EPA-520/5-77-002

EPA ASSESSMENT OF FALLOUT IN THE UNITED STATES FROM ATMOSPHERIC NUCLEAR TESTING ON SEPTEMBER 26 AND NOVEMBER 17, 1976 BY THE PEOPLE'S REPUBLIC OF CHINA

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August 1977

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FOREWORD

The Office of Radiation Programs (ORP) of the U.S. Environmental Protection Agency (EPA) has a primary responsibility to establish radiation protection guidance and to interpret existing guides for Federal agencies. This responsibility was transferred to the Administrator of EPA from the Federal Radiation Council which was abolished by Reorganization Plan No. 3 of 1970. One of ORP's mandates in carrying out this responsibility is to monitor and assess the impact on public health and the environment of radiation from all sources in the United States, both ionizing and nonionizing. Therefore, ORP has initiated a radiological dose assessment program to determine the status of radiation data nationwide, to analyze these data in terms of individual and population doses, and to provide guidance for improving radiation data. In addition, this program will provide information to guide the direction of ORP by the analysis of radiation trends, identification of radiation problems, and support for establishing radiation protection guidance.

As a part of this program, ORP operates a system for monitoring levels of radioactivity in the environment. This system is called the Environmental Radiation Ambient Monitoring System (ERAMS) and is operated by EPA's Eastern Environmental Radiation Facility in Montgomery, Alabama. This monitoring program is designed to provide long-term radioactivity assessment of trends and seasonal changes and short-term early warning to establish the need for emergency abatement actions or contingency sampling operations. Sampling media included in this program are air particulates, precipitation, surface water, drinking water and pasteurized milk.

Following the atmospheric nuclear weapons tests by the People's Republic of China on September 26 and November 17, 1976, the ERAMS network was fully activated and frequent samples of air particulates, precipitation, and pasteurized milk were collected for several weeks after each event. Population doses for the United States were calculated using the levels of radioactivity measured in these samples. Based on the calculated doses, health effects to the population of the United States were estimated. This report is a summary of EPA's assessment regarding the radiation doses and potential health effects which may be attributed to radioactive fallout from these nuclear weapons tests.

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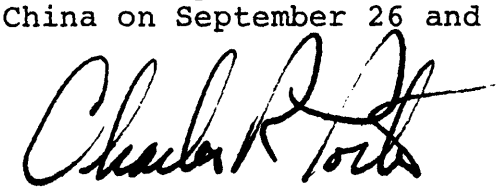
PREFACE

The Eastern Environmental Radiation Facility (EERF) participates in the identification of solutions to problem areas as defined by the Office of Radiation Programs. The Facility provides analytical capability for evaluation and assessment of radiation sources through environmental studies and surveillance and analysis. The EERF provides technical assistance to the State and local health departments in their radiological health programs and provides special analytical support for Environmental Protection Agency Regional Offices and other federal government agencies as requested.

This report was generated to assess environmental radiation contributions from the atmospheric nuclear tests by the People's Republic of China on September 26 and November 17, 1976.



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ABSTRACT

The People's Republic of China conducted atmospheric nuclear weapons tests over the Lop Nor testing area in Southwest China on September 26, and November 17, 1976. Based on past experience, EPA expected that radioactive fallout from these events should be barely measurable in the United States. However, for several weeks following both events, EPA monitored for fallout by fully activating the Environmental Radiation Ambient Monitoring System (ERAMS) network even though no significant radioactivity levels were expected. Rainstorms in parts of the eastern United States following the September test resulted in radioiodine levels on pasture grass and in cow's milk which were easily detectable and higher than expected. Slight elevations of radioiodine levels in milk above background were also observed at the other milk sampling locations across the U. S. Radionuclide levels in air particulates and precipitation were also elevated. Radionuclide levels in all sampling media and at all sampling locations were only slightly above background following the November test. EPA reviewed the potential for aircraft related exposures due to fallout following the November detonation and has concluded that there were no significant exposures to passengers or to commercial airline employees following the detonation.

A review of the environmental levels of radioactivity following both events indicated that radionuclide levels following the November event were so low that dose calculations would not be meaningful. Maximum individual doses for all nuclides detected in air and milk following the September event were calculated to obtain an indication of the relative importance of the various dose pathways. The highest dose was for the ^{131}I-milk-thyroid pathway which was at least a factor of 7.5 higher than for any other pathway. After reviewing these maximum calculated individual doses, it was decided to calculate a U. S. thyroid population dose for the first event using ^{131}I levels measured in the ERAMS milk samples and U. S. Department of Agriculture milk production data. A U. S. population thyroid dose of 68,000 man-rads was calculated. Using EPA's current best estimate for risk for thyroid health effects (63 excess thyroid cancer cases per 10^6 man-rads), it is predicted that 4.3 excess thyroid cancer cases could potentially occur in the United States during the next 45 years

due to the ^{131}I in milk following the September event. This number of potential thyroid cancers calculated for the U. S. population are small and will be undetectable when compared to the estimated 380,000 cases of thyroid cancer which might be expected in the United States from all causes during the next 45 years.

ACKNOWLEDGMENT

The authors would like to express their appreciation to Christopher B. Nelson and J. David Lutz, Environmental Analysis Division, and to Jon A. Broadway and Charles R. Phillips, Eastern Environmental Radiation Facility, for their many comments and suggestions used in the compilation of this report.

1. INTRODUCTION

Description of Fallout Incidents

During the fall of 1976, the People's Republic of China detonated two nuclear devices in the atmosphere over the Lop Nor testing area in Southwest China. The first explosion occurred on September 26, 1976, and was rated as a low yield nuclear device with an explosive power equivalent to 20-200 thousand tons of TNT. The second device detonated on November 17, 1976, had a high yield of about four million tons TNT equivalent. This was the largest device yet tested by the People's Republic of China.

Since both detonations were above ground, it was expected that radioactive materials would be injected into the atmosphere. The prevailing air currents over China move in an easterly direction. Therefore, within 4 to 7 days these airborne radioactive materials would be expected to arrive over the North American Continent. The fastest moving of these air currents of initial interest generally move at altitudes of 20 to 40 thousand feet. Normally, the materials carried by these air currents pass over the United States and Canada within 2 to 4 days after arrival at the west coast. The radioactive materials usually remain at the higher altitudes until slowly dropping down to the earth's surface as fallout over a period of several months or years.

The Environmental Protection Agency's experience, and that of its predecessor organizations, with atmospheric nuclear testing by the People's Republic of China (18 tests since October 1964) indicated that radioactive fallout should be barely measurable in the United States. Consequently, EPA was prepared to monitor for any fallout which might occur although no significant radioactivity levels were expected.

The movement of air masses carrying radioactive materials from the September 26, 1976, nuclear test, however, encountered a storm system causing it to behave differently from normal. During passage over the United States at about 30 thousand feet, turbulence brought the radioactive materials down to altitudes where rainfall was occurring over the eastern

part of the United States. Subsequently, these materials were carried downward by rain (rainout) and deposited on the ground. This rainout did not occur following the November 17, 1976, nuclear test which was more in accordance with fallout behavior of previous tests.

Concerns for Fallout

Airborne radioactive materials produced by atmospheric nuclear weapons testing may cause radioactive exposures to people in several ways. The primary concern is when the radioactive materials come down from the atmosphere as fallout. Then people may potentially be exposed by inhalation of radioactive dust particles or more importantly by ingestion of foods which may contain fallout materials. Milk is the main food of concern because there is a possibility of radioactive deposition on grass being transferred into cow's milk. Fallout of dry materials or more significantly rainout of radioactive materials could deposit on large areas of land including pastures for dairy cattle. Cows consume large quantities of grass and some of the radioactive materials which may be on this grass are transferred within a day or two to the cow's milk. Times involved in milk production, transport, processing and bottling are such that normally several days would be required for any such potential contamination to reach pasteurized milk for retail sales to consumers.

An additional concern for airborne radioactive materials is for potential exposures to people aboard aircraft flying at altitudes where these materials are being carried by air currents. There is also some possibility that radioactive particles may be picked up on aircraft surfaces such as engine air intake ducts. Such contaminated surfaces could potentially cause exposures to aircraft maintenance personnel.

EPA Responsibilities

EPA has responsibility through its Office of Radiation Programs to evaluate exposures to the public from all sources of radiation, and to issue guidance for control of these exposures or to set appropriate

exposure standards. Inherent in this responsibility is the determination of the impact of radiation doses from radioactive fallout. To assess the radiation doses from radionuclides in the general ambient environment, EPA maintains a monitoring program known as the Environmental Radiation Ambient Monitoring System (ERAMS). This system was alerted for special radiation measurements prior to and during the times of anticipated fallout from the September and November nuclear tests. ERAMS is described in detail later in this report.

In addition, EPA has the responsibility to notify State agencies of the possibility of radioactive fallout. EPA also keeps these State agencies informed on the national and regional radiological picture and advises these agencies regarding surveillance or protective actions which they may pursue.

EPA collects information from its own monitoring system, from State monitoring programs, and from other Federal agencies to assess the national radiological situation. This information is then relayed to the public by means of press releases during the time of potential fallout. Other Federal agencies are also informed of the situation as appropriate.

Purpose and Scope of This Report

This report represents EPA's assessment of radiation doses due to radioactive fallout from both atmospheric nuclear tests during the fall of 1976. This assessment is based upon data from EPA's national monitoring program for fallout. Primarily, this assessment focuses on the potential for radiation exposures due to fallout materials in pasteurized milk after the September 26, 1976, nuclear test. The potential doses from inhalation of radioactive aerosols following this test were very small. Also, fallout levels after the November 17, 1976, nuclear test were below or barely at measurable levels. Consequently, the only potential doses of significance were attributed to consumption of pasteurized milk after the September 26 nuclear test.

To simplify reporting of EPA's assessment for the combined nuclear tests, this report is organized to present information from each test in series within each section of the report. For example, the following section on movement of contaminated air masses presents the September 26 information first and then follows with information for the November 17 nuclear test.

Detailed data on EPA's monitoring measurements are included as an appendix to this report. These data were used to assess individual and population doses as discussed in section 9. The assessment of population health effects is given in section 10. Each of these sections briefly outlines the assessment approach and modelling parameters. The interpretation of dose and health effects is presented in the discussion in section 11.

In particular, this report is intended to present information on the following items:

(a) description of fallout incidents
(b) movement of contaminated air masses
(c) EPA's general monitoring program
(d) EPA's specific fallout monitoring efforts
(e) EPA's monitoring results
(f) population dose assessment
(g) potential health effects
(h) interpretation of dose and health effects and conclusions

2. SUMMARY AND CONCLUSIONS

Summary

EPA has assessed the short term* impact on public health in the United States which may be attributed to radioactive fallout from the two atmospheric nuclear tests during the fall of 1976.

The first detonation occurred on September 26 and the initial pass of the cloud was calculated to reach the western coast of the U. S. on October 1. EPA activated the standby air particulate and precipitation stations of ERAMS on September 29 and September 30. Routine nationwide pasteurized milk samples were collected during the week of October 4 which was early in the buildup cycle of levels in milk. EPA continued frequent sampling until levels of fallout radionuclides in all sampling media returned to normal background levels.

Detectable levels of fresh fission products were documented in air, precipitation and milk samples from the ERAMS program following this test. Although radioactivity levels in air particulates were quite low, fresh fission products were detected geographically throughout most of the U. S. The heaviest concentrations of radioactive fallout were apparently deposited in rainfall with the most significant concentration along the east coast. Subsequently the highest concentrations of ^{131}I and ^{140}Ba in milk were detected in that area.

The second detonation occurred on November 17 and the initial pass of the cloud was predicted to reach the western coast of the United States on November 20. ERAMS air particulate and precipitation stations were fully activated on November 18. Special nationwide pasteurized milk samples were collected beginning November 24. EPA continued the special sampling until

* Over the long term of many years most of the fallout will be deposited over the earth, contributing to a slight increase in background levels. This long term impact is not assessed in this report.

it was obvious that there was not going to be a significant buildup of radionuclides in the environmental samples as a result of this event. No fresh fission product activity from the test of November 17 was detected in the air particulate and precipitation samples and only two milk samples contained measurable amounts of ^{131}I. This activity in milk is probably attributable to the September 26 test since slightly elevated levels of activity remained in air samples through the first part of November. There were special concerns following the November 17, 1976, detonation regarding potential aircraft related exposures. EPA has reviewed these concerns and has concluded that there were no significant exposures to passengers or to maintenance personnel as a result of commercial air traffic following the November detonation. Press releases were issued frequently during the sampling period after both events to keep the public informed.

For both events, the only potentially significant increase in radioactivity in environmental samples was ^{131}I in milk following the September event. A population thyroid dose for this event was calculated to be 68,000 man-rad. Using EPA's best estimate for health effects, this population dose translates to an estimate of 4.3 excess thyroid cancers which could potentially occur in the 45 years following this event. These estimates of potential excess thyroid cancers and deaths are a factor of 88,000 below the spontaneous natural occurrence of thyroid cancers projected for the same time period. EPA's assessment of potential health effects resulting from short term fallout from the September and the November events indicates that these events will not significantly affect the health of the United States population.

Conclusions

The conclusions that can be drawn from this evaluation of potential radiological health effects of the fallout from the September and November 1976 nuclear weapons tests by the People's Republic of China are:

(a) These two nuclear weapons tests will not contribute significantly to thyroid cancer deaths in the United States.

(b) There were no significant exposures to commercial airline passengers or employees as a result of flights following the November detonation.

(c) ERAMS data can be used to make reasonable estimates of doses to the population of the United States due to radioactivity in the environment.

3. EPA MONITORING PROGRAM

ERAMS

Continuing surveillance of radioactivity levels in the United States is maintained through EPA's Environmental Radiation Ambient Monitoring System (ERAMS). This system was formed in July 1973 from the consolidation and redirection of separate monitoring networks formerly operated by the U. S. Public Health Service prior to EPA's formation. These previous monitoring networks had been oriented primarily to measurements of fallout levels. They were modified by changing collection and analysis frequencies and sampling locations and by increasing the analyses for some specific radionuclides. The emphasis of the current system is toward identifying trends in the accumulation of long-lived radionuclides in the environment. However, the ERAMS is flexible in design to also provide for short-term assessment for large scale events such as fallout.

ERAMS normally involves over 7000 individual analyses per year on samples of air particulates, precipitation, milk, surface and drinking water. Samples are collected at about 150 locations in the United States and its territories mainly by State and local health agencies. These samples are forwarded to ORP's Eastern Environmental Radiation Facility (EERF) in Montgomery, Alabama for analyses. ERAMS data are tabulated quarterly and issued to the groups involved in the program.*

* An indepth analysis summary of ERAMS data will be presented in each year's publication of EPA's Radiological Quality of the Environment. This publication is available from the Office of Radiation Programs, USEPA, 401 M Street, S.W., Washington, D.C. 20460. Previously, ERAMS data were published monthly in Radiation Data and Reports. This publication was terminated in December 1974.

Airborne Particulates and Precipitation Sampling

The air monitoring program of ERAMS consists of 21 continuously operating stations and 46 standby stations located throughout the United States, Puerto Rico, and the Canal Zone (figure 1). At the continuously operating stations, airborne particulates are collected continuously on filters which are changed twice weekly. Aliquots of precipitations are also collected twice weekly and are submitted to EERF for analysis with the air particulate samples. When the possibility of fallout occurs, the 46 additional standby stations are alerted and daily sampling is started at all stations. The air particulate samples are important for estimating the potential population dose from inhalation of fallout materials. Precipitation samples are collected to indicate rainout of radioactive materials which may contaminate pasture and crop lands.

High efficiency, charcoal impregnated, cellulose filters are used for air particulate collection. Field gross beta measurements are made with a G-M survey meter at 5 hours and 29 hours after collection to allow subtraction of naturally occurring radon and thoron daughter products. Field estimates are reported to the Eastern Environmental Radiation Facility (EERF) via telephone if the activity level is twice the normal reading for the sampling area.

The filters are then sent to the EERF for more sensitive gross beta measurements in the laboratory. If the laboratory gross beta activity exceeds 1 pCi/m^3, a sodium iodide (NaI) gamma analysis is performed to identify and quantify the following radioisotopes: ^{144}Ce, ^{131}I, ^{106}Ru, ^{137}Cs, ^{95}Zr-Nb, ^{232}Th, ^{65}Zn, ^{60}Co, ^{40}K, ^{140}Ba, and ^{214}Bi. Due to the similarity of gamma energies and resolution of the NaI crystal, ^{141}Ce may be present with the ^{144}Ce, and ^{103}Ru, and ^{7}Be may be reported with ^{106}Ru.

Precipitation samples from the 21 continuously operating stations are sent directly to the EERF for gamma analysis whereas aliquots of the precipitation from the 46 standby stations are evaporated to dryness and gross beta field estimates are made prior to shipment to the EERF.

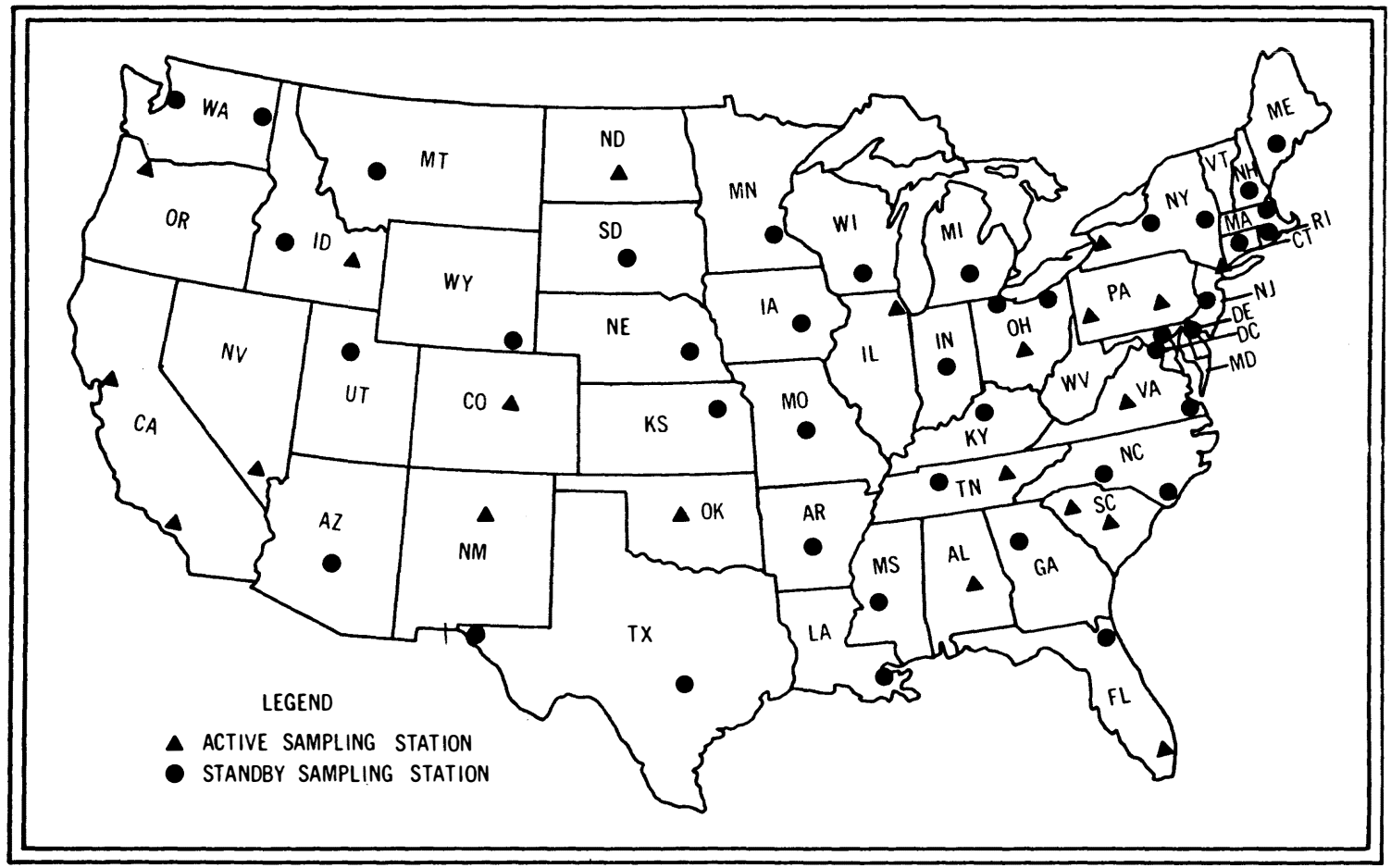

Figure 1. Environmental Radiation Ambient Monitoring System (ERAMS) airborne particulates and precipitation sampling locations.

Pasteurized Milk Sampling

The milk monitoring program of ERAMS is a cooperative program between EPA, ORP, and the Milk Sanitation Section of the Food and Drug Administration. Pasteurized milk samples are collected the first week of the month by FDA representatives at 65 sampling sites with one or more located in each State and in Puerto Rico and the Canal Zone (figure 2). These are composite samples based on the volume of milk sold by the various milk processors in the sampling station area and represent more than 80 percent of the milk consumed in major population centers of the United States. Additional samples may be collected upon request to respond to events, such as fallout from nuclear weapons testing.

Gamma analyses are performed on the milk samples as soon as they arrive at the EERF and results for ^{131}I, ^{140}Ba, ^{137}Cs, and ^{40}K are available within hours after receipt. If samples have ^{131}I and ^{140}Ba activity levels greater than 10 pCi/liter or abnormally high ^{137}Cs values, then ^{89}Sr, ^{90}Sr analyses are performed. The radiostrontium data are usually available within two weeks after sample receipt at EERF.

The radioisotopes ^{131}I, ^{140}Ba, ^{137}Cs, ^{90}Sr, and ^{89}Sr have been shown in previous fallout episodes to be sensitive indicators of fission product radioactivity from nuclear detonations. Pasteurized milk consumption is important in determining population dose resulting from radionuclides which rapidly transfer from the environment through food chains to man. The food chain of interest starts with particulate deposition on grass forage. The grass forage is consumed by grazing dairy cows. The metabolized radionuclides in cows are rapidly transferred to milk which is processed by the dairy and is ready for public consumption within one to four days after deposition.

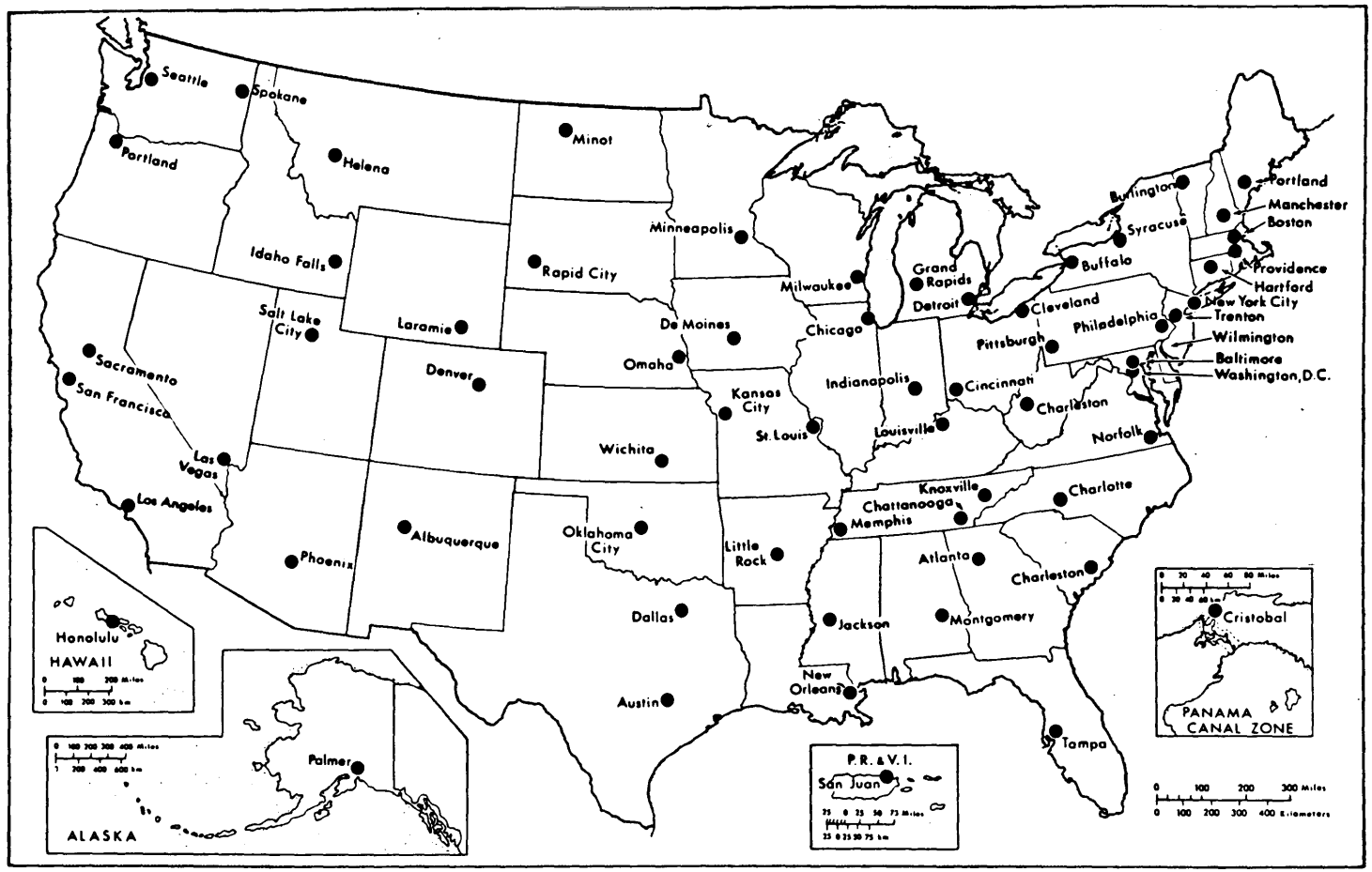

Figure 2. ERAMS pasteurized milk component sampling locations.

