HASL-55
HEALTH AND SAFETY

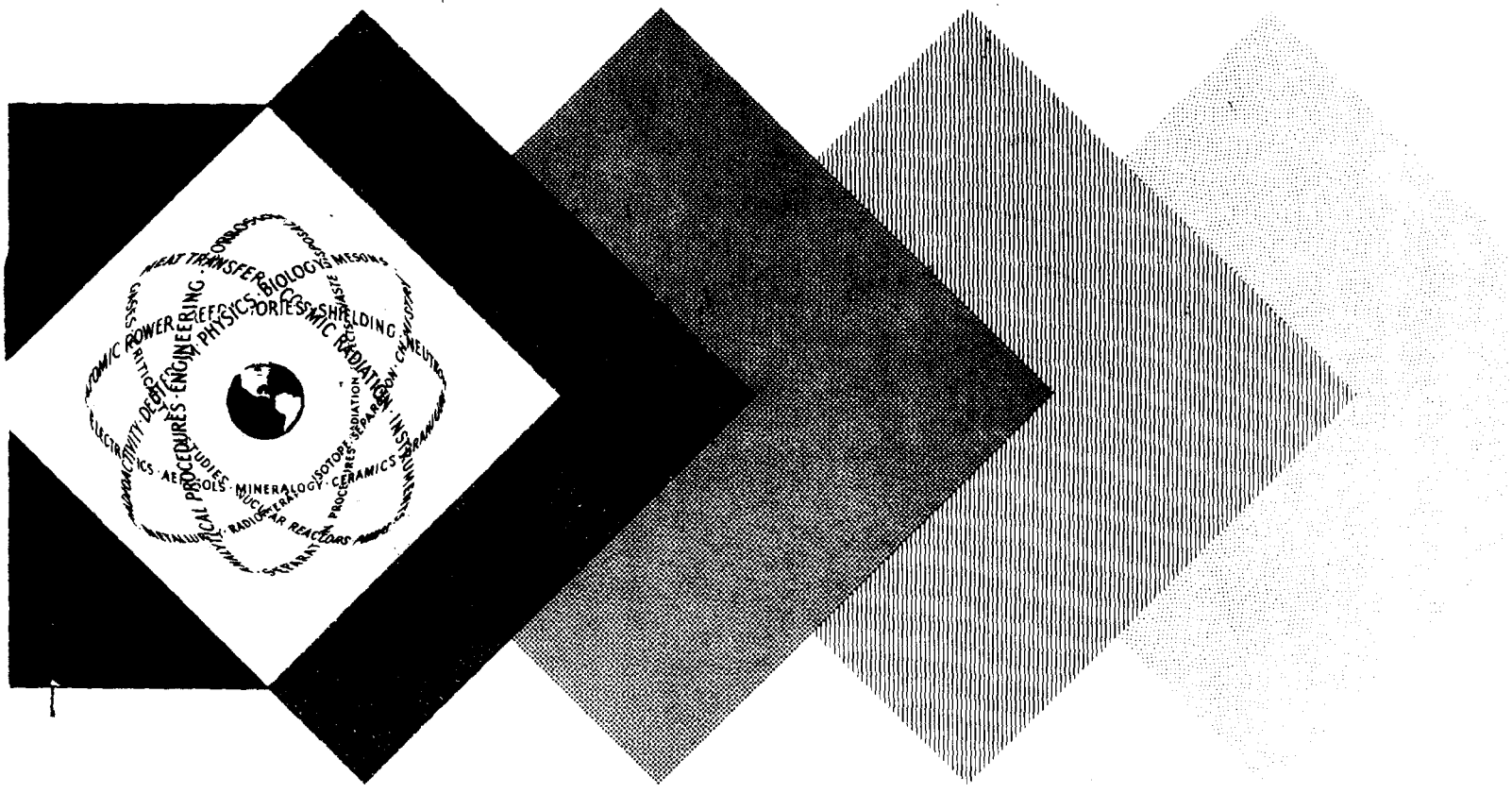
STRONTIUM PROGRAM

Quarterly Summary Report

By
Edward P. Hardy, Jr.
Stanley Klein

February 24, 1959

Health and Safety Laboratory
New York Operations Office
New York, New York



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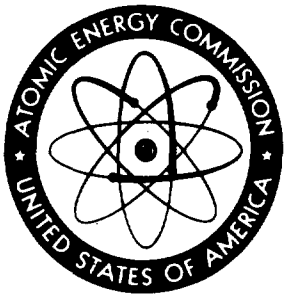

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EXPLANATORY NOTE

The most recent data for milk levels in New York City and Mandan, North Dakota, are not available for this report. This was caused by the loss of the group of samples during analysis. Additional material is presently being analyzed and results will be given in our next report.

Since the preparation of this report additional information has been made available by the U. S. Public Health Service. The results of their milk analyses for October, November, and December are given in the table below.

Strontium-90 in Milk - Micromicrocuries per liter

	October	November	December
Atlanta, Georgia	10.4	8.8	10.2
Austin, Texas	5.1	3.7	2.6
Chicago, Illinois	6.0	8.4	7.0
Cincinnati, Ohio	8.6	15.2	9.6
Fargo, North Dakota	15.0	11.5	12.3
New York, New York	9.5	8.8	7.9
Sacramento, California	1.4	6.1	4.2
Salt Lake City, Utah	3.1	5.2	6.1
Spokane, Washington	8.6	11.9	8.6
St. Louis, Missouri	12.2	20.1	15.6

Abstract

This report is one of a sequence of quarterly reports, each designed to up-date its predecessor beginning with HASL-42, "Environmental Contamination from Weapon Tests". Herein are reported data which have accrued since HASL-51. In particular, the levels of strontium 90 in fallout, milk, tap water, vegetation, and foods are given, based on data available from November 1, 1958 to January 30, 1959.

HASL-55

HEALTH AND SAFETY LABORATORY

STRONTIUM PROGRAM

Quarterly Summary Report

Prepared by

Edward P. Hardy, Jr.
and
Stanley Klein

Analytical Division

February 24, 1959

UNITED STATES ATOMIC ENERGY COMMISSION
New York Operations Office

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Introduction

Quarterly summary reports are prepared by the Health and Safety Laboratory (HASL) with the objective of presenting a current picture of the Strontium Program. It is hoped that these reports will aid investigators in relating their own work to that of others. Thus we urge other investigators to send recent results of their work to the Health and Safety Laboratory for publication in succeeding summaries. No attempt is made to interpret the data in these reports.

This report, which up-dates HASL-51, presents data routinely reported by the Analytical Division of the Health and Safety Laboratory and four contractor laboratories - Nuclear Science and Engineering Corporation, Isotopes, Incorporated, Radiochemistry, Incorporated, and Tracerlab, Incorporated. In addition, this issue includes data submitted by the U. S. Public Health Service and the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft; a Food and Drug Administration summary of their own work also appears. Omission of one phase of the program in a given quarterly period indicates that insufficient information has accrued to justify its inclusion in a given issue.

Please note that data presented in these summaries are subject to revision and that changes in format may occur because of the dynamic nature of the program.

Fallout Monitoring and Documentation

1. Deposition

The two important features of deposition are the total accumulated fallout and the fallout rate. The measurement of fallout rate requires collection over relatively short periods, usually on the order of one month, and radiochemical measurement for Sr^{90}. The stainless steel open vessel or pot, when exposed continuously, collects both dry fallout and material carried down by precipitation. The material carried down by individual rainfalls is also monitored to obtain meteorological information as to the probable atmospheric source of fallout. Such short term collections may also be analyzed for shorter-lived isotopes to estimate the approximate age of the radioactive debris.

The radiochemical analysis of soils allows direct measurement of fallout accumulated since the start of testing.

1.1 Pot Fallout Collections for Radiostrontium

1.11 New York City

The New York City collection pot (exposed surface 0.82 ft^2) is maintained on the roof of the Health and Safety Laboratory building. The following are the conditions of collection and analysis:

1. Samples were collected weekly from February 1954 through December 1956.
2. Since January 1957, samples have been collected monthly.
3. Duplicate pots have been exposed since July 1956.
4. Samples have been collected at the end of a calendar period regardless of whether this coincided with the end of a period during which precipitation occurred.

Recent results of New York City fallout are summarized in Table 1. The cumulative data are plotted in Figure 1.

Normally the cumulative error term represents the counting error but when more than two samples are analyzed for the same period, the standard error of the mean is shown and incorporated into the cumulative error term.

TABLE 1

STRONTIUM 90 IN NEW YORK CITY FALLOUT

(Monthly Pot Collections)

Collection Period from	to	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90}*	Precipitation (inches)
2-1-54	12-31-57	---	39.27 ± 0.75	--	--
1958					
	January	1.20 ± 0.05 1.37 ± 0.05	40.52 ± 0.75	21 17	3.79(6)
	February	1.23 ± 0.07	41.75 ± 0.75	13	2.98(6)
	March	0.94 ± 0.07 0.84 ± 0.07	42.64 ± 0.75	16 18	3.19(6)
	April	1.52 ± 0.42(1)	44.17 ± 0.86	10.5 ± 6(2)	6.14(6)
	May	2.70 ± 0.07 2.57 ± 0.06	46.80 ± 0.86	11 10	3.25
	June	1.84 ± 0.06 1.67 ± 0.05	48.55 ± 0.86	11 12	2.55
	July	1.58 ± 0.29(3)	50.13 ± 0.91	28 ± 5(4)	3.68
	August	0.60 ± 0.05(1)	50.73 ± 0.91	38 ± 7(5)	2.36
	September	0.65 ± 0.11(1)	51.38 ± 0.92	28 ± 1(2)	
	October	1.06 ± 0.33(1)	52.44 ± 0.97	53 ± 15(2)	
	November	0.98 ± 0.21(1)	53.31 ± 1.00	29 ± 11(2)	
	December				

* At midpoint of collection period.

(1) The mean and standard error of four analyses.

(2) See Footnote 1. Only two of four samples were analyzed for Sr^{89}. Therefore this term represents an average ratio and standard deviation of two Sr^{89}/Sr^{90} ratios.

(3) The mean and standard error of three analyses.

(4) Represents an average ratio and standard deviation of three Sr^{89}/Sr^{90} ratios.

(5) Represents an average ratio and standard deviation of four Sr^{89}/Sr^{90} ratios.

(6) Replaces values previously reported in HASL-51.

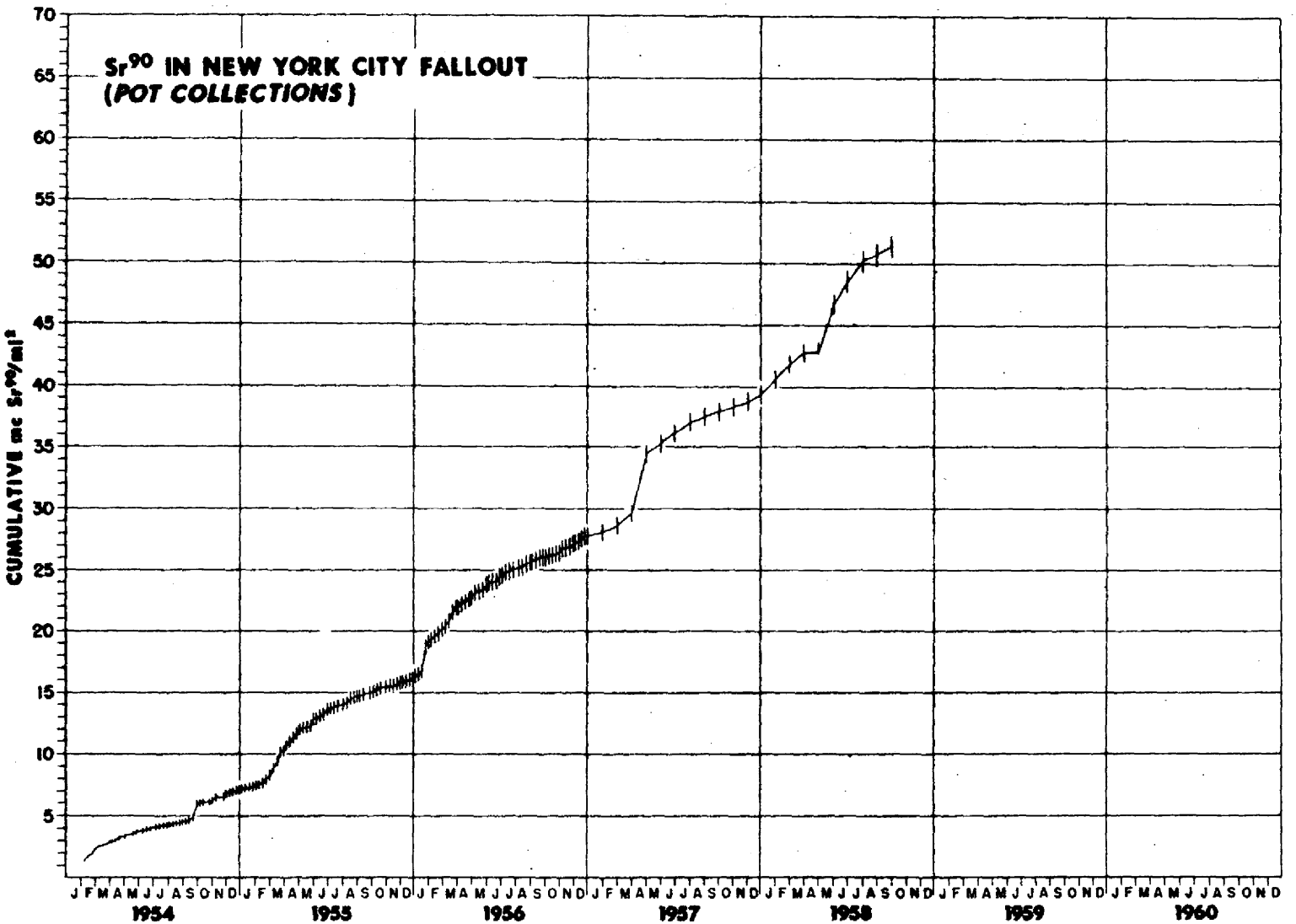

Sr90 IN NEW YORK CITY FALLOUT
(POT COLLECTIONS)
CUMULATIVE mc Sr90/mi2
70
65
60
55
50
45
40
35
30
25
20
15
10
5
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 1

1.12 Other Continental United States Sites

Monthly fallout collectors are maintained at other sites within the continental United States. Exposed surfaces of the collectors are 0.82 ft^2 except at Lemont, Ill. (0.75 ft^2) and Richmond, Calif. (4.91 ft^2). At Pittsburgh, Pa., Westwood, N. J., Houston, Texas, and Richmond, Calif., two collectors are exposed.

Table 2 summarizes the most recently analyzed monthly collections. The Sr^{89}/Sr^{90} ratios have been extrapolated to the midpoint of the collection period. The cumulative levels of strontium 90 for each site are plotted in Figure 2, pages 19 and 20.

Explanation of Error Terms in Table 2

The counting error is shown in the column "mc Sr^{90}/mi^2" and is used to compute the cumulative error term when only one collector is exposed. For two collections, the standard error of the mean is incorporated into the cumulative error term.

