revised fallout

estimates for 1964-1965

and verification of the

1963 predictions

October 1964

Report of the

FEDERAL RADIATION COUNCIL

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SUMMARY

On the basis of information available in June 1964, new estimates of the levels of fallout expected in 1964 and 1965 from the atmospheric testing of nuclear weapons conducted through 1962 have been made by the Federal Radiation Council.

Based on the stratospheric inventory of strontium−90 in January 1964, the predicted annual depositions in 1964 and 1965 have been increased by 50 percent over those presented in FRC Report No. 4. This adjustment is well within the expected uncertainty of the original estimate and does not change the 30−year and 70−year dose estimates made on the basis of the original predictions.

The inventory of long−lived fission products such as strontium−90 and cesium−137 in the atmosphere by mid 1964 was reduced to one−half that in January 1963.

The deposition of fallout in the United States in 1963 was very close to the predicted values. The average deposition in the "wet" areas was a little less than predicted and that in the "dry" areas a little more. The time of maximum deposition occurred about a month later than it has in previous years.

Iodine−131 from the atmospheric testing of nuclear weapons had disappeared by May 1963 and strontium−89 by June 1964.

The observed levels in 1963 for strontium−89, strontium−90, and cesium−137 in milk and dairy products, short−lived nuclides leading to external exposure, and carbon−14 in the atmosphere at ground level were all very close to the values predicted in FRC Report No. 4. The observed values of strontium−90 in the total diet and in new bone were less than predicted for 1963. This discrepancy is

considered to result from the fact that some non-dairy products, particularly cereal grains, do not enter the diet in significant quantities in the same year in which they are grown.

New predictions for the strontium-90 and cesium-137 levels in milk, and strontium-90 in cereal grains and the total diet expected in 1964 and 1965 have been made to reflect the adjusted annual fallout level and the lag time for cereal grain products to enter the diet. These predictions are that the levels of long-lived radionuclides in milk in 1964 will be about the same as they were in 1963. The strontium-90 concentrations in the total diet in 1964 are expected to be higher than they were in 1963 and to drop to 1963 levels in 1965.

Based on the predictions of dietary contamination levels anticipated in 1963 and subsequent years, the Council concluded in FRC Report No. 4 that the health risks from radioactivity in food over the next several years are too small to justify protective actions to limit the intake of radionuclides by diet modifications or altering the normal distribution and use of food, particularly milk and dairy products. The present study has shown that the predictions in FRC Report No. 4 were substantially correct, and the conclusions in that report still apply.

SECTION I

INTRODUCTION

1.1   In FRC Report No. 4, issued May 1963, the Federal Radiation Council evaluated the levels of fallout that might be anticipated in the United States in 1963 and subsequent years following the programs of atmospheric nuclear weapons testing conducted through 1962.   The report forecast a substantial increase in the probable levels of radionuclides from fallout during 1963 with decreasing quantities in subsequent years.

1.2   On the basis of the radiation doses associated with these levels, it was concluded that the health risk from radioactivity in foods anticipated over the next several years would be too small to justify protective actions to limit the intake of these radionuclides by altering the normal production, processing, and distribution of food, particularly milk and dairy products

1.3   The purposes of the present report are to: (1) compare the predictions made as to the levels of fallout anticipated in 1963 with the experience based on surveillance measurements, (2) make more precise estimates of the levels anticipated in 1964 and 1965, and (3) evaluate the validity of the prediction procedures when they are applied to a changing fallout situation such as now exists.   The study is based on information available through June 1964.   Although the probable average levels for 1964 can be projected directly from currently available surveillance information, new estimates of the anticipated average levels of radionuclides in food in 1964 and 1965 utilize the stratospheric inventory data and the cumulative levels in soil as of January 1964.

SECTION II

THE INVENTORY OF LONG—LIVED RADIONUCLIDES

Verification of Predicted 1963 Fallout

2.1   As an aid in presenting the predictions contained in FRC Report No. 4, the regions in the United States were divided into "wet" and "dry" areas depending on average annual rainfall (roughly separated by the 20" rainfall isoline).   The deposition of strontium—90 in 1963 was expected to average 50 mc/mi^2 (millicuries per square mile) in the wetter regions and 20 mc/mi^2 in the drier regions.   A considerable range of variability within each climatic area was expected due to rainfall and other differences (depositions in the "wet" areas were expected in the range of 30—60 mc/mi^2 and those in the "dry" areas, 10-30 mc/mi^2).

2.2   The verification of the 1963 strontium—90 fallout over the United States appears on the large map shown in Figure 1.   The shading in Figure 1, taken from FRC Report No. 4, separates the "wet" (heavy shading) from the "dry" (unshaded) areas.   The light shading in the midwestern United States denotes areas with slightly less than 20 inches of annual precipitation while the lighter shading over the state of Florida indicates an expected lesser fallout compared with the "wet" eastern United States because of its sub—tropical location.

2.3   The fallout in "wet" areas generally lies in the 30—60 mc/mi^2 range. No station reported a value in excess of 60 mc/mi^2.   The average derived from the isolines in the "wet" areas is about 45 mc/mi^2 or within about 10 percent of the predicted average.   Fallout in the drier regions of the United States was expected to be about four—tenths as large as that in the "wet" regions.   Except for a few areas, deposition values were below the predicted upper value of 30 mc/mi^2. The observed mean value derived from the isolines is about 25 mc/mi^2, which is about 25 percent greater than the prediction of fallout in the "dry" area.

2.4   It should be noted that the prediction of fallout for the year 1963 contained the possibility that it might be in error by a factor of two. Thus, the 10 and 25 percent discrepancies fall well within the uncertainty in the prediction. The north central United States appears to have received higher fallout and the south central and southwestern United States lower fallout than expected.

2.5   The 1963 fallout data and a reexamination of the results from earlier years suggest that the designation of the "wet"and "dry" areas be modified to conform with observed fallout data. The redefined areas are shown in the inset in Figure 1.