4. MOVEMENT OF THE CONTAMINATED AIR MASSES

Since both detonations by the People's Republic of China were above ground, large amounts of radioactive materials were injected into the atmosphere and were carried in an easterly direction toward the United States. These radioactive materials (which are normally invisible to the eye) will begin dispersing laterally and vertically depending on particle sizes and shapes, temperature, and wind velocity. At each particular altitude, there is a forward region where contaminated air begins mixing with uncontaminated air. This area is called the "leading edge" of the contaminated air mass and can be detected by instrument-carrying aircraft. The movement of contaminated air masses at various altitudes can be predicted on the basis of meteorological data.

September 26, 1976 Detonation

Figure 3 shows the initial trajectory of the radioactive debris from the Chinese nuclear detonation on September 26, 1976. This detonation was a relatively low-powered explosion, consequently, the majority of the radioactive material did not penetrate into the stratosphere but remained in the troposphere (i.e. below approximately 35,000 ft.). It took approximately 5 days for the leading edge of the radioactive air mass in the upper troposphere (30,000 ft. level) to reach the west coast of the United States and about 2 more days to cross the United States.

A lower altitude segment of the contaminated air mass at approximately the 20,000 foot level crossed the Pacific more slowly than the first segment and reached the west coast of the United States on October 6, 1976, 9 days after the nuclear detonation. Figure 4 shows the approximate path of the leading edge of this segment as it crossed the United States. This segment took 3 days to cross the United States in a sweep across the Western,Southern, and Northeastern States.

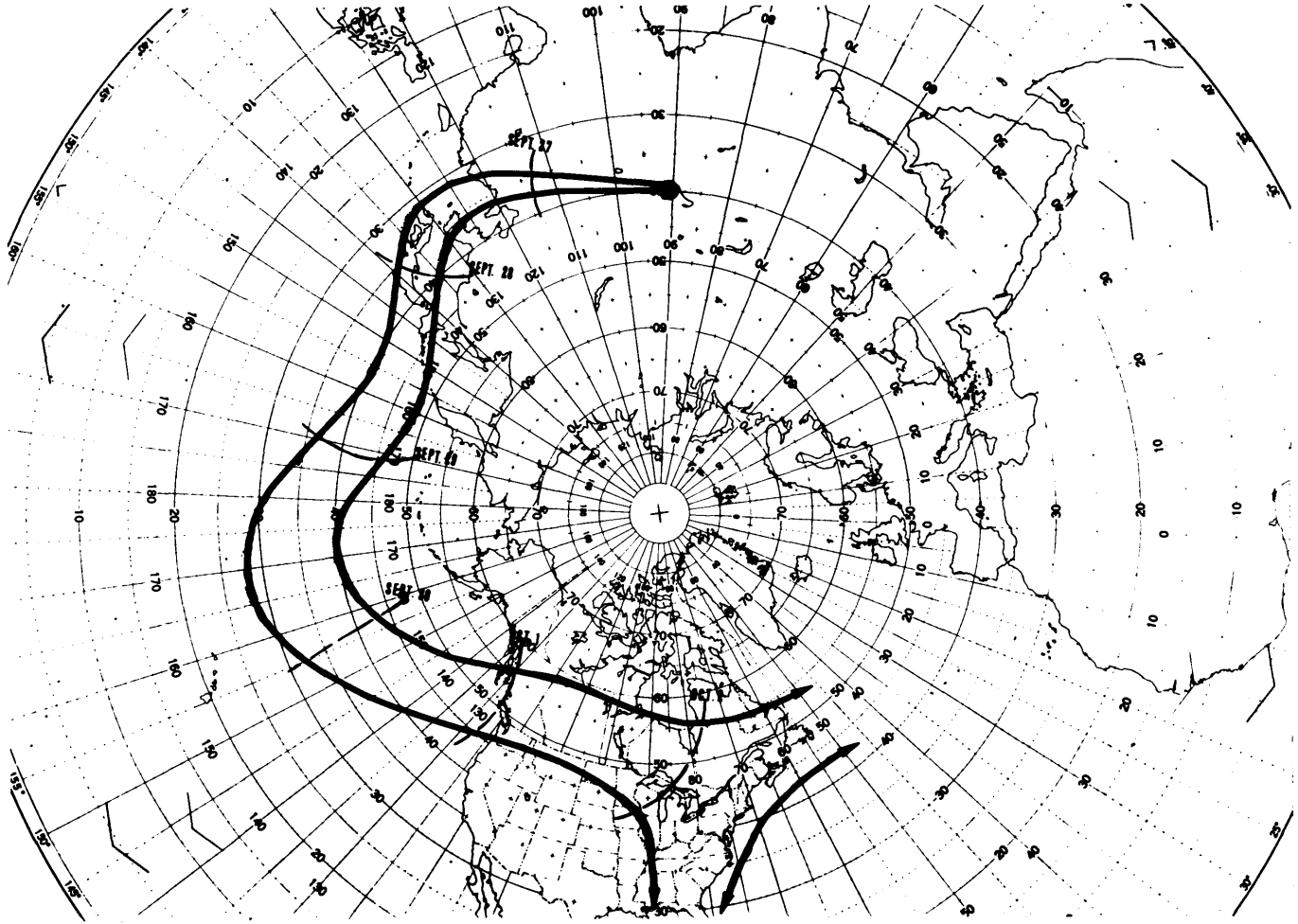

Figure 3. Post facto analysis of path of debris at 300 millibar level (approximately 30,000 ft.) Approximate path of leading edge of upper tropospheric debris (30,000 ft.) from the Chinese nuclear detonation of September 26, 1976.

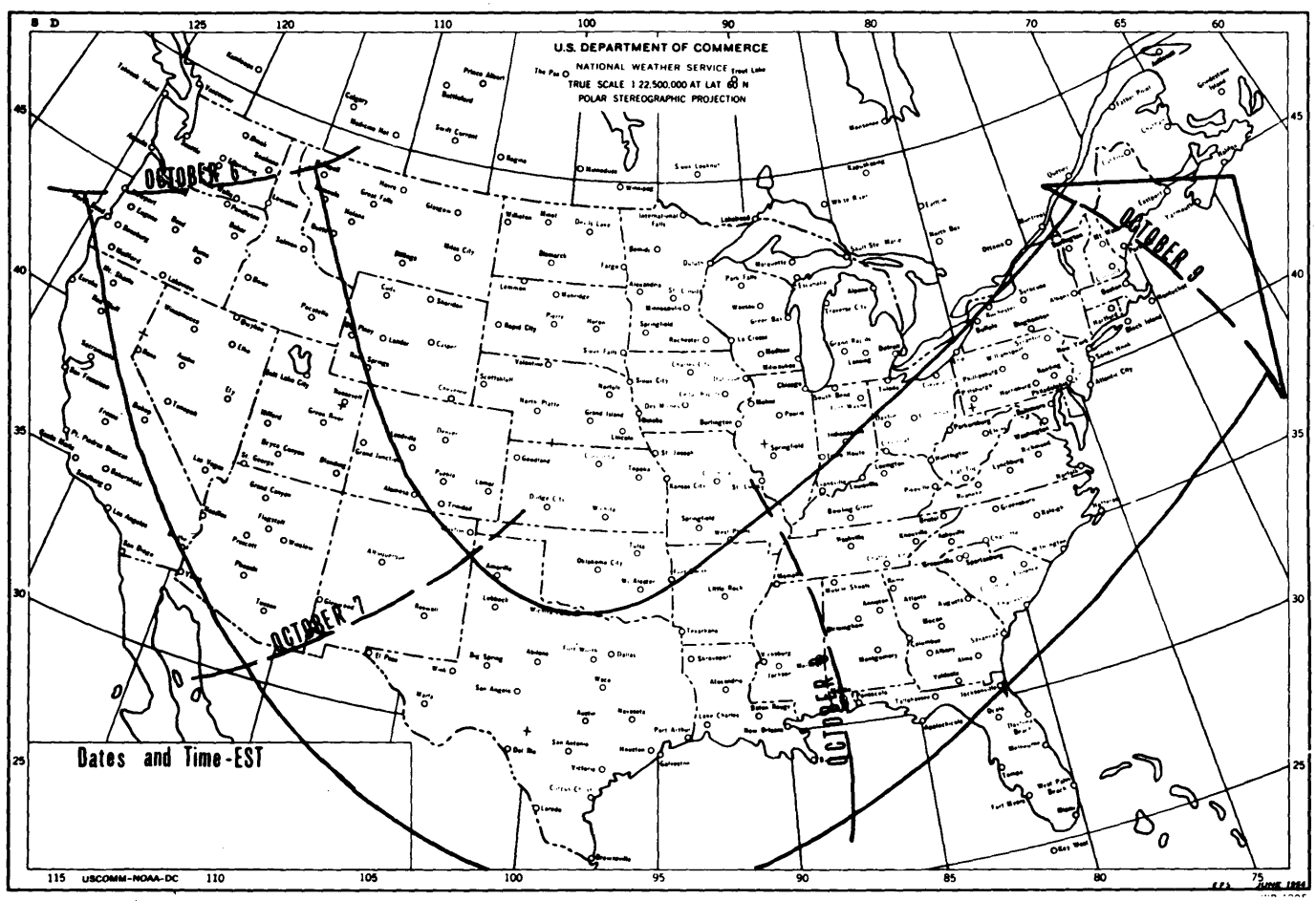

Figure 4. Approximate path of leading edge of lower tropospheric debris (approximately 20,000 ft.) from the Chinese nuclear detonation of September 26, 1976.

After passing across the United States, the radioactive air mass circled the world and passed over the United States again by October 15. After this pass the contaminated air mass became very diffuse and the radioactivity had decayed to the point where further passes could not be positively detected.

November 17, 1976 Detonation

The November 17, 1976, nuclear detonation by the People's Republic of China was a much larger explosion than the one in September. Because of the much larger size of the detonation, a hotter thermal column was created which caused the majority of the radioactive debris to be injected high into the stratosphere where it is expected to remain over a period of several years. This long residence time in the stratosphere allows the short-lived radionuclides to decay away and spreads out the length of time the longer-lived radionuclides will take to reach the ground.

The predicted path across the United States of the first pass of the radioactive air mass from the November 17 detonation is shown in figure 5. The radioactive air mass was moving very rapidly and the leading edge reached the west coast of the United States only 3 days after detonation. One day later, the leading edge had crossed the east coast. The rain clouds that occurred along the east coast apparently did not reach up into the stratosphere and the rain that occurred during passage of the contaminated air mass did not bring down any radioactive materials by rainout.

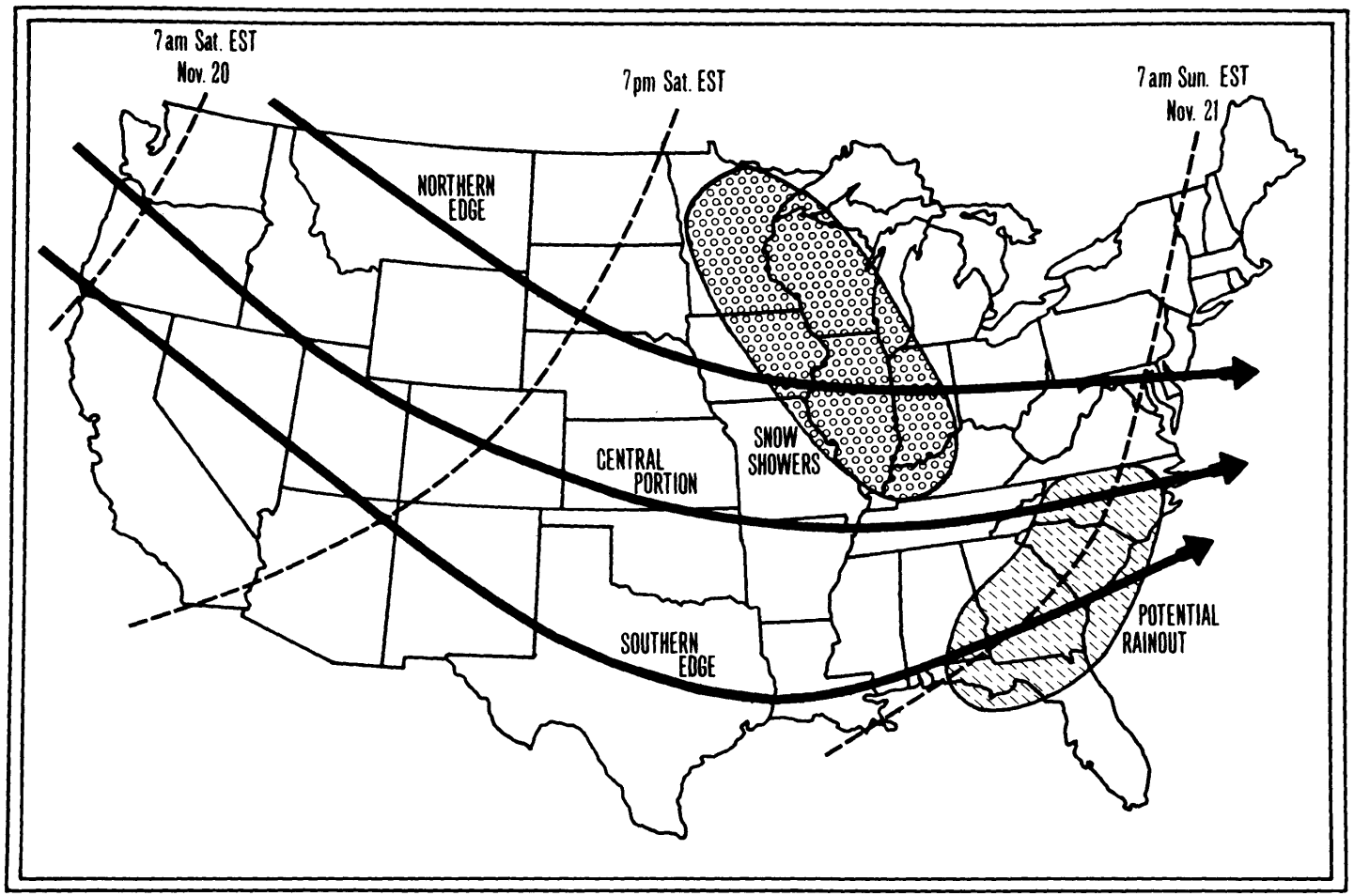

Figure 5. Predicted movement of air mass containing radioactive debris across the United States and possible areas of rainout from this air mass following the Chinese nuclear detonation of November 17, 1976.

5. EPA FALLOUT MONITORING RESPONSES

September 26, 1976 Detonation

The Energy Research and Development Administration (ERDA) on Monday September 27, 1976, informed the EPA of the nuclear detonation and also made a public announcement of the test. The ERDA has the responsibility in the Federal government of announcing both domestic and foreign nuclear detonations along with other pertinent information about the detonations.

On September 29, 1976, the National Oceanic and Atmospheric Administration (NOAA) made the first prediction of the trajectory of the leading edge of the contaminated air mass. These predictions were revised daily as more information became available to them. The NOAA has the Federal responsibility for predicting the airborne trajectory of the contaminated air masses and the time of potential radioactive fallout across the United States.

Based on the above information, the EPA began notifying the States and the ERAMS air particulate and precipitation sampling stations on September 29 to activate the standby portion of the network and to increase the sampling frequency for the other sampling stations. The entire network was in full operation by Thursday, September 30.

The leading edge of the contaminated air mass entered North America late on September 30 over British Columbia. The southern portion of this air mass passed over the northern portions of Washington, Idaho, Montana, North Dakota, and Minnesota on October 1. On the night of October 1, a low pressure center formed over Illinois, Indiana, and Ohio, and caused a severe atmospheric disturbance that intersected the southern portions of the fallout cloud. Subsequent rainout resulted in radioactive particles being brought down to ground level in northeastern Maryland, southeastern Pennsylvania, Delaware, New Jersey, southeastern New York, western Connecticut, and western Massachusetts.

The rainout was first detected late on Saturday, October 2, at Chester, N.J. by the ERDA's Health and Safety Laboratory. On Sunday, October 3, radioactivity

was detected at the Peach Bottom Atomic Power Station in southeastern Pennsylvania. The Philadelphia Electric Company, which operates this station, issued a press release on October 4 concerning the elevated levels of radioactivity. By Tuesday, October 5, it became apparent, as more analyses were completed, that the rainout pattern extended northeast to Massachusetts. Measurements of airborne radioactivity and measurements of milk samples consequently indicated that low levels of fallout were also present in other areas of the country. These measurements will be discussed in more detail later in this report.

Based on the radioactive measurements in the precipitation samples, the EPA requested that the FDA collect additional milk samples from all sampling stations. Normally, samples are collected from all stations the first week of the month. After October 15, special milk samples were also collected from those stations that previously reported fallout or those that might potentially have received fallout from rainout of radioactive particles.

The EPA monitored the concentrations of radioactivity in air particulates, precipitation, and in pasteurized milk into November 1976, until the concentrations returned to normal. Overall EPA's monitoring program for the September 26 detonation resulted in collection of 293 pasteurized milk samples, 1,124 air particulate samples, and 95 precipitation samples. Over 1,700 radiation measurements were made on these samples at EPA's Eastern Environmental Radiation Facility in Montgomery, Alabama. Information based on these measurements was issued through seven press releases from October 5 to October 15. These press releases indicated that at no time did EPA evaluate the fallout situation as warranting any protective actions on a broad basis and no such actions were suggested.

November 17, 1976 Detonation

The ERDA notified the EPA of the nuclear detonation on Wednesday, November 17, and the first trajectory information was received from the NOAA on November 19. The leading edge of the contaminated

air mass was expected over the United States on Saturday, November 20, but would have a much wider north-south dispersion than the previous fallout cloud. The air mass passed southeasterly over about 3/4 of the United States and on out to sea by November 21. There was no interaction with weather fronts to bring the fallout to ground level.

As with the previous test, the EPA activated the standby portion of the ERAMS air particulate and precipitation network on Thursday, November 18, and special milk samples were collected in November and December until it was apparent that no fallout would be detected from this nuclear detonation. For this event, the ERAMS program collected 180 milk samples, 793 air particulate samples, and 51 precipitation samples for a total of over 1,000 analyses. From November 17 to December 2, the EPA issued 9 press releases on the fallout trajectories and EPA data. The EPA also maintained close contact with the States and other Federal Agencies during this potential fallout episode for data exchange.

Following the November 17 detonation, EPA also responded to concerns for potential exposures related to commercial aircraft. This is discussed in the next section.

6. COMMERCIAL AIR TRAFFIC CONCERNS

There were special concerns following the November 17, 1976, detonation regarding potential aircraft related exposures. One concern was for potential exposures to people aboard aircraft flying at altitudes where the airborne radioactive materials were being carried. As expected, there were no real problems at normal commercial air traffic altitudes (up to 40,000 feet). Measurements aboard aircraft indicated that exposures from radioactive materials at altitudes of 30 to 35 thousand feet would only be increased by about two percent over the exposures normally received at these altitudes from cosmic radiation. Exposures at lower altitudes were even smaller. The slightly increased exposures due to fallout debris were roughly the equivalent of increased cosmic radiation when flying at 32 thousand feet compared to 30 thousand feet.

EPA consulted with the Federal Aviation Agency (FAA), ERDA, and the Air Force in assessing the impact of airborne radioactive materials on aviation. All of these agencies agreed that there would be no problem with passenger exposures at normal altitudes. Therefore, no recommendations were made to divert flights around the path of the fallout debris. EPA advised that business should be continued as usual for regular jet air travel.

One new potential problem was identified concerning aircraft passenger exposures. Namely, with the advent of high altitude commercial aircraft (above 50,000 feet) there might be possibilities of interaction with the more highly contaminated air masses at such stratospheric altitudes characteristic of high yield atmospheric detonations. Since commercial aircraft did not operate at these high altitudes during high yield nuclear testing of previous years, there was little experience from which to determine potential problems. Because the higher altitude air masses move very slowly, there was no immediate problem following the November 17 detonation. However, precautions were taken such as installing monitoring equipment aboard aircraft to assure the avoidance of radiation exposures. This monitoring indicated either none or barely detectable exposures which could be attributed to the radioactive materials from nuclear testing.

The other concern regarding aircraft was that radioactive particles may be picked up on aircraft surfaces such as air intake ducts during high altitude flights. Such contaminated surfaces could potentially cause exposures to aircraft maintenance personnel. Therefore, plans were made for decontamination of aircraft if that might be necessary. Subsequent monitoring of aircraft indicated only limited contamination on certain parts of aircraft. It was concluded that such limited contamination would not result in significant exposures to either passengers or maintenance personnel.

7. AIR PARTICULATE AND PRECIPITATION MEASUREMENTS

September 26, 1976 Detonation

Laboratory gross beta measurements are performed on all air particulate samples, usually within 3 - 5 days following collection, after the decay of naturally occurring short-lived radon and thoron daughter products. These measurements are used as screening mechanisms to determine the need for additional specific isotopic analyses. Gross beta measurements alone are not sufficient for dose estimates which require data on concentrations of individual isotopes. However, the beta measurements are useful for determining trends and patterns of fallout in the United States.

The geographical distribution of maximum gross beta radioactivity in laboratory measurements of airborne particulates in the weeks following the September 26, 1976, test are presented in Figures 6-10. The contours denoting separation of radioactivity levels were arrived at mathematically with interpolation of concentrations between sampling stations. Variations within the two lower levels are normally seen as ambient gackground variations. These concentrations are rarely exceeded without the intrusion of a contaminating source such as the Chinese atmospheric nuclear tests.

During the first week of sampling, the air particulate radioactivity was concentrated in the eastern section of the United States, but by October 10, most of the airborne radioactivity levels had fallen below 1.0 pCi/m^3, the exception being the extreme southwest. During the week of October 17-23, with the second passage of the radioactive cloud, levels again began to increase with the higher levels (>1.0 pCi/m^3) being in the west, southwest, and Florida. Radioactivity then declined until the end of the alert status on November 5 at which time only Denver, Colorado and Pierre, South Dakota, reached the 1 pCi/m^3 level. A detailed summary of the airborne particulate data is given in Table A-1, Appendix A, including the specific gamma results, for samples with the maximum gross beta radioactivity.