TABLE 2

Sr^{90} IN FALLOUT AT OTHER UNITED STATES MONITORING SITES

(Monthly Pot Collections)

Alabama, Birmingham

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	April to November	---	5.05 ± 0.12	--	--
	December	0.40 ± 0.02	5.45 ± 0.12	18	4.01
1958	January	0.66 ± 0.03	6.11 ± 0.12	17	3.42
	February	0.24 ± 0.01	6.35 ± 0.13	12	5.14
	March	0.38 ± 0.02	6.73 ± 0.13	16	3.03
	April	1.67 ± 0.00	8.40 ± 0.13	14	3.51
	May	1.17 ± 0.05	9.56 ± 0.14	15	2.33
	June	0.65 ± 0.04	10.21 ± 0.14	29	3.10
	July	2.11 ± 0.02	12.32 ± 0.14	42	6.79
	August	1.06 ± 0.04	13.38 ± 0.15	44	1.98
	September				
	October				
	November				
	December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

California, Richmond

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958				
March 20				
to	4.47 ± 0.07	3.74 ± 1.04	20	6.64
April 3	3.00 ± 0.05		25	
to	0.38 ± 0.01	4.11 ± 1.04	16	2.57
April 30	0.36 ± 0.01		11	
May	0.33 ± 0.01	4.48 ± 1.04	20	0.80
	0.42 ± 0.01		16	
June	0.21 ± 0.00	4.65 ± 1.05	6	0.47
	0.12 ± 0.00		12	
July	0.046 ± 0.003	4.70 ± 1.08	19	0
	0.062 ± 0.003		15	
August	0.020 ± 0.001	4.91 ± 1.08	27	0
	0.021 ± 0.001		26	
September				
October				
November				
December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

California, West Los Angeles

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90}*	Precipitation (inches)
1956	December				
1957	to November	---	4.74 ± 0.09	--	--
	December	0.20 ± 0.01	4.94 ± 0.10	20	2.10
1958	January	0.44 ± 0.02	5.37 ± 0.10	14	1.49
	February	0.90 ± 0.05	6.28 ± 0.11	11	6.26
	March	1.30 ± 0.08	7.58 ± 0.13	24	5.25
	April	1.50 ± 0.00	9.08 ± 0.13	9	2.04
	May	0.05 ± 0.03	9.13 ± 0.14	33	0.01
	June	0.10 ± 0.01	9.23 ± 0.14	4	trace
	July	0.160 ± 0.003	9.39 ± 0.14	2	trace
	August	0.08 ± 0.01	9.46 ± 0.14	36	0.02
	September				
	October				
	November				
	December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Florida, Coral Gables

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
April 1957 to January 6, 1958	---	5.63 ± 0.07	--	--
1958				
January 6 to February 6	0.29 ± 0.01	5.93 ± 0.08	15	2.63
February 6 to March 6	0.22 ± 0.01	6.14 ± 0.08	11	1.76
March 6 to April 6	0.60 ± 0.00	6.74 ± 0.08	9	5.08
April 6 to May 6	0.49 ± 0.03	7.23 ± 0.08	19	1.70
May 6 to June 6	1.70 ± 0.04	8.93 ± 0.09	26	16.47
June 6 to July 6	1.39 ± 0.08	10.32 ± 0.12	16	9.31
July 6 to August 6	0.77 ± 0.02	11.09 ± 0.12	54	4.30
August 6 to September 6	6.20 ± 0.12	17.29 ± 0.17	9	9.82
September 6 to October 6				3.76
October 6 to November 6				
November 6 to December 6				
December 6 to January 6, 1959				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Illinois, Lemont

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
December 1956 to December 19, 1957	---	5.94 ± 0.07	--	--
1958				
January and February	0.30 ± 0.00	6.24 ± 0.07	9	1.45
March				0.33
April	0.57 ± 0.05		19	1.64
May	0.79 ± 0.03		17	3.12
June	4.87 ± 0.03		13	6.43
July	0.09 ± 0.01		12	4.74
August	3.67 ± 0.10		6	2.51
September				
October				
November				
December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

New Jersey, Westwood

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957					
	August to December	---	4.78 ± 0.45	--	
1958					
	January	1.15 ± 0.02 1.91 ± 0.02	6.31 ± 0.71	-- --	6.42
	February	0.46 ± 0.01 1.00 ± 0.02	7.04 ± 0.81	-- --	
	March	0.99 ± 0.02 1.02 ± 0.02	8.06 ± 0.81	-- --	4.92
	April	1.61 ± 0.04 1.85 ± 0.04	9.79 ± 0.82	28 17	6.38
	May	2.66 ± 0.03 2.95 ± 0.03	12.60 ± 1.04	11 12	3.98
	June	1.06 ± 0.03 1.03 ± 0.02	13.65 ± 1.04	11 16	
	July	1.10 ± 0.02 1.11 ± 0.02	14.76 ± 1.04	38 40	
	August	1.21 ± 0.03 1.01 ± 0.03	15.87 ± 1.06	21 24	
	September	0.67 ± 0.02 0.73 ± 0.02	16.48 ± 1.06	29 25	
	October	1.67 ± 0.03 1.61 ± 0.03	18.12 ± 1.06	44 52	
	November				
	December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Oklahoma, Tulsa

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958				
January	0.35 ± 0.02	0.35 ± 0.02	19	1.78
February	0.40 ± 0.02	0.75 ± 0.03	9	0.86
March	2.29 ± 0.06	3.04 ± 0.07	17	6.14
April 1 to May 5	2.84 ± 0.15	5.88 ± 0.16	21	4.64
May 5 to June 1	2.22 ± 0.67	8.10 ± 0.69	11	3.44
June	1.47 ± 0.05	9.57 ± 0.69	15	
July	1.92 ± 0.05	11.49 ± 0.69	88	
August	1.05 ± 0.03	12.54 ± 0.69	53	
September				
October				
November				
December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Pennsylvania, Pittsburgh

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957				
July 3 to December 31	---	2.07 ± 0.21	--	--
1958				
January	0.57 ± 0.03 0.57 ± 0.03	2.64 ± 0.21	7 7	3.40
February	0.29 ± 0.02 0.33 ± 0.03	2.95 ± 0.21	12 12	1.00
March	0.41 ± 0.02 0.42 ± 0.02	3.36 ± 0.21	12 12	3.36
April	1.20 ± 0.09 0.54 ± 0.54	4.23 ± 0.50	15 13	3.87
May	0.76 ± 0.04 0.73 ± 0.04	4.98 ± 0.51	11 13	3.00
June	2.28 ± 0.14 2.15 ± 0.12	7.19 ± 0.52	1 17	2.28
July	1.89 ± 0.09 2.16 ± 0.12	9.22 ± 0.56	51 42	8.20
August	1.44 ± 0.08 1.47 ± 0.12	10.67 ± 0.57	30 27	
September	0.59 ± 0.03 0.59 ± 0.03	11.26 ± 0.57	31 27	
October	0.48 ± 0.02 0.49 ± 0.02	11.74 ± 0.57	35 29	
November				
December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

South Dakota, Vermillion

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957					
	April to December	---	9.18 ± 0.19	--	--
1958					
	January	0.08 ± 0.01	9.26 ± 0.19	17	0.22
	February	0.38 ± 0.02	9.64 ± 0.19	13	2.13
	March	0.20 ± 0.01	9.84 ± 0.19	13	0.52
	April	2.54 ± 1.00	12.38 ± 0.19	12	3.15
	May	2.28 ± 0.06	14.66 ± 0.21	12	1.85
	June	0.16 ± 0.02	14.82 ± 0.21	5	1.09
	July	2.42 ± 0.08	17.24 ± 0.22	31	4.47
	August	0.50 ± 0.02	17.74 ± 0.22	49	0.19
	September				0.88
	October				
	November				
	December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Texas, Houston

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958				
May	0.37 ± 0.01 0.38 ± 0.02	0.38 ± 0.01	10 9	1.55
June	0.67 ± 0.03 0.74 ± 0.02	1.08 ± 0.32	23 23	2.10
July	0.62 ± 0.02 0.48 ± 0.02	1.63 ± 0.52	66 66	1.94
Aug. 1-Sept. 8	0.61 ± 0.02 0.61 ± 0.02	2.24 ± 0.52	53 61	6.44
September				
October				
November				
December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Utah, Salt Lake City

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1956	December				
	to	---	13.06 ± 0.19	--	--
1957	December				
1958					
	January	0.70 ± 0.05	13.76 ± 0.19	14	0.87
	February	1.10 ± 0.04	14.86 ± 0.20	11	2.20
	March	1.47 ± 0.08	16.33 ± 0.22	29	2.19
	April	2.10 ± 0.05	18.43 ± 0.22	12	2.92
	May	1.30 ± 0.06	19.73 ± 0.23	9	0.30
	June	0.28 ± 0.02	20.01 ± 0.23	12	0.04
	July	0.060 ± 0.003	20.07 ± 0.23	109	0.05
	August	0.71 ± 0.11	20.78 ± 0.26	44	0.23
	September				
	October				
	November				
	December				

* Values extrapolated to midpoint of collection period.

TABLE 2 - Cont'd.

Washington, Seattle

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958					
	April 18 to April 30	0.51 ± 0.01	0.51 ± 0.01	15	1.34
	May	2.12 ± 0.06	2.63 ± 0.06	6	0.92
	June	0.57 ± 0.05	3.20 ± 0.08	26	0.72
	July	0.040 ± 0.003	3.24 ± 0.08	4	trace
	August				0.32
	September				
	October				
	November				
	December				

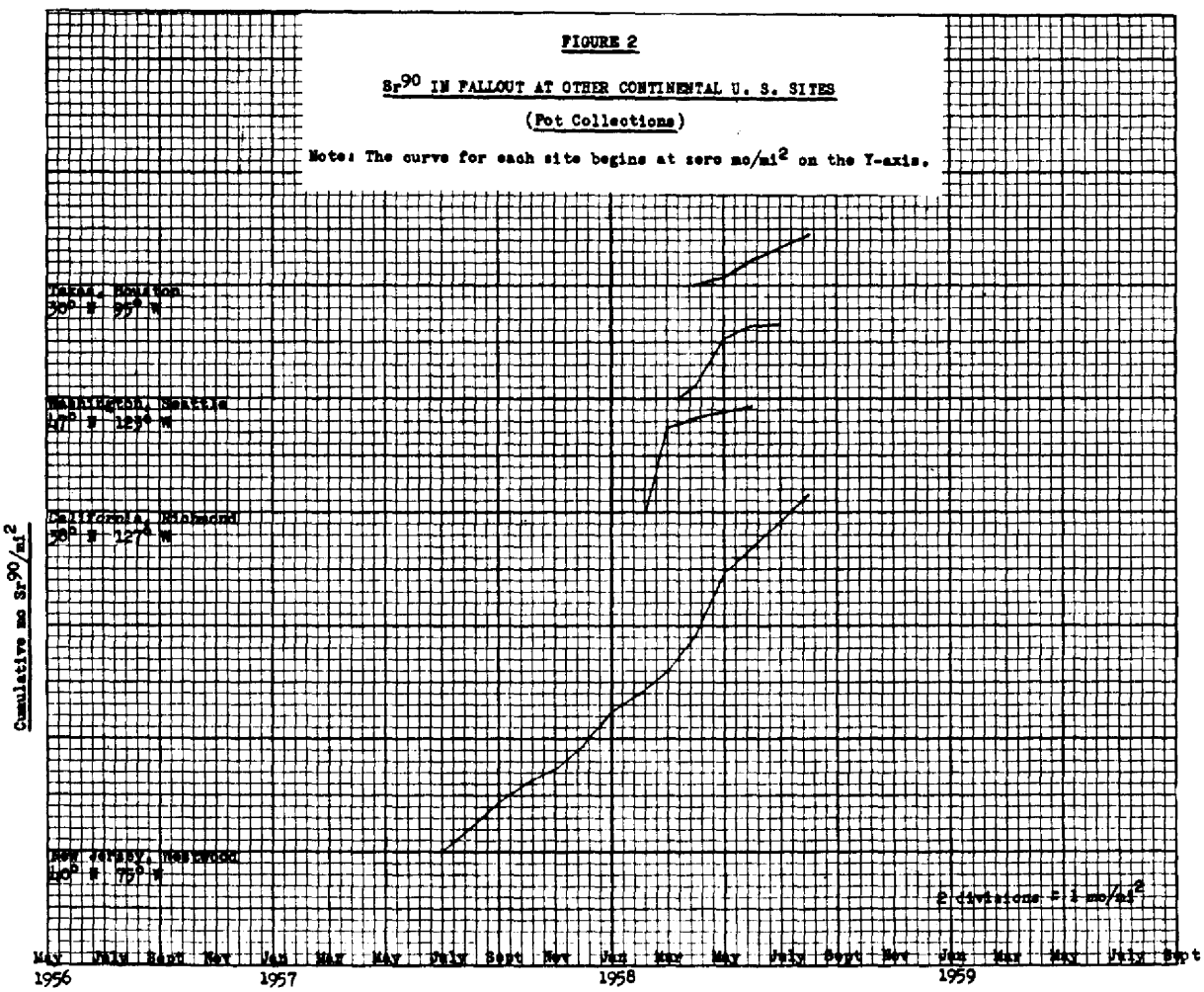
* Values extrapolated to midpoint of collection period.

FIGURE 2

Sr^{90} IN FALLOUT AT OTHER CONTINENTAL U. S. SITES

(Pot Collections)

Note: The curve for each site begins at zero mc/mi^2 on the Y-axis.



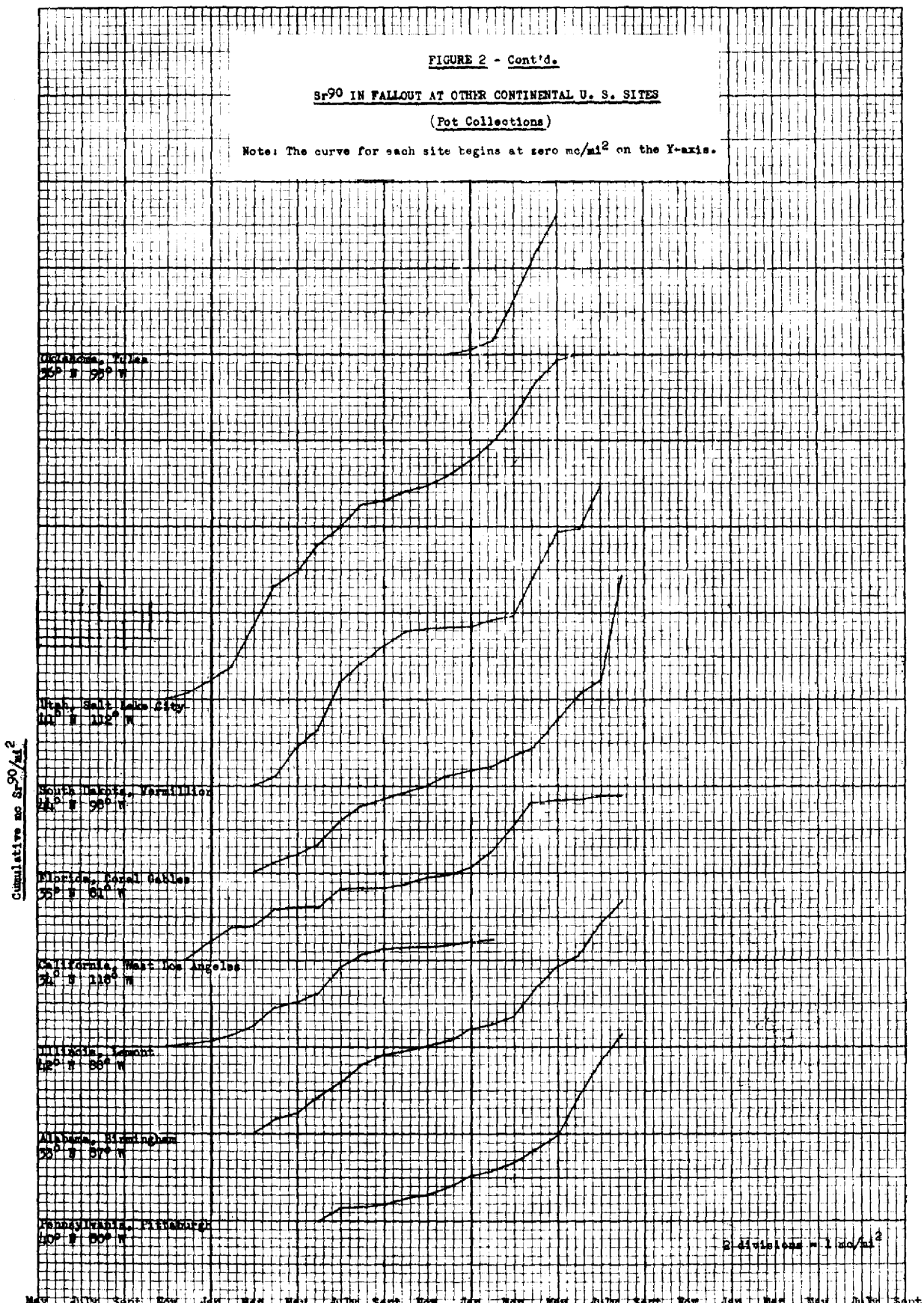
Cont'd.

FIGURE 2 - Cont'd.

Sr^{90} IN FALLOUT AT OTHER CONTINENTAL U. S. SITES

(Pot Collections)

Note: The curve for each site begins at zero mc/mi^2 on the Y-axis.



1.13 Sites Outside Continental United States

Monthly fallout collection pots (exposed surface 0.82 ft^2) are maintained at stations outside the continental United States.

Table 3 up-dates pot data appearing in HASL-51. Figure 3 on pages 40 and 41 depicts the cumulative levels of strontium 90 at each site starting from the most northerly latitude and continuing southward.

The Sr^{89}/Sr^{90} ratios are for the midpoint of the collection period.

The error term represents the standard error of counting.