2.6   It should also be noted that the seasonal variation in the deposition of strontium–90 during 1963 differed from that in previous years. Figure 2 presents the time history of fallout in each hemisphere. Fallout in the United States closely follows that of the northern hemisphere. From 1958 through 1962 the peak northern hemisphere fallout occurred in March, April, or May. On the average, about 70 percent of the annual fallout is deposited in the first six months of each calendar year. However, in 1963 the peak concentration extended into July and it took seven, rather than six, months for 70 percent of the annual fallout to be deposited.

Predictions of Future Fallout

2.7   The procedures used to predict the fallout anticipated in the future are the same as those described in FRC Report No. 4, and are based on measurements of the stratospheric inventory of strontium–90 as it existed in January 1964.

2.8   To reflect the stratospheric inventory as of January 1964, the predictions of the fallout expected in 1964 appearing in Table 1 have been increased by 50 percent over the prediction made for the same year in FRC Report No. 4 (1963). This increase lies well within the expected uncertainty of a factor of two or more attributed to the forecast for 1964 made in that report. The forecast for 1964 given in the present report is expected to be verified well within a factor of two.

2.9   Table 1 also contains a prediction of 1965 fallout. This forecast has also been increased by 50 percent over that previously reported. The uncertainty in the present 1965 prediction is greater than a factor of two. If the predictions are in error, there is more likely to be an overestimation of the 1965 fallout than an underestimation.

2.10   Table 2 lists the partition of strontium–90 in various parts of the atmosphere (to 100,000 feet) from 1963 to 1965. Figure 3 and Table 2 emphasize the presence of greatest concentrations in the northern hemisphere. It is likely that in a few years there will be a tendency for equality between hemispheres as suggested in Table 2. Thus, after the 1964 and 1965 fallout has been deposited, roughly one–half of the remaining stratospheric inventory, about one megacurie, should be in the stratosphere of the northern hemisphere. It may therefore be anticipated that in the years following 1965 the total additional strontium–90 deposition will be about 10 and 25 mc/mi^2 in the "dry" and "wet" United States respectively.

2.11   The total inventory of strontium–90 on the ground will increase until the fraction lost each year by radioactive decay equals the annual deposit. On the basis of present information it is anticipated that this condition will have been reached by 1967. The total inventory of strontium–90 on the earth's surface will then continue to decrease in subsequent years.

2.12   The increase in carbon–I4 in the atmosphere at ground level predicted in FRC Report No. 4 has been verified by observations made in 1963, and original predictions in that report are considered to be substantially correct.

FIGURE 1
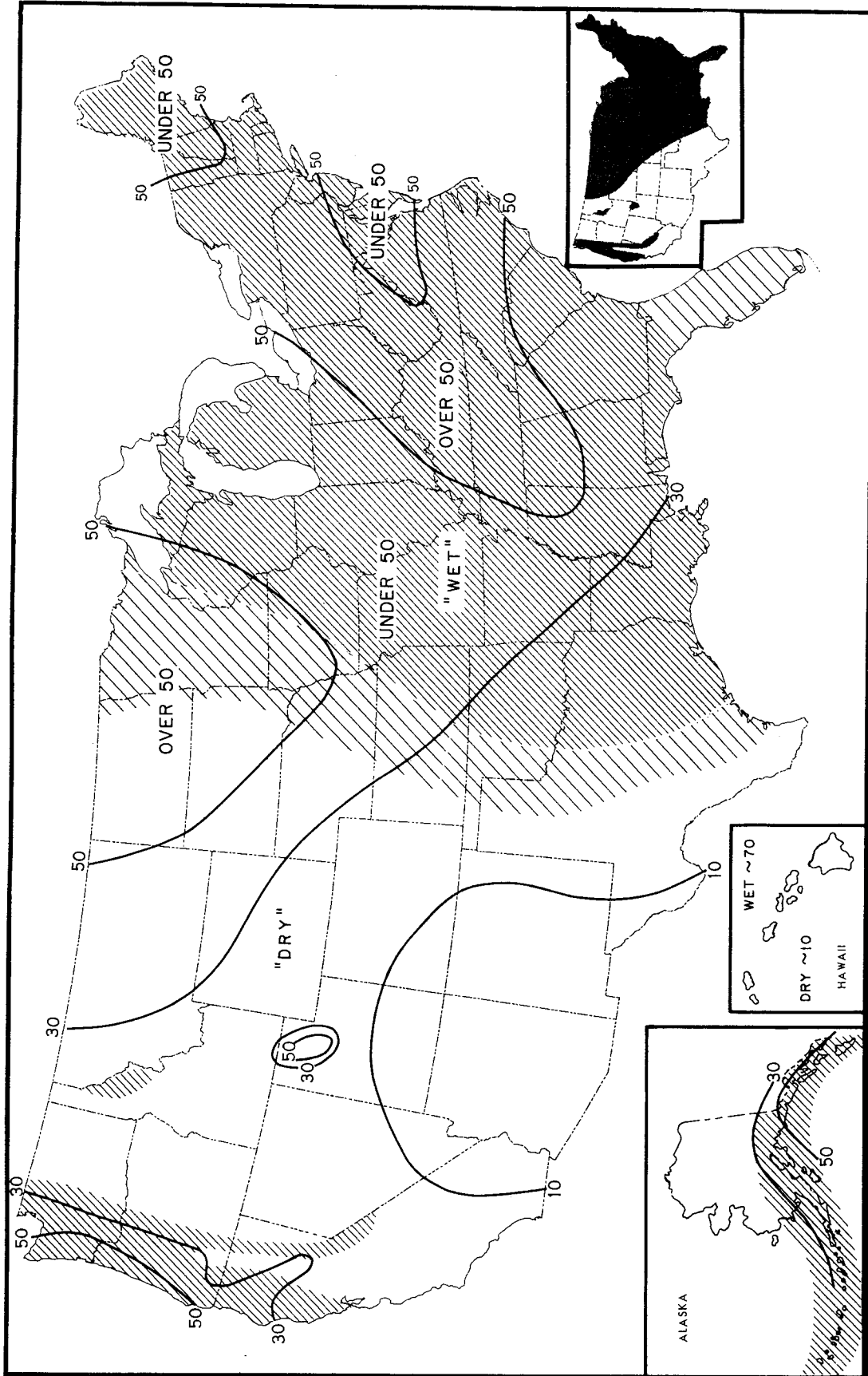
Strontium-90 deposition over the United States during 1963, in millicuries per square mile. The heavily shaded area denotes the "wet" U.S., the unshaded area, "dry" U.S., intermediate fallout regions possess light shading. The shaded area on the small inset map depicts the modified "wet" (or heavier fallout) areas, the unshaded "dry" (or lighter fallout) areas in the conterminous U.S. used in the predictions of this report.