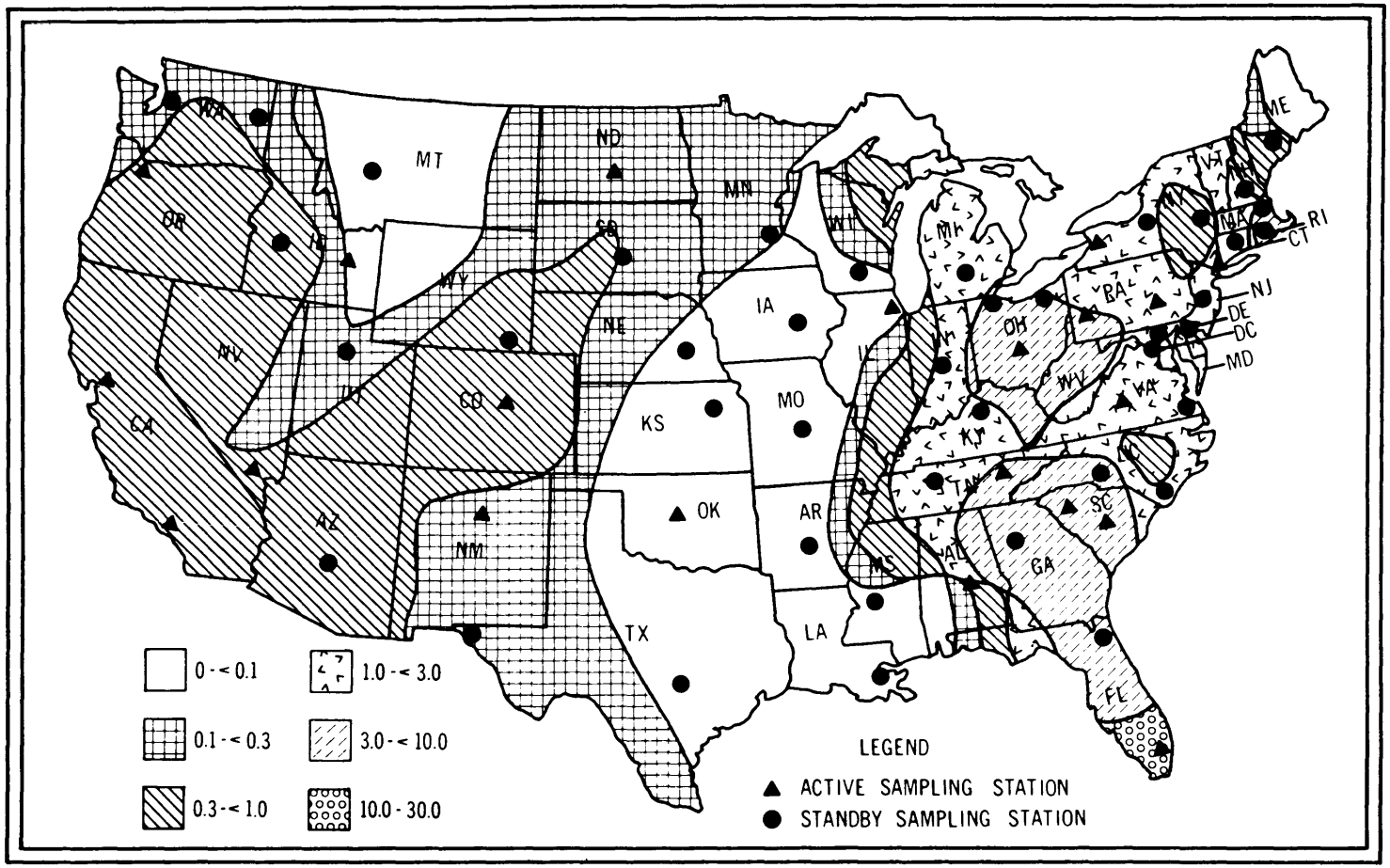

Figure 6. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - October 1-9, 1976 (pCi/m^3).

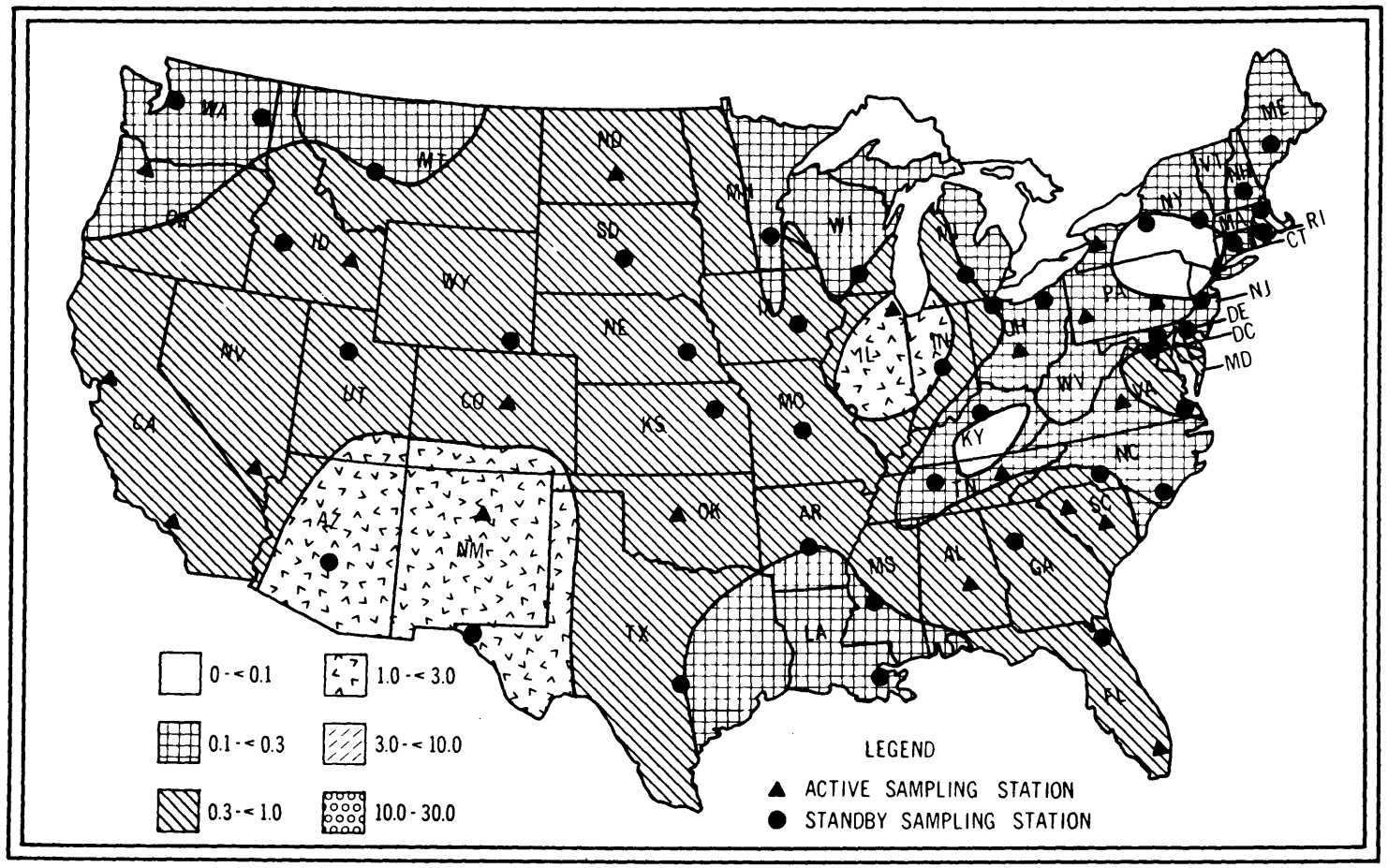

Figure 7. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - October 10-16, 1976 (pCi/m^3).

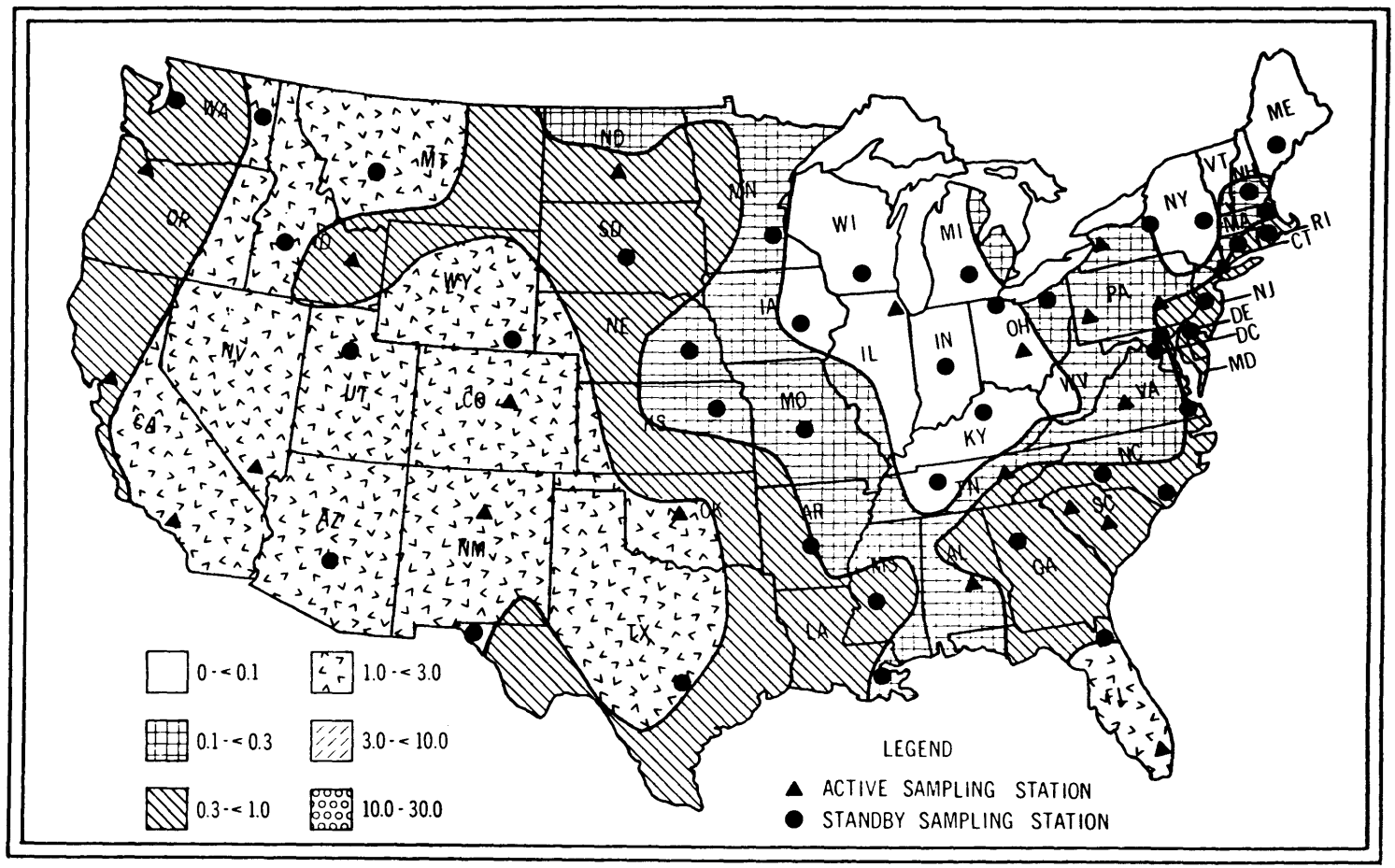

Figure 8. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - October 17-23, 1976 (pCi/m^3).

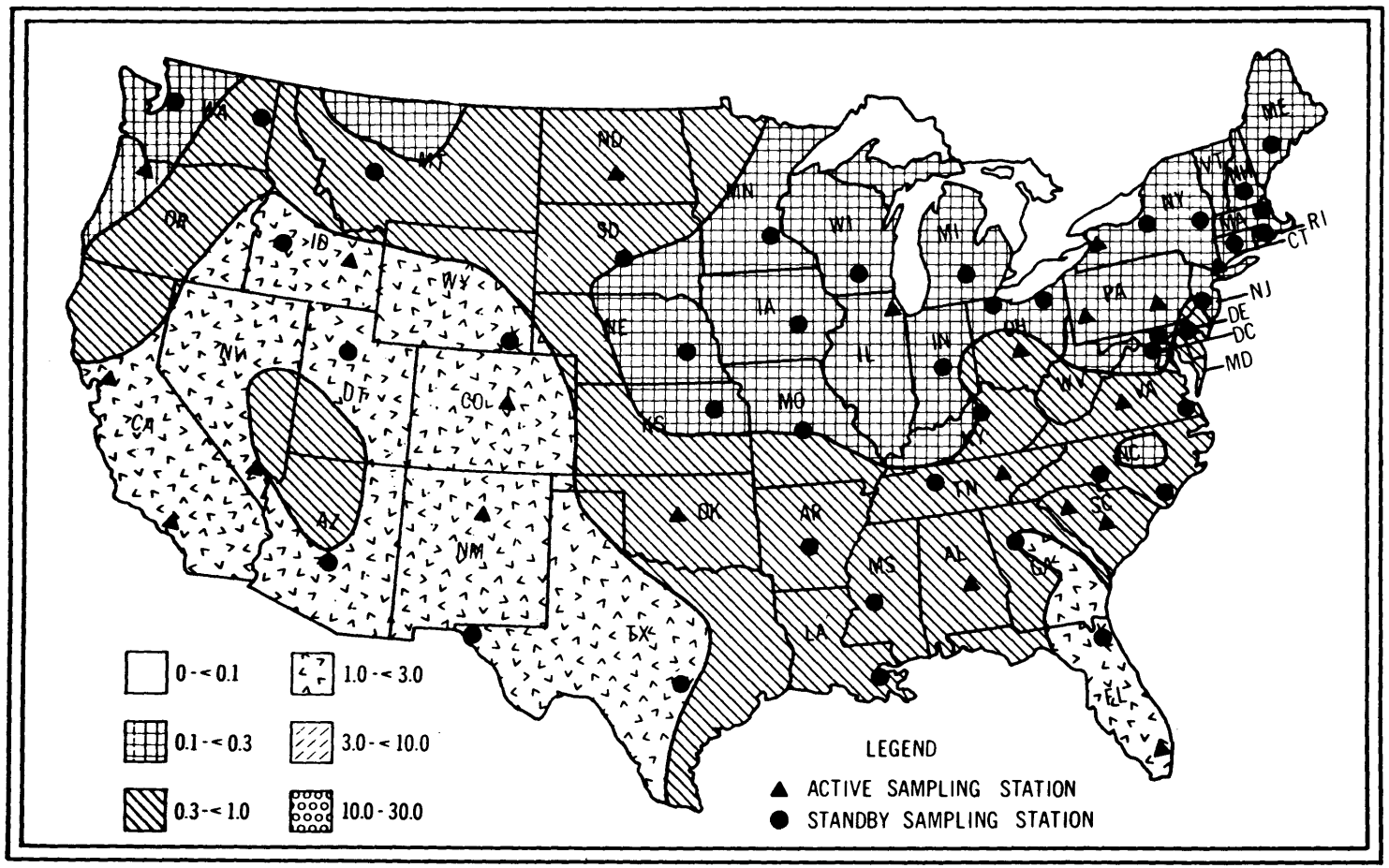

Figure 9. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - October 24-30, 1976 (pCi/m^3).

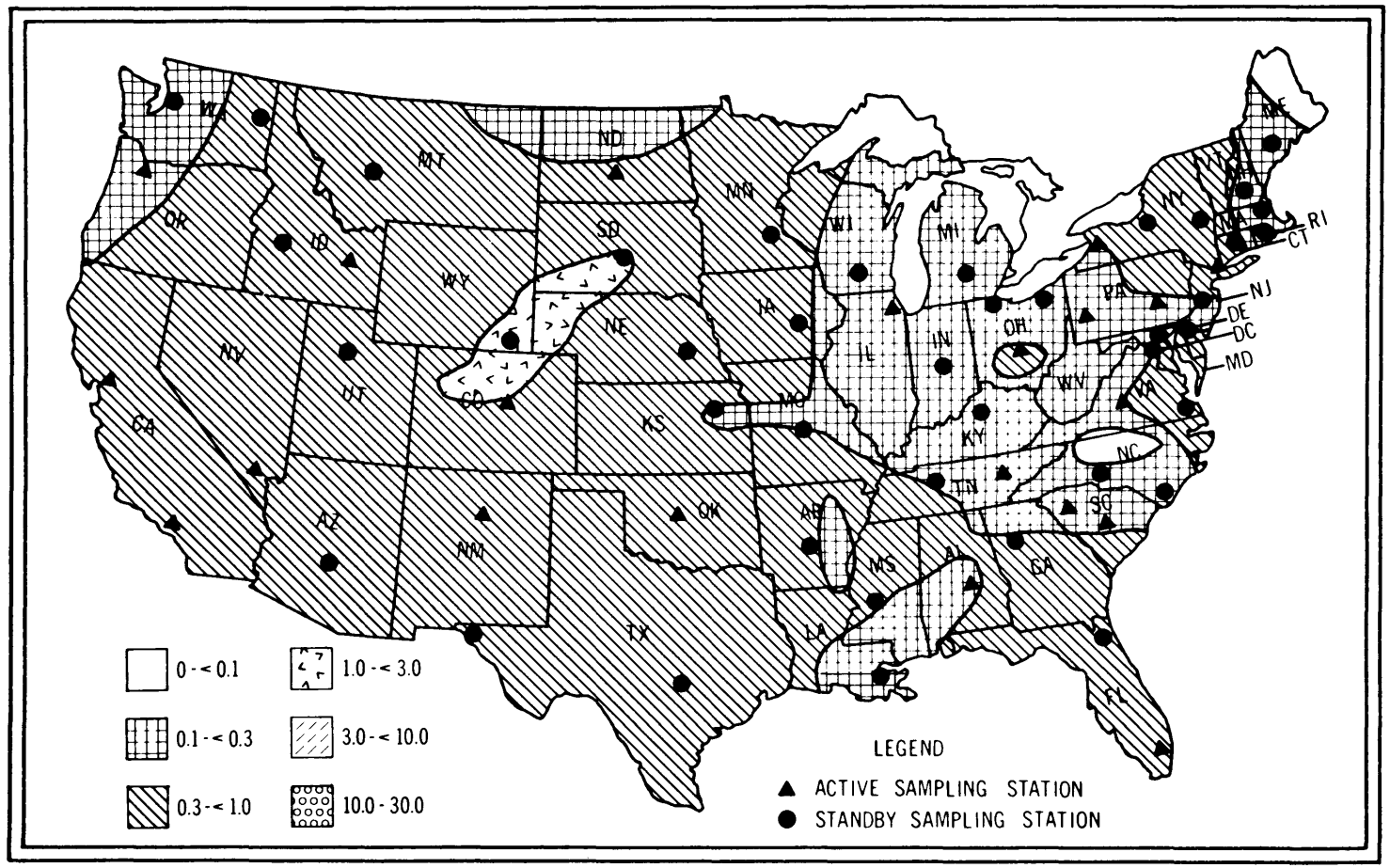

Figure 10. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - October 31-November 5, 1976 (pCi/m^3)

Precipitation samples were collected together with the air samples at most locations. Gamma results from samples containing detectable levels of radioactivity are presented in Table A-2, Appendix A.

Radioactivity in precipitation was highest on the eastern seaboard during the first 10 days of October probably as a result of turbulence causing rain clouds to intermingle with the airborne radioactive debris in the 30,000 ft. upper tropospheric trajectory. The highest overall levels were recorded in the deep south October 18-20 and are attributed to the second pass of the contaminated air masses which interacted with rain storms.

November 17, 1976 Detonation

Figures 11 and 12 depict the geographical distribution of maximum gross beta values for air particulates collected the first 2 weeks following the November 17 event and may be considered as representative of background fluctuations of gross beta radioactivity. Only three sampling sites had values exceeding the two lower distribution levels and these were generally attributed to stagnant air masses which produced unusually high ambient radioactivity. These data are in contrast to those shown in Tables 6-10 following the September 26 event when almost all of the stations were influenced by fallout and at some time had levels exceeding 0.3 pCi/m^3.

A summary of the data from air particulate samples collected November 20 - December 10 is given in Table B-1, Appendix B. None of the samples had a laboratory gross beta values greater than 1 pCi/m^3, therefore, there was no need for gamma analyses. However, several of the samples with the highest gross beta values were scanned for gamma emitters and were not found to contain fresh fission products such as ^{131}I or ^{140}Ba. The precipitation samples collected during this same time period were also devoid of fresh fission products.

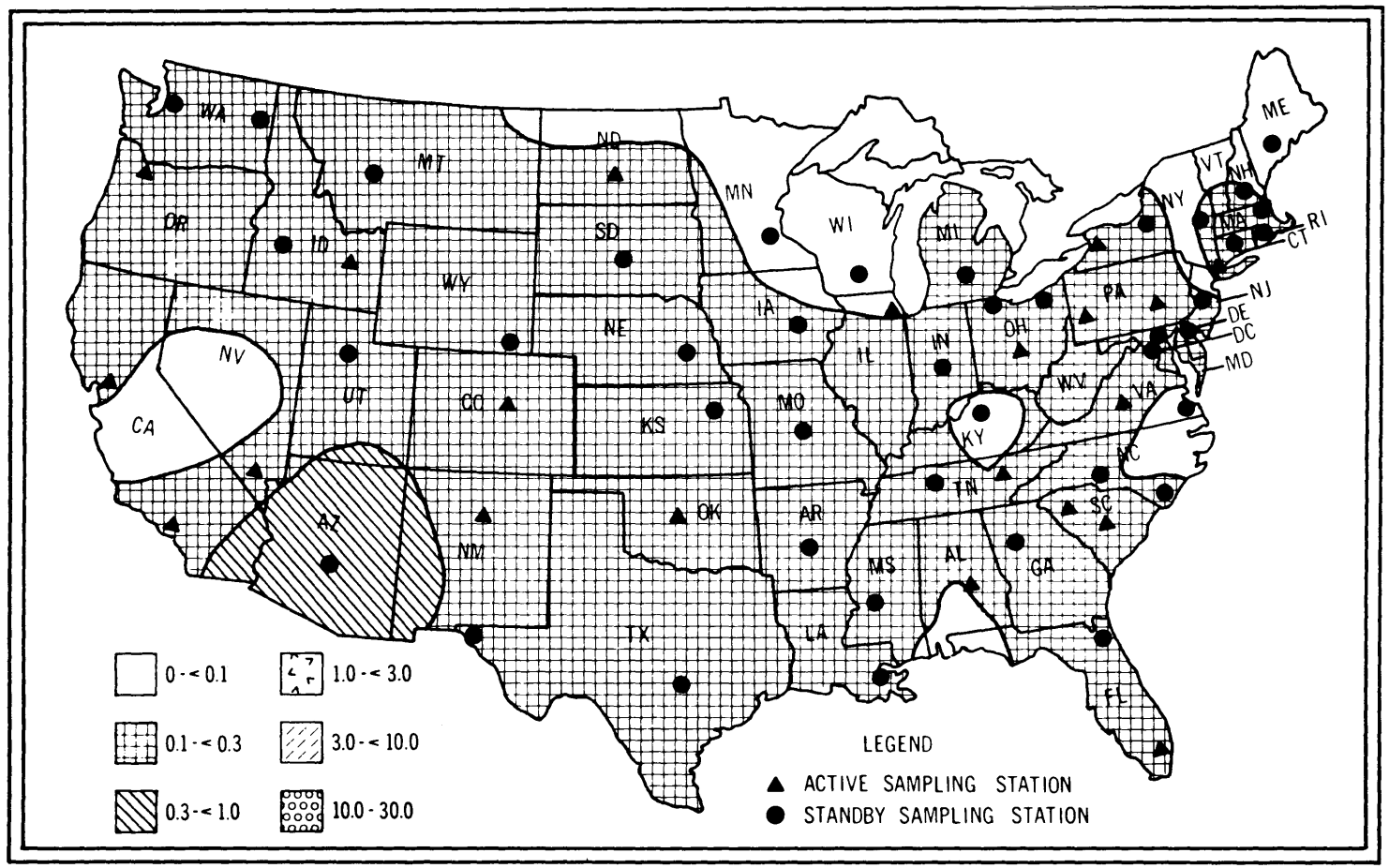

Figure 11. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - November 18-24, 1976 (pCi/m^3)

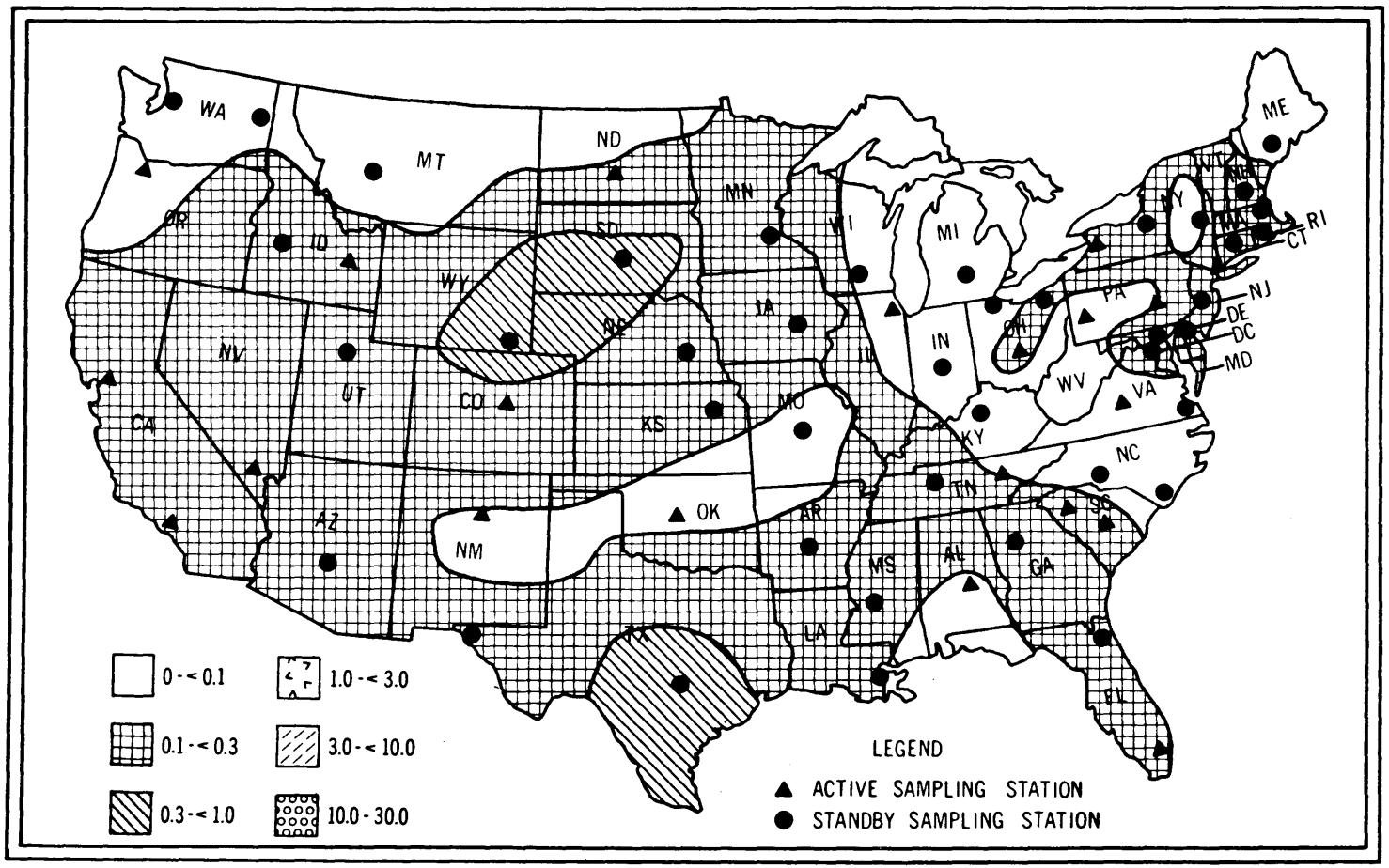

Figure 12. Distribution of gross beta in airborne particulates. Maximum daily laboratory measurements - November 25-December 1, 1976 (pCi/m^3).