TABLE 3

OUTSIDE CONTINENTAL UNITED STATES FALLOUT MONITORING SITES

(Monthly Pot Collections)

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
Australia, Adelaide				
1958				
July	0.16 ± 0.01		14	
August				
September				
October				
Australia, Brisbane				
1958				
July	0.011 ± 0.001		0	
August				
September				
October				
Australia, Darwin				
1958				
July	0.43 ± 0.002		13	
August				
September				
October				
Australia, Melbourne				
1958				
June	0.08 ± 0.01	0.08 ± 0.01	3	
July	0.05 ± 0.01	0.13 ± 0.01	21	
August				
September				
October				
November				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
Australia, Perth				
1958				
June 11-July 1	0.093 ± 0.003	0.093 ± 0.003	9	
July	0.156 ± 0.001	0.249 ± 0.003	15	
August				
September				
October				
Australia, Sidney				
1958				
June 3-July 1	0.34 ± 0.02	0.34 ± 0.02	1	
July	0.26 ± 0.01	0.60 ± 0.02	23	
August				
September				
October				
Australia, Townsville				
1958				
June 6-July 1	0.25 ± 0.01	0.25 ± 0.01	16	
July	0.10 ± 0.01	0.35 ± 0.01	4	
August				
September				
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Austria, Klagenfurt

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	August to November	---	1.81 ± 0.06	--	--
	December	0.09 ± 0.02	1.90 ± 0.06	27	
1958	January	0.13 ± 0.01	2.03 ± 0.06	25	2.73
	February	0.17 ± 0.02	2.20 ± 0.07	10	2.34
	March	1.15 ± 0.05	3.35 ± 0.08	29	1.56
	April	1.26 ± 0.06	4.61 ± 0.11	18	
	May				1.56
	June				8.19
	July	3.51 ± 0.12			5.07
	August				6.63
	September				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Austria, Vienna

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	June to November	---	4.03 ± 0.11	--	--
	December	0.11 ± 0.01	4.14 ± 0.11	22	
1958	January	0.16 ± 0.01	4.30 ± 0.11	25	1.17
	February	0.27 ± 0.02	4.57 ± 0.11	14	2.34
	March	0.35 ± 0.01	4.92 ± 0.11	15	2.73
	April	0.71 ± 0.05	5.63 ± 0.12	18	
	May				0.78
	June	3.13 ± 0.08		1	5.85
	July	1.07 ± 0.03		12	1.95
	August				3.90
	September				3.51

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
Brazil, Manaus				
1958				
8/3 to 8/29	0.14 ± 0.02	0.60 ± 0.07	21	
Brazil, Rio de Janeiro				
1956 September to 1957 February	---	0.50 ± 0.07	--	--
1957 March 1 to April 5	0.10 ± 0.02	0.60 ± 0.07		
April 5 to May 1	0.14 ± 0.02	0.74 ± 0.08		1.95
June	0.00 ± 0.02	0.74 ± 0.08		1.56
July	0.03 ± 0.02	0.77 ± 0.08		0.78
August	0.39 ± 0.04	1.16 ± 0.09		2.73
Chile, Santiago				
1958				
June				
July	0.13 ± 0.01		53	
August				
September				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Columbia, Bogota

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	August to September	---	0.04 ± 0.01	--	--
	October	≤0.01	0.05 ± 0.01		4.63
	November	Sample not available			1.70
	December	≤0.01	0.06 ± 0.02		0.43
1958	January	0.04 ± 0.01	0.10 ± 0.02	12	0.35
	February	0.04 ± 0.01	0.14 ± 0.02	15	0.61
	March	0.12 ± 0.01	0.26 ± 0.02	4	1.79
	April	0.03 ± 0.02	0.29 ± 0.03	33	2.89
	May	0.12 ± 0.01	0.41 ± 0.03	13	1.05
	June	0.02 ± 0.03	0.43 ± 0.03	133	
	July	0.10 ± 0.01	0.53 ± 0.10	43	
	August				
	September				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Hawaii, Oahu (Cocoonut Island, A.E.C. Laboratory)

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
June 1957 to January 6, 1958	---	4.82 ± 0.14	--	--
1958 to February 3	0.32 ± 0.02	5.14 ± 0.14	15	
to March 3	0.95 ± 0.05	6.09 ± 0.15	10	
to April 1	1.68 ± 0.09	7.77 ± 0.17	15	
April	1.98 ± 0.12	9.75 ± 0.21	18	
May				
June	1.13 ± 0.03		27	
July	0.16 ± 0.04		24	
August	0.90 ± 0.06		35	
September				
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Hawaii, Oahu (Coconut Island, Weather Station)

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
July 1957 to January 6, 1958	---	3.93 ± 0.02	--	--
1958 to February 3	0.22 ± 0.01	4.15 ± 0.02	15	
to March 3	0.70 ± 0.05	4.85 ± 0.05	9	
to April 1	1.65 ± 0.08	6.50 ± 0.10	14	
May	0.90 ± 0.02	7.40 ± 0.10	18	
June	0.08 ± 0.02	7.48 ± 0.10	2	
July	1.16 ± 0.04	8.64 ± 0.11	45	
August	0.51 ± 0.05	9.15 ± 0.12	46	
September				
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Hawaii, Oahu (University of Hawaii, Gartley Hall)

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
June 1957 to January 6, 1958	---	2.81 ± 0.10	--	--
1958 to February 3	0.71 ± 0.03	3.52 ± 0.10	15	
to March 3	0.36 ± 0.02	3.88 ± 0.11	11	
to April 2	1.33 ± 0.08	5.21 ± 0.13	21	
May 6/6 - 7/1	1.21 ± 0.05		2	
July	0.07 ± 0.01		55	
August	0.70 ± 0.03		54	
September				
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Japan, Hiroshima

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
August 1956 to December 1957	---	5.80 ± 0.12	--	--
1958				
January	0.24 ± 0.04	6.04 ± 0.13	23	2.65
February	0.25 ± 0.01	6.29 ± 0.13	20	2.95
March	0.92 ± 0.06	7.21 ± 0.14	11	4.88
April	3.37 ± 0.02	10.58 ± 0.14	10	10.49
May	1.06 ± 0.06	11.64 ± 0.15	14	3.74
June	0.64 ± 0.02	12.28 ± 0.15	11	3.98
July	0.43 ± 0.02	12.71 ± 0.15	0	6.90
August	2.66 ± 0.07	15.37 ± 0.17	17	9.87
September				3.59
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Japan, Nagasaki

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
August 1956 to December 1957	---	7.90 ± 0.15	--	--
1958				
January	0.60 ± 0.05	8.50 ± 0.16	16	2.50
February	0.55 ± 0.03	9.05 ± 0.16	9	2.77
March	1.13 ± 0.06	10.18 ± 0.17	14	5.38
April	2.52 ± 0.07	12.70 ± 0.19	15	14.94
May	1.75 ± 0.06	14.45 ± 0.20	4	7.29
June	0.88 ± 0.11	15.33 ± 0.23	35	5.93
July	2.10 ± 0.05	17.43 ± 0.23	86	1.33
August	0.50 ± 0.03	17.93 ± 0.23	60	14.27
September				2.77
October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Kenya, Kikuyu

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957					
	January to December	---	1.30 ± 0.07	--	--
1958					
	January	0.03 ± 0.01	1.33 ± 0.07	22	
	February	0.14 ± 0.03	1.47 ± 0.08	12	
	March	0.22 ± 0.01	1.69 ± 0.08	5	
	April				
	May	0.90 ± 0.05			
	June	0.22 ± 0.01		5	
	July	0.26 ± 0.01		30	
	August	0.13 ± 0.01		48	
	September			24	
	October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Pakistan, Karachi

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958					
	February	0.02 ± 0.01	0.02 ± 0.01	45	0.39
	March	0.07 ± 0.00	0.09 ± 0.01	40	0
	April	0.13 ± 0.01	0.22 ± 0.01	4	0
	May	0.39 ± 0.01	0.61 ± 0.02	3	0
	June	0.07 ± 0.01	0.68 ± 0.02	13	0
	July				
	August				
	September				

Senegal, Dakar

1958					
	7/5 to 8/4	0.23 ± 0.02	0.23 ± 0.02		0
	8/4 to 9/4	0.033 ± 0.003	0.26 ± 0.02		0

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

South Rhodesia, Salisbury

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90}	Precipitation (inches)
November 1956 to May 1957	---	0.58 ± 0.06	--	--
1957				
June to October	Samples not collected			
November	0.11 ± 0.01	0.11 ± 0.01		1.32
December	0.10 ± 0.02	0.21 ± 0.02		9.21
1958				
January	0.10 ± 0.01	0.31 ± 0.02	4	5.87
February	0.04 ± 0.01	0.35 ± 0.02	5	8.98
March	0.02 ± 0.01	0.37 ± 0.03	8	0.57
April				1.87
May	0.55 ± 0.04			Nil
June	0.02 ± 0.003		9	
July	0.02 ± 0.003		14	
August	0.05 ± 0.004		0	
September				
October				

TABLE 3 - Cont'd.

Taiwan, Tainan

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1958	January	0.03 ± 0.01	0.03 ± 0.01	27	
	February	0.07 ± 0.01	0.10 ± 0.01	12	
	March	0.19 ± 0.02	0.29 ± 0.02	10	
	April	0.05 ± 0.00	0.34 ± 0.02	12	
	May				
	June	0.22 ± 0.02		47	
	July	1.01 ± 0.02		65	
	August	0.30 ± 0.01		10	
	September				

Taiwan, Taipei

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90}	Precipitation (inches)
1958	February	0.15 ± 0.01	0.15 ± 0.01	9	9.36
	March	0.10 ± 0.01	0.25 ± 0.01	14	5.46
	April	0.57 ± 0.01	0.82 ± 0.02	11	2.34
	May				4.29
	June	1.01 ± 0.03		34	8.58
	July	0.07 ± 0.01		327	19.50
	August	0.57 ± 0.02		51	4.68
	September				7.02

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Taiwan, Taitung

Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90}*	Precipitation (inches)
1958				
April	0.22 ± 0.01	0.22 ± 0.01	10	
May				
June	0.57 ± 0.06		56	
July	0.45 ± 0.02		51	
August	0.07 ± 0.004		1	
September				
October				
November				

Tasmania, Hobart

1958				
6/13 to 7/1	0.08 ± 0.02	0.08 ± 0.02	2.2	
July	1.07 ± 0.10	1.15 ± 0.10	0	
August				
September				
October				
November				
December				

TABLE 3 - Cont'd.

Thailand, Bangkok

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	March to November	---	0.38 ± 0.04	---	--
	December	Sample not collected			
1958	January	0.12 ± 0.01	0.50 ± 0.04	8	1.56
	February	Sample lost in transit			1.56
	March	0.04 ± 0.00	0.54 ± 0.04	5	0.12
	April	0.04 ± 0.03	0.58 ± 0.05	44	0.12
	5/1 to 6/4	0.05 ± 0.03	0.63 ± 0.06	17	1.56
	6/4 to 7/3	0.17 ± 0.01	0.80 ± 0.06	79	
	7/3 to 8/1	0.40 ± 0.02	1.20 ± 0.06	86	
	August				
	September				
	October				
	November				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Union of South Africa, Durban

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	June to December	----	1.27 ± 0.05	--	--
1958	January	0.02 ± 0.01	1.29 ± 0.05		9.75
	February	0.18 ± 0.01	1.47 ± 0.05	12	10.53
	March	0.09 ± 0.01	1.56 ± 0.05	3	4.68
	April				11.70
	May	0.91 ± 0.05			0.39
	June	0.04 ± 0.003		34	0.78
	July	0.44 ± 0.02		4	0.78
	August	0.02 ± 0.002		15	
	September				
	October				

* Values extrapolated to midpoint of collection period.

TABLE 3 - Cont'd.

Union of South Africa, Pretoria

	Collection Period	mc Sr^{90}/mi^2	Cumulative mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} *	Precipitation (inches)
1957	July to November	---	0.87 ± 0.03	--	--
	December	0.12 ± 0.01	0.99 ± 0.03		0.63
1958	January	0.10 ± 0.01	1.09 ± 0.03	19	4.91
	February	0.06 ± 0.01	1.15 ± 0.03	4	1.13
	March	0.11 ± 0.00	1.26 ± 0.03	3	3.32
	April	0.17 ± 0.06	1.43 ± 0.07	3	3.39
	May	0.49 ± 0.04	1.92 ± 0.08	--	0.92
	June	0.02 ± 0.003	1.94 ± 0.08	38	0
	July				0
	August				
	September				
	October				

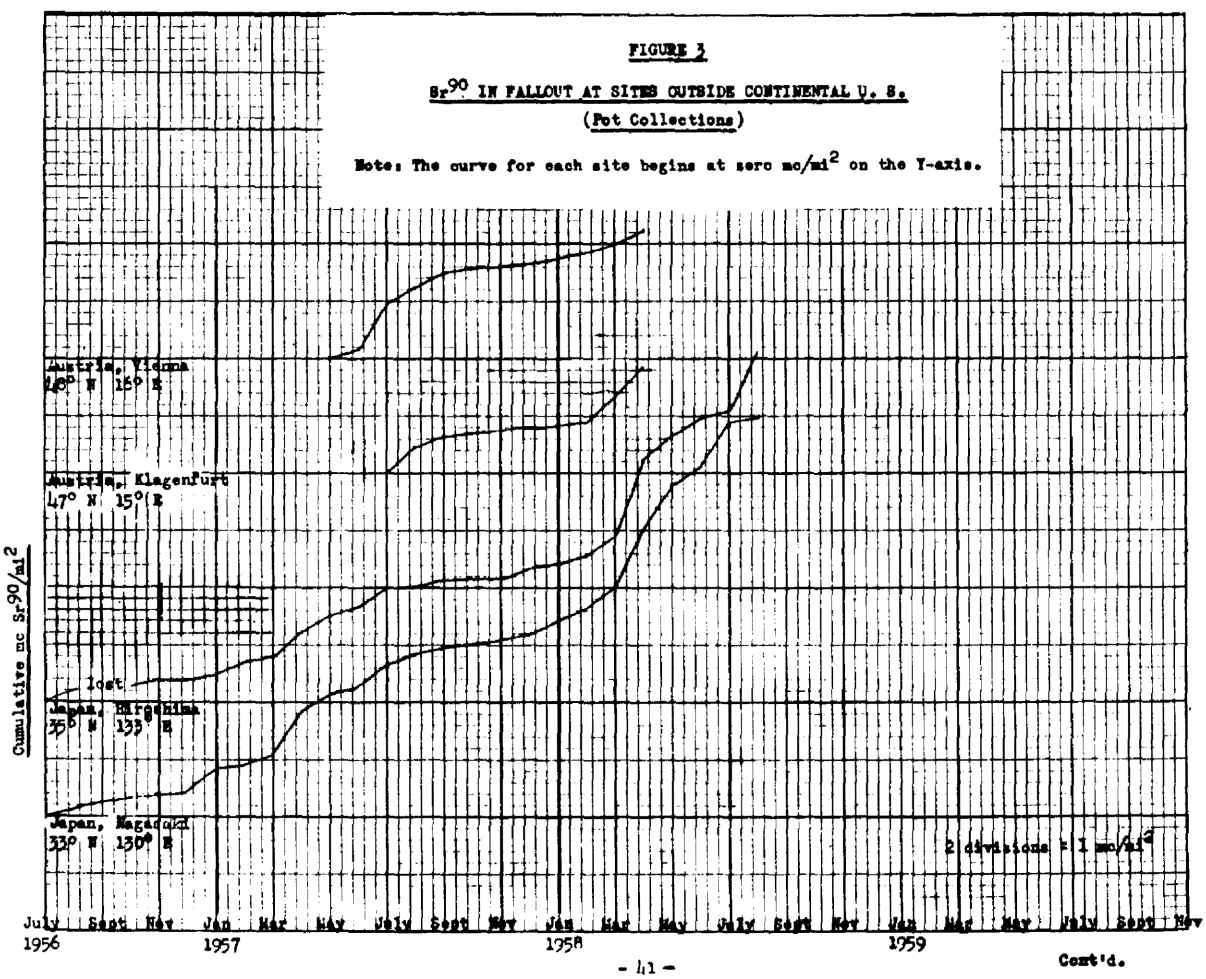
* Values extrapolated to midpoint of collection period.

FIGURE 3

Sr^{90} IN FALLOUT AT SITES OUTSIDE CONTINENTAL U. S.

(Pot Collections)

Note: The curve for each site begins at zero mc/mi^2 on the Y-axis.