FIGURE 2

SURFACE DEPOSITION
— Northern Hemisphere
--- Southern Hemisphere

Sr-90 Megacuries/Month
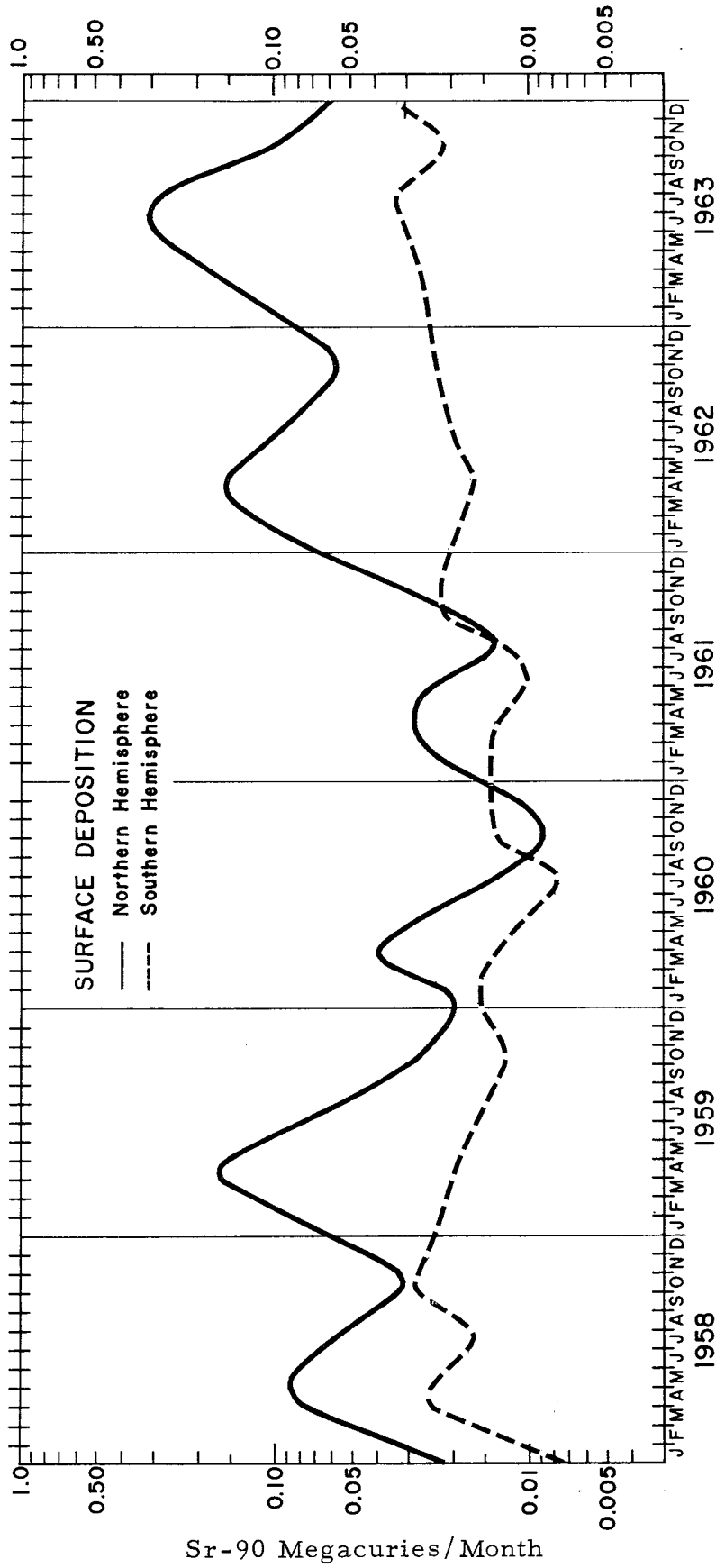
TIME HISTORY OF STRONTIUM-90 SURFACE DEPOSITION

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TABLE 1

Expected Annual Deposition of Strontium - 90 in the
United States

(millicuries per square mile)

	Most Probable Value	Variability within area
Accumulated Deposition to January 1, 1964		
"Wet" area	150	120-190
"Dry" area	65	40-85
Expected Deposition during 1964		
"Wet" area	30	15-60
"Dry" area	12	5-20
Expected Deposition during 1965		
"Wet" area	15	5-25
"Dry" area	6	2-10
Expected Total Deposition after January 1, 1966		
"Wet" area	25	10-50
"Dry" area	10	5-20

In each year, it is expected that about 70% of the annual fallout will occur in the first 6 months of the year.

Note: Designation of "wet" and "dry" areas have been modified slightly since FRC Report No. 4 (see Figure 1)

TABLE 2

Global Strontium - 90 in the Atmosphere
Month of January (megacuries)