8. PASTEURIZED MILK MEASUREMENTS

September 26, 1976 Detonation

Results for pasteurized milk samples collected October 1 - November 16 are presented in Table A-3, Appendix A. For the first 2 weeks following the arrival of the fallout in the U. S. on October 2, 1976, all stations were requested to provide additional samples. Beyond that time only those stations previously reporting fallout radioactivity or those suspected to have received significant amounts of fallout in rainfall deposition from the second passage of the contaminated air mass were asked to submit samples. Figures 13 - 15 show the geographical distribution of average ^{131}I concentrations in pasteurized milk samples for October 1-9, October 10-16, and November 1-16, respectively.

The highest ^{131}I value obtained for an ERAMS pasteurized milk sample was 155 pCi/liter in the sample collected at Baltimore, Maryland, on October 8. This level was far below that at which any type of protective action was warranted. Several state agencies reported raw milk sample radioactivities as high as 1,000 pCi/liter; however, these were for individual dairies and did not generally represent the composited milk as it appeared in grocery stores. In the States of Connecticut and Massachusetts, where some of the highest individual results were reported, the concerned State agencies ordered that dairy herds be switched to the use of stored feed only. This was a prudent action since at this time of the year, most large dairy herds were already primarily on stored feed and stored feed was readily available. The fact that most dairy cattle were not on outdoor pasturage was significant in keeping the radioactivity in milk at low levels.

November 17, 1976 Detonation

Pasteurized milk sample data collected following this second test are presented in Table B-2, Appendix 2. Only two samples contained levels of ^{131}I above 10 pCi/liter. It is believed that this radioactivity is probably traceable to the September 26 test since

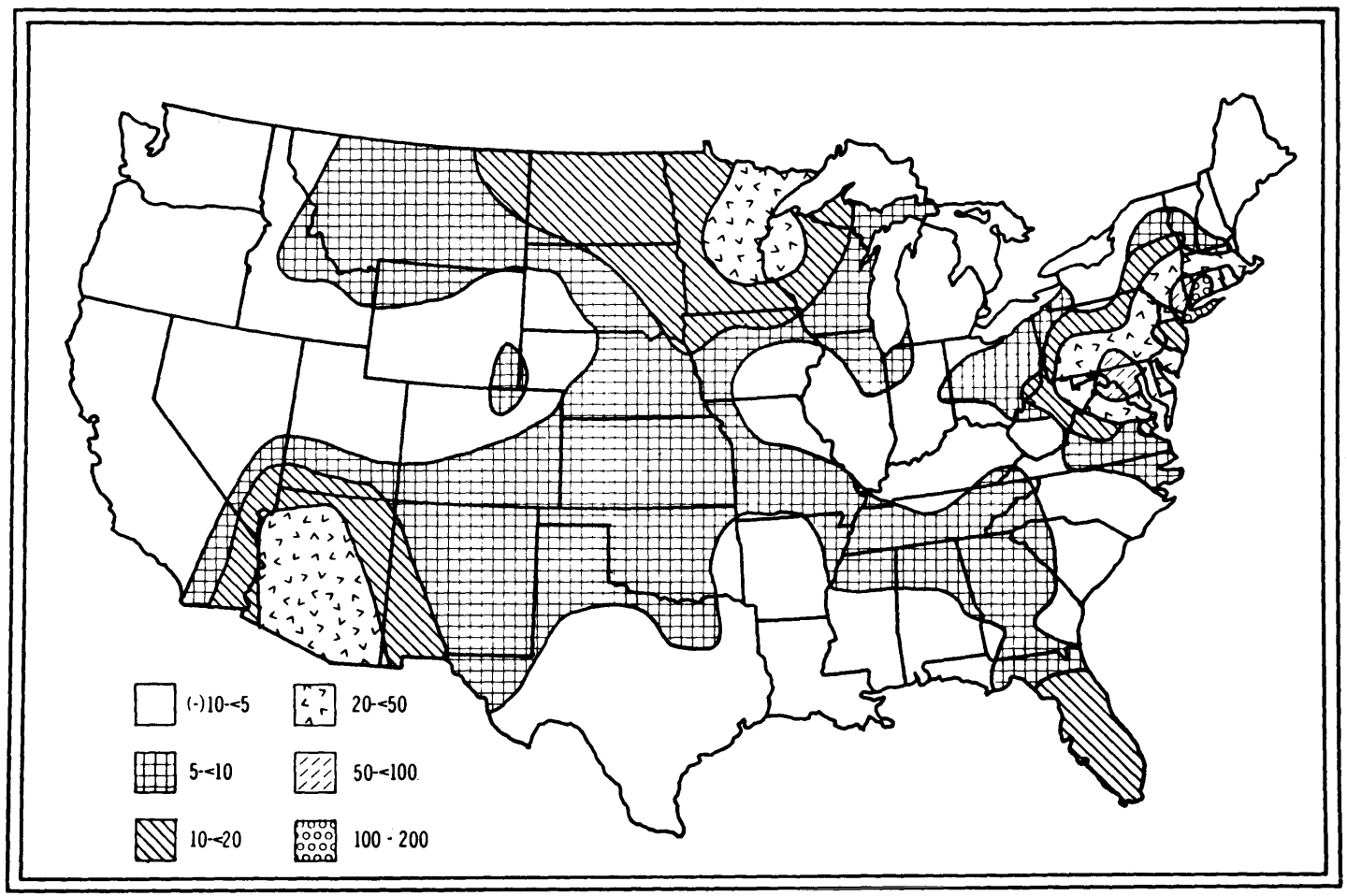

Figure 13. Distribution of iodine-131 in milk. Average concentrations October 1-9, 1976 (pCi/ℓ).

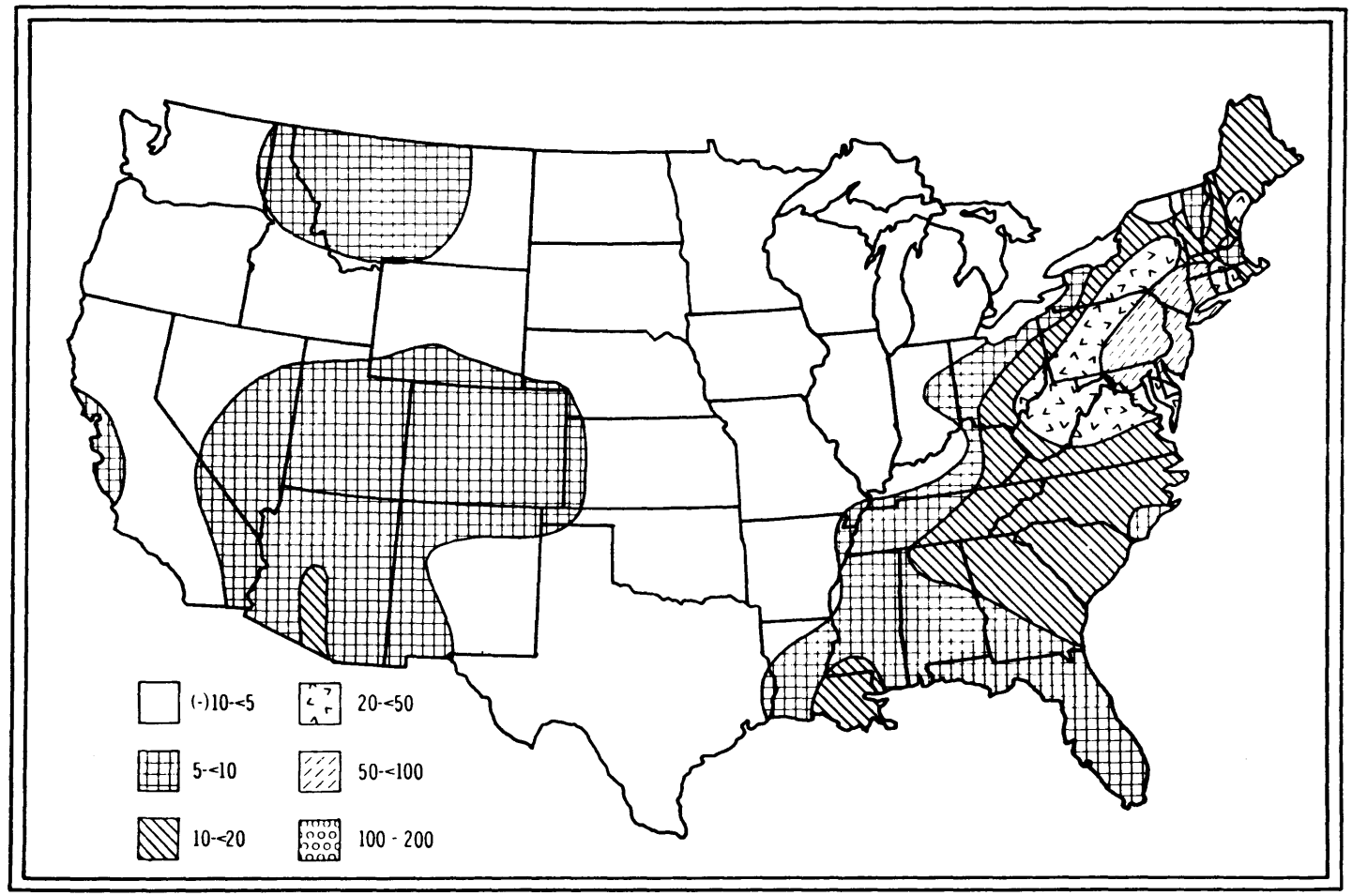

Figure 14. Distribution of iodine-131 in milk. Average concentrations October 10-16, 1976 (pCi/ℓ).

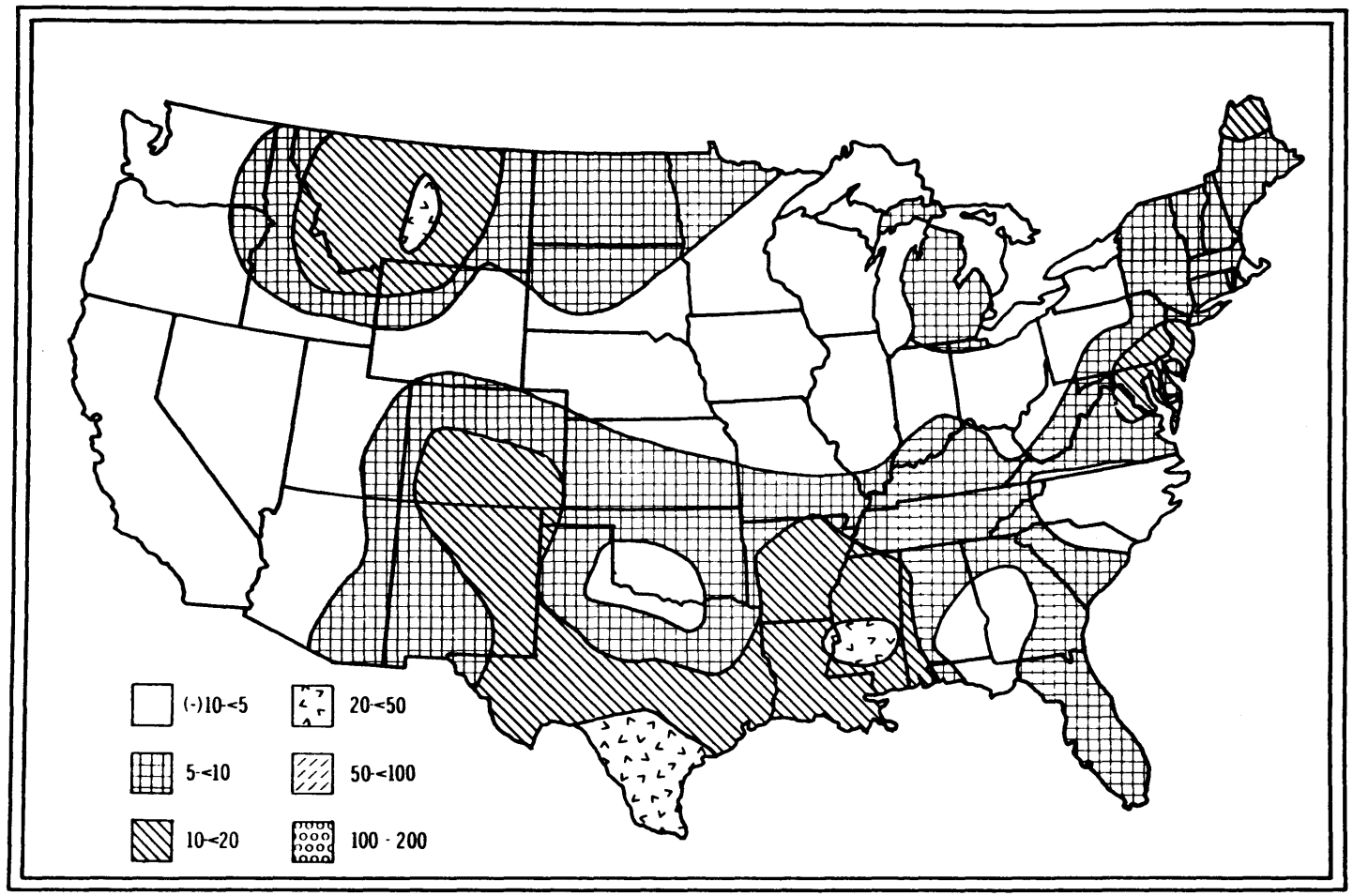

Figure 15. Distribution of iodine-131 in milk. Average concentrations November 1-16, 1976 (pCi/ℓ).

these samples were collected in the south and southwest where slight elevations in air radioactivity had persisted through the first week of November.

Figure 16 shows the average distribution of ^{131}I concentrations in milk for the time period December 4 - 10 when levels were reduced to essentially background fluctuations. This figure may be compared to Figures 13-15 to show the influence of the fallout ^{131}I.

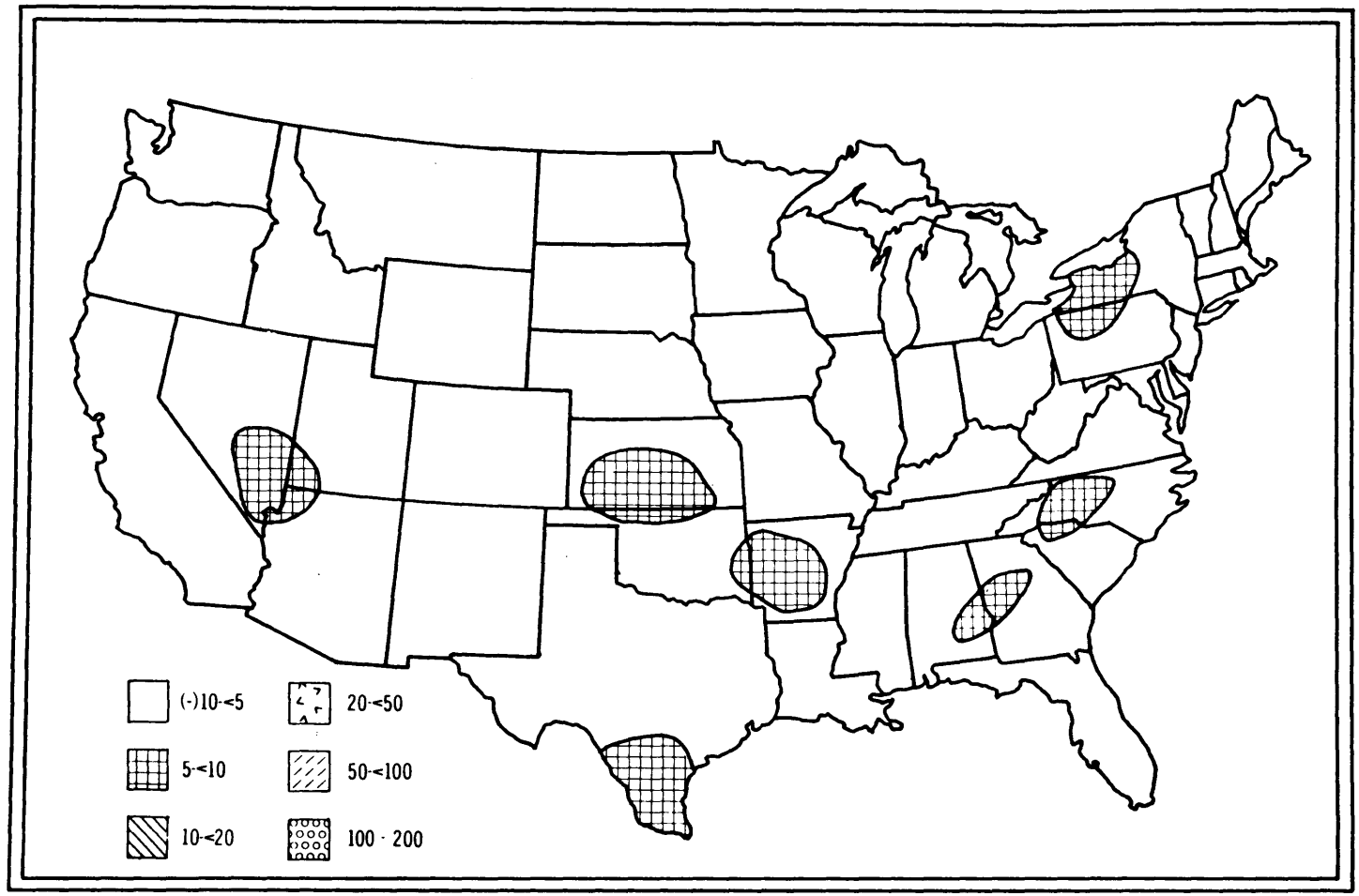

Figure 16. Distribution of iodine-131 in milk. Average concentrations December 4-10, 1976 (pCi/ℓ).

9. RADIATION DOSE ASSESSMENT*

Dose Types and Pathways

Radiation doses to humans from fallout radionuclides occur as a result of external and internal radiation. Skin and total body external radiation doses occur due to submersion of people in the air containing fallout radionuclides and due to irradiation of the body from radionuclides deposited on the ground and on vegetation. Normally, the external doses due to ground and vegetation contamination are much lower than the submersion doses (1). For this reason, the only external doses considered in this report are submersion doses. Internal doses result from inhalation of air or ingestion of food or water containing fallout radionuclides. Vegetation contaminated by direct fallout or uptake of deposited radionuclides from the soil may be consumed either directly by humans or by animals (such as dairy cows) which provide human food. Thus the fallout radionuclides find their way into the human body by ingestion of foods directly by the vegetation pathway or indirectly by a vegetable-to-animal pathway. Historically, consumption of ^{131}I in cows milk (^{131}I - milk - thyroid dose pathway) has been the most significant contributor to doses to humans from fallout radionuclides.

* In this report, the term "dose" is used broadly to mean "absorbed dose" (rads) or "dose equivalent" (rems) and applies only to radiation protection. The term "dose" refers to either internal or external pathways. For internal pathways, dose refers to the dose committed during the integration period and for external pathways, dose refers to the dose delivered during the integration period. Population dose is calculated in man-rads and the health effects data is expressed as health effects per man-rad which is consistent with the population dose. However, in comparing doses for different pathways, and for the same pathway but calculated by different organizations, it has been assumed that 1 rad of dose is equal to 1 rem of dose equivalent.

The internal doses calculated in this report are for air particulate inhalation and for milk ingestion. Doses for the leafy vegetable and meat pathways were not calculated for the following reasons:

(a) Considering the entire United States, it is believed that the fraction of feed obtained by beef cattle by direct grazing would be low, and the growing season for many fresh leafy vegetables has ended by October and November.

(b) These pathways are generally less significant than the ^{131}I-milk pathway (1).

(c) The calculational accuracy of doses for these pathways would be substantially less than for the milk pathway, since samples of beef and leafy vegetables were not collected and analyzed. To calculate these doses, one would have to use measured air concentrations to predict leafy vegetable and meat concentrations. Several uncertainties would be encountered in calculating doses for these pathways which are not encountered in the calculations summarized in this report. These uncertainties include predicting:

- deposition onto grass and leafy vegetables,
- fraction of cattle feed represented by fresh grass,
- fraction of vegetable consumption represented by fresh vegetables,
- transfer coefficients to human food.

Data were available at some stations on radioactivity in precipitation samples. However, doses were not calculated for these data since precipitation does not represent a direct dose pathway to man.