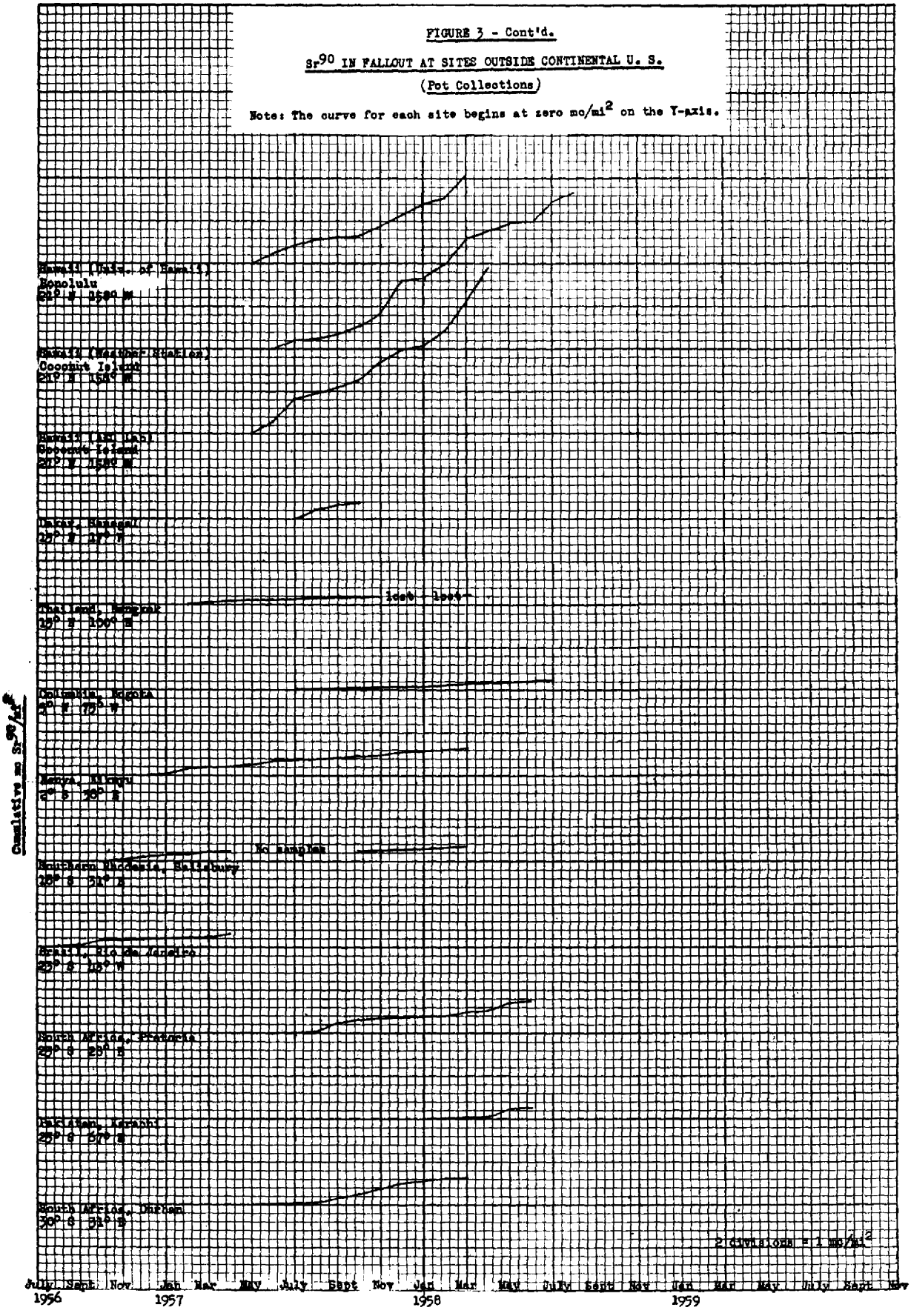
Cont'd.

FIGURE 3 - Cont'd.

Sr^{90} IN FALLOUT AT SITES OUTSIDE CONTINENTAL U. S.

(Pot Collections)

Note: The curve for each site begins at zero mc/mi^2 on the Y-axis.



1.2 Precipitation Collections for Radiostrontium and Radiobarium

In precipitation collections, two collectors are simultaneously exposed during dry and rainy weather. The collection period terminates immediately after a precipitation or after a week of no rainfall.

1.21 Pittsburgh, Pennsylvania

Since February 1955, precipitation collections have been made by Nuclear Science and Engineering Corporation in galvanized tubs (exposed surface 2.58 ft^2 per tub).

Table 4 up-dates the Pittsburgh precipitation data in HASL-51. Figure 4 depicts cumulative Sr^{90} fallout. The cumulative error terms represent the standard error of duplicate analyses.

Until February 1957, the contents of the two tubs were combined resulting in one analysis for the collection period. Since February 1957, the contents of each tub have been analyzed separately.

Precipitation values were obtained from the United States Weather Bureau until June 19, 1957. Since then, precipitation has been measured by Nuclear Science and Engineering personnel using a Fisher # 1-242-5 United States Weather Bureau type rain gauge.

TABLE 4

STRONTIUM 90 IN PITTSBURGH, PENNSYLVANIA FALLOUT

(Precipitation Collections)

Collection Period from	to	mc Sr^{90}/mi^2	Cumulative* mc Sr^{90}/mi^2	d/m Sr^{90}/liter	Sr^{89}/Sr^{90} **	Ba^{140}/Sr^{90} **	Precipitation in inches
2-25-55	7-7-58	---	31.04 ± 0.24	---	--	--	--
7-7-58	7-8-58	0.013 ± 0.002 0.016 ± 0.003	31.06 ± 0.24	22.5 ± 4.2 27.5 ± 4.2	21 22	<9.2 38	0.02
7-8-58	7-11-58	0.244 ± 0.015 0.258 ± 0.015	31.31 ± 0.24	6.6 ± 0.4 7.0 ± 0.4	40 57	66 95	1.25
7-11-58	7-12-58	0.067 ± 0.010 0.060 ± 0.004	31.37 ± 0.24	8.7 ± 1.3 7.9 ± 0.5	36 43	64 70	0.26
7-12-58	7-14-58	0.097 ± 0.007 0.076 ± 0.006	31.46 ± 0.25	11.7 ± 0.9 9.2 ± 0.7	43 53	63 80	0.28
7-14-58	7-15-58	0.132 ± 0.007 0.111 ± 0.006	31.58 ± 0.25	5.7 ± 0.3 4.8 ± 0.3	43 56	48 80	0.78
7-15-58	7-16-58	0.056 ± 0.004 0.058 ± 0.003	31.64 ± 0.25	6.6 ± 0.5 6.8 ± 0.3	80 67	127 126	0.29
7-16-58	7-21-58	0.048 ± 0.004 0.056 ± 0.006	31.69 ± 0.25	--- ---	50 33	165 86	trace
7-21-58	7-22-58	0.190 ± 0.010 0.200 ± 0.010	31.89 ± 0.25	7.4 ± 0.4 7.7 ± 0.4	62 63	81 59	0.88
7-22-58	7-23-58	0.055 ± 0.003 0.060 ± 0.003	31.94 ± 0.25	5.3 ± 0.3 5.8 ± 0.3	58 52	65 60	0.35
7-23-58	7-24-58	0.150 ± 0.008 0.180 ± 0.010	32.11 ± 0.25	12.7 ± 0.6 15.3 ± 0.7	28 24	17 20	0.40
7-24-58	7-25-58	0.026 ± 0.003 0.019 ± 0.002	32.13 ± 0.25	30.0 ± 2.8 21.7 ± 2.2	22 23	13 21	0.03
7-25-58	7-29-58	0.173 ± 0.010 0.159 ± 0.008	32.30 ± 0.25	4.2 ± 0.2 3.8 ± 0.2	66 70	66 80	1.40
7-29-58	7-30-58	0.057 ± 0.005 0.076 ± 0.010	32.36 ± 0.25	7.63 ± 0.66 10.20 ± 1.32	32.6 27.4	36.0 33.0	0.25
7-30-58	7-31-58	0.205 ± 0.010 0.189 ± 0.010	32.56 ± 0.25	6.1 ± 0.3 5.7 ± 0.3	35 31	29 36	1.13
7-31-58	8-1-58	0.041 ± 0.003 0.039 ± 0.003	32.60 ± 0.25	3.8 ± 0.3 3.5 ± 0.3	62 62	58 74	0.37
8-1-58	8-3-58	0.149 ± 0.007 0.131 ± 0.007	32.74 ± 0.25	2.7 ± 0.1 2.4 ± 0.1	37 42	32 36	1.88
8-3-58	8-7-58	0.076 ± 0.008 0.078 ± 0.005	32.82 ± 0.25	2.20 ± 0.21 2.25 ± 0.03	24.9 27.9	23.2 23.3	0.17
8-7-58	8-8-58	0.34 ± 0.02 0.32 ± 0.02	33.15 ± 0.25	9.86 ± 0.56 9.30 ± 0.42	21.8 21.9	13.2 13.4	1.17
8-8-58	8-12-58	0.061 ± 0.004 0.063 ± 0.005	33.21 ± 0.25	22.91 ± 1.45 23.64 ± 1.82	43.6 45.4	44.0 42.5	0.09

* The cumulative error term represents the standard error of duplicate analyses.
** Values extrapolated to midpoint of sampling period.

TABLE 4 - Cont'd.

Collection Period from	to	mc Sr^{90}/mi^2	Cumulative* mc Sr^{90}/mi^2	d/m Sr^{90}/liter	Sr^{89}/Sr^{90} **	Ba^{140}/Sr^{90} **	Precipitation in inches
8-12-58	8-14-58	0.022 ± 0.005 0.018 ± 0.005	33.23 ± 0.25	18.75 ± 4.17 15.83 ± 4.17	35.0 43.9	29.1 33.9	0.04
8-14-58	8-15-58	0.078 ± 0.006 0.069 ± 0.005	33.30 ± 0.25	20.25 ± 1.52 17.85 ± 1.27	33.6 34.2	24.5 29.7	0.13
8-15-58	8-16-58	0.098 ± 0.008 0.097 ± 0.008	33.40 ± 0.25	19.51 ± 1.46 19.42 ± 1.46	37.1 39.1	22.1 19.6	0.17
8-16-58	8-17-58	0.012 ± 0.005 0.015 ± 0.004	33.41 ± 0.25	--- ---	13.3 16.0	15.8 <100	trace
8-17-58	8-21-58	0.067 ± 0.004 0.061 ± 0.005	33.48 ± 0.25	18.77 ± 1.10 17.26 ± 1.37	28.7 23.3	19.7 12.0	0.12
8-21-58	8-22-58	0.067 ± 0.004 0.062 ± 0.004	33.54 ± 0.25	20.60 ± 1.19 18.96 ± 1.04	22.8 27.6	16.0 29.0	0.11
8-22-58	8-25-58	0.151 ± 0.055 0.131 ± 0.012	33.68 ± 0.25	5.4 ± 0.2 4.6 ± 0.4	29.7 30.1	19.2 26.0	0.95
8-25-58	9-2-58	0.123 ± 0.022 0.119 ± 0.024	33.80 ± 0.25	31.9 ± 5.8 30.9 ± 6.2	24.6 28.7	-- --	0.13
9-2-58	9-5-58	0.115 ± 0.007 0.131 ± 0.006	33.93 ± 0.25	6.04 ± 0.39 6.89 ± 0.31	26.8 28.2	12.2 14.5	0.64
9-5-58	9-7-58	0.068 ± 0.007 0.055 ± 0.004	33.99 ± 0.25	5.22 ± 0.56 4.25 ± 0.26	25.9 33.1	13.2 23.6	0.44
9-7-58	9-14-58	<0.020 <0.010	34.00 ± 0.25	--- ---	>10 <23	-- --	0
9-14-58	9-16-58	0.040 ± 0.004 0.058 ± 0.005	34.05 ± 0.25	6.80 ± 0.57 9.84 ± 0.82	26.5 19.1	7.5 5.5	0.20
9-16-58	9-17-58	0.041 ± 0.003 0.054 ± 0.006	34.10 ± 0.25	3.9 ± 0.3 5.2 ± 0.6	32.0 15.2	9.0 6.1	0.35
9-17-58	9-18-58	0.018 ± 0.004 0.011 ± 0.003	34.12 ± 0.25	7.76 ± 1.43 4.6 ± 1.02	18.9 29.1	5.0 <5.5	0.08
9-18-58	9-21-58	0.041 ± 0.004 0.051 ± 0.006	34.16 ± 0.25	1.29 ± 0.13 1.60 ± 0.20	38.0 33.9	10.5 10.0	1.08
9-21-58	9-22-58	0.020 ± 0.005 0.019 ± 0.007	34.18 ± 0.25	8.5 ± 2.0 8.0 ± 2.7	18.5 19.5	-- --	0.08
10-11-58	10-18-58	0.034 ± 0.003 0.033 ± 0.003		28.3 ± 2.5 27.4 ± 2.5	22.9 39.4	102.1 102.1	0.04

* The cumulative error term represents the standard error of duplicate analyses.
** Values extrapolated to midpoint of sampling period.

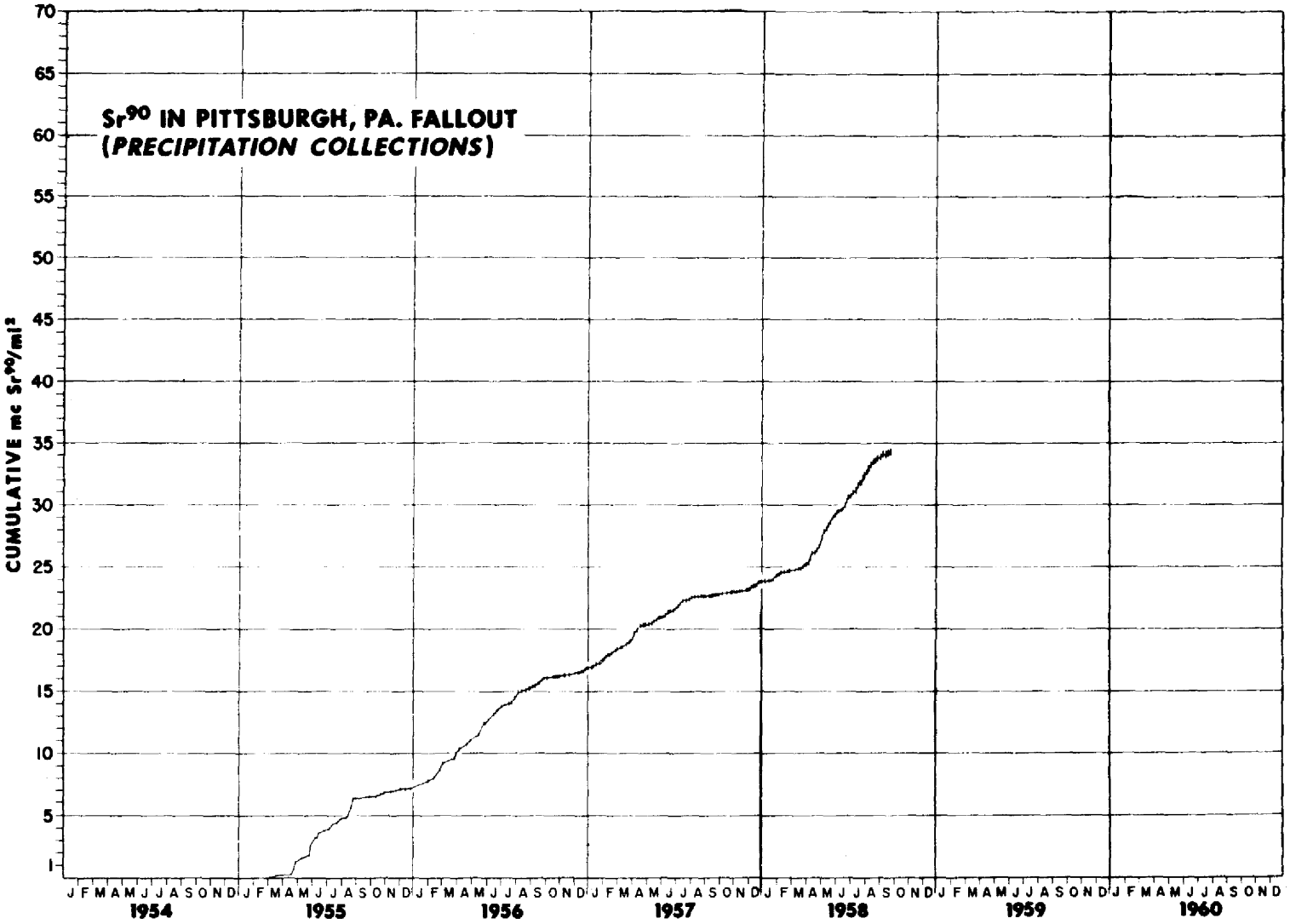

Sr90 IN PITTSBURGH, PA. FALLOUT
(PRECIPITATION COLLECTIONS)
CUMULATIVE mc Sr90/mi2
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 4

1.22 Westwood, New Jersey

Since February 1958, precipitation collections have been made by Isotopes, Inc. in polyethylene tubs (exposed surface 2.58 ft^2).

