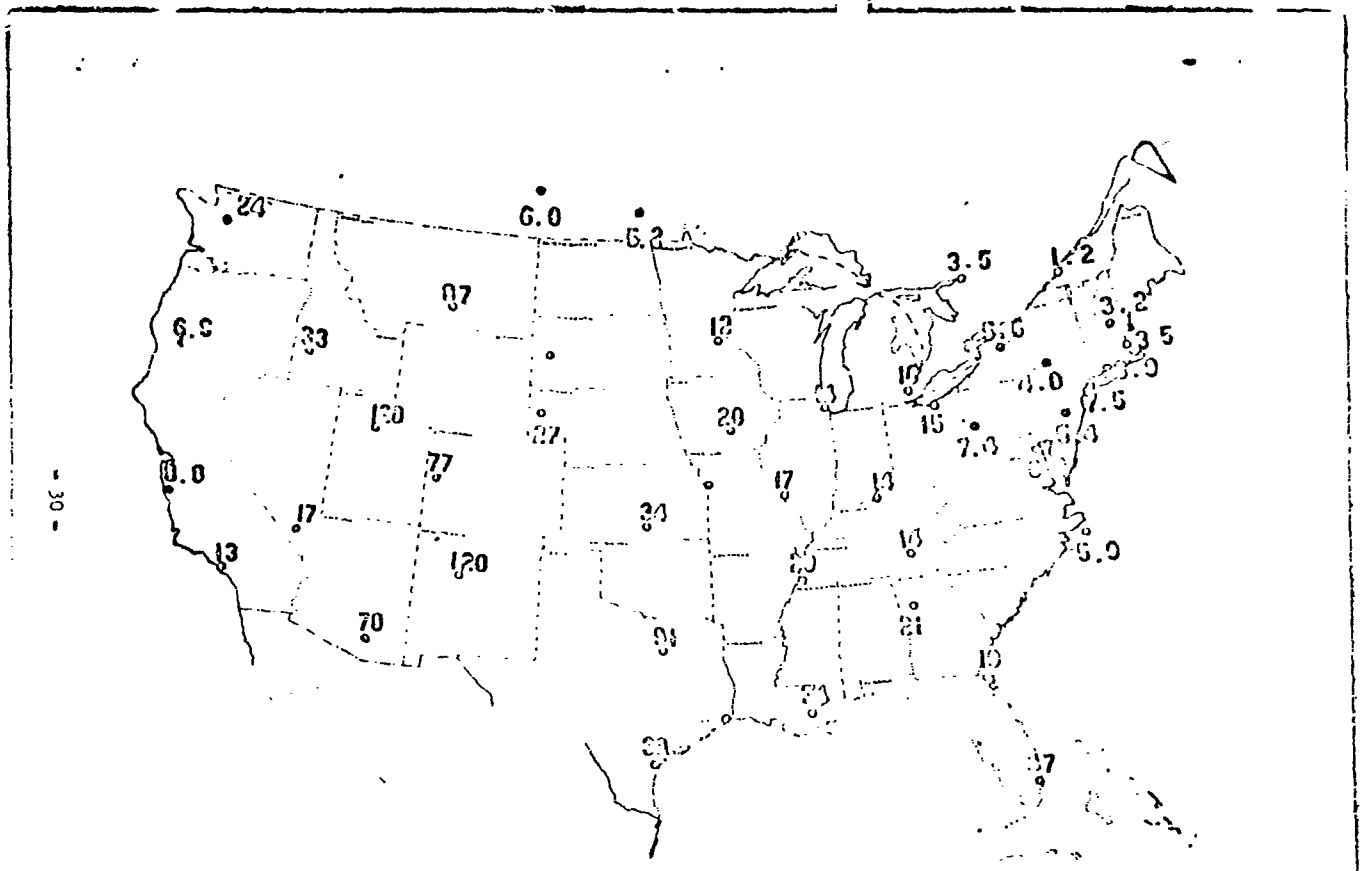


Fig. 19 -Radioactive Fallout, Total 4/28 - 5/31/54, U. S.
mc/mi^2, extrapolated to 7/1/55