Dose Estimates for Individuals

A review of the quantities of radionuclides in the ERAMS milk and air particulate samples collected after the November detonation indicated that no measurements were significant enough for meaningful dose calculations. It appeared that the only potentially significant population doses in the United States were those attributed to the ^{131}I-milk-thyroid dose pathway following the September 26, 1976, nuclear detonation. However, it was decided to calculate individual doses for all radionuclides detected in milk (^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{140}Ba) and air (^{95}Zr, ^{95}Nb, ^{106}Ru, ^{131}I, ^{140}Ba) after the September detonation to give an indication of the significance of these radionuclides and pathways with respect to the ^{131}I-milk-thyroid pathway. These individual doses were calculated for the network stations showing the highest radionuclide levels.*

Equations

The equations used for the individual dose calculations are:

$$ID = (C_j)\ (IR)\ (DCF) \qquad \text{(Eq. 1)}$$ milk ingestion and air particulate inhalation

$$ID = 24\ (C_j)\ (DF) \qquad \text{(Eq. 2)}$$ air submersion external exposures

* Since the pasteurized milk samples are composited from several milk supplies in an area, it is possible that higher doses could have been calculated for an individual who drinks milk from a single dairy or who drinks unprocessed milk from a single farm.

where:

ID = individual dose for integration period (mrem)*

C_j = integrated radionuclide concentration in milk or air for highest station, corrected to sample collection time (pCi-d/ℓ or pCi-d/m^3)**

IR = intake rate for milk or air (ℓ/d or m^3/d)

DCF = dose commitment factor*** for critical receptor (mrem/pCi intake)

24 = hours in one day

DF = skin or total body dose factor for critical receptor (mrem/h per pCi/m^3)

Age groups

For all of the calculations (individual and population dose calculations) the receptors were divided into four age groups to account for the variation of dose with age. The age groups described in NRC Regulatory Guide 1.109 (2) were used as follows:

Infant	0- 1 year
Child	1-12 years
Teenager	12-18 years
Adult	18 years and over

* 1,000 mrem equals 1 rem. The rem is the product of the absorbed dose (rads), an assigned quality factor, and other necessary modifying factors specific for the radiation considered.

** The Curie (Ci) is a measure of radionuclide transformation rate. One Ci equals 3.7×10^{10} transformations per second. There are 10^{12} picocuries (pCi) per Ci.

*** Dose commitment is the dose which will be delivered during the 50-year period following radionuclide intake.

Milk pathway

For the milk pathway, the infant is the critical receptor. An infant milk consumption rate of 1 ℓ/d was chosen based on information in ICRP #23 (3). This consumption rate is for a 6-month-old male and is the highest milk consumption rate listed in the ICRP report. The consumption rates varied from 0.13 ℓ/d for a female over 60 to 1 ℓ/d for a male 6 months old. After examining the data on radionuclide levels in pasteurized milk, it was obvious that radionuclide concentrations in milk started increasing in early October and were approaching background again by early November. Thus an integration period of October 1 - November 12, 1976 (43 days) was chosen for the milk samples.

Inhalation pathway

For the inhalation pathway, the child is the critical receptor. A breathing rate of 10.4 m^3/d was chosen based on information in ICRP #23 (3). There are large variations in breathing rates depending on age and amount of physical activity. There can be factors of 5 and 13 variation between breathing rate at rest and during maximal exercise for an adult and a child, respectively. The number used (10.4 m^3/d) is based on 16 hours per day of light activity and 8 hours per day of rest. A review of the radionuclide levels in air showed that the highest air particulate concentrations occurred in a period between October 1 and October 10, 1976 (10 days). This was the integration period for the air particulate pathway doses.

Dose commitment factors

The dose commitment factors used for the internal dose calculations are an expression of the internal dose which will be delivered for a unit quantity of radionuclide ingested or inhaled. The dose commitment factors for inhalation and milk ingestion are from NRC Regulatory Guide 1.109 (2) except for ^{131}I in milk. These are from Kereiakes, et al., (4) and are based on more recent ^{131}I thyroid uptake fractions than the factors in Regulatory Guide 1.109. The dose factors used for external dose calculations are an expression of the external dose rate per unit concentration of radionuclide in air. The dose factors for submersion

are from the FESALAP report (5) since they are not given in Regulatory Guide 1.109. The dose commitment factors and dose factors used in these analyses are listed in Table 1. In general, the ratios of the maximum to minimum values of dose commitment factors or dose factors as reported in the literature are less than 2.

Comparison of calculated doses

The integrated milk concentrations used in equation 1 were obtained by plotting the radionuclide levels measured in the ERAMS samples, extrapolating these curves to November 12, and using a planimeter to estimate the integrated milk concentrations. A representative curve for ^{131}I milk concentrations at Baltimore, Maryland, is shown in Figure 17.

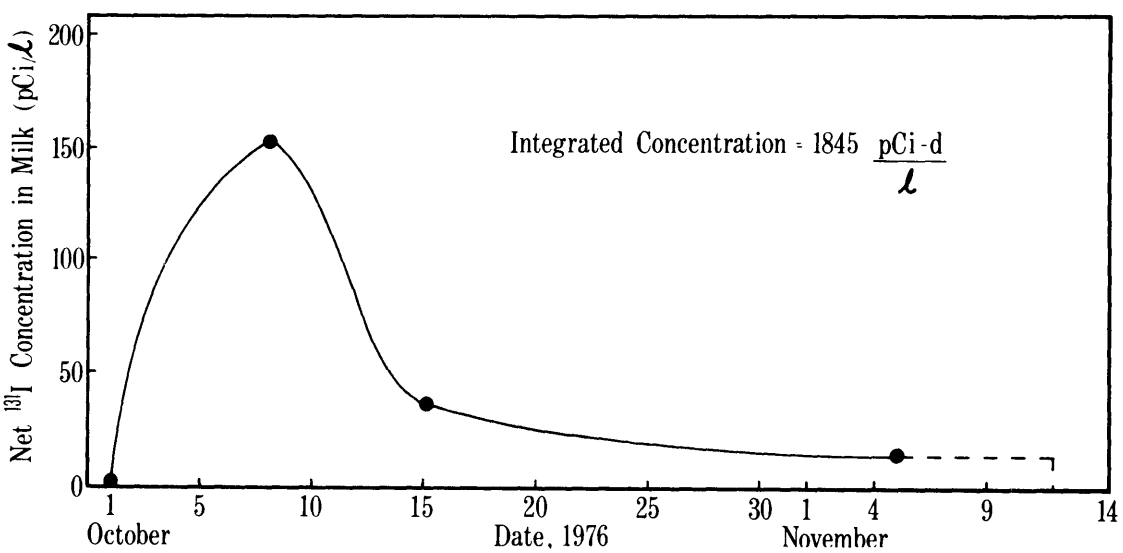

Figure 17. Net iodine-131 concentration in milk as a function of date for Baltimore, Maryland.

Table 1: Dose commitment factors for critical organs and critical receptors.

Radionuclide	External exposure (5) (mrem/h per pCi/m^3) DF		Inhalation (2) (mrem/pCi inhaled) DCF	Milk Ingestion a. (mrem/pCi ingested) b. (mrad/pCi ingested) DCF	
	Skin	Total Body			
^{95}Zr, ^{95}Nb	8.4(-7)†	6.8(-7)	5.7(-4) child-lung		
^{89}Sr				2.9(-3) infant-bone	(2) a
^{90}Sr				2.5(-2) infant-bone	(2) a
^{103}Ru, ^{106}Ru*	1.5(-6)**	4.1(-7)**	3.9(-3) child-lung		
^{131}I	4.9(-7)	3.1(-7)	4.2(-3) child-thyroid	1.0(-2) infant-thyroid	(4) b
				3.6(-3) child-thyroid	(4) b
				1.6(-3) teen-thyroid	(4) b
				1.1(-3) adult-thyroid	(4) b
^{137}Cs				7.3(-4) infant-liver	(2) a
^{140}Ba	4.4(-7)	2.2(-7)	2.5(-4) teen-lung	1.7(-4) infant-bone	(2) a
^{140}La***	2.7(-6)	1.9(-6)	2.7(-5) teen-lung	2.1(-8) infant-bone	(2) a
^{141}Ce, ^{144}Ce*	1.2(-6)**	5.9(-8)	3.3(-3) child-lung		

Table 1 (continued)

† 8.4(-7) = 8.4×10^{-7}

* Both isotopes contribute to gamma peak in procedure used at EERF. The highest dose factor was used in the dose calculations.

** Includes daughter products.

*** It was assumed that ^{140}La was in equilibrium with ^{140}Ba.

The estimates for integrated air concentrations were obtained in the same way. The integrated milk and air particulate concentrations and the individual doses, committed during the integration period and calculated using equations 1 and 2, are listed in Table 2. From a review of the information in this table, it can be seen that the highest individual dose (18.4 mrad to the infant thyroid) is for ^{131}I in milk. The next highest dose (2.4 mrem to the infant bone) is for ^{89}Sr in milk and is a factor of 7.5 lower than the dose for ^{131}I in milk. The inhalation dose to the lung for all particulate radionuclides detected in air is 1.8 mrem which is a factor of 10 below the dose to the thyroid for ^{131}I in milk. The submersion doses for skin and total body are insignificant (<0.01 mrem). These individual doses substantiate the original opinion that the most significant pathway was for ^{131}I in milk. Therefore, it was decided to carry out detailed population dose calculations only for the ^{131}I - milk - thyroid pathway.

Population Dose Calculations

The population dose is computed by summing the individual doses for all members of a population. It has units of persons times dose (man-rad).

Equation for population dose

The equation used to calculate the thyroid population dose is:

(Eq. 3)

$$PD = \frac{10^6}{43\rho} \sum_{j=1}^{51} \sum_{i=1}^{4} \sum_{m=1}^{2} (C_j)(MC_j)(f_m)(f_i)(DCF_i)e^{-\lambda_r t_m}$$

where:

PD = U. S. population dose to the thyroid from ^{131}I in milk during the period October 1 - November 12, 1976 (man-rads)

Table 2. Integrated milk and air concentrations and individual doses for the stations with the highest measured activity levels.

Pathway	Radionuclide	Location	Integrated Concentration in milk or air, C_j (pCi-d/l or pCi-d/m^3)		Individual Dose, ID
Milk	^{89}Sr	Hartford, CT	8.0(+2)†	2.4	mrem infant-bone
	^{90}Sr	Norfolk, VA	4.2(+1)	1.1	mrem infant-bone
	^{131}I	Baltimore, MD	1.85(+3)	1.84(+1)	mrad infant-thyroid
	^{137}Cs	Jackson, MS	2.0(+2)	2.0(-1)	mrem infant-liver
	^{140}Ba, ^{140}La	Hartford, CT	6.5(+2)	1.0(-1)	mrem infant-bone
Air-Inhalation**	^{95}Zr, ^{95}Nb	Miami, FL	2.4	1.5(-2)	mrem child-lung
	^{103}Ru, ^{106}Ru	Miami, FL	1.6(+1)	7.0(-1)	mrem child-lung
	^{131}I	Miami, FL	2.9	1.0(-1)	mrem child-lung
	^{140}Ba, ^{140}La	Miami, FL	8.3	4.5(-2)	mrem child-lung
	^{141}Ce, ^{144}Ce	Miami, FL	2.9(+1)	1.0	mrem child-lung
	Total	Miami, FL		1.8	mrem child-lung

Table 2 (continued)

Air-Submersion*,**	All isotopes listed under inhalation	Miami, FL	Skin mrem	Total Body mrem
			2.1(-3)	6.8(-4)

† 8.0(+2) = 8.0×10^2

* We assumed that the submersion doses would be the same for all age groups.

** The doses for air inhalation and submersion are gross dose (no background subtracted). Background levels for specific isotopes are not available.

10^6 = conversion factor (lbs/Mlbs)

j = summation index for state (51 states; including all states and D.C.)

i = summation index for age group (4 age groups)

m = summation index for food group (2 food groups)

C_j = integrated net milk concentration for state corrected to sample collection date, pCi-d/ℓ

MC_j = total fluid milk and fluid milk products consumed in state during integration period (Mlbs. consumed or committed for consumption)

f_m = fraction of milk used for food group m (dimensionless)

f_i = fraction of total milk consumption used by age group i (dimensionless)

DCF_i = ingestion dose commitment factor for age group i (man-rads committed/pCi ^{131}I ingested)*

λ_r = ^{131}I radioactive decay constant (d^{-1})

t_m = time between sample collection and consumption (d)

43 = days in period of integration

ρ = milk density (lbs/ℓ)

State milk concentrations

The pasteurized milk portion of the ERAMS network includes 63 sampling locations within the United States. There is at least one sampling location in each state and the District of Columbia. In general ^{131}I concentrations in milk were available for one or more samples per week for each of the 63 U. S. locations. The data

* For population dose calculations where the collective dose to a large group of people is desired, the units on the dose commitment factor are defined as man-rad/pCi ^{131}I ingested. The man-rad dose actually results from the group of persons collectively consuming all the milk represented in the term MC_j.

for each location were corrected for background, plotted, extrapolated and integrated as described earlier to estimate an integrated concentration (C_j) for each location (see Appendix C). For states with only one sampling location, the integrated milk concentration for that location was used as the value of C_j for the entire state. For states with more than one sampling location, an arithmetic average of the data for each location was used for C_j.* There is a limitation in the accuracy of these calculations since it was assumed that one, or at most three, milk sampling locations were representative of an entire state. Obviously, the accuracy could be improved by substantially expanding the milk sampling network to include several locations and wider geographical coverage in each state. However, while this may be the largest uncertainty in these calculations a substantial expansion of the ERAMS sampling network would significantly increase the cost of the program. The use of a single sampling location to represent milk consumed in each state is supported by the following:

(1) The milk samples are a weighted composite of milk from each major milk processor supplying an area. The samples are representative of locally consumed milk whether the processor obtained it from local or remote supplies.

(2) Many processors supply the smaller cities and towns in a state as well as the metropolitan areas where these milk samples were taken.

The integrated milk concentrations for each state are shown in Figure 18.

State milk products consumption

The total U. S. milk production of 13,434 million pounds for the integration period was obtained by using the U. S. Department of Agriculture (USDA) milk production rate data for October 1976 (6) for the entire

* For New York State, the data for New York City were given increased weighting based on population (see Appendix C).

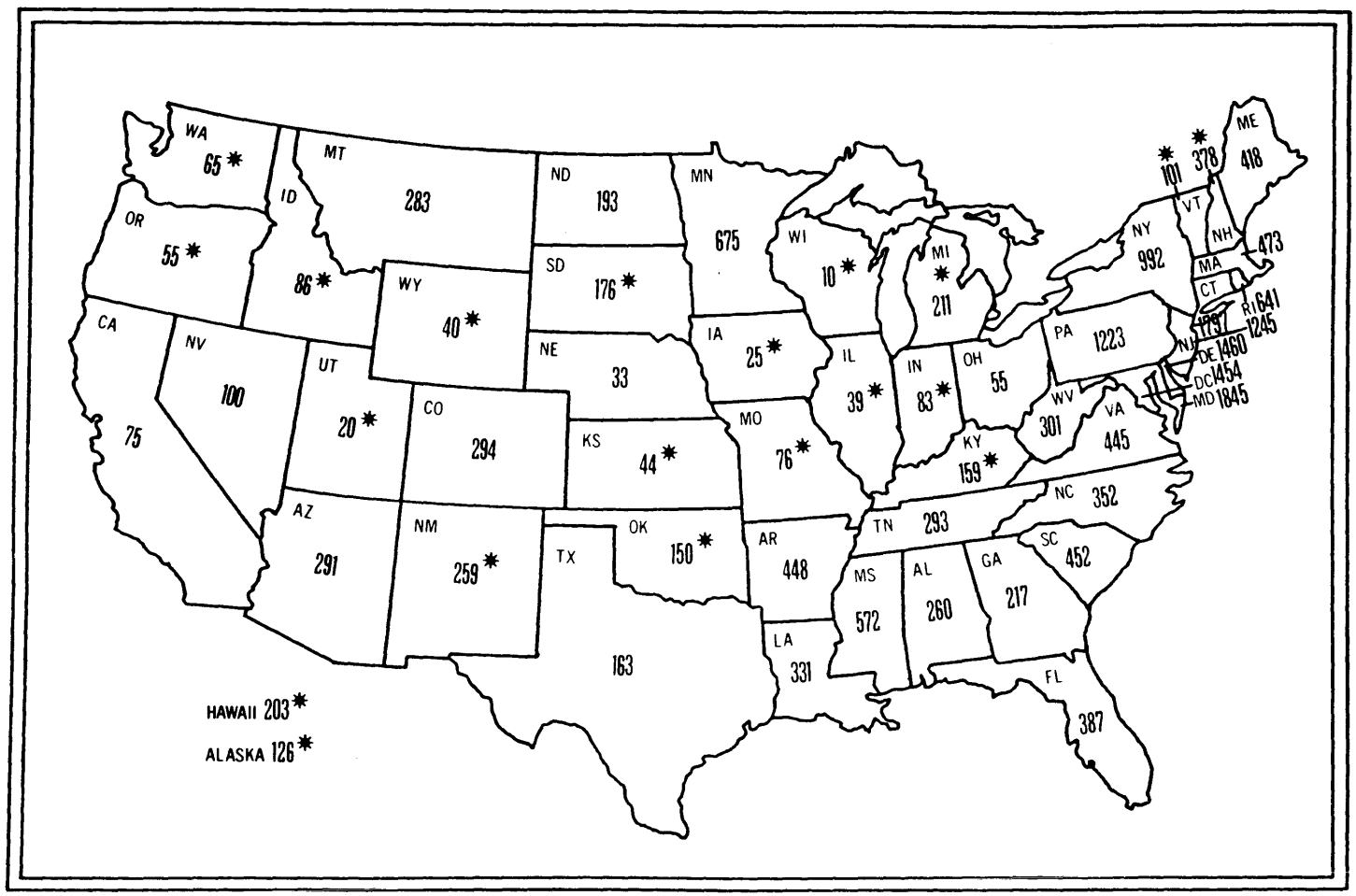

Figure 18. Integrated milk concentration of iodine-131 (pCi-d/ℓ) by State, for the period October 1 - November 12, 1976.

integration period of October 1 through November 12 (see Appendix C). It was assumed that the entire domestic milk production would be consumed within the U. S. The milk consumption within individual states was estimated by taking the ratio of total state population to total U. S. population (7) and multiplying by the estimated milk production for the U. S. (see Appendix C). These assumptions were discussed with USDA personnel who agreed that they are reasonable (8). The estimated milk consumption for each state is shown in Figure 19.

Milk usage

The fraction of the total milk consumption going into different dairy products was estimated using USDA milk utilization data for 1975 (9). After discussions with USDA dairy personnel (8) regarding the time between marketing and consumption of various dairy products, it was decided to establish two food groups (described further in Appendix C) as follows:

Food Group 1: Includes butter, ice cream, cheese, canned and condensed milk, dry milk, and other manufactured products. Fraction of total U. S. milk consumption (f_m) equals 0.52. Marketing-to-consumption time (t_m) equals 30 d.

Food Group 2: Includes fluid milk products, cottage cheese and residual milk. Fraction of total U. S. milk consumption (f_m) equals 0.48. Marketing-to-consumption time (t_m) equals 1 d.

Age dependent milk consumption

The NRC Regulatory Guide 1.109 age groups discussed previously were used for the population dose calculations. U. S. age-dependent population data for 1968 and 1969 (10) were used to estimate the fraction of the population in each age group (Table 3). Using Equation 4, age-dependent per capita milk consumption data (R_i, Table 3) from ICRP #23 (3) were combined with the age-dependent population fractions (A_i Table 3) to obtain the fractional milk consumption, f_i, for each age group in the U. S. population (see Appendix C).

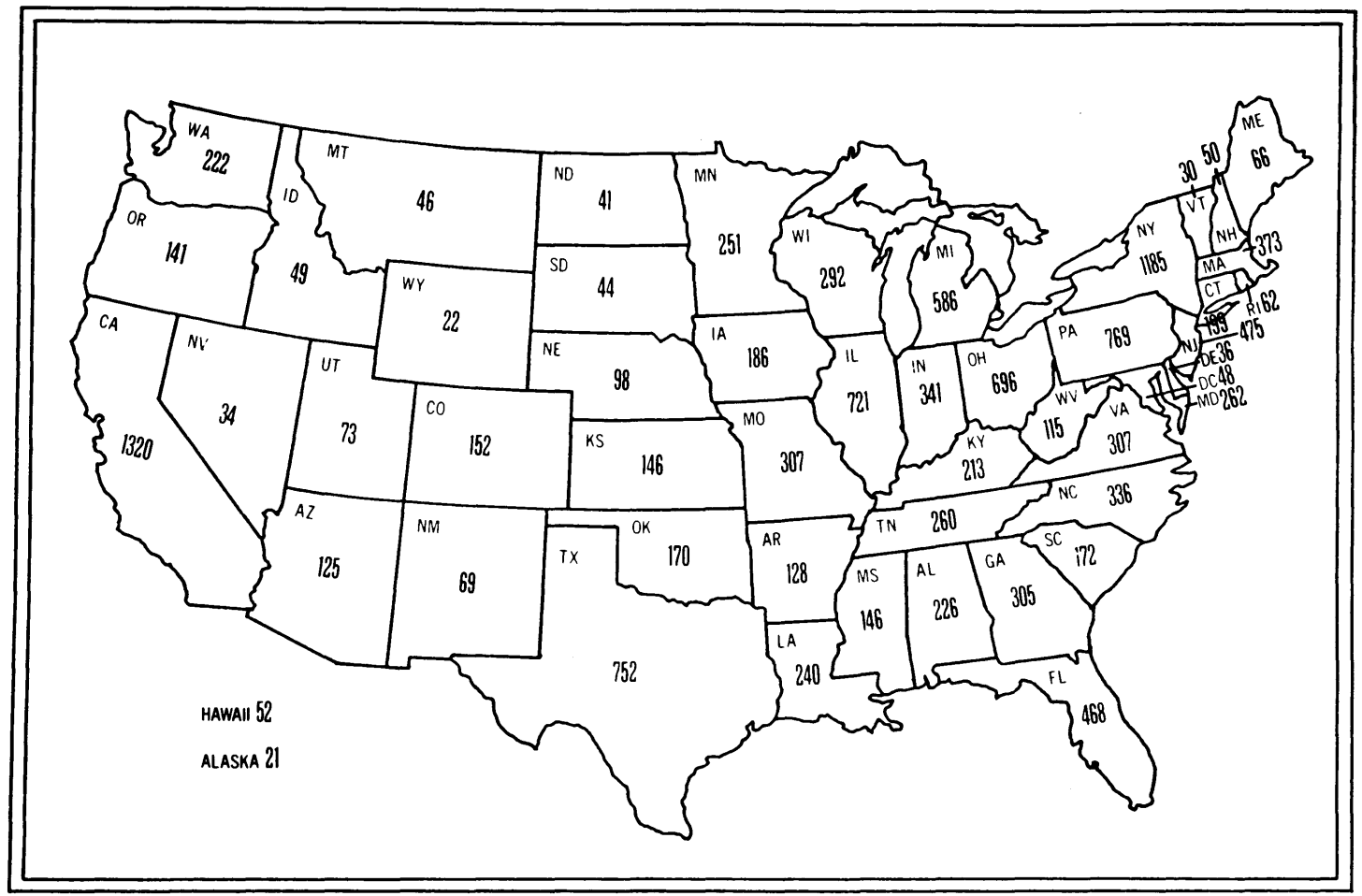

Figure 19. Estimated milk consumption (million pounds) by State, for the period October 1 - November 12, 1976.

Table 3. Age distribution, absolute milk consumption and milk consumption distribution for the U. S. population

Age Group	Age Distribution Fractions A_i	Reference Man Milk Consumption (3) (ℓ/d) R_i	Milk Consumption Distribution Fractions f_i
Infant (0-1 y)	0.02	0.72	0.04
Child (1-12 y)	0.21	0.46	0.33
Teenager (12-18 y)	0.12	0.38	0.15
Adult (18 + y)	0.65	0.22	0.48

(Eq. 4)

$$f_i = \frac{(A_i)\ (R_i)}{\sum_{i=1}^{4} (A_i)\ (R_i)}$$

where:

A_i = age distribution fraction for age group i (dimensionless)

R_i = reference man milk consumption rate for age group i (ℓ/d).

Other data

The food group fractions (f_m) were applied to all states and all age groups and the age group fractions (f_i) were applied to all states and to both food groups. In reality, f_m is probably a function of state and age group and f_i is probably a function of state and food group. Information was not readily available to define f_m and f_i as functions of these quantities and, considering other uncertainties in the calculation, it is believed that this interaction is not significant.

The age-dependent dose commitment factors for ^{131}I (DCF_i) given by Kereiakes, et al. (4) (Table 1) were used. The radiological half-life for ^{131}I is 8.05 d which yields a radioactive decay constant, λ_r, of 0.086/d. A milk density of 2.3 lbs/ℓ (11) was used.

Calculated dose

Using the methods, equation, and data discussed, the thyroid population doses were calculated for each State as shown in Figure 20. The total thyroid dose to the U. S. population is calculated to be 67,850 man-rad which is rounded to 68,000 man-rad.