Precipitation data for Westwood, New Jersey are summarized in Table 5. Figure 5 graphically illustrates the cumulative Sr^{90} fallout.

TABLE 5

STRONTIUM 90 IN WESTWOOD, NEW JERSEY FALLOUT

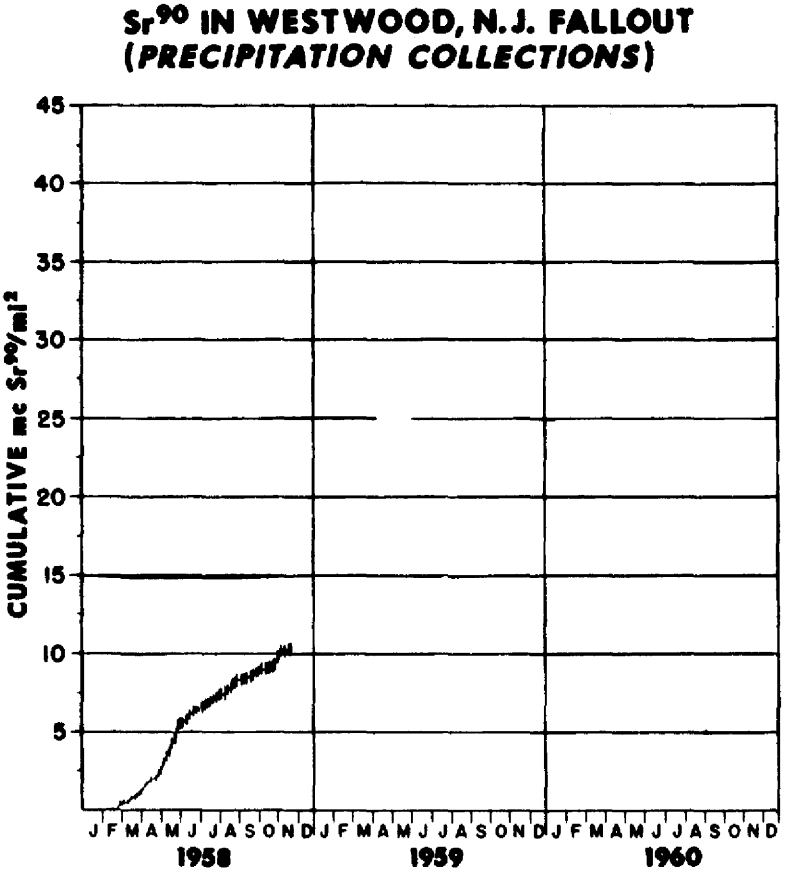
(Precipitation Collections)

Collection Period from	to	mc Sr^{90}/mi^2	Cumulative* mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} **	Ba^{140}/Sr^{90} **	Precipitation in inches
1958						
2-4	8-15	---	7.74 ± 0.35	--	--	--
8-15	8-18	0.249 ± 0.007 0.268 ± 0.007	8.00 ± 0.35	28.4 28.4	13.7 12.6	0.76
8-18	8-23	0.058 ± 0.003 0.064 ± 0.004	8.06 ± 0.35	23.6 28.3	16.0 16.6	0.05
8-23	8-25	0.114 ± 0.004 0.122 ± 0.004	8.18 ± 0.36	37.0 37.0	20.4 19.2	1.38
8-25	9-4	0.015 ± 0.004 0.022 ± 0.004	8.20 ± 0.36	13.6 7.9	20.2 14.5	dry
9-4	9-8	0.101 ± 0.004 0.099 ± 0.004	8.30 ± 0.36	29.3 26.2	9.2 9.5	0.69
9-8	9-10	0.018 ± 0.003 0.014 ± 0.002	8.31 ± 0.36	25.8 36.2	14.3 19.5	0.03
9-10	9-18	0.133 ± 0.007 0.139 ± 0.006	8.45 ± 0.36	33.9 30.6	10.4 9.9	1.72
9-18	9-22	0.083 ± 0.006 0.076 ± 0.004	8.53 ± 0.36	24.0 24.4	5.3 11.1	0.64
9-22	9-27	0.133 ± 0.005 0.123 ± 0.004	8.66 ± 0.36	26.9 27.9	6.3 12.6	0.64
9-27	9-30	0.057 ± 0.003 ---	8.71 ± 0.36	29.2 --	3.6 --	0.14
9-30	10-2	0.140 ± 0.004 0.139 ± 0.005	8.85 ± 0.36	22.3 23.7	38.7 10.3	1.03
10-2	10-10	0.029 ± 0.005 0.055 ± 0.008	8.90 ± 0.36	9.1 5.6	50.3 39.2	0.02
10-10	10-14	0.027 ± 0.007 0.044 ± 0.004	8.93 ± 0.36	22.0 17.7	57.8 57.9	0.04
10-14	10-15	0.043 ± 0.003 ---	8.98 ± 0.36	-- 51.4	-- 157.0	0.09
10-15	10-22	0.023 ± 0.003 0.020 ± 0.003	9.00 ± 0.36	15.3 19.7	129.5 139.5	dry
10-22	10-23	0.121 ± 0.005 0.173 ± 0.005	9.14 ± 0.36	29.5 30.1	33.8 28.4	1.59
10-23	10-27	0.616 ± 0.006 lost	9.76 ± 0.36	59.0 lost	253.2	2.40
10-27	10-29	0.067 ± 0.004 0.077 ± 0.004	9.83 ± 0.36	58.9 46.2	258.2 172.8	0.09
10-29	11-3	0.275 ± 0.006 0.267 ± 0.006	10.10 ± 0.36	45.8 45.6	117.0 104.4	0.72
11-3	11-10	0.245 ± 0.005 0.233 ± 0.004	10.12 ± 0.36	34.2 35.7	93.4 79.8	0.32
11-10	11-18	0.453 ± 0.014 0.333 ± 0.006	10.24 ± 0.37	36.2 50.4	89.4 114.1	0.70
11-18	11-19	0.021 ± 0.003 0.025 ± 0.003	10.26 ± 0.37	31.5 31.7	68.7 60.7	0.09

* Cumulative error term represents the standard deviation of duplicate analyses.

** Values extrapolated to midpoint of sampling period.

FIGURE 5


Sr90 IN WESTWOOD, N.J. FALLOUT
(PRECIPITATION COLLECTIONS)
CUMULATIVE mc Sr90/mi2
45
40
35
30
25
20
15
10
5
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1958
1959
1960

1.23 Richmond, California

Since March 1958, precipitation collections have been made by Tracerlab, Inc. in stainless steel tubs (exposed surface 4.91 ft^2).

Precipitation data for Richmond, California are summarized in Table 6. Figure 6 graphically illustrates the cumulative Sr^{90} fallout.

TABLE 6

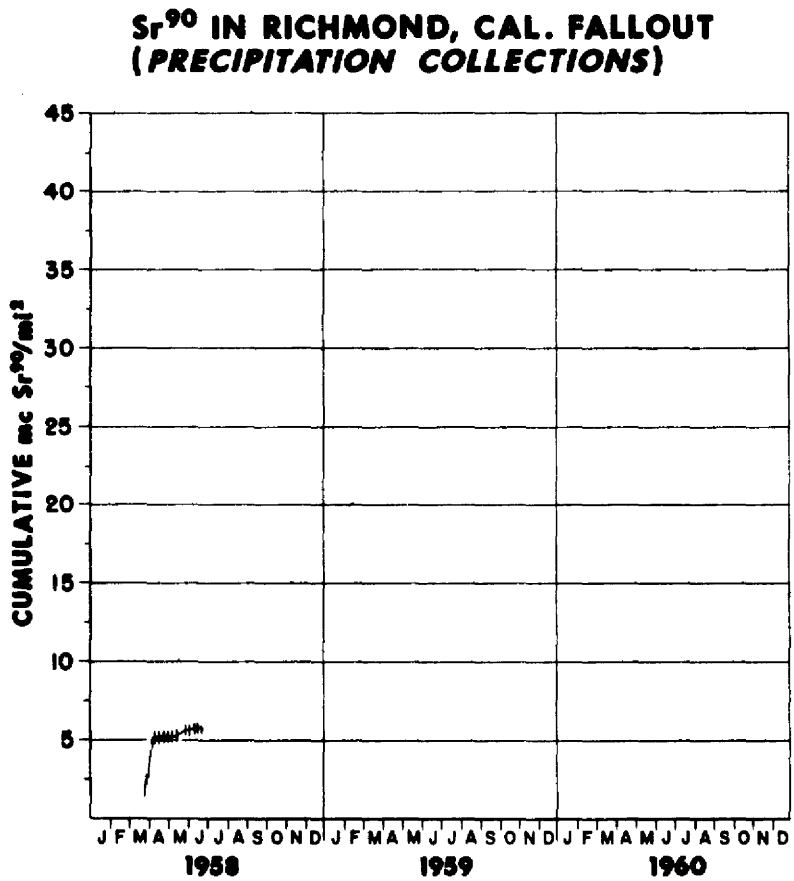
STRONTIUM 90 IN RICHMOND, CALIFORNIA FALLOUT

(Precipitation Collections)

Collection Period from	to	mc Sr^{90}/mi^2	Cumulative* mc Sr^{90}/mi^2	Sr^{89}/Sr^{90} **	Ba^{140}/Sr^{90} **	Precipitation in inches
1958						
3-20	6-24	---	5.75 ± 0.34	--	--	--
6-24	6-30					
6-30	7-3	0.009 ± 0.001		4.3	5.3	dry
		0.0048 ± 0.0005		9.2	13.9	
7-3	7-11	0.0136 ± 0.0005		20.1	69.8	dry
		0.0141 ± 0.0005		28.0	116.3	
7-11	7-18	0.019 ± 0.001		12.7	12.0	dry
		lost		--	--	
7-18	7-25	0.0138 ± 0.0005		18.4	47.1	dry
		0.0138 ± 0.0005		18.2	32.6	
7-25	8-1	0.081 ± 0.004		7.4	7.0	dry
		0.069 ± 0.003		9.1	9.5	
8-1	8-8	0.007 ± 0.001		12.4	22.5	dry
		0.005 ± 0.001		16.4	26.4	
8-8	8-15					
8-15	8-22					
8-22	8-29	0.005 ± 0.001		17.6	14.8	dry
		0.005 ± 0.001		17.0	16.8	
8-29	9-6					
9-6	9-13	0.028 ± 0.001		22.5	<22.8	dry
		0.021 ± 0.001		30.4	<23.3	
9-13	9-20	0.006 ± 0.001		3.8	4.0	dry
		0.005 ± 0.001		5.8	6.2	
9-20	9-24	0.016 ± 0.001		15.6	5.6	0.05
		0.014 ± 0.001		18.5	6.4	

* Error term represents the standard deviation of duplicate analyses.
** Values extrapolated to midpoint of collection period.

FIGURE 6


Sr90 IN RICHMOND, CAL. FALLOUT
(PRECIPITATION COLLECTIONS)
CUMULATIVE mc Sr90/mi2
45
40
35
30
25
20
15
10
5
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1958
1959
1960

2. Water

2.1 Sr^{90} in Tap Water - New York City

New York City tap water has been analyzed since August 1954. Until the end of November 1956, the sampling period lasted about two weeks during which time an average of 50 liters was collected (3-4 liters per day). Since December 1956, the collections are made over a period of a month and the total volume is about 100 liters. The strontium 90 content in μμc/liter is shown in Table 7 for collections made in 1958. Data for collections carried out before 1958 have been presented in HASL-42 entitled "Environmental Contamination from Weapon Tests". Data for all samples analyzed are presented graphically in Figure 7. The error term depicts one standard deviation due to the error in counting.

TABLE 7

STRONTIUM 90 IN NEW YORK CITY TAP WATER

Sampling Period	Sr^{90} μμc/l	Sr^{89}/Sr^{90}
1958		
January	0.20 ± 0.03	--
February	0.20 ± 0.05	--
March	0.027 ± 0.004	--
April	0.028 ± 0.018	--
May	0.04 ± 0.03	--
June	0.38 ± 0.06	--
July	0.09 ± 0.01	--
August	0.14 ± 0.02	--
September	0.128 ± 0.004	5
October	0.05 ± 0.01	4
November	0.066 ± 0.002	5
December		

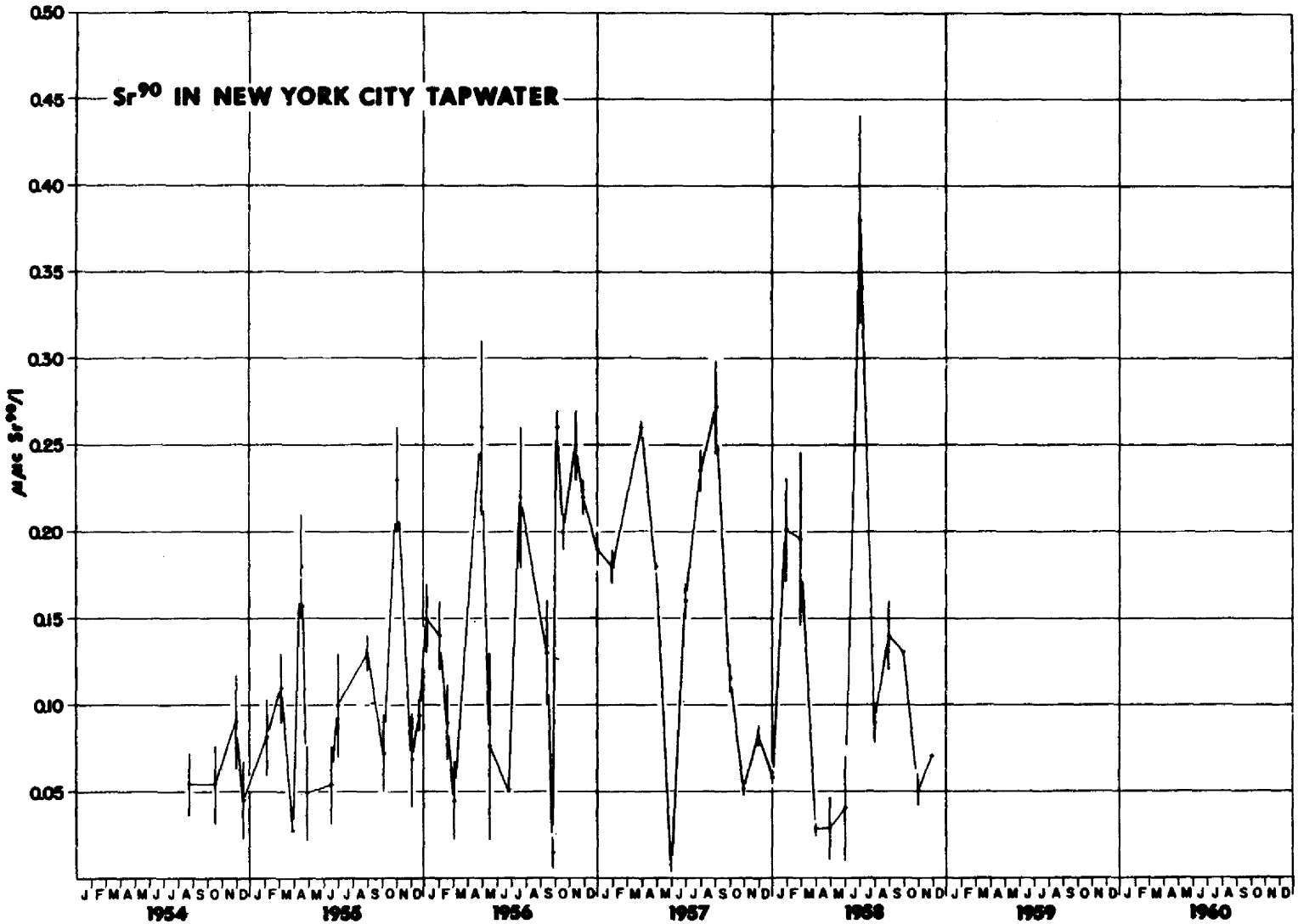

Sr90 IN NEW YORK CITY TAPWATER
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 7

3. Uptake of Strontium 90

3.1 Milk

Since early 1954, HASL has monitored milk for strontium 90 activity. Powdered milk from Perry, New York and liquid milk purchased in New York City have been analyzed weekly. In 1955, five additional United States locations and Japan and England were included in the program. Samples have been received from England since April 1957 but now serve cross-checking purposes since England monitors her own milk. Samples from Japan are received sporadically; samples from State College, Mississippi; St. Louis, Missouri; and Portland, Oregon have not been received since 1956. These latter data can be found in HASL-42, "Environmental Contamination from Weapon Tests".