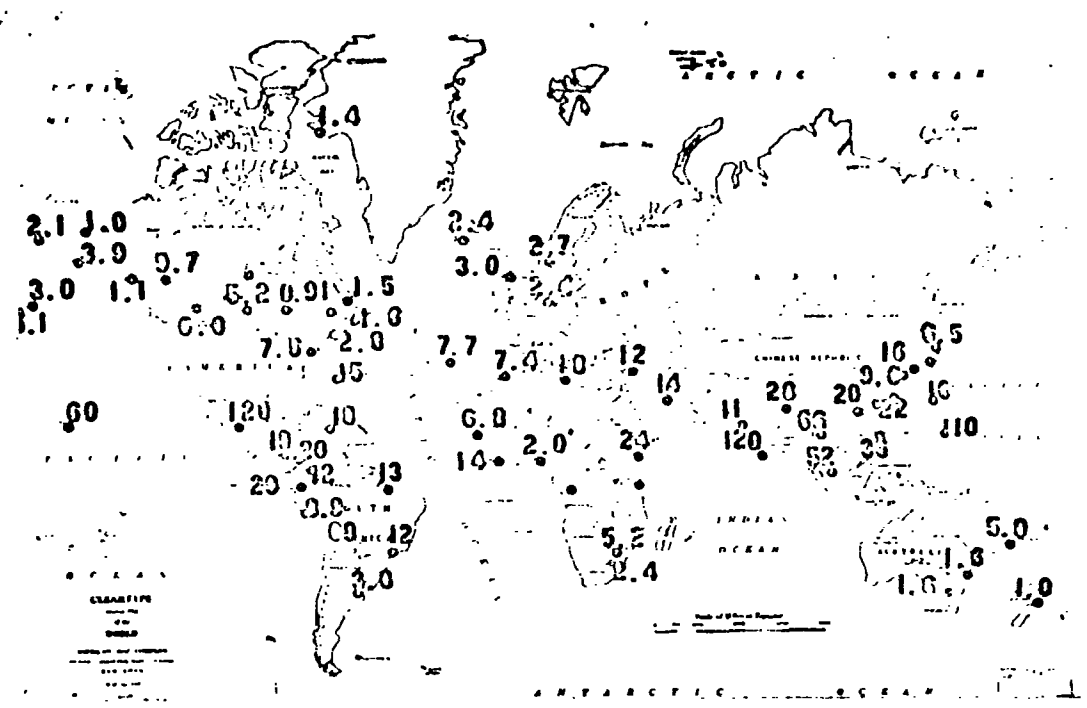


Fig. 20 - Radioactive Fallout, Total 4/28 - 5/31/54, Worldwide
mc/mi^2, extrepolated to 1/1/55