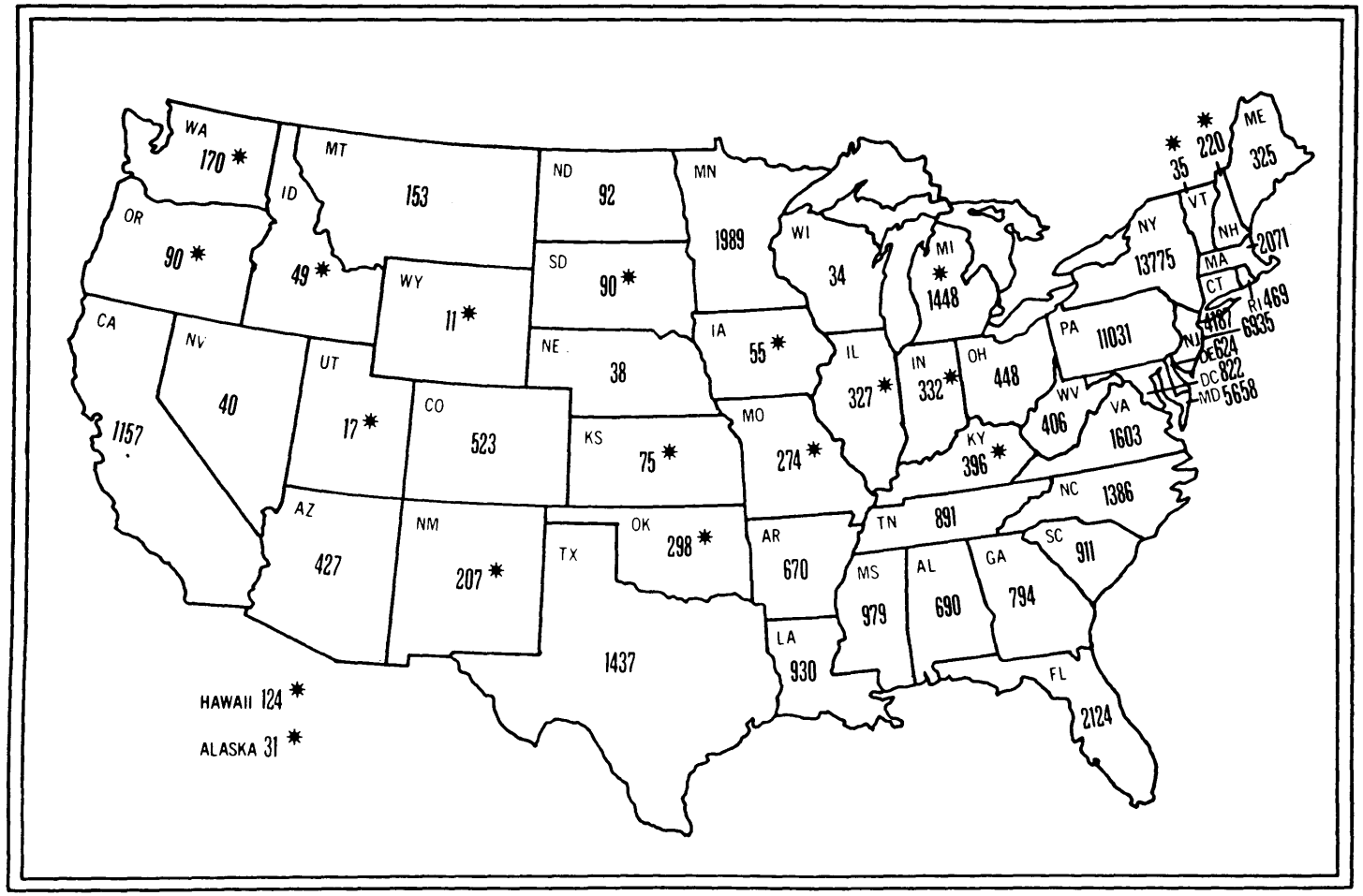

Figure 20. Population thyroid dose (man-rad) by State, for the period October 1 - November 12, 1976.

10. HEALTH EFFECTS ASSESSMENT

EPA Policy Statement on
Relationship Between Radiation Dose and Effect

The need to assess environmental radiation impacts in terms of health effects has led EPA to establish a policy for relating radiation dose to health effects. The following policy statement was published in the Federal Register on July 9, 1976 (12):

"The actions taken by the Environmental Protection Agency to protect public health and the environment require that the impacts of contaminants in the environment or released into the environment be prudently examined. When these contaminants are radioactive materials and ionizing radiation, the most important impacts are those ultimately affecting human health. Therefore, the Agency believes that the public interest is best served by the Agency providing its best scientific estimates of such impacts in terms of potential ill health.

"To provide such estimates, it is necessary that judgments be made which relate the presence of ionizing radiation or radioactive materials in the environment, i.e., potential exposure, to the intake of radioactive materials in the body, to the absorption of energy from the ionizing radiation of different qualities, and finally to the potential effects on human health. In many situations, the levels of ionizing radiation or radioactive materials in the environment may be measured directly, but the determination of resultant radiation doses to humans and their susceptible tissues is generally derived from pathway and metabolic models and calculations of energy absorbed. It is also necessary to formulate the relationships between radiation dose and effects; relationships derived primarily from human epidemiological studies but also reflective of extensive research utilizing animals and other biological systems.

"Although much is known about radiation dose-effect relationships at high levels of dose, a great deal of uncertainty exists when high level dose-effect relationships are extrapolated to lower levels of dose, particularly when given at low dose rates. These uncertainties in the relationships between dose received

and effect produced are recognized to relate, among many factors, to differences in quality and type or radiation, total dose, dose distribution, dose rate, and radiosensitivity, including repair mechanisms, sex, variations in age, organ, and state of health. These factors involve complex mechanisms of interaction among biological, chemical, and physical systems, the study of which is part of the continuing endeavor to acquire new scientific knowledge.

"Because of these many uncertainties, it is necessary to rely upon the considered judgments of experts on the biological effects of ionizing radiation. These findings are well-documented in publications by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the National Academy of Sciences (NAS), the International Commission on Radiological Protection (ICRP), and the National Council on Radiation Protection and Measurements (NCRP), and have been used by the Agency in formulating a policy on relationship between radiation dose and effect.

"It is the present policy of the Environmental Protection Agency to assume a linear, nonthreshold relationship between the magnitude of the radiation dose received at environmental levels of exposure and ill health produced as a means to estimate the potential health impact of actions it takes in developing radiation protection as expressed in criteria, guides, or standards. This policy is adopted in conformity with the generally accepted assumption that there is some potential ill health attributable to any exposure to ionizing radiation and that the magnitude of this potential ill health is directly proportional to the magnitude of the dose received.

"In adopting this general policy, the Agency recognizes the inherent uncertainties that exist in estimating health impact at the low levels of exposure and exposure rates expected to be present in the environment due to human activities, and that at these levels, the actual health impact will not be distinguishable from natural occurrences of ill health, either statistically or in the forms of ill health present. Also, at these very low levels, meaningful epidemiological studies to prove or disprove this relationship are difficult, if not practically impossible, to conduct. However, whenever new information is forthcoming,

this policy will be reviewed and updated as necessary.

"It is to be emphasized that this policy has been established for the purpose of estimating the potential human health impact of Agency actions regarding radiation protection, and that such estimates do not necessarily constitute identifiable health consequences. Further, the Agency implementation of this policy to estimate potential human health effects presupposes the premise that, for the same dose, potential radiation effects in other constituents of the biosphere will be no greater. It is generally accepted that such constituents are no more radiosensitive than humans. The Agency believes the policy to be a prudent one.

"In estimating potential health effects, it is important to recognize that the exposures to be usually experienced by the public will be annual doses that are small fractions of natural background radiation to at most a few times this level. Within the United States, the natural background radiation dose equivalent varies geographically between 40 to 300 mrem per year. Over such a relatively small range of dose, any deviations from dose-effect linearity would not be expected to significantly affect actions taken by the Agency, unless a dose-effect threshold exists.

"While the utilization of a linear, nonthreshold relationship is useful as a generally applicable policy for assessment of radiation effects, it is also EPA's policy in specific situations to utilize the best available detailed scientific knowledge in estimating health impact when such information is available for specific types of radiation, conditions of exposure, and recipients of the exposure. In such situations, estimates may or may not be based on the assumptions of linearity and a nonthreshold dose. In any case, the assumptions will be stated explicitly in any EPA radiation protection actions.

"The linear hypothesis by itself precludes the development of acceptable levels of risk based solely on health considerations. Therefore, in establishing radiation protection positions, the Agency will weigh not only the health impact, but also social, economic, and other considerations associated with the activities addressed."

Projected Health Effects for September Event

The health effects projections used in this document are those adopted by EPA. The current best estimate for risk for thyroid health effects is 63 excess thyroid cancer cases per 10^6 man-rads to the U. S. population occurring over the next 45 years (13,14). More information relative to EPA's position on calculating health effects is given in Reference 15. Using the risk estimate stated above, it is predicted that 4.3 excess thyroid cancer cases could occur in the U. S. during the next 45 years due to the ^{131}I in milk following the September event. This estimate of potential thyroid cancers is slightly higher than the earlier estimate reported by EPA (14), which was based on preliminary data. A comparison of these projected health effects with the health effects due to spontaneous natural occurrence of thyroid cancer from all causes lends perspective to these calculations. EPA estimates that during the next 45 years, on the order of 380,000 cases of thyroid cancer might be expected in the United States from all causes (16). Thus the projected thyroid health effects for the September event are 88,000 times lower than for spontaneous natural occurrences.

11. DISCUSSION

Philosophy Regarding Calculation of Environmental Doses and Effects

A traditional philosophy in the health physics profession is to estimate high for calculating doses and health effects in order to develop conservative criteria for protection of public health and safety. However, in recent years there has been a movement within the profession to establish a philosophy of using the conservative calculational approach for radiation protection, design, and criteria setting calculations but to strive for realistic calculations when estimating doses and health effects resulting from an actual event. For the calculations in this report the parameters were chosen to yield realistic dose estimates.

Another philosophy, which is standard practice in engineering calculations, has been applied in these calculations. The philosophy is one of not spending the time required to refine the value of one parameter to a few percent uncertainty when there is another parameter which cannot be refined within a much larger percentage uncertainty. The most uncertain numbers in these population dose calculations are probably the integrated milk concentrations for the states because they are based on only one (in a few cases - 2 or 3) sampling location per state. It is believed that the uncertainties in the other parameters in the calculation are less than for the integrated milk concentrations and it would not be meaningful to further refine these other parameters to reduce their uncertainty.

Review of Calculational Uncertainties

for Population Dose Calculations

For many of the parameters used in these dose calculations, a range of values were reported in the literature. Realistic values for parameters from within the range of reported numbers have been chosen instead of choosing the values which would lead to the highest dose estimate.

Discussions of uncertainties in values chosen for these parameters appear in Section 8. These parametric uncertainties are summarized in the following discussion.

Laboratory data

The minimum detectable level (MDL) of ^{131}I in milk for the analytical procedures used at EERF is 10 pCi/ℓ at a 2-σ confidence level. However, in this report, all of the available data were used for the dose calculations. Milk concentrations of ^{131}I below 10 pCi/ℓ were used, when they occurred, as best estimates of the actual concentration. For reported concentrations below 10 pCi/ℓ the error may exceed the best estimate concentration. At least two other methods are available for treating concentrations below 10 pCi/ℓ. These are to assume all concentrations below 10 pCi/ℓ are zero or 10. It is estimated that if all concentrations below 10 pCi/ℓ had been assumed to be zero, the calculated population dose would have decreased by 15 - 20 percent. It is estimated that if all concentrations below 10 pCi/ℓ had been assumed to be 10, the calculated population dose would have increased by 30 - 50 percent. It is believed that the best estimate values, which are used in the calculations, are preferable to either of these other methods since the objective is to realistically estimate the dose. Use of best estimate numbers keeps one from having to arbitrarily set concentrations below MDL to either 0 or 10 pCi/ℓ.

In calculating net milk concentrations of ^{131}I, background concentrations were established using ERAMS data for August and September 1976. These two months were chosen because they immediately preceeded the

weapons tests, and during these two months, no events had taken place in the world which would have tended to increase background levels of ^{131}I in milk in the United States. However, a longer time period for establishing background would be preferable and EPA intends to establish a more precise method for determining background for future calculations.

Sampling locations

It is assumed that one (and in a few cases two or three) milk sampling locations, composited for major metropolitan areas, were representative of an entire state. These milk samples are composites of consumed milk from several processors which makes them more representative of the states than if the samples were from only one processor. However, it is believed that the small number of samples in each state may be the most limiting factor regarding the accuracy of these dose calculations. Without samples from additional locations in each state, it is not possible to quantify the magnitude of this uncertainty.

Milk consumption data

Actual USDA milk production data for October 1976 was used to estimate total consumption during the integration period. Use of the milk for fluid consumption and for manufactured products was estimated using USDA data for calendar year 1975. The milk consumption values should be relatively free of uncertainty. A slight conservatism was introduced into the calculation by establishing only two milk usage groups with consumption times of 1 day for group 1 and 30 days for group 2 since actual estimated consumption times for some specific products in group 2 were as long as six months. However, it is estimated that this conservatism would cause the population dose to be high by less than a factor of 1.5.

Dose commitment factors

The dose commitment factors for ^{131}I are age dependent and are those recommended by Kereiakes, et al. (4).

These factors are based on more recent thyroid uptake fractions than many of the factors in the literature and, for this reason, are believed to be most representative of realistic conditions. These dose commitment factors are less than a factor of two below other dose commitment factors reported in the literature.

A generic discussion will lend perspective to the uncertainties encountered in population dose calculations. The basic mechanism involved in calculating population doses tends to minimize uncertainty when realistic parameters are used. Much of the uncertainty involved in calculating a dose to a particular individual within a population occurs because of the range of reported values for an individual. For example, one 5-year old may drink substantially more milk than another. With realistic data from the literature on consumption of milk by a large group of five-year olds, a mean which is very representative of the group may be obtained. The significant point is that uncertainties are a smaller problem in population dose calculations than in individual dose calculations as long as several values for each parameter are available from the literature to consider in determining a realistic value.

Doses Calculated by Other Agencies

The reports issued by the ERDA Health and Safety Laboratory (HASL) (17) and by Battelle's Pacific Northwest Laboratories (PNL) (18) have been reviewed. In the HASL report, the calculated individual dose for an infant drinking milk from a dairy in Chester, New Jersey, with an integrated milk concentration of 1300 pCi-d/ℓ is 15 mrad. Using the ERAMS integrated milk concentration of 1245 pCi-d/ℓ for the dairies supplying Trenton, New Jersey, a dose of 12 mrad was calculated. The individual dose calculations of HASL and EERF are in very good agreement. In the PNL report, a maximum individual dose to a child's thyroid (at a location in New Jersey) was calculated to be 220 mrem. This is a factor of 18 higher than the 12 mrad we calculated. It is believed that there are at least two reasons causing the PNL dose estimates to be substantially higher than the HASL and EERF dose estimates. First, PNL started with grass concentration rather than

milk concentration. Generally there is conservatism in the factors used to predict milk concentration from grass concentration. Secondly, it appears that the PNL dose is based on grass samples taken at a single location. Since the HASL and EERF calculations use processed milk concentrations, a dilution factor is inherent in these calculations (due to mixing of milk from many locations) which would not be included in the PNL calculations.

Significance of Estimated Health Effects

A prudent position for radiation protection is that any amount of radiation exposure is potentially harmful and that any unnecessary exposure to ionizing radiation should be discouraged. With this in mind, it would certainly be preferable to abolish atmospheric nuclear testing in all countries and thereby avoid this source of unnecessary population dose to the world's population. However, the projected U. S. health effects from these two nuclear tests are small when compared to other sources of the health effects. The health effects to the U. S. population from these two tests will be undetectable because of the larger influence of other sources of the same health effects.

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APPENDIX A

Data for September 26, 1976, Detonation

TABLE A-1

RESULTS OF AIR SAMPLES COLLECTED IN RESPONSE TO THE NUCLEAR TEST OF SEPTEMBER 26, 1976, BY THE PEOPLE'S REPUBLIC OF CHINA

October 1 - November 5

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	^{95}Zr-Nb	^{140}Ba
AK:Anchorage	13	0	.04 10/20/76	*				
AL:Montgomery	24	0	.42 10/26/76	*				
AR:Little Rock	14	0	.46 10/25/76	*				
AZ:Phoenix	10	1	1.11 10/15/76	0.7	0.1	0.7	0.2	0.2
CA:Berkeley	33	1	1.00 10/24/76	0.6	0.1	0.7	0.2	0.2
Los Angeles	25	1	1.52 10/26/76	1.1	0.1	1.7	0.4	0.3
CO:Denver	29	9	2.63 10/23/76	1.6	0.2	2.0	0.5	0.6
CT:Hartford	28	3	2.00 10/9/76	2.0	0.2	1.4	0.3	0.5
DC:Washington	19	2	1.50 10/8/76	0.7	0.1	0.6	0.2	0.3

TABLE A-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	^{95}Zr-Nb	^{140}Ba
DE:Wilmington	32	2	1.60 10/9/76	2.2	0.3	1.6	0.4	0.8
FL:Jacksonville	33	6	3.70 10/8/76	3.0	0.2	1.6	0.6	0.7
Miami	29	5	13.3 10/6/76	13.4	1.2	6.4	1.1	3.3
GA:Atlanta	16	4	8.40 10/6/76	6.2	0.5	2.4	1.0	1.6
HI:Honolulu	22	7	5.45 10/19/76	2.3	0.3	1.9	0.8	1.0
IA:Iowa City	21	0	0.40 10/13/76	*				
ID:Boise	25	2	1.16 10/25/76	0.8	0.1	1.1	0.2	0.3
Idaho Falls	10	1	1.19 10/26/76	0.9	0.1	1.2	0.3	0.3
IL:Chicago	17	1	2.60 10/13/76	0.3	0.03	0.2	0.2	0.1
IN:Indianapolis	12	1	1.10 10/5/76	0.2	0.02	0.1	.06	.06

TABLE A-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	^{95}Zr-Nb	^{140}Ba
KS:Topeka	26	0	0.60 10/14/76	*				
KY:Frankfort	21	2	1.80 10/6/76	1.1	0.3	1.0	0.3	0.7
LA:New Orleans	10	0	0.31 10/21/76	*				
MA:Lawrence	24	2	3.00 10/9/76	2.3	0.3	1.5	0.5	0.8
ME:Augusta	11	0	0.50 10/8/76	*				
MI:Lansing	21	1	2.50 10/5/76	2.5	0.2	0.8	0.3	0.5
MN:Minneapolis	17	0	0.44 11/2/76	*				
MO:Jefferson City	25	0	0.66 10/14/76	*				
MS:Jackson	27	0	0.79 10/25/76	*				
MT:Helena	19	1	1.27 10/22/76	1.0	0.1	1.3	0.3	0.4

TABLE A-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	$^{95}Zr-Nb$	^{140}Ba
NC:Charlotte	25	0	0.70 10/5/76	*				
Wilmington	21	1	1.06 10/8/76	0.8	0.1	0.6	0.2	0.2
ND:Bismarck	26	0	0.70 10/29/76	*				
NE:Lincoln	25	0	0.53 11/2/76	*				
NJ:Trenton	26	1	1.20 10/8/76	1.0	0.1	0.7	0.2	0.4
NM:Santa Fe	24	4	1.60 10/15/76	0.3	0.1	0.5	0.1	0.2
NY:Albany	15	0	0.80 10/7/76	*				
Buffalo	21	1	1.20 10/6/76	0.8	0.1	0.6	0.1	0.2
Syracuse	26	1	1.10 10/7/76	1.0	0.1	0.6	0.2	0.3
NV:Las Vegas	23	5	2.55 10/22/76	1.5	0.2	1.8	0.4	0.6

TABLE A-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	^{95}Zr-Nb	^{140}Ba
OH:Columbus	19	3	6.31 10/5/76	4.1	0.5	1.5	0.6	1.1
Painesville	20	3	3.70 10/6/76	2.1	0.4	1.5	0.5	0.7
OK:Oklahoma City	19	1	1.19 10/22/76	0.7	0.1	0.7	0.3	0.1
OR:Portland	26	0	0.47 10/22/76	*				
PA:Pittsburgh	14	3	3.40 10/6/76	3.4	0.3	1.0	0.4	0.6
RI:Providence	15	1	1.00 10/8/76	1.9	0.2	1.7	0.4	0.7
SC:Columbia	26	5	5.02 10/5/76	4.2	0.4	1.4	0.5	0.9
SD:Pierre	24	0	0.99 11/1/76	*				
TN:Nashville	23	1	1.81 10/5/76	1.5	0.1	0.5	0.2	0.3
TX:El Paso	24	5	1.44 10/25/76	1.2	0.1	1.9	0.3	0.5

TABLE A-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples with Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3	Gamma Activity for Sample with Maximum Gross Beta Activity PCi/m^3 $^{144-141}Ce$	^{131}I	$^{106-103}Ru$	$^{95}Zr-Nb$	^{140}Ba
VA:Lynchburg	20	4	2.50 10/7/76	1.8	0.2	0.7	0.3	0.5
Norfolk	26	1	2.00 10/8/76	1.9	0.2	1.1	0.3	0.5
WI:Madison	23	0	0.30 10/13/76	*				

*Gamma analysis performed on only those samples with gross beta activity greater than 1 pCi/m^3.