3.11 Monthly Sr^{90} Levels in Powdered Milk from Perry, New York

Since April 1954, 5-pound cans of powdered whole milk have been sent to HASL each week from a milk powdering plant at Perry, New York.

Table 8 summarizes 1958 data in $\mu\mu c$ Sr^{90}/gram Ca. The data are graphed in Figure 8. The values through December 1955 represent monthly averages of weekly samples, the error term representing one standard deviation from the mean. The monthly values for the year 1956 represent one analysis and a standard error of counting since the weekly samples were pooled each month. Starting January 1957, the monthly composites have been analyzed in replicate, the values thus being an average and the error term one standard deviation from the mean.

TABLE 8

POWDERED MILK - PERRY, NEW YORK

1958

Sampling Month	Sr^{90} μμc/g Ca	Sr^{89}/Sr^{90}*
January	3.40 ± 0.37	---
February	3.57 ± 0.39	1.3 ± 0.5
March	2.99 ± 0.36	---
April	3.03 ± 0.53	6.5 ± 1.9
May	4.98 ± 0.32	4.4 ± 0.4
June	5.45 ± 1.25	---
July	8.60 ± 1.20	---
August		
September		
October		
November		
December		

* Extrapolated to midpoint of sampling period.

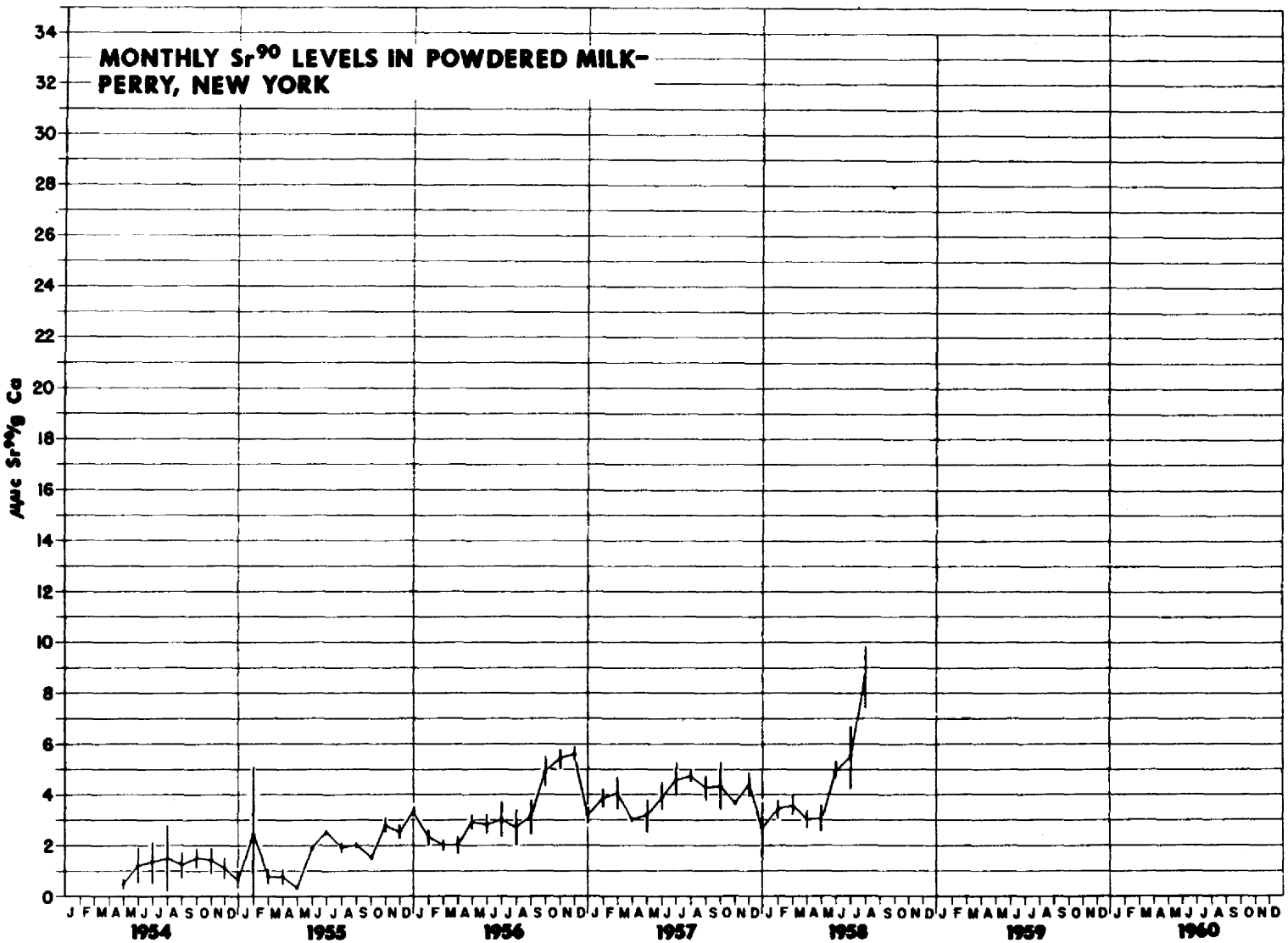

MONTHLY Sr90 LEVELS IN POWDERED MILK-
PERRY, NEW YORK
μμc Sr90/g Ca
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 8

3.12 Monthly Sr^{90} Levels in Liquid Milk from New York City

Beginning in June 1954, a quart of liquid milk was purchased five days a week from a store near HASL. The labeled brands were varied to avoid sampling milk from particular farms. The daily samples were combined, evaporated to dryness, ashed and analyzed as a weekly sample.

Since January 1957, the daily samples have been combined to form a monthly composite.

Table 9 summarizes data in $\mu\mu c\ Sr^{90}/g$ Ca. The data are graphed in Figure 9. The values through May 1956 represent monthly averages of weekly analyses. Since January 1957, the values represent averages of replicate analyses made on monthly composites. In both cases, the error term represents one standard deviation from the mean.

From June through December 1956, no liquid milk samples were analyzed. This program was resumed after it was recognized that the powdered milk samples from Perry, New York did not represent the New York City milkshed.

Table 9

Liquid Milk - New York City

1958

Sampling Month	Sr^{90} μμc/g Ca	Sr^{89}/Sr^{90}*
January	3.62 ± 0.37	2.6 ± 0.5
February	3.93 ± 0.38	1.7 ± 0.3
March	3.20 ± 0.27	
April	4.09 ± 0.30	8.1 ± 5.6
May	3.92 ± 0.44	4.6 ± 1.4
June	10.16 ± 0.82	---
July	11.31 ± 0.30	---
August	10.91 ± 1.71	---
September	10.54 ± 0.73	---
October		
November		
December		

* Extrapolated to midpoint of sampling period.

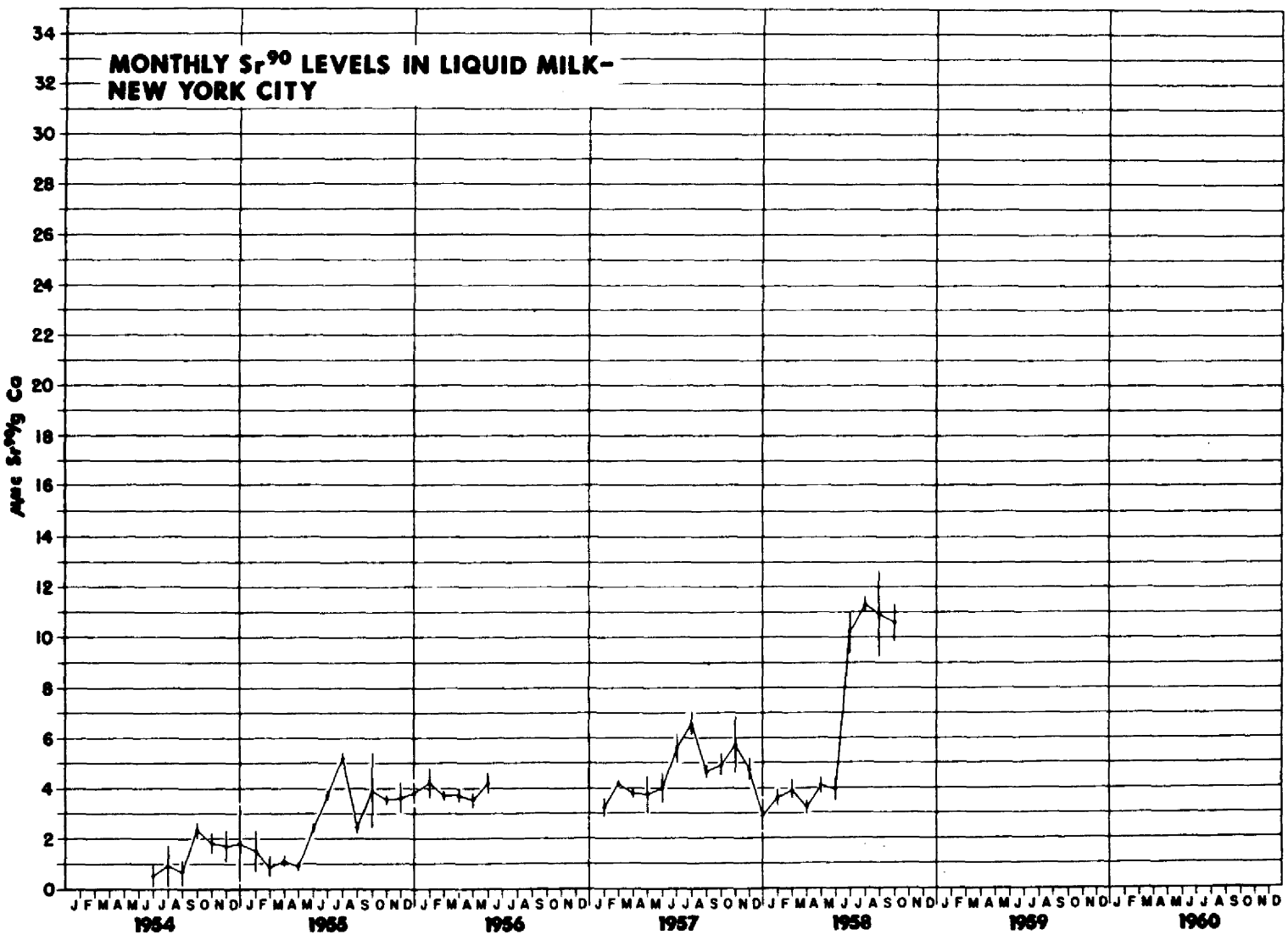

MONTHLY Sr90 LEVELS IN LIQUID MILK-
NEW YORK CITY
Mμc Sr90/g Ca
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 2

3.13 Columbus, Wisconsin and Mandan, North Dakota

Five-pound samples of powdered milk have been obtained weekly from milk powdering plants in Columbus, Wisconsin (powdered whole milk) and Mandan, North Dakota (powdered buttermilk) and composited on a monthly basis.

Table 10 summarizes the data in $\mu\mu c\ Sr^{90}/g$ Ca. Figures 10 and 11 graphically illustrate the data. The error term is one standard deviation from the mean of replicate analyses.

Table 10

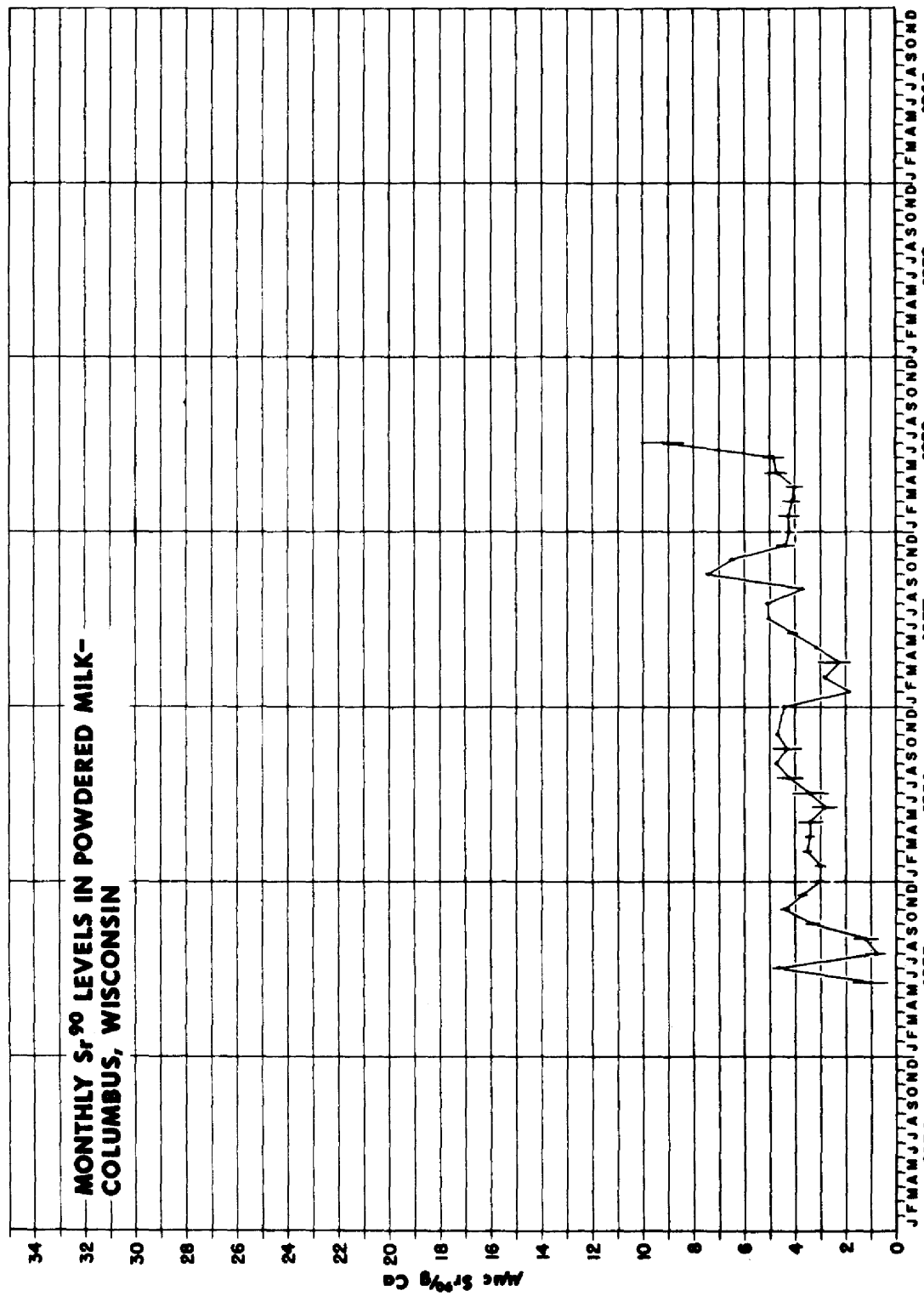
MONTHLY Sr^{90} LEVELS IN POWDERED MILK

FROM COLUMBUS, WISCONSIN AND MANDAN, NORTH DAKOTA

		Columbus, Wisconsin		Mandan, North Dakota (2)	
		Sr^{90}	Sr^{89}/Sr^{90} (1)	Sr^{90}	Sr^{89}/Sr^{90} (1)
1957		μμc/g Ca		μμc/g Ca	
	November	4.36 ± 0.37		29.57 ± 0.26	
	December	4.2 ± 0.2		20.11 ± 0.66	
1958					
	January	4.21 ± 0.42	3.6 ± 0.1	15.24 ± 0.53	7.6 ± 0.8
	February	4.12 ± 0.35	1.4 ± 0.3	16.46 ± 0.63	5.0 ± 1.5
	March	4.00 ± 0.33	0.9 ± 0.1	15.57 ± 0.64	4.3 ± 0.3
	April	4.76 ± 0.44	1.6 ± 1.2	21.65 ± 0.72	4.3 ± 0.3
	May	4.81 ± 0.41	3.6 ± 0.2	21.30 ± 4.34	7.0 ± 2.0
	June	9.19 ± 0.84	---	26.28 ± 0.56	---
	July			26.74 ± 1.52	---
	August				
	September				
	October				
	November				
	December				

(1) Extrapolated to midpoint of sampling period.
(2) Buttermilk.