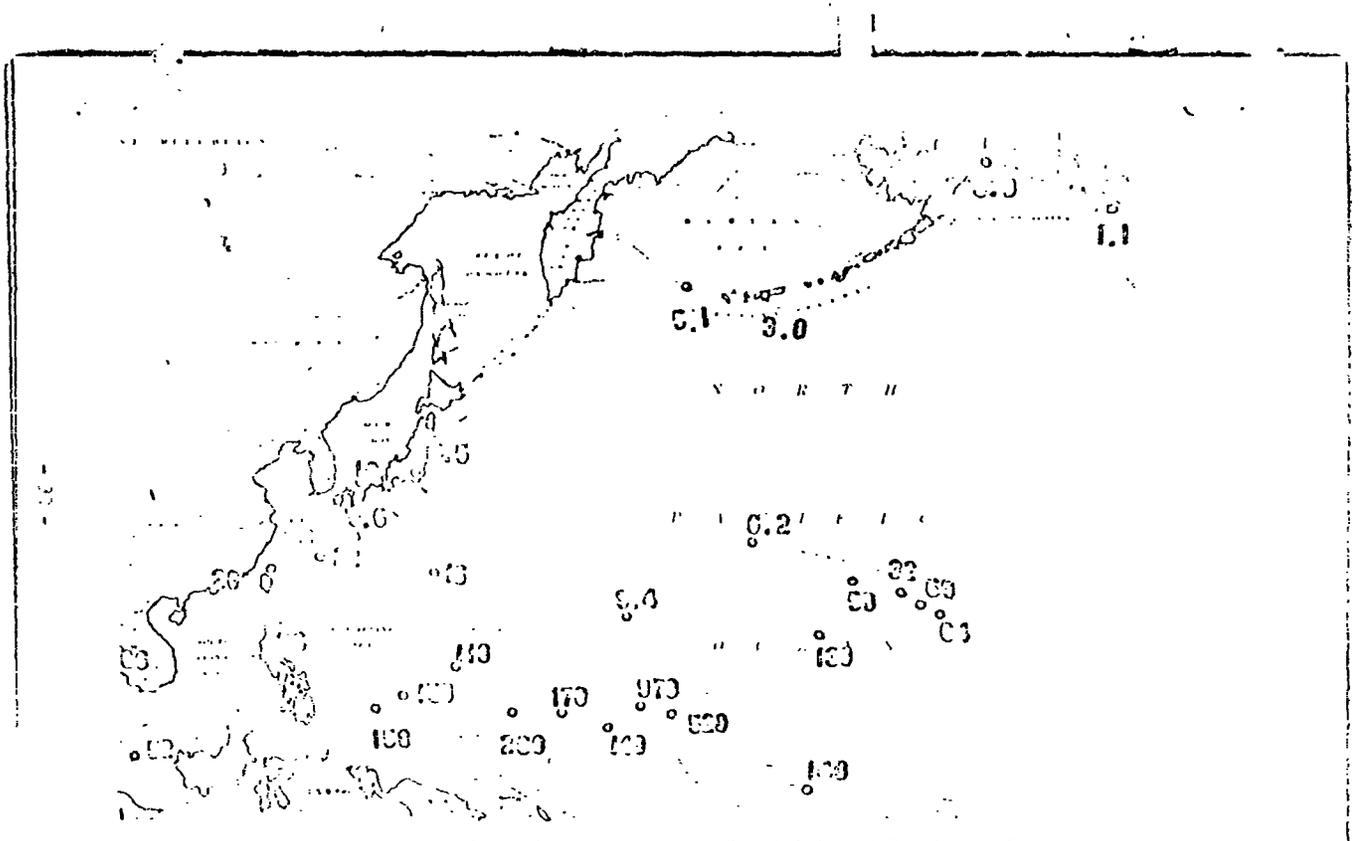
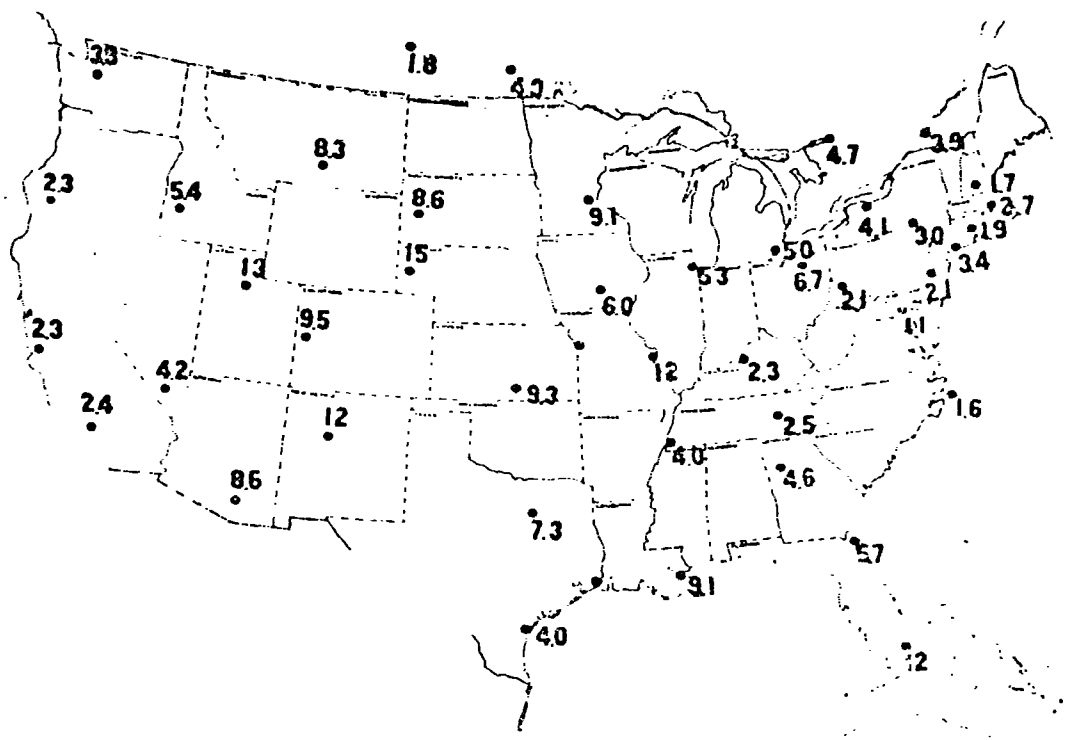


Fig. 21 - Radioactive fallout, Total 2/28 - 5/31/54, Pacific
mc/mi^2, extrapolated to 1/1/55


3.3
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4.7
3.9
8.3
2.3
5.4
8.6
9.1
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3.0
1.9
3.4
1.3
1.5
5.0
5.3
6.7
2.1
2.1
6.0
9.5
2.3
4.2
12
2.3
9.3
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12
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5.7
9.1
4.0
12