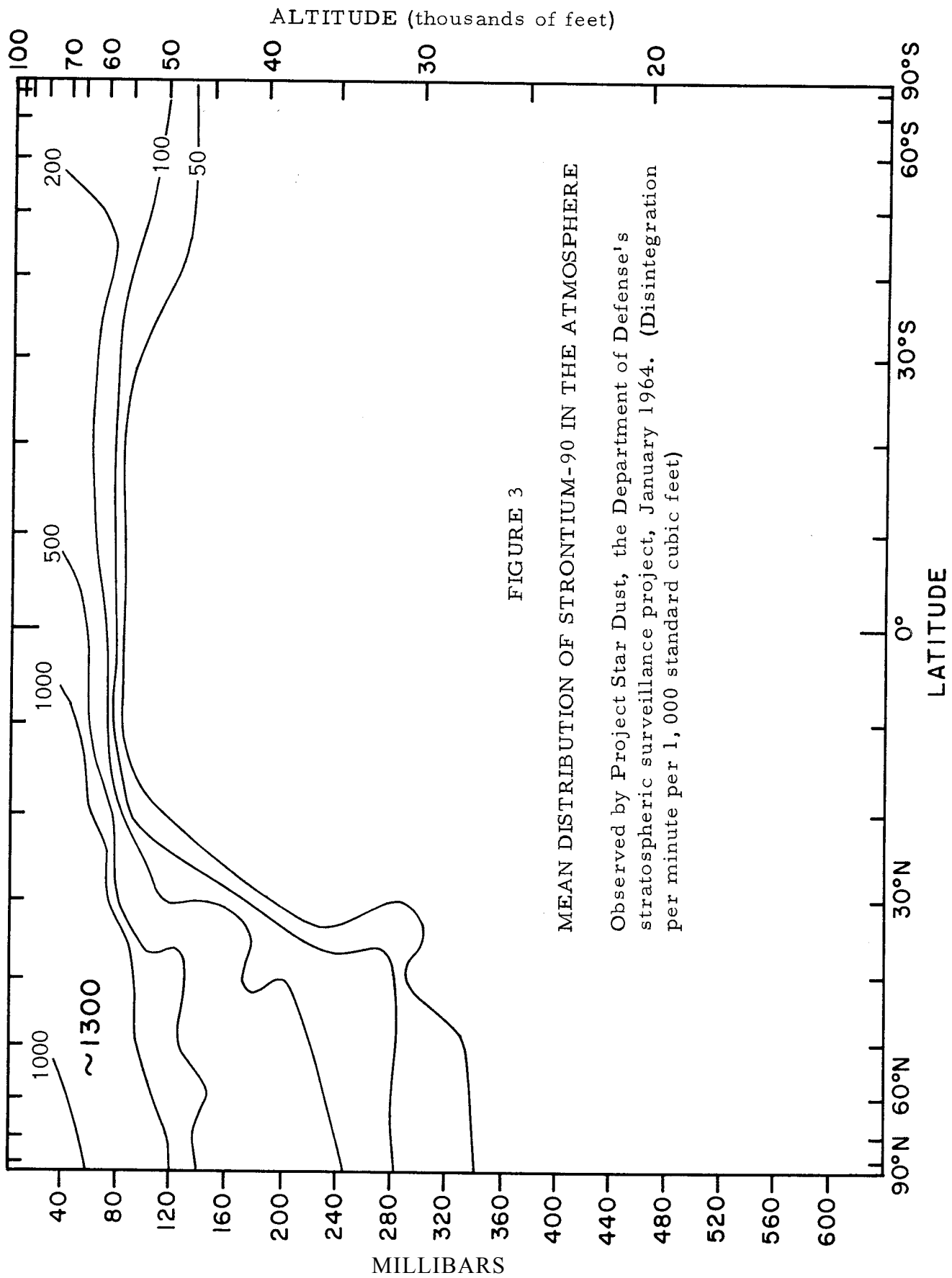|	1963	1964	Predicted 1965
NorthernHemisphere			
Stratosphere	5.7	3.4	2.1
Troposphere	0.3	0.2	0.1
Total Observed	6.0	3.6	2.2
Southern Hemisphere			
Stratosphere	0.5	0.6	0.6
Trosposphere	0.1	0.1	0.1
Total Observed	0.6	0.7	0.7
Total Observed (both hemispheres)	6.6	4.3	2.9

FIGURE 3

MEAN DISTRIBUTION OF STRONTIUM-90 IN THE ATMOSPHERE

Observed by Project Star Dust, the Department of Defense's stratospheric surveillance project, January 1964. (Disintegration per minute per 1,000 standard cubic feet)

SECTION III

RADIONUCLIDES IN THE DIET AND IN PEOPLE

General Considerations

      3.1   This section is concerned with that part of the fallout which enters the food chain of man. Inhalation of radioactive materials and external sources from fallout are not discussed in this report. Both strontium−90 and cesium−137 have been measured in the total diet and various diet components. Quantitative relationships attempting to relate the radionuclide levels in the total diet and diet components to the quantity of fallout deposited, however, have been studied much more extensively in regard to strontium−90.

      3.2   The predictions have been made by a special ad hoc group of technical representatives of all interested agencies in the Federal Government. The detailed methodology has been reported in the hearings of the Joint Committee on Atomic Energy, "Fallout, Radiation Standards, and Countermeasures," June 3, 4, and 6, 1963, and in technical reports of the Health and Safety Laboratory, U.S. Atomic Energy Commission.

      3.3   These prediction procedures have been developed to describe the general situations as found in the conterminous United States. Special situations, such as the lichen−caribou−manfood chain in Alaska require different procedures to adequately describe them. The factors concerned in this food chain are the subject of studies being conducted by the Atomic Energy Commission and the Public Health Service.

      3.4   The general considerations related to estimates of the strontium−90 content of the total diet and diet components were outlined in FRC Report No. 4. Milk, fresh fruits, and fresh vegetables are distributed regionally or locally. Therefore, these items in the diet tend to reflect the local levels of fallout. Differences in the strontium−90 to calcium ratio of the

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total diet in different localities should be related primarily to the strontium-90 in these dietary items. Nationally distributed processed foods tend to lead to a contribution of strontium-90 that is about the same in all parts of the country. The delayed marketing and consumption of such nationally distributed foods introduces a lag between the time of fallout deposition and the appearance of strontium-90 in the total diet.

       3.5   Predictions of the anticipated levels of strontium-90 in the diet and diet components may be made by one or both of two general procedures: (1) Prediction of the contamination levels expected in different dietary components as a function of the fallout rate and cumulative levels of strontium-90 in the soil, and the calculation of total diet levels on the basis of the contribution each component makes to the total diet; or (2) multiplying the strontium-90 value for milk by an empirically developed factor related to the fractional contribution of milk to the strontium-90 and calcium intake in the total diet. This factor changes when the rate of fallout deposition changes.