FIGURE 10


MONTHLY Sr⁹⁰ LEVELS IN POWDERED MILK-
COLUMBUS, WISCONSIN
μμc Sr⁹⁰/g Ca
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

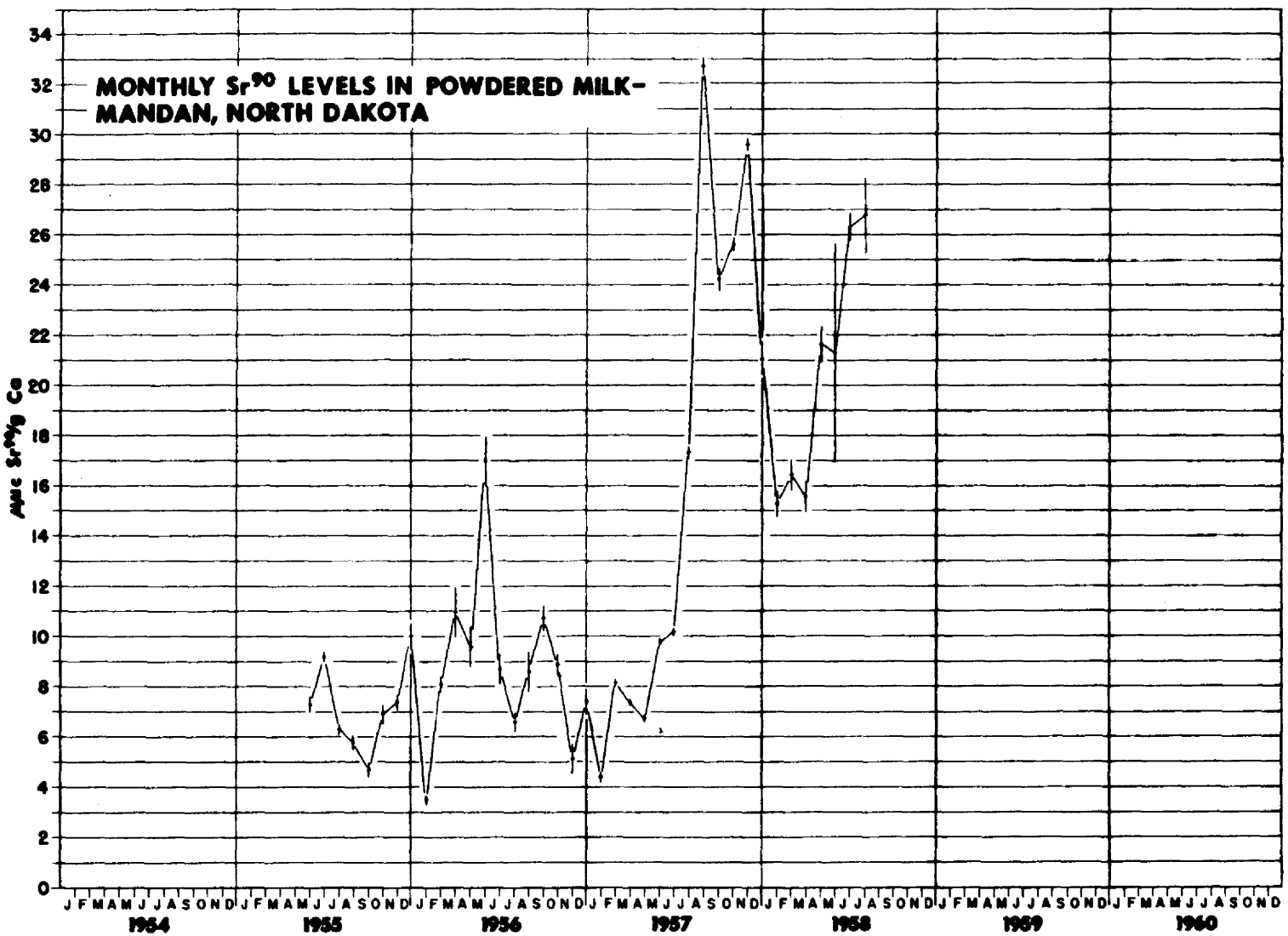

MONTHLY Sr90 LEVELS IN POWDERED MILK–
MANDAN, NORTH DAKOTA
μμc Sr90/g Ca
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1954
1955
1956
1957
1958
1959
1960

FIGURE 11

3.14 Monthly Sr^{90} and Other Radionuclide Levels in Milk Sampled and Analyzed by the U. S. Public Health Service.

The U. S. Public Health Service (Department of Health, Education and Welfare) maintains a milk monitoring program of their own. The following tables of data were extracted from their reports.

Table 11a

Concentration of Long Half-lived Radionuclides in Milk*

(concentration expressed as μμc/liter)

Month 1957-58	No. Weapons** Tests Reported		MILKSHEDS									
	Continental U. S.	Elsewhere	Sacramento		Salt Lake City		St. Louis		Cincinnati		New York City	
			Cs^{137}	Sr^{90}	Cs^{137}	Sr^{90}	Cs^{137}	Sr^{90}	Cs^{137}	Sr^{90}	Cs^{137}	Sr^{90}
Jan-April	0	11										
May	1	3	31.7	4.5	30.6	4.6	18.0	10.1	26.0	5.5	37.8	4.6
June	4	1	40.6	7.0	52.6	6.4	69.1	12.9	35.8	6.7	30.4	5.1
July	4	0	48.5	3.6	51.0	4.9	61.3	11.0	36.2	5.1	22.8	8.7
Aug	4	1	78.7	1.9	39.0	4.1	36.4	7.7	40.3	4.4	48.8	6.9
Sept	7	3	44.2	1.5	154.4	4.3	63.7	9.1	53.3	5.0	69.1	6.1
Oct	1	3	40.5	1.7	47.2	5.5	65.7	9.7	41.6	7.7	48.4	5.0
Nov	0	1	48.7	9.6	44.9	4.8	35.1	7.8	36.2	7.0	45.0	5.2
Dec	0	1	33.3	5.0	35.4	3.0	48.9	7.1	41.3	5.9	40.2	5.0
Jan	0	0	43.6	5.9	38.5	3.0	41.1	7.9	48.3	4.1	29.5	5.6
Feb	0	2	44.2	3.8	65.3	2.2	44.7	7.0	55.5	3.9	46.3	5.2
Mar	0	7	47.9	4.2	79.5	3.0	54.7	10.0	61.6	4.1	50.6	3.9
Apr	0	2	102.2	10.5	65.0	4.7	61.4	12.3	50.2	6.4	44.3	4.0
AVERAGE			50.3	4.9	58.6	4.2	50.0	9.4	43.9	5.5	42.8	5.4

* Table extracted from a paper, Campbell, J.E. et al, "The Occurrence of Strontium-90, Iodine-131, and other Radionuclides in Milk - May 1957 Through April 1958", submitted to HASL by the U. S. Public Health Service (Department of Health, Education, and Welfare).

** Compiled from various press releases.

Table 11b

Concentration of Short and Intermediate Half-lived Radionuclides in Milk
(concentration expressed as μμc/liter)

Month 1957-58	No. Weapons** Tests Reported		MILKSHEDS														
	Continental U. S.	Elsewhere	Sacramento			Salt Lake City			St. Louis			Cincinnati			New York City		
			I^{131}	Ba^{140}	Sr^{89}	I^{131}	Ba^{140}	Sr^{89}	I^{131}	Ba^{140}	Sr^{89}	I^{131}	Ba^{140}	Sr^{89}	I^{131}	Ba^{140}	Sr^{89}
Jan-April	0	11															
May	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
June	4	1	250	-	-	440	71.5	-	410	94.7	-	370	-	-	40	-	-
July	4	0	-	10.8	-	-	197.9	-	-	146.8	-	-	-	-	-	-	-
Aug	4	1	10	9.6	26.2	200	46.3	71.7	210	51.3	79.3	230	98.8	87.3	50	76.4	74.0
Sept	7	3	10	25.0	14.1	740	83.0	55.6	970	532.0	243.2	430	125.8	66.4	300	125.9	84.1
Oct	1	3	20	43.3	21.7	990	130.8	90.5	890	120.9	141.9	300	68.5	131.7	250	158.8	122.0
Nov	0	1	0	46.9	9.2	0	5.1	23.5	0	8.3	66.4	0	13.3	48.9	100	3.5	37.4
Dec	0	1	0	25.7	21.4	50	3.5	11.1	0	16.4	29.5	0	3.5	12.3	0	0	14.1
Jan	0	0	0	0	0	0	1.3	8.6	0	6.0	25.5	0	0	0.3	0	0	5.5
Feb	0	2	0	8.2	2.9	40	0.5	8.1	0	4.1	14.8	0	1.7	8.5	0	8.7	3.4
Mar	0	7	0	6.4	17.5	0	0.3	3.3	0	4.6	19.1	0	1.7	5.6	0	0.9	2.6
Apr	0	2	10	20.8	77.4	30	0	2.2	100	50.2	35.5	30	0	13.1	50	0	2.0
AVERAGE			30.0	19.7	21.2	249	49.1	30.5	258	94.1	72.8	136	34.8	41.5	79	41.6	38.4

* Table extracted from a paper, Campbell, J.E. et al, "The Occurrence of Strontium-90, Iodine-131, and Other Radionuclides in Milk - May 1957 Through April 1958", submitted to HASL by the U. S. Public Health Service (Department of Health, Education, and Welfare).

** Compiled from various press releases.

Table 11c

Average Radionuclide Contribution of Milk Expressed as a Per Cent of Maximum Permissible Concentration for the General Population*

Radionuclide	MPC (μμc/liter)	MILKSHEDS				
		Sacramento	Salt Lake City	St. Louis	Cincinnati	New York City
Sr^{90}	80	6.2	5.3	11.7	6.9	6.8
I^{131}	3000	1.0	8.3	8.6	4.5	2.6
Sr^{89}	7000	0.3	0.4	1.3	0.6	0.6
Cs^{137}	150,000	0.03	0.04	0.03	0.03	0.03
Ba^{140}	200,000	0.01	0.02	0.05	0.02	0.02

* Table extracted from a paper, Campbell, J.E. et al, "The Occurrence of Strontium-90, Iodine-131, and Other Radionuclides in Milk - May 1957 Through April 1958", submitted to HASL by the U. S. Public Health Service (Department of Health, Education, and Welfare).

Table 11d

Calcium Content of Milk Samples* (grams/liter)

Month 1957-58	MILKSHEDS				
	Sacramento	Salt Lake City	St. Louis	Cincinnati	New York City
May	1.127	1.114	1.200	1.146	1.008
June	1.092	1.120	1.204	1.151	1.047
July	1.102	1.115	1.199	1.138	1.034
Aug	1.114	1.125	1.200	1.142	1.038
Sept	1.090	1.126	1.204	1.157	1.033
Oct	1.141	1.167	1.273	1.222	1.116
Nov	1.146	1.172	1.298	1.192	1.101
Dec	1.157	1.165	1.313	1.162	1.116
Jan	1.167	1.164	1.317	1.180	1.123
Feb	1.123	1.092	1.310	1.154	1.092
Mar	1.149	1.155	1.273	1.080	1.047
Apr	1.146	1.131	1.244	1.144	1.078
AVERAGE	1.130	1.137	1.253	1.156	1.069

* Table extracted from a paper, Campbell, J.E. et al, "The Occurrence of Strontium-90, Iodine-131, and Other Radionuclides in Milk - May 1957 Through April 1958", submitted to HASL by the U. S. Public Health Service (Department of Health, Education, and Welfare).

Table 12a

Radioactivity in Milk*: ATLANTA, GEORGIA

Results of Composite Samples for Period Ending September 1958

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo.. Average
						AVAILABLE TO DATE						
6-2-58	1.164		0		37		13.7		6		118	
7-2	1.158		22		39		10.2		12		111	
8-2	1.188		65		114		11.9		50		103	
9-2	1.154		20		72		13.8		7		79	

* This table was extracted from a press release (January 5, 1959) prepared by the U.S. Public Health Service which maintains a milk monitoring program of their own.

Table 12b

Radioactivity in Milk*: AUSTIN, TEXAS

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
AVAILABLE TO DATE												
6-6-58	1.115		0		26		2.2		1		74	
7-3	1.144		8		15		3.5		5		48	
8-6	1.160		50		40		3.4		18		51	
9-4	1.121		16		32		3.9		6		43	

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12c

Radioactivity in Milk*: CHICAGO, ILLINOIS

Results of Composite Samples for the Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
AVAILABLE TO DATE												
7-16-58	1.069		124		58		7.1		36		112	
8-18	1.098		43		64		9.3		18		88	
9-16	1.161		13		94		7.9		10		71	

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12d

Radioactivity in Milk*: CINCINNATI, OHIO

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
10-18-57	1.222		300		132		7.7		68		42	
11-14	1.192		0		49		7.0		13		36	
12-18	1.162		0		12		5.9		4		41	
1-20-58	1.180		0		0		4.1		0		48	
2-16	1.154		0		8		3.9		2		56	
3-16	1.080		0		6		4.1		2		62	
4-14	1.144	1.156	30	135	13	42	6.4	5.5	0	35	50	44
5-13	1.161	1.158	0	123	70	44	8.6	5.8	16	33	50	46
6-16	1.227	1.164	0	89	106	50	11.6	6.2	36	33	78	51
7-20	1.082	1.159	107	91	194	62	13.0	6.8	112	40	96	54
8-13	1.102	1.155	42	76	97	63	7.5	7.1	84	39	84	58
9-19	1.132	1.153	5	40	98	65	9.4	7.4	13	29	59	58

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12e

Radioactivity in Milk*: FARGO, NORTH DAKOTA

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
					AVAILABLE TO DATE							
6-7-58	1.112		30		80		15.6		18		110	
7-6	1.108		92		142		16.3		47		147	
8-3	1.116		48		53		10.2		14		96	
9-4	1.125		27		140		14.1		53		113	

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12f

Radioactivity in Milk*: NEW YORK, NEW YORK

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
10-15-57	1.116		250		122		5.0		159		48	
11-15	1.101		100		37		5.2		4		45	
12-15	1.116		0		14		5.0		0		40	
1-16-58	1.123		0		6		5.6		0		30	
2-15	1.092		0		3		5.2		9		46	
3-15	1.047		0		3		3.9		1		51	
4-15	1.078	1.077	50	79	2	38	4.0	5.4	0	42	44	43
5-15	1.036	1.072	32	74	23	37	3.6	5.3	5	38	40	43
6-17	1.093	1.076	0	71	63	39	9.9	5.7	20	36	71	46
7-15	1.062	1.078	67	71	84	43	10.5	5.9	64	39	83	51
8-15	1.048	1.079	69	72	41	40	3.3	5.6	28	35	67	53
9-15	1.241	1.096	10	48	73	39	5.6	5.6	15	25	76	53

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12g

Radioactivity in Milk*: SACRAMENTO, CALIFORNIA

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
10-14-57	1.141		20		22		1.7		43		40	
11-14	1.146		0		9		9.6		47		49	
12-19	1.157		0		21		5.0		26		33	
1-15-58	1.167		0		0		5.9		0		44	
2-16	1.123		0		3		3.8		8		44	
3-16	1.149		0		18		4.2		6		48	
4-14	1.146	1.130	10	30	77	21	10.5	4.9	21	20	102	50
5-15	1.141	1.131	0	27	38	23	3.8	4.8	12	19	54	55
6-15	1.122	1.133	240	26	40	24	7.1	4.8	6	18	79	58
7-13	1.036	1.128	45	28	20	24	3.3	4.9	7	18	53	56
8-17	1.150	1.131	22	29	24	24	6.8	5.3	0	17	65	55
9-17	1.161	1.137	9	29	17	24	3.8	5.5	0	15	72	57

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12h

Radioactivity in Milk*: SALT LAKE CITY, UTAH

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
10-10-57	1.167		990		90		5.5		131		47	
11-13	1.172		0		24		4.8		5		45	
12-15	1.165		50		11		3.0		4		35	
1-15-58	1.164		0		9		3.0		1		38	
2-17	1.092		40		8		2.2		0		65	
3-13	1.155		0		3		3.0		0		80	
4-14	1.131	1.137	30	249	2	30	4.7	4.2	0	49	65	59
5-14	1.142	1.140	0	226	26	30	3.3	4.1	8	46	42	60
6-11	1.129	1.140	0	186	68	33	7.3	4.2	21	41	59	60
7-15	1.068	1.136	156	184	26	33	4.7	4.2	16	26	40	59
8-14	1.108	1.135	77	174	44	31	4.2	4.2	20	24	43	59
9-13	1.207	1.142	14	113	44	30	5.0	4.2	14	18	48	51

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 121

Radioactivity in Milk*: SPOKANE, WASHINGTON

Results of Composite Samples for the Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in umc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
					AVAILABLE TO DATE							
8-8-58	1.168		68		64		6.9		18		93	
9-3-58	1.163		11		43		8.2		5		78	

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12j

Radioactivity in Milk*: ST. LOUIS, MISSOURI

Results of Composite Samples for Period Ending September 1958.