- 33 -

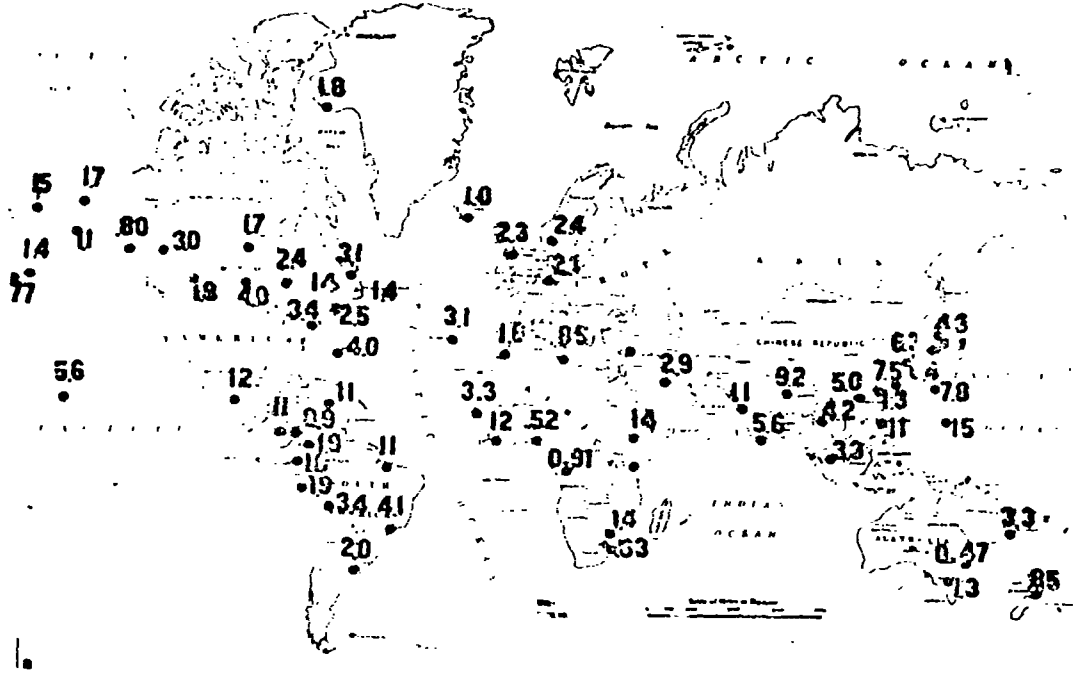


Fig. 13 - Radioactive Fallout, June 1954, Worldwide
mc/mi^2, extrapolated to 1/1/55