       3.6   The predictions for strontium-90 in the total diet and milk as presented in both FRC Report No. 4 and the present report are Lased on estimates made for New York City as representative of the "wet"areas and for San Francisco as representative of the "dry" areas. This practice has been adopted because the numerical constants relating the fallout rate and the cumulative levels of strontium-90 in soil to the respective dietary contamination levels in these cities are the best estimates available for these factors and also because bone sampling in these areas is correlated with the diet sampling. Strontium-90 and cesium-137 levels in milk and the total diet have been measured in many localities throughout the country under programs sponsored by the Food and Drug Administration, the U.S. Public Health Service, and the Atomic Energy Commission. Averages computed from these data for the "wet"and "dry" areas, as described in Figure 1, indicate that the averages for "wet"and "dry" regions as a whole will usually be comparable to the values predicted for New York and San Francisco respectively.

<u>Verification</u> <u>of</u> <u>1963</u> <u>Estimates</u>

3.7   Based on the information available in early 1963, estimates of the anticipated levels of strontium−90, strontium−89, cesium−137, and iodine−131 in the diet and some diet components were made in FRC Report No. 4.   The evaluation of iodine−131 data observed in 1963 was incorporated in FRC Report No. 4.   It was also estimated that the annual average strontium−89 concentration in milk would be about the same in 1963 as it had been in 1962, and that this nuclide would be reduced to negligible levels in 1964.   The observed average concentrations of iodine−131, strontium−89, strontium−90, and cesium−137 in milk from the middle of 1961 through June 1964 are shown in Figure 4.   This figure illustrates the general trends.   The network average is plotted instead of the separate values for the "wet"and "dry" areas.   It can be seen that iodine−131 was essentially gone by May 1963 and strontium−89 by June 1964.

3.8   The estimates for the longer−lived nuclides in the diet and in people were presented in the form of the expected annual average for the "wet"and "dry" areas as described in Figure 1.   These estimates were based on the most probable value of the annual fallout deposit, the expected distribution of this annual increment by month, and the cumulative deposit on the ground at the beginning of 1963.

3.9   Table 3 compares the observed levels of strontium−89, strontium−90, and cesium−137 in the 1963 diet and strontium−90 in the bone with the anticipated annual averages for the "wet"and "dry" areas.   The observed values reported are based on all surveillance data available.   Figure 5 shows isolines of the annual average concentrations of strontium−90 in milk based on the Pasteurized Milk Network of the U.S. Public Health Service.   The computed averages are 27 and 16 picocuries strontium−90 per liter for the "wet"and "dry" areas respectively.   The agreement between the predicted and observed values is quite good in all categories except for the strontium−90 to calcium ratio in the total diet and new bone.   The diet values, which represent the predictions for the final step in the chain of this radionuclide transmitted through the environment to man,

were overestimated by a factor of 1.7 for the "wet" areas and 3.5 for the "dry" areas.

3.10   The predictions in FRC Report No. 4 for strontium−90 in the diet were made before most of the 1963 fallout occurred and before some crops were grown. The predictions were not expected to differ from the observed values by more than a factor or two.   The discrepancy between the predicted and observed value for the total diet is larger than expected.   It is now apparent from detailed studies that non−milk products contributed less to strontium−90 content of the total diet in 1963 than would be calculated by the past prediction procedures used in relating fallout rate to the strontium−90 content of the total diet.   Adjustments in the prediction procedures will be discussed in connection with the new estimates.   (Par. 3.23)

3.11   Table 3 shows two values for the strontium−90 to calcium ratio in bone. The ratio in new bone being formed is one−fourth that in the average diet because the body selectively discriminates against strontium.   The observed value for new bone is based on a few measurements on infants less than 1 year old.   The observed value for the average of the 0−4 year age group is less because, in the older children, the concentration of strontium−90 is diluted more by the calcium already present.

3.12   The 1963 predictions of 50 and 35 picocuries strontium−90 per gram calcium as the expected values for the total diet in the "wet" and "dry" areas respectively led to predicted concentrations of 12 and 9 picocuries strontium−90 per gram calcium in new bone formed in 1963. The observed values of 7 and 2 picocuries strontium−90 per gram calcium for new bone and 5 and 3 picocuries strontium−90 per gram calcium in the 0−4 age group are in good agreement with the observed ratios in the total diets in 1963.   However, they are lower than the values of 12 and 9 picocuries strontium−90 per gram calcium reported in FRC Report No. 4 as the values expected to result from fallout anticipated in 1963.

Predictions of Future Levels

     3.13   After the termination of atmospheric testing, iodine–131 essentially disappeared from the environment by May 1963 and strontium–89 by June 1964. New predictions will be made for only the long–lived nuclides strontium–90 and cesium–137.

Milk

     3.14   The radionuclide concentrations in fresh milk follow closely the radionuclide content of the cow's fodder. In many parts of the country, the dairy cows are put on pasture in the spring, and during the months while the cows are on pasture the radionuclide concentration in milk varies with the fallout rate. As indicated in Section II, a maximum in the fallout rate is usually reached in April, May, or June. Strontium–90 and cesium–137 concentrations in milk usually increase to a maximum in these months, followed by steadily diminishing concentrations during the summer and early fall. This decrease reflects the lower fallout rate during these seasons plus the loss of surface deposits through weathering, new growth replacing the contaminated grass, and normal changes of feeding practices during the season. When the cows are shifted to stored fodder the radionuclide concentration in milk then reflects the content of the fodder. The slight perturbation in the pattern of fallout deposited by month in 1963 as compared to previous years did not have much effect on the annual average concentrations in milk possibly because dairy cattle were on pasture in many parts of the country during the whole period of interest.

     3.15   Table 4 summarizes the data on the average strontium–90 content of milk from 1959 through 1963 and presents new predictions for 1964 and 1965. These predictions reflect the new values for the annual increment of fallout in 1964 and 1965, as shown in Table 1, and the cumulative level of strontium–90 in the soil at the beginning of 1964. Figure 4 shows the trends in average concentrations of strontium–90 and cesium–137 in milk through June 1964. A breakdown of the data into separate estimates for the "wet" and "dry" areas suggests that the prediction for the average concentration of

strontium–90 in milk of the "wet"areas in 1964 will probably be very close to the observed value and that the prediction for the "dry" areas may be less than the observed value. This possible discrepancy is not expected to exceed a factor of two.