TABLE A-2

GAMMA RESULTS OF PRECIPITATION SAMPLES
CONTAINING SIGNIFICANT AMOUNTS OF RADIOACTIVITY

Location	Date Collected	pCi/liter					
		^{144}-, ^{141}Ce	^{131}I	^{106}-, ^{103}Ru	^{137}Cs	^{95}Zr-Nb	^{140}Ba
AL:Montgomery	10/7/76		24				
	10/18/76	374	456	3090		82	261
	10/26/76	194	43	550		25	35
	10/29/76	88	17	125			17
CO:Denver	10/18/76	226	116	159		45	62
	10/25/76		35	62			25
CT:Hartford	10/6/76	835	37				263
	10/7/76	836	49	281		247	344
	10/20/76	176		116		101	
FL:Jacksonville	10/8/76	186	148	275		36	125
	10/16/76						31
	10/27/76	111	20	236		21	21
	11/2/76	61	28	112		21	16
Miami	10/10/76		59				17
	10/19/76	159	48	184		19	97

TABLE A-2 - CONTINUED

Location	Date Collected	pCi/liter ^{144}-, ^{141}Ce	^{131}I	^{106}-, ^{103}Ru	^{137}Cs	^{95}Zr-Nb	^{140}Ba
FL:Miami	10/20/76		43				42
GA:Atlanta	10/7/76						177
IL:Chicago	10/19/76					71	58
MA:Lawrence	10/9/76	236	89	172		67	112
ND:Bismarck	10/18/76	386	67	307		122	93
NJ:Trenton	10/4/76	298	160	916		82	342
	10/10/76	39		237		12	
	10/20/76	654		602		129	193
	10/21/76	112		227		47	
	10/25/76	73		714		17	168
	10/26/76	52		273			
PA:Harrisburg	10/4/76	3310	454	566	80	226	372
	10/8/76	266	176	180		11	348
	10/9/76	90	84	91		15	63

TABLE A-2 - CONTINUED

Location	Date Collected	pCi/liter					
		^{144}-, ^{141}Ce	^{131}I	^{106}-, ^{103}Ru	^{137}Cs	^{95}Zr-Nb	^{140}Ba
PA:Harrisburg	10/10/76	183		125		77	87
	10/20/76	389	90	230		68	139
	10/21/76		24				16
SC:Columbia	10/7/76	428	137	196		44	89
	10/19/76	273	116	204		93	127
	10/21/77	175	45			41	62
	10/26/76	166		172			146
VA:Lynchburg	10/4/76	100	20				18
	10/11/76			105			52
	10/18/76						74

TABLE A-3

RESULTS OF PASTEURIZED MILK SAMPLES COLLECTED IN RESPONSE TO THE NUCLEAR TEST OF SEPTEMBER 26, 1976, BY THE PEOPLE'S REPUBLIC OF CHINA

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
AK:Palmer	10/05	1.46 ± .12	5 ± 7	8 ± 9	2 ± 7		
	10/07	1.49 ± .12	4 ± 6	- 2 ± 9	4 ± 7		
	10/15	1.46 ± .12	8 ± 7	8 ± 9	5 ± 7		
	11/10	1.45 ± .11	7 ± 8	8 ± 9	- 2 ± 7		
AL:Montgomery	10/06	1.54 ± .12	10 ± 7	- 2 ± 9	1 ± 7		
	10/08	1.43 ± .11	0 ± 6	2 ± 9	3 ± 7		
	10/12	1.42 ± .12	8 ± 7	- 3 ± 9	4 ± 7		
	10/15	1.40 ± .11	7 ± 7	11 ± 10	14 ± 7	3.6 ± 1.2	0 ± 5
	10/22	1.37 ± .11	9 ± 8	13 ± 12	17 ± 9	6.1 ± 1.1	3 ± 5
	10/29	1.38 ± .11	13 ± 8	3 ± 9	10 ± 7		
	11/10	1.40 ± .11	9 ± 8	7 ± 9	3 ± 7		
AR:Little Rock	10/04	1.41 ± .12	4 ± 6	6 ± 9	2 ± 7		
	10/07	1.39 ± .11	10 ± 6	8 ± 9	3 ± 7		
	10/12	1.44 ± .11	8 ± 7	7 ± 9	2 ± 7		
	11/01	1.45 ± .11	12 ± 8	3 ± 10	13 ± 8	6.1 ± 0.8	10 ± 5
AZ:Phoenix	10/07	1.38 ± .11	4 ± 7	11 ± 9	25 ± 7	.8 ± 0.6	0 ± 5
	10/13	1.46 ± .11	4 ± 7	10 ± 11	10 ± 9	.9 ± 0.6	0 ± 5
	11/10	1.30 ± .11	6 ± 8	- 1 ± 9	4 ± 7		
CA:Los Angeles	10/08	1.44 ± .11	7 ± 7	8 ± 9	2 ± 7		
	10/12	1.45 ± .11	4 ± 7	4 ± 9	- 2 ± 6		
	10/15	1.47 ± .12	0 ± 6	4 ± 9	4 ± 7		
	11/08	1.40 ± .11	4 ± 8	12 ± 9	0 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
CA:Sacramento	10/08	1.44 ± .11	4 ± 7	9 ± 10	4 ± 7		
	10/12	1.53 ± .12	4 ± 7	11 ± 10	1 ± 7	1.3 ± 1.0	0 ± 5
	10/15	1.47 ± .12	3 ± 6	3 ± 9	3 ± 8		
San Francisco	10/08	1.44 ± .11	7 ± 8	4 ± 9	2 ± 7		
	10/12	1.54 ± .11	9 ± 7	10 ± 12	16 ± 10	1.1 ± 0.8	4 ± 5
	10/15	1.41 ± .11	2 ± 6	10 ± 10	0 ± 7		
	11/04	1.37 ± .11	0 ± 8	- 2 ± 9	1 ± 6		
DO:Denver	10/07	1.32 ± .11	2 ± 6	0 ± 9	5 ± 7		
	10/12	1.45 ± .11	7 ± 7	4 ± 9	8 ± 7		
	10/18	1.43 ± .11	8 ± 8	4 ± 9	1 ± 7		
	11/05	1.38 ± .11	8 ± 8	6 ± 9	11 ± 7		
CT:Hartford	10/08	1.52 ± .11	5 ± 7	20 ± 11	114 ± 10	4.1 ± 0.5	14 ± 5
	10/12	1.44 ± .11	11 ± 8	36 ± 11	123 ± 11	3.6 ± 0.3	36 ± 5
	10/15	1.43 ± .12	5 ± 7	23 ± 11	61 ± 9	3.9 ± 0.5	15 ± 5
	10/22	1.40 ± .11	5 ± 8	28 ± 12	38 ± 10	3.4 ± 0.5	26 ± 5
	10/29	1.53 ± .12	7 ± 8	9 ± 11	15 ± 9	2.4 ± 0.3	16 ± 5
	11/05	1.44 ± .11	10 ± 8	5 ± 9	6 ± 7		
CZ:Cristobal	10/12	1.47 ± .12	13 ± 7	10 ± 12	18 ± 10	2.1 ± 0.8	4 ± 5
	11/08	1.52 ± .12	18 ± 8	1 ± 9	0 ± 7		
DC:Washington	10/15	1.39 ± .11	9 ± 8	34 ± 21	73 ± 20	4.2 ± 0.5	19 ± 5
	10/18	1.37 ± .11	5 ± 7	24 ± 11	47 ± 9	5.1 ± 0.7	15 ± 5
	11/05	1.50 ± .12	5 ± 8	4 ± 10	13 ± 9	6.7 ± 0.8	11 ± 5
	11/08	1.49 ± .12	10 ± 8	9 ± 9	16 ± 7	2.4 ± 0.4	21 ± 5

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
DE:Wilmington	10/04	1.37 ± .11	5 ± 6	5 ± 9	0 ± 6		
	10/12	1.41 ± .11	11 ± 7	14 ± 11	93 ± 10	6.6 ± 1.2	1 ± 5
	10/15	1.39 ± .11	8 ± 7	16 ± 12	68 ± 10	5.6 ± 0.6	21 ± 5
	10/22	1.42 ± .11	5 ± 8	20 ± 12	31 ± 11	6.2 ± 1.0	7 ± 5
	10/29	1.31 ± .11	10 ± 8	19 ± 11	21 ± 9	5.1 ± 0.6	18 ± 5
	11/15	1.39 ± .11	5 ± 8	15 ± 9	5 ± 7	3.5 ± 0.6	9 ± 5
FL:Tampa	10/07	1.45 ± .11	28 ± 7	3 ± 9	17 ± 7	2.6 ± 0.7	2 ± 5
	10/08	1.46 ± .12	26 ± 7	16 ± 11	17 ± 9	4.2 ± 1.1	0 ± 5
	10/15	1.57 ± .12	21 ± 7	- 1 ± 9	6 ± 7		
	10/22	1.45 ± .12	32 ± 9	7 ± 9	6 ± 7		
	11/01	1.46 ± .11	27 ± 8	- 4 ± 9	7 ± 7		
GA:Atlanta	10/04	1.43 ± .11	6 ± 7	- 1 ± 9	8 ± 7		
	10/12	1.43 ± .11	12 ± 7	7 ± 9	5 ± 7		
	10/15	1.43 ± .11	2 ± 8	5 ± 11	17 ± 9	7.0 ± 2.1	3 ± 5
	10/22	1.32 ± .11	13 ± 8	4 ± 9	8 ± 7		
	11/16	1.43 ± .11	11 ± 8	6 ± 9	4 ± 7		
HI:Honolulu	10/06	1.43 ± .11	8 ± 7	8 ± 9	2 ± 7		
	10/15	1.34 ± .11	3 ± 6	6 ± 9	6 ± 7		
	11/05	1.35 ± .11	4 ± 8	4 ± 9	4 ± 7		
IA:Des Moines	10/05	1.42 ± .11	1 ± 6	6 ± 9	- 1 ± 6		
	10/08	1.46 ± .12	2 ± 6	6 ± 9	3 ± 7		
	10/12	1.40 ± .11	4 ± 7	10 ± 9	4 ± 7		
	10/15	1.45 ± .11	0 ± 6	2 ± 9	4 ± 7		
	11/08	1.42 ± .11	0 ± 8	5 ± 9	1 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a) ^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
ID:Idaho Falls	10/14	1.50 ± .12	8 ± 8	2 ± 9	0 ± 7		
	10/15	1.45 ± .12	1 ± 8	4 ± 9	3 ± 7		
IL:Chicago	10/04	1.41 ± .11	7 ± 7	1 ± 9	9 ± 7		
	10/07	1.47 ± .12	4 ± 6	2 ± 9	6 ± 7		
	10/12	1.43 ± .11	2 ± 6	0 ± 9	1 ± 6		
	10/15	1.47 ± .12	3 ± 6	0 ± 9	- 2 ± 6		
	11/01	1.36 ± .11	8 ± 8	4 ± 9	3 ± 7		
IN:Indianapolis	10/04	1.35 ± .11	- 4 ± 6	2 ± 9	3 ± 6		
	10/08	1.39 ± .11	7 ± 7	6 ± 9	3 ± 7		
	10/12	1.40 ± .11	2 ± 6	7 ± 9	5 ± 7		
	10/18	1.40 ± .11	3 ± 6	1 ± 9	1 ± 6		
	11/08	1.33 ± .11	6 ± 8	13 ± 9	2 ± 7		
KS:Wichita	10/11	1.42 ± .11	3 ± 6	0 ± 9	- 3 ± 6		
	10/12	1.46 ± .12	5 ± 7	7 ± 10	0 ± 7		
	10/15	1.41 ± .11	5 ± 8	3 ± 9	4 ± 7		
	11/01	1.41 ± .11	4 ± 8	0 ± 9	6 ± 7		
KY:Louisville	10/04	1.43 ± .11	9 ± 7	8 ± 9	1 ± 7		
	10/08	1.30 ± .19	1 ± 14	2 ± 22	- 5 ± 16		
	10/12	1.23 ± .19	- 4 ± 14	10 ± 22	- 7 ± 16		
	10/19	1.35 ± .11	8 ± 7	5 ± 9	4 ± 7		
	10/21	1.44 ± .11	6 ± 8	1 ± 9	9 ± 7		
	11/02	1.50 ± .12	- 1 ± 8	9 ± 9	8 ± 7		
LA:New Orleans	10/07	1.34 ± .11	7 ± 7	7 ± 9	3 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
LA:New Orleans	10/12	1.46 ± .12	8 ± 7	14 ± 12	5 ± 9	7.8 ± 1.4	1 ± 5
	10/15	1.38 ± .11	10 ± 7	30 ± 12	18 ± 10	8.8 ± 1.8	0 ± 5
	10/22	1.39 ± .11	10 ± 8	10 ± 9	1 ± 7		
	11/05	1.39 ± .11	11 ± 8	6 ± 11	18 ± 9	5.4 ± 0.9	16 ± 5
MA:Boston	10/05	1.55 ± .12	5 ± 7	3 ± 9	6 ± 7		
	10/07	1.44 ± .11	7 ± 7	1 ± 9	19 ± 9	6.0 ± 1.4	0 ± 5
	10/12	1.48 ± .12	8 ± 7	11 ± 11	18 ± 9	4.8 ± 1.2	1 ± 5
	10/22	1.46 ± .12	7 ± 8	2 ± 9	10 ± 7		
	10/29	1.50 ± .12	0 ± 8	6 ± 9	6 ± 7		
	11/09	1.40 ± .11	10 ± 8	2 ± 9	4 ± 7		
MD:Baltimore	10/01	1.40 ± .11	3 ± 6	0 ± 9	1 ± 6		
	10/08	1.54 ± .12	10 ± 7	23 ± 11	155 ± 11	6.1 ± 0.6	13 ± 5
	10/15	1.52 ± .12	3 ± 7	19 ± 12	38 ± 11	5.5 ± 0.6	18 ± 5
	11/05	1.43 ± .11	0 ± 8	6 ± 11	17 ± 9	5.5 ± 0.7	13 ± 5
ME:Portland	10/05	1.29 ± .19	1 ± 14	- 8 ± 22	- 1 ± 16		
	10/12	1.40 ± .11	9 ± 8	6 ± 15	23 ± 14	5.2 ± 0.9	3 ± 5
	10/25	1.34 ± .11	11 ± 8	9 ± 9	7 ± 7		
	11/02	1.46 ± .12	8 ± 8	4 ± 9	8 ± 7		
MI:Detroit	10/08	1.45 ± .12	5 ± 7	7 ± 9	5 ± 7		
	10/12	1.44 ± .12	2 ± 6	10 ± 9	3 ± 7		
	10/21	1.38 ± .11	4 ± 8	0 ± 9	3 ± 7		
	11/10	1.40 ± .11	2 ± 8	2 ± 9	5 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a) ^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
MI:Grand Rapids	10/04	1.46 ± .12	6 ± 7	0 ± 9	3 ± 7		
	10/08	1.41 ± .11	4 ± 7	14 ± 9	4 ± 7	4.6 ± 1.2	0 ± 5
	10/12	1.49 ± .12	4 ± 6	1 ± 9	4 ± 7		
	10/15	1.42 ± .12	8 ± 7	4 ± 9	4 ± 7		
	11/01	1.48 ± .12	1 ± 8	1 ± 9	8 ± 7		
MN:Minneapolis	10/04	1.45 ± .12	15 ± 7	6 ± 9	10 ± 7		
	10/08	1.47 ± .12	17 ± 7	19 ± 11	31 ± 9	5.1 ± 1.5	0 ± 5
	10/12	1.48 ± .12	3 ± 8	- 1 ± 9	- 2 ± 6		
	10/15	1.43 ± .11	4 ± 8	13 ± 9	3 ± 7		
MO:Kansas City	10/08	1.47 ± .12	0 ± 7	7 ± 9	7 ± 7		
	10/12	1.44 ± .12	2 ± 6	4 ± 9	3 ± 7		
	10/15	1.49 ± .12	5 ± 7	5 ± 9	0 ± 7		
	11/10	1.37 ± .11	6 ± 8	3 ± 9	4 ± 7		
St. Louis	10/05	1.35 ± .11	0 ± 6	8 ± 9	4 ± 7		
	10/12	1.41 ± .11	4 ± 7	0 ± 9	5 ± 7		
	10/15	1.29 ± .11	1 ± 6	8 ± 9	2 ± 7		
	11/10	1.47 ± .12	3 ± 8	4 ± 9	4 ± 7		
MS:Jackson	10/04	1.37 ± .11	5 ± 7	3 ± 9	0 ± 7		
	10/08	1.46 ± .11	8 ± 7	- 2 ± 9	2 ± 7		
	10/12	1.42 ± .11	10 ± 7	7 ± 9	5 ± 7		
	10/15	1.44 ± .11	9 ± 8	3 ± 9	6 ± 7		
	10/25	1.31 ± .11	14 ± 8	9 ± 10	32 ± 8	6.0 ± 0.7	11 ± 5
	10/29	1.58 ± .12	5 ± 8	12 ± 11	19 ± 9	7.6 ± 1.1	8 ± 5
	11/01	1.34 ± .11	9 ± 8	18 ± 11	22 ± 8	5.6 ± 0.9	7 ± 5

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
MT:Helena	10/06	1.44 ± .11	7 ± 7	6 ± 9	6 ± 7		
	10/07	1.56 ± .12	7 ± 7	2 ± 9	7 ± 7		
	10/12	1.48 ± .12	6 ± 7	7 ± 9	10 ± 7		
	10/15	1.52 ± .12	3 ± 6	7 ± 9	5 ± 7		
	11/01	1.38 ± .11	1 ± 8	7 ± 10	17 ± 8	2.0 ± 0.6	3 ± 5
NC:Charlotte	10/04	1.41 ± .11	5 ± 6	5 ± 9	2 ± 7		
	10/07	1.48 ± .12	10 ± 7	9 ± 9	5 ± 7		
	10/11	1.41 ± .11	4 ± 6	1 ± 9	3 ± 7		
	10/15	1.38 ± .11	5 ± 7	17 ± 11	20 ± 9	5.5 ± 0.8	6 ± 5
	10/22	1.39 ± .11	9 ± 8	16 ± 12	11 ± 10	6.0 ± 0.9	7 ± 5
	11/01	1.42 ± .11	11 ± 8	16 ± 10	3 ± 8	4.9 ± 1.0	13 ± 5
ND:Minot	10/07	1.42 ± .11	10 ± 7	8 ± 11	15 ± 9	3.9 ± 1.1	0 ± 5
	10/11	1.51 ± .12	5 ± 8	3 ± 9	2 ± 7		
	10/15	1.53 ± .12	4 ± 6	- 6 ± 9	- 2 ± 6		
	11/01	1.50 ± .12	6 ± 8	4 ± 9	6 ± 6		
NE:Omaha	10/07	1.29 ± .11	0 ± 6	3 ± 9	2 ± 6		
	10/08	1.35 ± .11	11 ± 7	11 ± 11	16 ± 9	2.0 ± 0.9	0 ± 5
	10/12	1.37 ± .11	3 ± 6	7 ± 9	4 ± 7		
	10/15	1.40 ± .11	5 ± 6	3 ± 9	5 ± 7		
	10/19	1.44 ± .11	2 ± 8	4 ± 9	- 1 ± 6		
	11/12	1.42 ± .11	5 ± 8	4 ± 9	1 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
NH:Manchester	10/04	1.52 ± .12	5 ± 7	4 ± 9	2 ± 7		
	10/15	1.39 ± .11	7 ± 7	5 ± 9	8 ± 7		
	11/03	1.37 ± .11	9 ± 8	12 ± 10	9 ± 8		
NJ:Trenton	10/22	1.42 ± .11	6 ± 8	22 ± 11	56 ± 10	5.0 ± 0.5	24 ± 5
	11/01	1.41 ± .11	11 ± 8	8 ± 10	23 ± 8	7.5 ± 0.9	13 ± 5
NM:Albuquerque	10/07	1.45 ± .11	3 ± 6	4 ± 9	7 ± 7		
	10/12	1.37 ± .11	6 ± 7	7 ± 9	2 ± 7		
	10/15	1.41 ± .11	2 ± 6	6 ± 9	7 ± 7		
NV:Las Vegas	10/12	1.43 ± .11	9 ± 7	12 ± 12	14 ± 9	0.9 ± 0.6	0 ± 5
	10/15	1.60 ± .12	0 ± 6	2 ± 9	1 ± 7		
	11/02	1.42 ± .11	2 ± 8	11 ± 9	- 3 ± 6		
NY:Buffalo	10/08	1.53 ± .12	3 ± 7	15 ± 12	5 ± 7	3.2 ± 1.0	1 ± 5
	10/15	1.49 ± .12	3 ± 6	- 2 ± 9	6 ± 7		
	10/21	1.47 ± .12	0 ± 8	9 ± 9	4 ± 7		
	11/04	1.54 ± .12	3 ± 8	2 ± 9	2 ± 7		
New York City	10/05	1.42 ± .11	1 ± 6	3 ± 9	4 ± 7		
	10/15	1.43 ± .11	1 ± 7	22 ± 12	95 ± 12	5.8 ± 0.8	9 ± 5
	11/01	1.42 ± .12	5 ± 8	10 ± 9	9 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
NY:Syracuse	10/04	1.48 ± .11	3 ± 6	2 ± 9	3 ± 7		
	10/21	1.43 ± .11	8 ± 8	2 ± 9	2 ± 7		
	11/08	1.33 ± .11	5 ± 8	7 ± 9	5 ± 7		
OH:Cincinnati	10/05	1.44 ± .11	0 ± 6	- 1 ± 9	8 ± 7		
	10/07	1.36 ± .11	4 ± 6	3 ± 9	5 ± 7		
	10/12	1.33 ± .11	3 ± 6	13 ± 9	10 ± 7	3.3 ± 1.6	2 ± 5
	10/15	1.38 ± .11	1 ± 6	5 ± 9	5 ± 7		
	11/09	1.34 ± .11	3 ± 8	8 ± 9	4 ± 7		
Cleveland	10/07	1.30 ± .11	7 ± 6	0 ± 9	3 ± 7		
	10/11	1.44 ± .11	4 ± 6	5 ± 9	9 ± 7		
	10/18	1.54 ± .12	3 ± 6	1 ± 9	7 ± 7		
	11/08	1.40 ± .11	3 ± 8	8 ± 9	3 ± 7		
OK:Oklahoma City	10/04	1.35 ± .11	3 ± 6	11 ± 9	2 ± 7		
	10/07	1.44 ± .11	2 ± 6	7 ± 9	8 ± 7		
	10/12	1.45 ± .12	5 ± 7	2 ± 9	4 ± 7		
	11/08	1.46 ± .12	4 ± 8	6 ± 9	5 ± 7		
OR:Portland	10/04	1.46 ± .12	5 ± 6	4 ± 9	6 ± 7		
	10/07	1.48 ± .12	3 ± 6	4 ± 9	2 ± 7		
	10/12	1.50 ± .12	6 ± 7	0 ± 9	4 ± 7		
	10/15	1.44 ± .11	7 ± 8	- 1 ± 9	1 ± 6		
	11/01	1.37 ± .11	3 ± 8	9 ± 9	2 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
PA:Philadelphia	10/04	1.39 ± .12	6 ± 7	7 ± 9	1 ± 7		
	10/08	1.42 ± .11	12 ± 7	19 ± 11	72 ± 10	4.6 ± 0.6	8 ± 5
	10/12	1.43 ± .12	4 ± 7	25 ± 11	46 ± 9	4.3 ± 0.7	8 ± 5
	10/13	1.46 ± .12	5 ± 6	15 ± 11	68 ± 9	4.1 ± 0.9	12 ± 5
	10/15	1.45 ± .12	3 ± 7	17 ± 11	61 ± 9	3.2 ± 0.4	17 ± 5
	10/22	1.40 ± .11	5 ± 8	13 ± 6	40 ± 16	4.1 ± 0.5	15 ± 5
	10/29	1.36 ± .11	12 ± 8	18 ± 12	28 ± 10	5.5 ± 0.7	12 ± 5
	11/08	1.38 ± .11	3 ± 8	15 ± 11	16 ± 9	5.1 ± 0.7	10 ± 5
PA:Pittsburgh	10/03	1.44 ± .11	4 ± 8	1 ± 9	- 3 ± 6		
	10/08	1.41 ± .11	8 ± 8	17 ± 26	60 ± 34	8.3 ± 1.4	0 ± 5
	10/12	1.33 ± .11	7 ± 7	14 ± 11	33 ± 8	5.7 ± 1.0	4 ± 5
	10/18	1.46 ± .12	6 ± 8	17 ± 14	33 ± 14	5.7 ± 0.9	9 ± 5
	10/22	1.45 ± .11	7 ± 8	6 ± 13	27 ± 11	4.8 ± 0.6	11 ± 5
	10/29	1.42 ± .11	9 ± 8	9 ± 13	24 ± 11	5.3 ± 0.7	13 ± 5
	11/09	1.38 ± .11	7 ± 8	6 ± 9	5 ± 7		
PR:San Juan	10/07	1.49 ± .12	7 ± 7	0 ± 9	2 ± 6		
	10/12	1.40 ± .11	10 ± 7	4 ± 9	6 ± 7		
	10/13	1.48 ± .12	6 ± 7	2 ± 9	2 ± 7		
	10/15	1.47 ± .12	2 ± 6	7 ± 9	0 ± 7		
	11/10	1.38 ± .11	10 ± 8	6 ± 9	3 ± 7		
RI:Providence	10/07	1.49 ± .12	9 ± 7	16 ± 10	10 ± 7	5.1 ± 1.2	2 ± 5
	10/12	1.54 ± .12	7 ± 7	16 ± 10	36 ± 8	4.7 ± 0.9	4 ± 5
	10/15	1.40 ± .11	9 ± 7	13 ± 12	31 ± 10	4.1 ± 0.6	8 ± 5
	10/22	1.60 ± .12	10 ± 8	12 ± 12	18 ± 10	5.3 ± 0.8	9 ± 5
	10/29	1.54 ± .11	11 ± 8	18 ± 11	10 ± 9	4.9 ± 0.6	13 ± 5