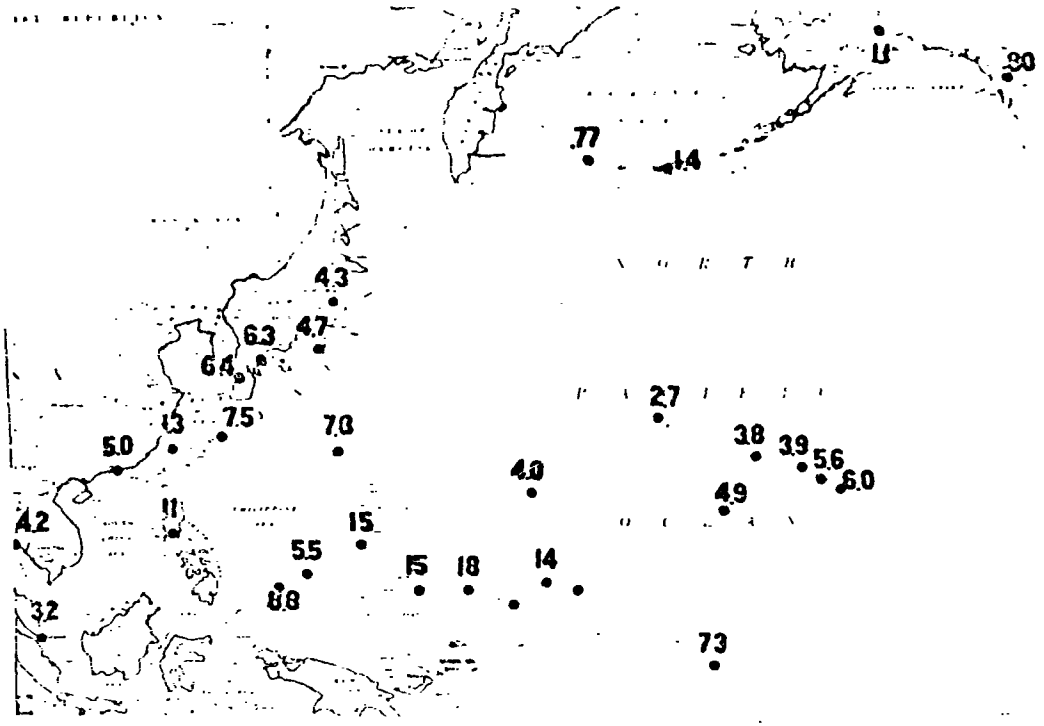
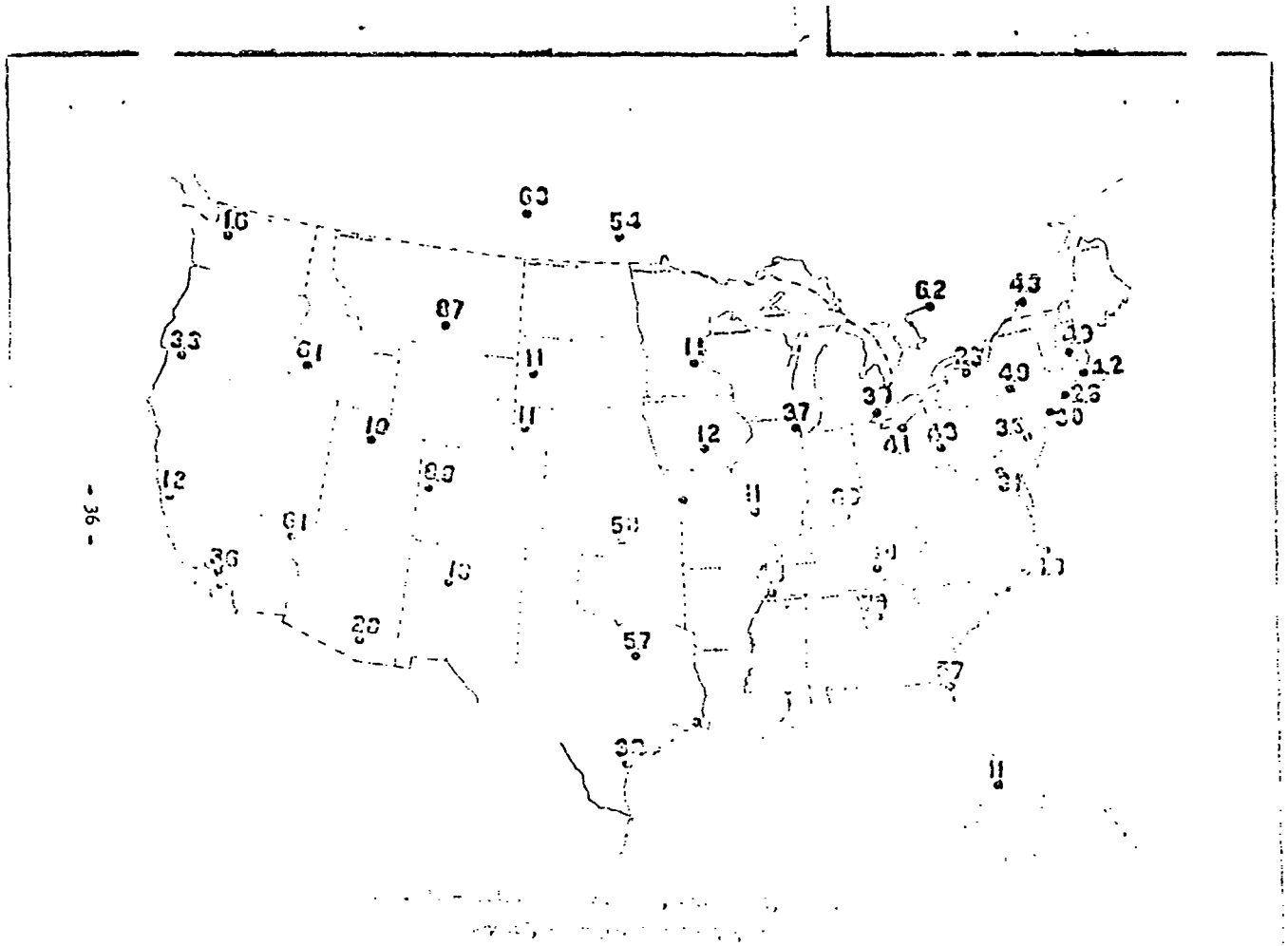