3.16   The formulas used to relate cesium–137 concentrations in milk to the fallout rate and the cumulative deposit of cesium–137 on the ground are more uncertain than those for strontium–90. On the basis of present information it is expected that the average concentration of cesium–137 in milk in 1964 will be about the same as it was in 1963 and will decrease in 1965. The ratio of cesium–137 to strontium–90 is not expected to remain constant with time because of the different mechanisms involved in the movement of these nuclides through the food chain to milk. In general, the cesium–137 concentrations are expected to decrease faster than the strontium–90 concentrations.

Wheat and Flour

3.17   The strontium–90 content of wheat and flour in the United States from 1959 through 1961 was shown in Table 8 of FRC Report No. 4. The analyses of the 1962 crop were not available at the time that report was written, so the expected value in 1962 was estimated on the basis of what was known about the fallout rate in 1962. The expected values of strontium–90 per kilogram of wheat were given as 130 picocuries in 1962, 250 picocuries in 1963, and 100 picocuries in 1964.

3.18   Table 5 summarizes the average concentrations of strontium–90 observed in wheat and flour from 1959 through 1963 and makes new predictions for 1964 and 1965. The observed value of strontium–90 in 1962 wheat was 40 percent less than the estimated value used in preparing the estimates of FRC Report No. 4. There is good agreement between the predicted and observed values for the 1963 crop.

3.19   The contamination of cereal grains by fallout appears to be far more sensitive to the fallout rate between the time the grain has headed out and harvest than to either the cumulative total in the soil

or to the total annual increment of fallout. This time-span is about 6 to 8 weeks for the most important crops, and makes the relative levels of contamination from year to year very sensitive to perturbations in the fallout rate by month. Under these conditions it is not surprising to find large variations in the same crops grown in different areas, or different crops grown in the same areas. The difference between the predicted and observed values for 1962 may be attributable at least in part to this cause.

3.20   The new estimates for 1964 and 1965 are based on the adjusted figures for the annual increment of fallout for those years as shown in Table 1 and the cumulative level of strontium-90 in the soil at the beginning of 1964. The formula used in making the present predictions assumes that the level of contamination in wheat is primarily determined by the fallout rate in the month of June of each year.

Total Diet

3.21   The levels of cesium-137 in the total diet in 1964 are expected to differ from those observed in 1963 by about the same percentage as strontium-90 in the total diets for the same years. The factors entering the prediction of the strontium-90 content of the total diet have been discussed in paragraphs 3.1 - 3.6. Tabulated predictions have been given for the strontium-90 levels in milk and wheat. Wheat may be considered representative of the cereal grains. In the past, these two components have accounted for 60 to 70 percent of the total strontium-90 intake and about 75 percent of the total calcium intake in the United States diet. The ratio of strontium-90 to calcium in the total diet should be close to the ratio estimated from these two components. The strontium-90 intake through fruits and vegetables is subject to a considerable regional variation. This source accounts for most of the remaining 30 percent of strontium-90 and an additional 13 percent of calcium.

3.22   Observations of the strontium-90 to calcium ratio in the total diet compared to that in milk have generally fluctuated between 1 and 2 for the past several years. The most logical explanation for this variability

appears to be that the lower values of the total diet to milk ratio occur during the periods of increased fallout deposition when the strontium−90 in milk, fresh fruits, and fresh vegetables is increasing; other non−milk components reflect the strontium−90 to calcium ratio of products grown before the fallout deposition started increasing. Following a period of relatively high fallout deposition and when the deposition rate is decreasing, the strontium−90 to calcium ratio in milk decreases. However, relatively high ratios of strontium−90 to calcium may be found in the total diet because the non−milk components will reflect the strontium−90 to calcium ratio of products grown during the time of the higher fallout deposition rate. It has been assumed that the strontium−90 to calcium ratio of the total diet will be 1.5 times the predicted value for milk for purposes of long−term prediction. However, this ratio (1.5) cannot be considered reliable for developing short−term predictions especially when the annual rate of fallout deposition changes such as it has done since 1962.

3.23   The predictions in FRC Report No. 4 utilized both the diet to milk ratio method and the procedure of directly predicting the anticipated strontium−90 levels in different dietary components. For the direct estimates it was assumed that the time lag between the production of all dietary components and the entry of the produce into the market is less than one year. In the present report, it is assumed that milk products and fruits and vegetables are consumed in the same year in which the products are produced. However, for the cereal grains it is assumed that 25 percent comes from the crop grown during the year of interest while 75 percent comes from the crop grown during the previous year. New predictions for the strontium−90 to calcium ratio of the total diet are shown in Table 6. These predictions reflect the adjusted estimates of the fallout deposition rates for 1964 and 1965 as shown in Table 1.

3.24   When the adjusted assumptions are applied to the 1963 figures, the "predicted" values would be 40 and 20 picocuries strontium−90 per gram calcium for the total diets of the "wet" and "dry" areas respectively. Although these values are closer to the observed values of 30 and

10 picocuries strontium-90 per gram calcium than the
original predictions of 50 and 35 picocuries strontium-90
per gram calcium, the adjusted assumptions would still
overestimate the strontium-90 contamination of the total
diet as it existed in 1963. However, the new predictions
of 40 and 20 picocuries strontium-90 per gram calcium for
the total diet in the "wet" and "dry" areas respectively
in 1964 may be closer to the observed annual averages
since 1964 is the second successive year of relatively
high fallout deposition.

Bone

3.25 The ratios of strontium-90 per gram calcium
in bone observed in the past and predicted for the future
are shown in Table 7. The numerical values for 1964 and
1965 are one-fourth the predicted ratio of strontium-90
to calcium in the total diet shown in Table 6. The
difference between the strontium-90 concentrations in new
bone being formed and the average level in the 0-4 year
age group (illustrated in Table 3) is expected to
decrease with time.

Dose Estimates

3.26 The estimates made in FRC Report No. 4 for
the expected 30-year and 70-year doses are not altered by
the revised estimates of radioactive nuclides in the
diet. The doses estimated for external exposure from
short-lived nuclides and for strontium-89 correspond to
the observed values for these nuclides in 1963. The
shift of one year in the time of the maximum value of
strontium-90 expected in the diet has very little effect
on the estimated 70-year dose from strontium-90.