Date of collection	Calcium Content grams/liter		Radioactivity in uuc/liter									
			Iodine - 131		Strontium - 89		Strontium - 90		Barium - 140		Cesium - 137	
	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average	Sample	12 Mo. Average
10-17-57	1.273		890		142		9.7		121		66	
11-18	1.298		0		66		7.8		8		35	
12-18	1.313		0		30		7.1		16		49	
1-17-58	1.317		0		26		7.9		6		41	
2-17	1.310		0		15		7.0		4		45	
3-18	1.273		0		19		10.0		5		55	
4-16	1.244	1.252	100	258	36	73	12.3	9.4	50	94	61	50
5-20	1.259	1.257	0	234	107	76	10.0	9.4	14	88	94	56
6-18	1.217	1.258	0	197	122	74	14.8	9.6	44	83	96	59
7-16	1.175	1.257	624	233	306	99	18.7	10.2	229	90	160	67
8-19	1.280	1.264	61	220	263	115	14.1	10.7	113	95	109	73
9-16	1.303	1.272	19	141	283	118	15.4	11.2	48	55	104	76

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

Table 12K

Analysis Summary of Milk Samples Collected in September 1958*
(in micromicrocuries per liter)

	Calcium grams/liter	Iodine^{131}	Strontium^{89}	Strontium^{90}	Barium^{140}	Cesium^{137}
Permissible Limits* Recommended by NCRP&M for Lifetime Exposure		3,000**	7,000**	80.0**	200,000**	150,000**
Atlanta, Ga.	1.154	20	72	13.8	7	79
Austin, Texas	1.121	16	32	3.9	6	43
Chicago, Ill.	1.161	13	94	7.9	10	71
Cincinnati, Ohio	1.132	5	98	9.4	13	59
Fargo, N. Dak.	1.125	27	140	14.1	53	113
New York, N. Y.	1.241	10	73	5.6	15	76
Sacramento, Calif.	1.161	9	17	3.8	0	72
Salt Lake City, Utah	1.207	14	44	5.0	14	48
Spokane, Washington	1.163	11	43	8.2	5	78
St. Louis, Mo.	1.303	19	283	15.4	48	104

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

** These limits are the maximum permissible limits for lifetime exposure of population groups to specific radioisotopes in water and are derived from the current recommendations of the National Committee on Radiation Protection and Measurement. The limits have been generally accepted as being equally applicable to milk.

Table 12L

MILK SAMPLES
Yearly Average Levels for Period Ending September 1958*
(in micromicrocuries per liter)

	Calcium grams/liter	Iodine^{131}	Strontium^{89}	Strontium^{90}	Barium^{140}	Cesium^{137}
Permissible Limits* Recommended by NCRP&M for Lifetime Exposure		3,000**	7,000**	80.0**	200,000**	150,000**
Cincinnati, Ohio	1.153	40	65	7.4	29	58
New York, N. Y.	1.096	48	39	5.6	25	53
Sacramento, Calif.	1.137	29	24	5.5	15	57
Salt Lake City, Utah	1.142	113	30	4.2	18	51
St. Louis, Missouri	1.272	141	118	11.2	55	76

* This table was extracted from a press release (January 5, 1959) prepared by the U. S. Public Health Service which maintains a milk monitoring program of their own.

** These limits are the maximum permissible limits for lifetime exposure of population groups to specific radioisotopes in water and are derived from the current recommendations of the National Committee on Radiation Protection and Measurement. The limits have been generally accepted as being equally applicable to milk.

3.2 Other Foods

3.21 Strontium 90 in Foods from Chile.

Table 13 shows the results of strontium 90 analyses on Chilean foods sampled during 1958.

Table 13

STRONTIUM 90 IN 1958 FOOD SAMPLES FROM CHILE

Ash Weight	% Ca in Ash	Sampling Date 1958	dpm Sr^{90} / g Ash		μμc Sr^{90} / g Ca	Food Type	Location Chile
10.00	11	May 7	0.053	± 0.005	0.22	Alfalfa	Santiago
26.4	24	May 7	0.0045	± 0.0003	0.01	Alfalfa	Santiago
9.00	7	May 6	0.982	± 0.090	6.42	Potatoes	Santiago
8.00	20	March 28	10.54	± 1.03	23.73	Potatoes	Santiago
10.00	10	May 7	0.123	± 0.001	0.54	Dehydrated Greens	Santiago
4.00	23	May 7	0.21	± 0.02	0.42	Dehydrated Alfalfa	Santiago
10.00	28	April 18	0.109	± 0.011	0.18	Fish Meal	Santiago
10.00	7	April 18	0.678	± 0.054	4.36	Wheat	Osorno
6.00	4	April 9	0.10	± 0.01	1.23	Potatoes	Osorno
10.00	29	April 18	0.980	± 0.080	1.52	Powdered Milk	"Chiprodal" Factory-Osorno
6.00	7	March 28	13.94	± 1.06	85.62	Wheat Flour	San Bernardo
10.00	12	March 28	0.121	± 0.085	4.60	Wheat	San Bernardo
2.00	47	April 18	2.83	± 0.28	2.74	Wheat Flour	Baquedano

CHILE:

Santiago: ~33° S 71° W
Osorno: ~10° S of Santiago
Baquedano: ~10° N of Santiago
San Bernardo: ~10 miles south of Santiago

3.22 Strontium 90 in Foods, Grass, Animal Bone and Water Analyzed by the Physikalisches Institut der Bundensforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14

STRONTIUM 90 IN FOODS, GRASS, ANIMAL BONE AND WATER*

Food and Origin	Sr^{90} µµc/g	S.U.
Vegetables		
Kale, Summer 1957 only the edible part Schleswig-Holstein	0.022	12
Potatoes, Fall 1957 raw, washed, with skin Schleswig-Holstein	0.005	40
Head lettuce, Fall 1957 only the edible part Schleswig-Holstein	0.017	24
Head lettuce, Fall 1957 only the edible part Schleswig-Holstein	0.005	20
Parsley root, Fall 1957 washed Schleswig-Holstein	0.009	2.7
Parsley green, Fall 1957 Schleswig-Holstein	0.014	4.5
Onion, Fall 1957 whole plant Unknown	0.0075	30
White Cabbage, Fall 1957 only the edible part Schleswig-Holstein	0.005	7
Brussels Sprouts, Fall 1957 only the sprouts Schleswig-Holstein	0.004	7.5
Turnips, Fall 1957 without leaves, washed Schleswig-Holstein	0.005	13
Cauliflower, Fall 1957 only the edible part Schleswig-Holstein	0.001	20
Asparagus, Spring 1958 only the stalk, washed Schleswig-Holstein	0.0045	45

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14- Cont'd.

Food and Origin	Sr^{90} μμc/g	S.U.
Vegetables		
Rhubarb, Spring 1958 only the stalks Schleswig-Holstein	0.010	2.5
Tomatoes, Spring 1958 only the fruit Schleswig-Holstein	0.010	80
Stringbeans, 1957/1958 only the pods, dried Thailand	0.010	2.6
Cucumbers, 1957/1958 only the fruit, dried Siam	0.020	3
Lettuce, 1957/1958 only the edible part, dried Siam	0.066	10
Green peas, Fall 1957 dried Holland	0.045	50
White Beans, Fall 1957 dried Holland	~0.001	~1
Fruits		
Hazelnuts, Fall 1957 whole seeds Sicily	0.014	5.3
Bananas, 1957/1958 whole fruit West Indies	0.0015	4.8
Oranges, Spring 1958 whole fruit Spain	0.006	10
Plums, 1957 South Africa	0.0089	4.5

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14- Cont'd.*

Food and Origin		Sr^{90} μμc/g	S.U.
Fruits			
Raisins, 1957 South Africa		0.0019	5.0
Candied Fruit, 1957 South Africa		0.005	10
Grains			
Winter Beets, Fall 1957 only the seeds Schleswig-Holstein		0.007	1.9
Rye, Fall 1957 only the seeds Amrum		0.045	128
Barley, Fall 1957 only the seeds Schleswig-Holstein		0.036	70
Wheat Bran	1957 from mixed wheat USA-Germany	0.070	80
Wheat Flour (low grade)		0.072	80
Wheat Flour (secondary)		0.024	37
Wheat Flour		0.005	31
Rye whole grain	1957 from mixed rye Germany / import	0.028	30
Rye Bran		0.110	100
Rye Flour (low grade)		0.053	57
Rye Flour		0.005	20
Oatmeal, 1957 Argentina		0.0045	8
Oat Spalt		~0.001	~1
Oat Flour		0.065	34
Oats		0.011	10

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14- Cont'd*

Food and Origin	Sr^{90} µµc/g	S.U.
Grains		
Wheat (whole grain), Syria, 1957	0.003	7
Wheat (whole grain), Syria, 1957	0.001	1
Barley, Syria, 1957	0.005	10
Corn, Africa, 1957-1958	0.002	44
Wheat, Alaska, 1957	0.040	100
Aniseed, Syria, 1957	0.020	1.2
Wheat, Congo, 1957	0.0025	6
Rice with hulls, 1957/1958, Ceylon	0.041	150
Oats, Fall 1957 Schleswig-Holstein	0.010	15
Wild Rice, 1957 Unknown origin	0.005	9
Corn, 1957 Unknown origin	~0.001	1
Fish		
Lungfish, Spring 1958 North Sea	0.001	0.1
Red Perch, Spring 1958 North Sea	0.001	0.1
Herring, Spring 1958 North Sea	0.001	0.1
Animal Bone		
Hogs, Spring 1958 Schleswig-Holstein	0.150	1.6
Ox "	0.300	3.6
Goose "	0.420	4.8
Seal "	<0.001	<0.1

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14- Cont'd.*

Food and Origin	Sr^{90} µµc/g	S.U.
Animal Bone		
Hare, Spring 1958 Schleswig-Holstein	0.150	10
Deer, male "	8.5	65
Horse "	0.450	4.6
Lamb "	0.450	4.7
Deer, female "	0.950	9
Calf "	0.150	1
Ox, 1958, Thailand	0.180	0.8
Hog, Thailand	0.250	0.7
Buffalo, 1958, Ceylon	0.170	1.8
Grass		
Grass, Spring 1958, Kiel	0.13	38
Grass, Spring 1958, Jungfern Island	0.120	11
Other Imported Foods		
Ground Nuts (kernels), 1958 China	0.009	60
Ginger, 1958 China	0.050	60
Bitter Almond Nuts, 1958 China	0.024	14
Cinnamon, 1957 China	0.380	85
Yellow Hens Eggs, 1957 China	0.010	8

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14- Cont'd.*

Origin	Sr^{90} μμc/Liter
Rainwater	
Kiel, 11/26/57	2.5
Kiel, 11/28 - 12/9/57	3.2
Kiel, 12/11/57 (Snow)	0.8
Kiel, 1/6 - 1/13/58	4.2
Kiel, 1/13 - 2/4/58	4.5
Kiel, 2/4 - 2/11/58	5.0
Kiel, 2/11 - 2/18/58	3.3
Kiel, 2/21 - 3/11/58	4.1
Kiel, 2/28/58 (Snow)	1.1
Tapwater	
Kiel, 10/17/57	<0.02

* Submitted by the Physikalisches Institut der Bundesforschungsanstalt für Milchwirtschaft, Kiel, West Germany.

TABLE 14 - Cont'd.*

Strontium 90 Content of Several Cheeses

Origin	Sr^{90} μμc/g	S.U.
Denmark, 1957	0.038	2.3
Italy, 1957	0.046	6.5
Switzerland, 1957	0.055	5.5
Scandinavia, 1957	0.041	5.1
	0.052	7
Tunis, Late 1957	0.075	9.5
Tunis, Late 1957	0.020	3
Tunis, April 1957	0.0045	1.1
Tunis, May 1957	0.083	8.9
Jordan, October 1957	0.030	5
Lebanon, January 1958	0.008	1.6
Lebanon, January 1958	0.012	3
East Africa, Fall 1957	0.011	0.8
East Africa, Fall 1957	0.0085	1.3
East Africa, Fall 1957	0.007	0.6
Norway, February 1957	0.041	9.9
Norway, February 1957	0.044	9.9
Norway, January 1957	0.073	7.8
Norway, January 1957	0.094	11.5
Norway, January 1957	0.057	5
Norway, August 1956	0.060	6.6
India, 1958	0.006	13
Cyprus, May 1957	0.020	2
Cyprus, February 1958	0.016	2
Cyprus, January 1958	0.006	6
Persia, February 1958	0.025	3.1
Nakuru (Tanganyika, Early 1958	0.024	3.6

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3.23 A SURVEY OF RADIOACTIVE RESIDUES IN FOODS BEFORE AND AFTER 1945: EVIDENCE OF POSSIBLE FALLOUT CONTAMINATION

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This report covers results of a survey conducted over the past two years to determine to what degree foods may have become contaminated with radioactive fallout. It has been assumed that no significant man-made radioactive contamination could have occurred prior to 1945, the year the first experimental and military nuclear devices were exploded. Foods produced before and after this critical date have therefore been examined for total radioactive content adjusted for the presence of potassium 40, a widely distributed naturally occurring radioactive isotope. It is possible that other naturally occurring radioactive substances may contribute to the total. This contribution is extremely small, and while it may vary from food to food there is no reason to expect it to vary with time. Consequently if we consider the radioactive content of all pre-'45 foods as a base line, any increase over this in food produced since 1945 can be interpreted as man-made radioactive contamination. This contamination is presently contributed mainly by fallout from weapons testing, but it can be expected also to reflect the presence of nuclear power plants and other applications.

In January 1957, in response to an appeal by the Food and Drug Administration, nearly a thousand samples of food antedating 1945 were submitted. These foods came from private homes and the food industry; some even from the caches of the Shackleton and Byrd Antarctica expeditions dating back to 1906. In addition, an equal number of post-'45 samples were collected mostly from retail outlets. The program is now current, with certain items under more intensive surveillance than others.

The following categories were examined for total radioactivity: vegetables, fruits, fruit juices, sea foods, dairy products, bread, meat products, wheat, sugars, jams and jellies, cocoa and cocoa beans, tea. Nearly half of the samples analyzed were fruits and vegetables.

Results

I. Vegetables. Analyses of the following number of samples of different vegetables, about half of each of which were produced before 1945, revealed that the post-'45 samples showed no significant increase in total radioactivity: potatoes, 29; corn, 90; beans, 132; peas, 92; beets and turnips, 40; carrots, 30; spinach, 27 and miscellaneous, 90.

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For delivery at 72nd Annual Convention, Association of Official Agricultural Chemists, Washington, D. C., October 15, 1958, 10:00 a.m., EST.

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II. Fruits. Analyses of the following number of samples of different fruits, about half of each of which were produced before 1945, revealed that the post-'45 samples showed no significant increase in total radioactivity: pears, 48; cherries, 61; peaches, 89; apricots, 28; plums, 61; tomatoes and tomato products, 134; berries, 73; fruit juices, 78 and miscellaneous, 57.

III. Sea Food. 51 samples of miscellaneous fish varieties and 32 samples of oysters and clams, half of each of which were canned after 1945, exhibited a trend toward higher radioactivity. However, individual shellfish values showed a significant rate of increase when plotted by years since 1944. Other types of sea food such as shrimp, lobster and crabs showed no trend whatsoever.

IV. A number of unrelated items were also examined for total radioactivity. Analyses of the following numbers of samples revealed no increase in total radioactivity: meat products, 26; wheat, 47; sugar and jams, 38. In the case of bread where there were unfortunately no pre-'45 samples available there was no evidence of total radioactivity that could not be accounted for by the potassium content. On the other hand in cocoa and cocoa beans there was a radioactive content greater than could be accounted for by potassium. Without comparison with pre-'45 samples it could of course not be determined whether this excess radioactivity had been caused by fallout contamination.

V. In consonance with the findings of other investigators, the analyses of dairy products consisting chiefly of fresh fluid milk, evaporated milk, milk powder and cheese, show a statistically significant increase in total radioactivity in those products produced since 1945.

VI. The largest increase noted was in tea. While the examination of 36 pre-'45 samples showed no radioactivity on the average in excess of that accountable by potassium, 78 post-'45 samples chiefly from 1956 and 1957 harvests showed radioactivity that averaged about 30 times greater, with 6 individual samples ranging as high as 109 to 135 times greater. In terms of micro micro curies per kilogram of tea leaves the average value for the 78 samples was 13,500. While no specific isotopes have been identified we may assume that at least 1% of this activity could potentially be Sr 90. It could therefore be possible that many of the tea samples examined contain Sr 90 in excess of the present tolerance of 80 micro micro curies per kg., but analyses of strong tea brews revealed that only about 17% of the radioactivity was extracted. It can be concluded therefore that the beverage as commonly consumed would not contain over-tolerance amounts of Sr 90.

Conclusion

Compared to food samples produced prior to 1945 this survey shows that the great majority of post-'45 samples do not carry significant burdens of radioactivity. Notable exceptions are certain sea foods, dairy products and tea.

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