Fig. [illegible] - Radioactive Fallout, June 1954, Pacific
Ocean, corrected to 1/1/55



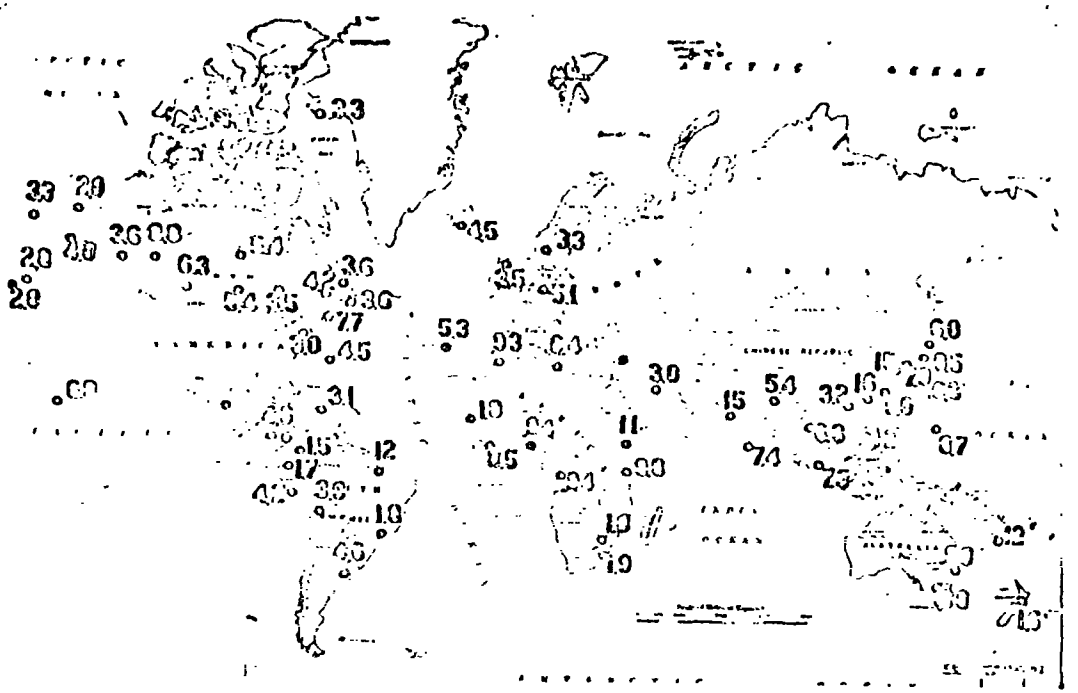
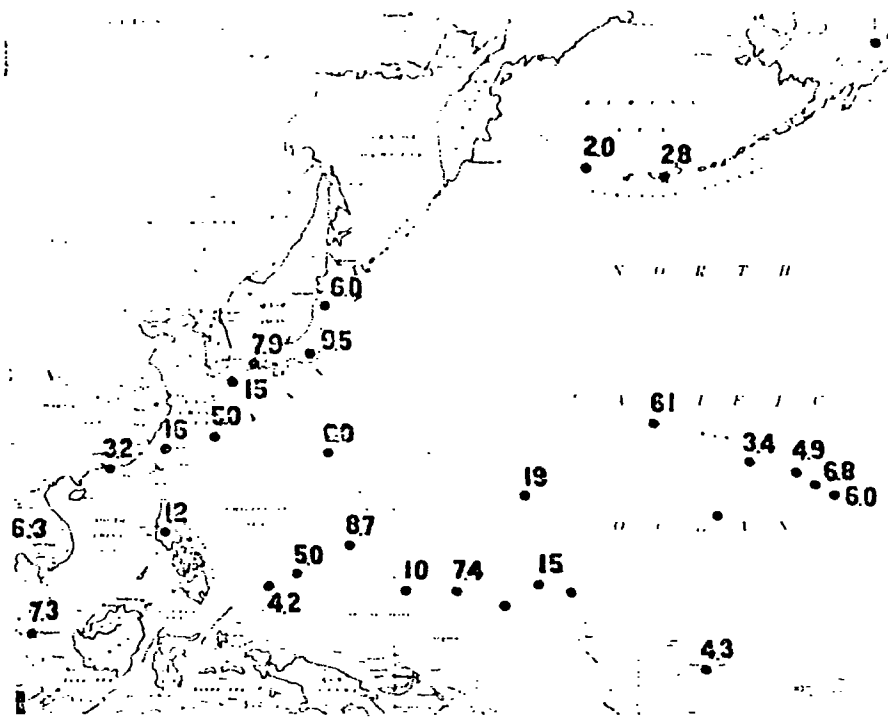