3.27 During the past three years a whole body
counter has been used to measure the cesium-137 body
burdens of the inhabitants of several villages in artic
Alaska chosen to evaluate environmental factors and
dietary patterns unique to that region. Estimates of
doses to individuals in 1964 based on these measurements
range up to about 400 millirems. Depending upon the
further fallout expected and the long-term retention in
the food chain, this might correspond to 30-year doses
ranging up to several rems.

3.28   On the basis of present information, the estimates made in FRC Report No. 4, regarding the maximum concentrations of radionuclides to be expected from fallout, the projected doses from these nuclides, and the evaluation of the possible risks were essentially correct.   However, the time of the maximum contamination of the total diet is now expected to occur in 1964 instead of 1963.   It is concluded that the predictions made in FRC Report No. 4 were substantially correct and the conclusions in that report still apply.
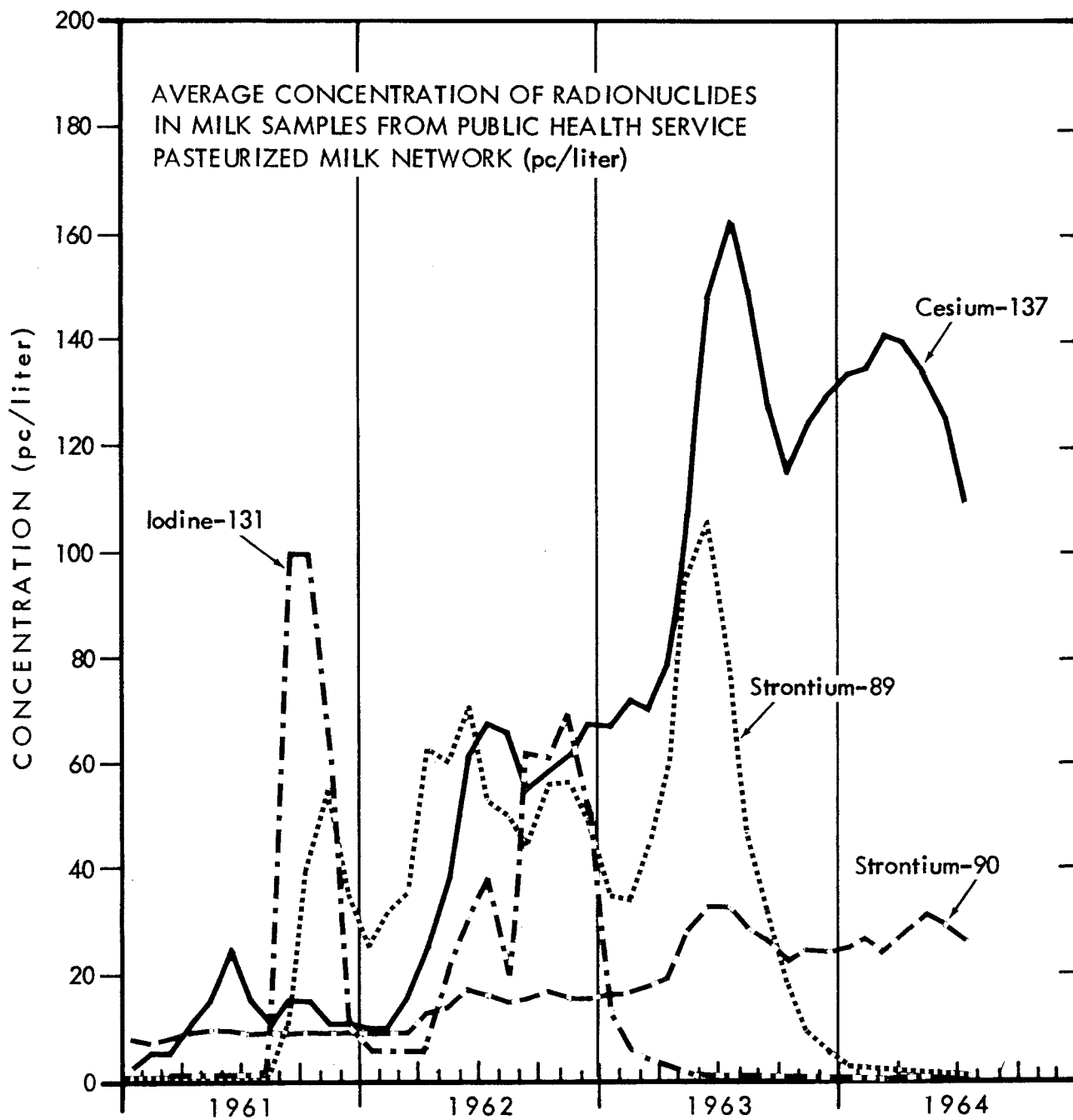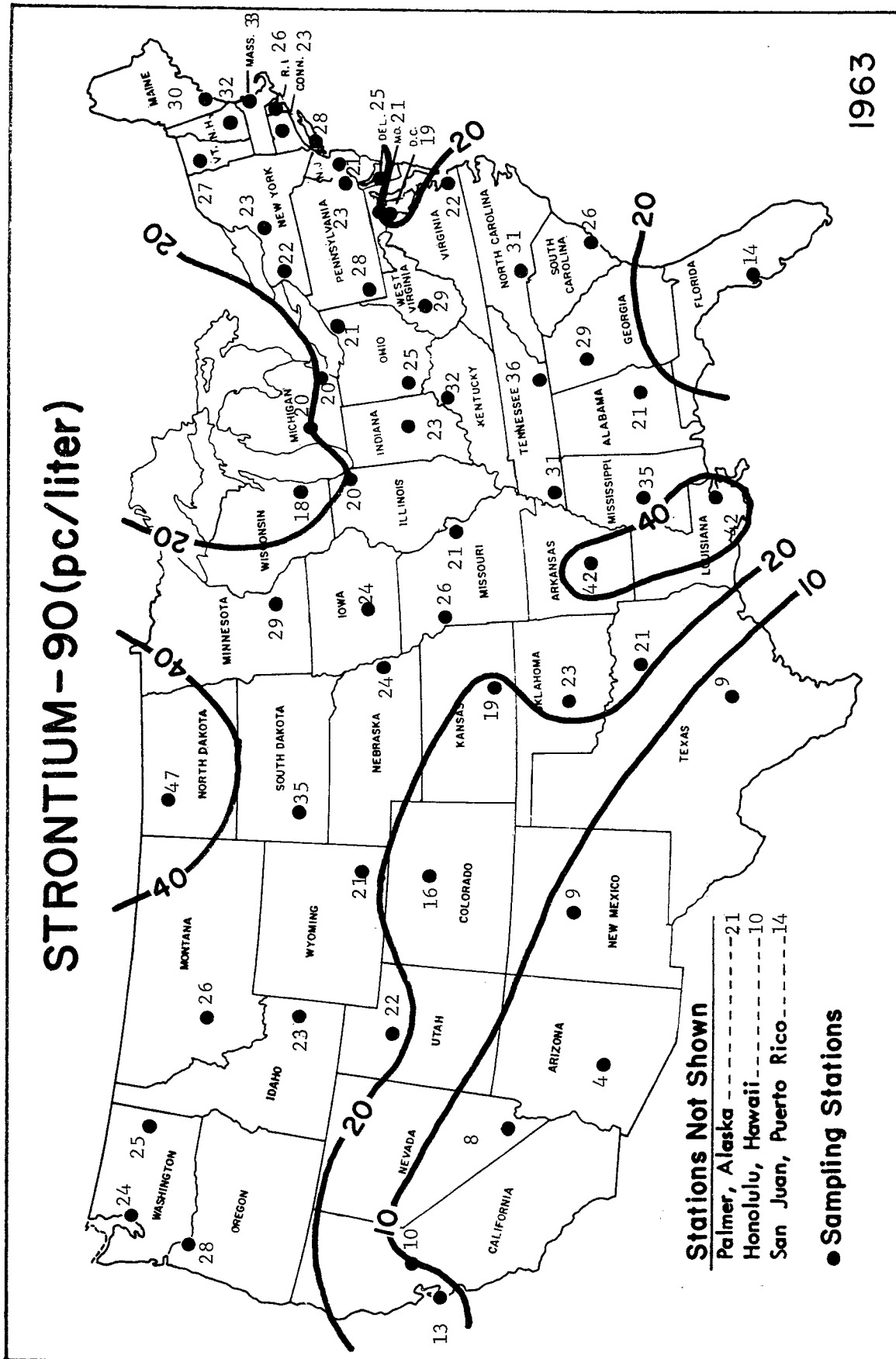
FIGURE 4