Fig. 16 - Radioactive Fallout, July 1954, Worldwide
mc/mi^2, extrapolated to 1/1/55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3.6
2.0
2.8
N O R T H
6.0
7.9
9.5
15
5.0
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3.2
6.3
12
8.7
5.0
4.2
10
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7.3
6.1
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4.9
6.8
6.0
19
4.3

Fig. 7 - [illegible]

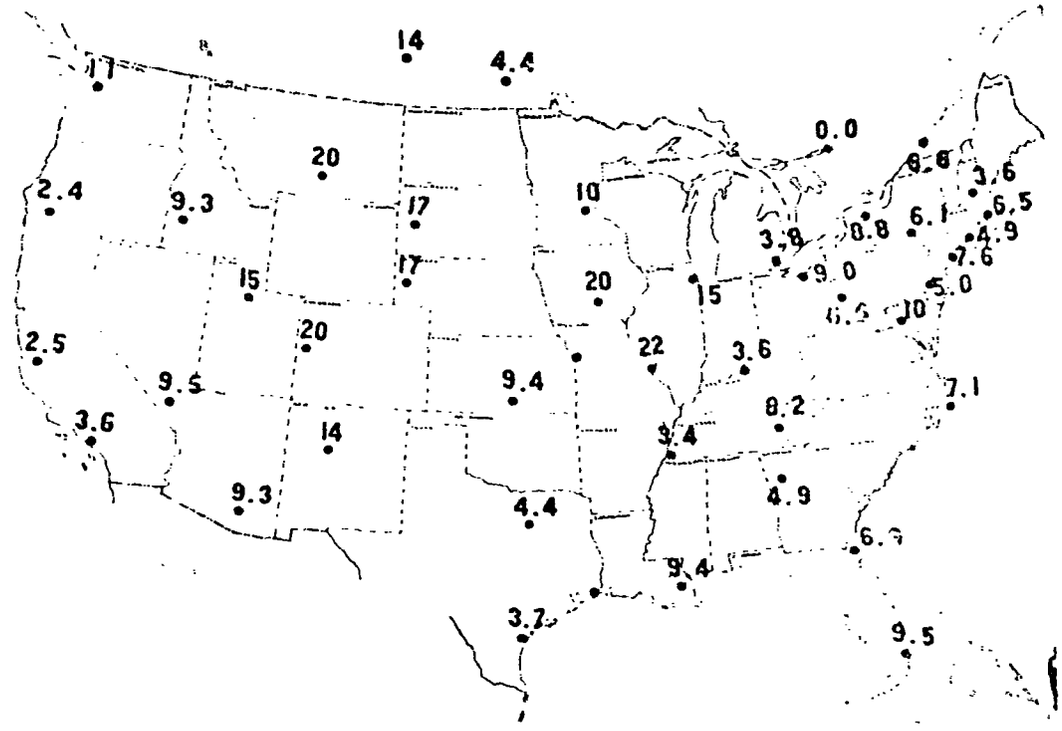


Fig. 23 - Precipitation Pattern, August 1956, U. S.
normal[2], extrapolated to 8/2/56

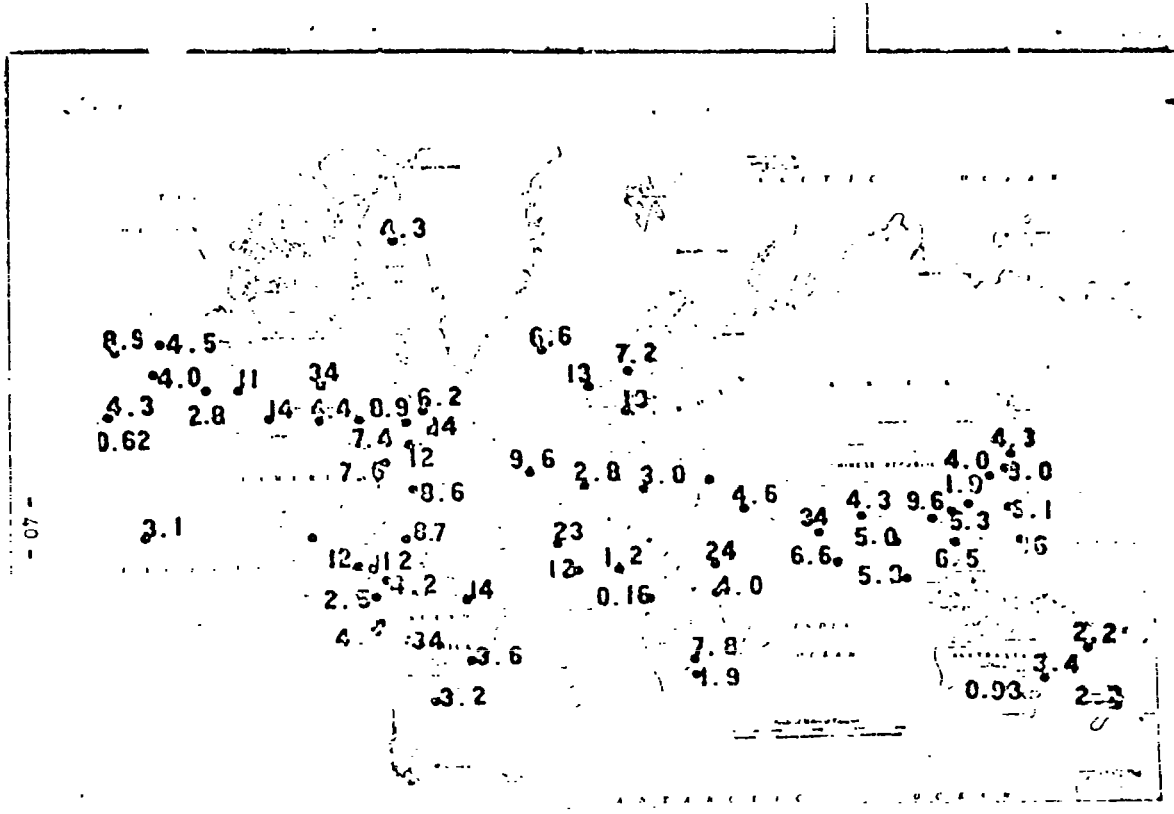
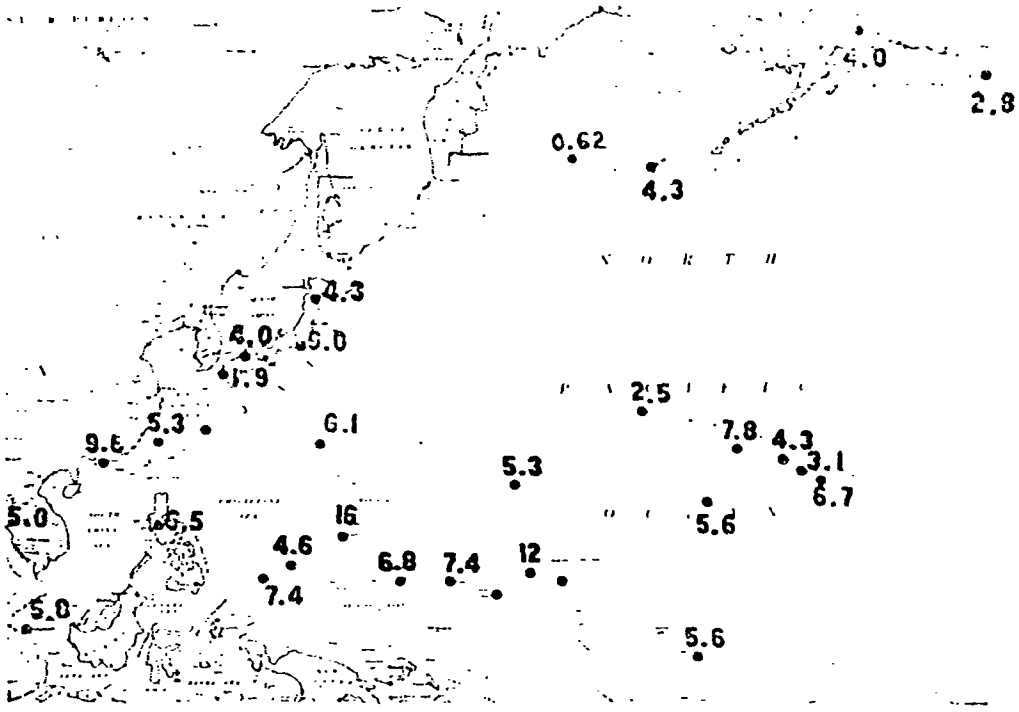


Fig. 39 – Radioactive Fallout, August 1964, worldwide
measurements, extrapolated to 9/65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0.62
4.3
4.3
4.0
5.0
1.9
2.5
5.3
6.1
7.8
4.3
9.6
3.1
5.3
6.7
5.0
5.5
16
5.6
4.6
6.8
7.4
12
7.4
5.0
5.6

END