AVERAGE CONCENTRATION OF RADIONUCLIDES
IN MILK SAMPLES FROM PUBLIC HEALTH SERVICE
PASTEURIZED MILK NETWORK (pc/liter)

TABLE 3

Comparison of Predicted and Observed Levels
of Radionuclides Deposited and in the U.S. Diet in 1963*

	"Wet"		"Dry"	
	Pred.	Obs.	Pred.	Obs.
Deposition (mc Sr^{90}/mi^2)				
Range	30–60		10–30	
Most Probable Value	50	45	20	25
Milk				
Sr^{90} (pc/liter)	30	25	10	15
Sr^{89} (pc/liter)	55	50	40	40
Cs^{137} (pc/liter)	140	125	--	85
Wheat (pc Sr^{90}/kg wheat)	250	220		
Flour (pc Sr^{90}/gm Ca)	40	40		
Total Diet (pc Sr^{90}/gm Ca)	50	30	35	10
New Bone (pc Sr^{90}/gm Ca)	12	7	9	2
Age 0–4 Bone (pc Sr^{90}/gm Ca)	5**	5	3**	2

*Except for bone, both predicted and observed values have
been rounded to the nearest 5 units for purposes of com-
parison since this is considered to be more in keeping
with the reliability of the estimates.

**Calculated from the observed strontium–90 calcium ratio
in the diet.

FIGURE 5

STRONTIUM-90(pc/liter)

1963

STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

Stations Not Shown

Palmer, Alaska	21
Honolulu, Hawaii	10
San Juan, Puerto Rico	14

● **Sampling Stations**

TABLE 4

Average Strontium–90 Content of Milk in the U.S.*

(picocuries strontium - 90 per liter of milk)

	New York	"Wet" Areas	San Francisco	"Dry" Areas
Observed				
1959	10	15	--	10
1960	10	10	5	5
1961	10	10	5	5
1962	15	15	5	10
1963	30	25	10	15
Predicted				
1964	30	--	10	--
1965	25	--	5	--

*Predicted and observed values have been rounded to the nearest 5 units for purposes of comparison since this is considered more in keeping with the reliability of the estimates.

TABLE 5

Strontium–90 Content of Wheat and Flour in the U.S.*

(picocuries per kilogram)

Average from 9–15 States
weighted for production

Year of Harvest	Wheat	Flour
	Observed	
1959	50	10
1960	25	5
1961	25	10
1962	85	15
1963	220	40
	Predicted	
1964	140	20
1965	80	10

*Predicted and observed values have been rounded to the nearest 5 units for purposes of comparison since this is considered more in keeping with the reliability of the estimates.

TABLE 6

Average Strontium−90 Content of U.S. Total Diet*

(picocuries strontium−90 per gram calcium)

	Observed	
	N.Y.C. ("Wet" Area)	S.F. ("Dry" Area)
1959	15	10
1960	10	5
1961	5	5
1962	10	5
1963	30	10
	Predicted	
1964	40	20
1965	30	15

*Predicted and observed values have been rounded to the nearest 5 units for purposes of comparison since this is considered more in keeping with the reliability of the estimates.

TABLE 7

Average Strontium−90 Content of Human Bone in the U.S.

(picocuries strontium−90 per gram calcium)

	Bone*	
	Observed (0−4 years old)	
	"Wet"Areas	"Dry"Areas
1958	2.0	2.0
1959	2.7	2.2
1960	2.4	1.8
1961	2.6	0.9
1962	3.1	1.1
1963	5.0	1.9
	Predicted (new bone 0−4 yr old)	
1964	10	5
1965	8	4

*See paragraph 3.25