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
RI:Providence	11/11	1.53 ± .12	9 ± 8	7 ± 9	8 ± 7		
SC:Charleston	10/08	1.42 ± .11	15 ± 7	4 ± 9	3 ± 7		
	10/12	1.37 ± .11	9 ± 7	1 ± 9	12 ± 8		
	10/21	1.40 ± .11	9 ± 8	6 ± 12	21 ± 10	3.3 ± 0.5	0 ± 5
	10/29	1.37 ± .11	12 ± 8	9 ± 9	7 ± 7		
	11/10	1.41 ± .11	10 ± 8	8 ± 9	10 ± 7		
SD:Rapid City	10/07	1.49 ± .12	2 ± 6	4 ± 9	4 ± 7		
	10/12	1.36 ± .19	8 ± 15	20 ± 23	2 ± 17	3.5 ± 1.4	0 ± 5
	10/15	1.32 ± .11	- 2 ± 6	13 ± 9	4 ± 7		
	10/14	1.45 ± .11	2 ± 8	3 ± 9	5 ± 7		
TN:Chattanooga	10/04	1.27 ± .11	8 ± 7	5 ± 9	2 ± 7		
	10/08	1.43 ± .12	7 ± 7	6 ± 9	12 ± 8		
	10/12	1.41 ± .11	6 ± 7	12 ± 11	19 ± 9	6.2 ± 1.3	0 ± 5
	10/15	1.46 ± .12	2 ± 6	8 ± 12	15 ± 9	4.1 ± 0.9	3 ± 5
	10/22	1.37 ± .11	8 ± 8	4 ± 9	7 ± 7		
	11/08	1.38 ± .11	6 ± 8	8 ± 9	7 ± 7		
Knoxville	10/08	1.37 ± .11	7 ± 7	5 ± 9	8 ± 7		
	10/12	1.44 ± .12	5 ± 7	16 ± 10	15 ± 7	4.3 ± 1.0	2 ± 5
	10/15	1.48 ± .12	6 ± 7	6 ± 12	17 ± 9	4.0 ± 0.9	3 ± 5
	10/21	1.51 ± .12	10 ± 8	6 ± 9	7 ± 7		
	10/26	1.41 ± .11	5 ± 8	4 ± 9	6 ± 7		
	11/10	1.42 ± .11	6 ± 8	5 ± 9	6 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a) ^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
TN:Memphis	10/08	1.43 ± .11	10 ± 7	4 ± 9	8 ± 7		
	10/11	1.46 ± .12	5 ± 6	2 ± 9	10 ± 7		
	10/15	1.43 ± .11	3 ± 6	5 ± 9	2 ± 7		
	10/22	1.37 ± .11	11 ± 8	5 ± 9	6 ± 7		
	11/10	1.43 ± .11	3 ± 8	6 ± 9	11 ± 7	5.6 ± 0.9	5 ± 5
TX:Austin	10/04	1.49 ± .12	3 ± 6	4 ± 9	- 2 ± 7		
	10/08	1.43 ± .11	1 ± 6	4 ± 9	4 ± 7		
	10/12	1.46 ± .12	6 ± 7	2 ± 9	3 ± 7		
	10/15	1.42 ± .11	1 ± 6	7 ± 9	- 3 ± 6		
	11/01	1.46 ± .12	6 ± 8	19 ± 11	15 ± 9	0.4 ± 0.1	14 ± 5
Dallas	10/04	1.39 ± .11	3 ± 6	5 ± 9	7 ± 7		
	10/06	1.39 ± .11	11 ± 7	6 ± 9	5 ± 7		
	10/14	1.37 ± .11	1 ± 6	6 ± 9	4 ± 7		
	11/08	1.44 ± .11	5 ± 8	7 ± 9	5 ± 7		
UT:Salt Lake City	10/04	1.44 ± .11	2 ± 6	3 ± 9	3 ± 7		
	10/07	1.44 ± .11	4 ± 6	1 ± 9	1 ± 7		
	10/12	1.38 ± .11	9 ± 7	6 ± 9	9 ± 7		
	10/15	1.35 ± .11	7 ± 7	8 ± 9	4 ± 7		
	11/01	1.48 ± .12	2 ± 8	5 ± 9	2 ± 7		
VA:Norfolk	10/01	1.47 ± .12	3 ± 7	1 ± 9	6 ± 7		
	10/08	1.48 ± .12	1 ± 6	6 ± 9	14 ± 9	3.8 ± 0.9	1 ± 5
	10/12	1.52 ± .12	4 ± 7	11 ± 10	12 ± 8	5.0 ± 1.3	0 ± 5
	10/21	1.45 ± .12	10 ± 8	13 ± 13	16 ± 11	6.6 ± 1.3	0 ± 5
	11/04	1.32 ± .11	9 ± 8	6 ± 9	5 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a) ^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
VT:Burlington	10/08	1.25 ± .11	4 ± 6	5 ± 9	1 ± 7		
	10/12	1.43 ± .12	7 ± 7	5 ± 9	4 ± 7		
	10/15	1.30 ± .11	6 ± 7	7 ± 9	5 ± 7		
WA:Seattle	10/07	1.40 ± .11	7 ± 7	5 ± 9	2 ± 7		
	10/12	1.41 ± .11	3 ± 6	7 ± 9	- 2 ± 6		
	10/15	1.52 ± .12	10 ± 7	3 ± 9	2 ± 7		
	11/09	1.48 ± .12	10 ± 8	3 ± 9	3 ± 7		
Spokane	10/07	1.37 ± .11	2 ± 6	- 2 ± 9	4 ± 7		
	10/07	1.45 ± .12	9 ± 7	13 ± 9	4 ± 6	2.5 ± 0.9	1 ± 5
	10/15	1.45 ± .11	2 ± 6	2 ± 9	5 ± 7		
	11/08	1.45 ± .12	11 ± 8	4 ± 9	6 ± 7		
WI:Milwaukee	10/06	1.50 ± .12	- 1 ± 6	8 ± 9	6 ± 7		
	10/07	1.52 ± .12	0 ± 6	7 ± 9	0 ± 7		
	10/12	1.36 ± .11	2 ± 6	6 ± 9	3 ± 7		
	10/15	1.41 ± .11	5 ± 6	6 ± 9	- 2 ± 6		
	11/02	1.43 ± .11	3 ± 8	4 ± 9	3 ± 7		
WV:Charleston	10/04	1.44 ± .11	- 1 ± 6	5 ± 9	- 1 ± 6		
	10/07	1.41 ± .11	5 ± 6	3 ± 9	5 ± 7		
	10/12	1.45 ± .12	7 ± 7	5 ± 10	20 ± 10	2.8 ± 0.8	2 ± 5
	11/01	1.49 ± .12	7 ± 8	3 ± 9	5 ± 7		

TABLE A-3 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
WY:Laramie	10/07	1.32 ± .11	2 ± 6	8 ± 9	5 ± 7		
	10/13	1.39 ± .11	8 ± 7	11 ± 10	9 ± 7		
	10/15	1.50 ± .12	- 2 ± 6	3 ± 9	2 ± 7		
	11/16	1.42 ± .11	0 ± 8	5 ± 9	2 ± 7		

(a) Negative values may be obtained when the actual concentration is at or near zero due to the statistical distribution of net counting results both positive and negative around zero.

APPENDIX B

Data for November 17, 1976, Detonation

TABLE B-1

RESULTS OF AIR SAMPLES COLLECTED IN RESPONSE TO THE NUCLEAR TEST OF NOVEMBER 17, 1976, BY THE PEOPLE'S REPUBLIC OF CHINA

November 18 - December 10, 1976

Location	Number of Samples Submitted	Number of Samples With Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3
AK: Anchorage	12	0	.09 12/3/76
AL: Montgomery	13	0	.10 11/22/76
AR: Little Rock	16	0	.24 11/18/76
AZ: Phoenix	13	0	.75 11/22/76
CA: Berkeley	22	0	.16 11/27/76
Los Angeles	18	0	.14 11/29/76
CO: Denver	21	0	.26 11/25/76
CT: Hartford	23	0	.08 12/3/76
CZ: Ancon	15	0	.06 12/9/76
DC: Washington	20	0	.21 11/19/76
DE: Wilmington	23	0	.15 11/19/76
FL: Miami	10	0	.16 11/25/76
GA: Atlanta	9	0	.27 11/20/76
HI: Honolulu	14	0	.15 11/23/76

TABLE B-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples With Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3
IA: Iowa City	17	0	.13 12/3/76
ID: Boise	18	0	.20 11/21/76
Idaho Falls	14	0	.23 11/20/76
IN: Indianapolis	7	0	.11 11/21/76
KS: Topeka	16	0	.15 11/18/76
KY: Frankfort	7	0	.09 11/20/76
LA: New Orleans	6	0	.12 11/19/76
MA: Lawrence	19	0	.14 11/19/76
ME: Augusta	9	0	.08 11/20/76
MI: Lansing	17	0	.11 11/24/76
MN: Minneapolis	17	0	.13 12/1/76
MO: Jefferson City	17	0	.14 11/19/76
MS: Jackson	16	0	.19 11/19/76
MT: Helena	17	0	.20 11/23/76

TABLE B-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples With Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3
NC: Charlotte	14	0	.09 11/24/76
Wilmington	10	0	.09 12/16/76
ND: Bismarck	18	0	.14 11/30/76
NE: Lincoln	16	0	.15 11/19/76
NJ: Trenton	16	0	.13 11/26/76
NM: Santa Fe	11	0	.15 11/18/76
NY: Albany	16	0	.10 11/26/76
Buffalo	16	0	.20 11/18/76
New York City	11	0	.09 11/26/76
Syracuse	17	0	.12 11/19/76
NV: Las Vegas	13	0	.14 11/21/76
OH: Columbus	7	0	.13 11/18/76
Painesville	6	0	.10 11/26/76
OK: Oklahoma City	15	0	.17 11/20/76

TABLE B-1 - CONTINUED

Location	Number of Samples Submitted	Number of Samples With Lab. Gross Beta Measurement > 1 pCi/m^3	Maximum Lab. Gross Beta Measurement & Date Collected pCi/m^3
OR: Portland	12	0	.12 11/21/76
PA: Harrisburg	18	0	.10 11/18/76
Pittsburgh	11	0	.10 11/23/76
RI: Providence	17	0	.12 11/19/76
SC: Columbia	17	0	.24 11/21/76
SD: Pierre	15	0	.25 11/21/76
TN: Nashville	17	0	.24 12/1/76
TX: Austin	15	0	.31 11/29/76
El Paso	15	0	.15 11/22/76
VA: Lynchburg	7	0	.14 11/22/76
Norfolk	13	0	.08 11/24/76
WA: Seattle	11	0	.11 11/22/76
WI: Madison	13	0	.09 11/18/76

TABLE B-2

RESULTS OF PASTEURIZED MILK SAMPLES COLLECTED IN RESPONSE TO THE NUCLEAR TEST OF NOVEMBER 17, 1976, BY THE PEOPLE'S REPUBLIC OF CHINA

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
AK: Palmer	11/24	1.48 ± .12	17 ± 8	12 ± 9	4 ± 7	0.9 ± 0.8	4 ± 5
	12/2	1.42 ± .11	5 ± 8	2 ± 9	9 ± 7		
	12/10	1.45 ± .12	2 ± 8	8 ± 9	- 1 ± 7		
AL: Montgomery	12/3	1.51 ± .12	3 ± 8	5 ± 9	3 ± 7		
	12/9	1.54 ± .12	4 ± 8	- 2 ± 9	5 ± 7		
AR: Little Rock	11/24	1.45 ± .11	17 ± 8	6 ± 9	8 ± 7		
	12/3	1.44 ± .11	7 ± 8	0 ± 9	5 ± 7		
	12/6	1.51 ± .12	6 ± 8	1 ± 9	6 ± 7		
AZ: Phoenix	11/24	1.41 ± .11	4 ± 8	3 ± 9	2 ± 7		
	12/9	1.43 ± .11	3 ± 8	1 ± 9	2 ± 7		
CA: Los Angeles	11/24	1.44 ± .12	1 ± 8	6 ± 9	2 ± 7		
	12/2	1.39 ± .11	1 ± 8	- 2 ± 9	5 ± 7		
	12/9	1.43 ± .11	0 ± 8	11 ± 9	- 2 ± 7	1.2 ± 0.9	3 ± 5
Sacramento	11/24	1.51 ± .12	1 ± 8	4 ± 9	- 4 ± 6		
	12/2	1.53 ± .12	5 ± 8	6 ± 9	2 ± 7		
	12/9	1.57 ± .12	6 ± 8	2 ± 9	2 ± 7		
San Francisco	11/24	1.42 ± .11	0 ± 8	8 ± 9	0 ± 7		
	12/3	1.44 ± .11	2 ± 8	7 ± 9	4 ± 7		
	12/10	1.46 ± .12	6 ± 8	7 ± 9	1 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
CO: Denver	11/22	1.46 ± .12	5 ± 8	5 ± 9	4 ± 7		
	12/2	1.41 ± .11	7 ± 8	- 2 ± 9	1 ± 6		
	12/9	1.48 ± .12	7 ± 8	1 ± 9	3 ± 7		
CT: Hartford	11/26	1.47 ± .12	2 ± 8	1 ± 9	2 ± 7		
	12/3	1.34 ± .11	3 ± 8	14 ± 9	5 ± 7	4.0 ± 0.6	8 ± 5
	12/10	1.45 ± .12	6 ± 8	5 ± 9	2 ± 7		
CZ: Cristobol	12/7	1.45 ± .11	17 ± 8	7 ± 9	- 3 ± 7		
DC: Washington	12/3	1.48 ± .12	9 ± 8	6 ± 9	0 ± 7		
DE: Wilmington	11/24	1.49 ± .12	1 ± 8	8 ± 9	5 ± 7		
	12/1	1.39 ± .11	0 ± 8	7 ± 9	0 ± 7		
	12/9	1.46 ± .12	6 ± 8	4 ± 9	0 ± 7		
FL: Tampa	11/23	1.46 ± .12	28 ± 8	15 ± 10	5 ± 7	3.0 ± 1.0	1 ± 5
	12/2	1.53 ± .12	34 ± 9	- 4 ± 9	5 ± 7		
	12/9	1.44 ± .11	35 ± 9	2 ± 9	0 ± 7		
GA: Atlanta	11/24	1.39 ± .11	3 ± 8	5 ± 9	8 ± 7		
	12/2	1.34 ± .11	6 ± 8	6 ± 9	5 ± 7		
	12/10	1.39 ± .11	3 ± 8	7 ± 9	5 ± 7		
HI: Honolulu	11/26	1.39 ± .11	0 ± 8	- 3 ± 9	0 ± 6		
	12/2	1.37 ± .11	5 ± 8	2 ± 9	2 ± 7		
IA: Des Moines	11/24	1.41 ± .11	2 ± 8	8 ± 9	4 ± 7		
	12/2	1.43 ± .11	- 1 ± 8	7 ± 9	6 ± 7		
	12/9	1.35 ± .11	8 ± 8	5 ± 9	3 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
ID: Idaho Falls	12/3	1.44 ± .11	4 ± 8	5 ± 9	2 ± 7		
	12/10	1.47 ± .11	7 ± 8	7 ± 9	3 ± 7		
IL: Chicago	11/24	1.45 ± .11	12 ± 8	- 2 ± 9	7 ± 7		
	12/2	1.49 ± .12	7 ± 8	2 ± 9	9 ± 7		
	12/10	1.36 ± .11	3 ± 8	5 ± 9	2 ± 7		
IN: Indianapolis	11/24	1.39 ± .11	6 ± 8	7 ± 9	6 ± 7		
	12/2	1.45 ± .11	4 ± 8	0 ± 9	2 ± 7		
	12/6	1.41 ± .11	5 ± 8	- 2 ± 9	3 ± 6		
	12/9	1.50 ± .12	5 ± 7	10 ± 9	5 ± 7		
KS: Wichita	11/24	1.46 ± .12	5 ± 8	6 ± 9	1 ± 7		
	12/2	1.53 ± .12	8 ± 8	4 ± 9	1 ± 7		
	12/9	1.42 ± .11	1 ± 8	7 ± 9	6 ± 7		
KY: Louisville	11/24	1.48 ± .12	0 ± 8	10 ± 9	1 ± 7	3.1 ± 0.7	7 ± 5
	12/3	1.43 ± .12	3 ± 8	3 ± 9	3 ± 7		
	12/9	1.39 ± .11	- 1 ± 8	2 ± 9	1 ± 6		
LA: New Orleans	11/24	1.39 ± .11	8 ± 8	8 ± 9	5 ± 7		
	12/2	1.47 ± .12	4 ± 8	1 ± 9	1 ± 7		
	12/10	1.45 ± .11	5 ± 8	7 ± 9	- 1 ± 7		
MA: Boston	11/24	1.49 ± .12	8 ± 8	9 ± 9	8 ± 7		
	12/2	1.40 ± .11	9 ± 8	7 ± 9	0 ± 7		
	12/9	1.43 ± .12	6 ± 8	2 ± 9	2 ± 7		
MD: Baltimore	11/26	1.38 ± .11	1 ± 8	2 ± 9	2 ± 7		
	12/3	1.39 ± .11	10 ± 8	14 ± 9	- 1 ± 7	5.8 ± 0.7	10 ± 5
	12/10	1.44 ± .11	8 ± 8	5 ± 9	- 1 ± 7		
ME: Portland	11/26	1.36 ± .11	8 ± 8	8 ± 9	6 ± 7		
	12/2	1.49 ± .12	12 ± 8	- 1 ± 9	3 ± 7		
	12/6	1.26 ± .11	13 ± 8	3 ± 9	5 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
MI: Detroit	11/24	1.46 ± .12	11 ± 8	2 ± 9	6 ± 7		
	12/2	1.38 ± .11	3 ± 8	7 ± 9	2 ± 7		
	12/9	1.45 ± .12	5 ± 8	7 ± 9	1 ± 7		
Grand Rapids	11/24	1.38 ± .11	11 ± 8	5 ± 9	2 ± 7		
	12/3	1.43 ± .11	9 ± 8	3 ± 9	2 ± 7		
	12/10	1.47 ± .11	3 ± 8	- 7 ± 9	3 ± 6		
MN: Minneapolis	11/24	1.45 ± .12	8 ± 8	4 ± 9	5 ± 7		
	12/1	1.48 ± .12	1 ± 8	- 1 ± 9	3 ± 7		
	12/8	1.48 ± .12	6 ± 8	2 ± 9	1 ± 6		
MO: Kansas City	11/24	1.45 ± .12	9 ± 8	11 ± 9	4 ± 7	4.1 ± 0.6	4 ± 5
	12/2	1.49 ± .12	4 ± 8	8 ± 9	0 ± 7		
	12/9	1.41 ± .11	5 ± 8	13 ± 9	2 ± 7	3.9 ± 0.7	5 ± 5
St. Louis	11/26	1.50 ± .12	3 ± 8	1 ± 9	7 ± 7		
	12/2	1.51 ± .12	1 ± 8	10 ± 9	- 1 ± 7		
	12/8	1.40 ± .11	0 ± 8	- 1 ± 9	0 ± 7		
MS: Jackson	11/24	1.38 ± .11	5 ± 8	6 ± 9	6 ± 7		
	12/1	1.28 ± .11	11 ± 8	1 ± 9	2 ± 7		
	12/6	1.34 ± .11	4 ± 8	- 4 ± 9	3 ± 6		
MT: Helena	11/24	1.55 ± .12	12 ± 8	5 ± 9	10 ± 7	1.5 ± 0.7	4 ± 5
	12/3	1.55 ± .12	3 ± 8	- 2 ± 9	- 3 ± 6		
	12/6	1.49 ± .12	3 ± 8	- 4 ± 9	2 ± 7		
NC: Charlotte	11/24	1.33 ± .11	3 ± 8	10 ± 9	5 ± 7		
	12/6	1.41 ± .11	3 ± 8	2 ± 9	5 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
ND: Minot	11/26	1.43 ± .11	5 ± 8	7 ± 9	6 ± 7		
	12/2	1.52 ± .12	1 ± 8	8 ± 9	0 ± 7		
	12/10	1.50 ± .12	0 ± 8	6 ± 9	0 ± 7		
NE: Omaha	11/24	1.07 ± .11	3 ± 8	8 ± 9	3 ± 7		
	12/1	0.84 ± .10	2 ± 8	7 ± 9	2 ± 6		
	12/10	1.32 ± .11	2 ± 8	- 2 ± 9	2 ± 6		
NH: Manchester	11/24	1.47 ± .12	5 ± 8	11 ± 9	- 1 ± 7	2.5 ± 0.9	3 ± 5
	12/3	1.40 ± .11	8 ± 8	10 ± 9	1 ± 7		
	12/10	1.62 ± .12	6 ± 8	12 ± 9	0 ± 7		
NJ: Trenton	11/24	1.43 ± .11	1 ± 8	- 1 ± 9	8 ± 7		
	12/2	1.44 ± .11	5 ± 8	1 ± 9	- 1 ± 7		
	12/9	1.38 ± .11	- 1 ± 8	5 ± 9	1 ± 7		
NM: Albuquerque	11/24	1.38 ± .11	9 ± 8	0 ± 9	2 ± 7		
	12/2	1.51 ± .12	2 ± 8	0 ± 9	4 ± 7		
	12/9	1.54 ± .12	2 ± 8	- 2 ± 9	2 ± 7		
NV: Las Vegas	12/1	1.39 ± .11	8 ± 8	- 3 ± 9	0 ± 6		
	12/2	1.62 ± .12	1 ± 8	- 3 ± 9	0 ± 6		
	12/10	1.49 ± .12	3 ± 8	1 ± 9	5 ± 7		
NY: Buffalo	11/24	1.45 ± .12	4 ± 8	7 ± 9	7 ± 7		
	12/10	1.47 ± .12	3 ± 8	5 ± 9	5 ± 7		
New York	11/24	1.36 ± .11	5 ± 8	6 ± 9	- 2 ± 6		
	12/6	1.35 ± .11	- 1 ± 8	- 1 ± 9	3 ± 7		
Syracuse	12/6	1.41 ± .11	3 ± 8	- 9 ± 9	5 ± 6		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
OH: Cincinnati	11/24	1.44 ± .11	2 ± 8	2 ± 9	8 ± 7		
	12/3	1.54 ± .12	8 ± 8	3 ± 9	1 ± 7		
	12/9	1.50 ± .12	- 1 ± 8	1 ± 9	4 ± 7		
Cleveland	12/2	1.41 ± .11	7 ± 8	- 1 ± 9	3 ± 7		
	12/8	1.41 ± .11	2 ± 8	0 ± 9	1 ± 7		
OK: Oklahoma City	11/24	1.45 ± .11	5 ± 8	5 ± 9	3 ± 7		
	12/2	1.49 ± .12	10 ± 8	5 ± 9	- 2 ± 7		
	12/6	1.47 ± .12	2 ± 8	4 ± 9	4 ± 7		
	12/9	1.45 ± .11	2 ± 8	- 2 ± 9	3 ± 7		
OR: Portland	11/24	1.53 ± .12	2 ± 8	4 ± 9	5 ± 7		
	12/2	1.45 ± .11	7 ± 8	4 ± 9	4 ± 7		
PA: Philadelphia	11/26	1.44 ± .11	5 ± 8	5 ± 9	- 1 ± 7		
	12/3	1.42 ± .11	3 ± 8	11 ± 9	0 ± 7	5.0 ± 0.7	8 ± 5
	12/10	1.55 ± .12	0 ± 8	10 ± 9	- 1 ± 7		
Pittsburgh	11/24	1.49 ± .12	5 ± 8	- 1 ± 9	8 ± 7		
	12/3	1.46 ± .12	7 ± 8	4 ± 9	0 ± 7		
	12/10	1.50 ± .12	3 ± 8	2 ± 9	1 ± 7		
PR: San Juan	11/26	1.53 ± .12	9 ± 8	- 3 ± 9	1 ± 7		
	12/2	1.46 ± .12	9 ± 8	4 ± 9	1 ± 7		
	12/8	1.44 ± .11	7 ± 8	8 ± 9	- 4 ± 6		
RI: Providence	11/24	1.52 ± .12	13 ± 8	11 ± 9	7 ± 7	4.4 ± 0.9	4 ± 5
	12/2	1.50 ± .12	8 ± 8	6 ± 9	3 ± 7		
	12/9	1.43 ± .11	7 ± 8	1 ± 9	5 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
SC: Charleston	11/23	1.40 ± .11	15 ± 8	4 ± 9	8 ± 7		
	12/2	1.45 ± .11	11 ± 8	3 ± 9	- 4 ± 6		
	12/6	1.35 ± .11	0 ± 8	7 ± 9	2 ± 7		
	12/9	1.43 ± .11	4 ± 8	1 ± 9	- 3 ± 6		
SD: Rapid City	11/26	1.36 ± .11	4 ± 8	- 7 ± 9	0 ± 6		
	12/3	1.42 ± .11	- 1 ± 8	2 ± 9	1 ± 6		
TN: Chattanooga	11/24	1.37 ± .11	10 ± 8	20 ± 10	3 ± 7	5.4 ± 0.8	3 ± 5
	12/3	1.43 ± .11	3 ± 8	3 ± 9	5 ± 7		
	12/6	1.49 ± .12	12 ± 8	- 1 ± 9	3 ± 7		
Knoxville	11/24	1.40 ± .11	9 ± 8	18 ± 9	18 ± 7	4.0 ± 1.0	6 ± 5
	12/15	1.53 ± .12	2 ± 8	0 ± 9	6 ± 7		
Memphis	11/26	1.39 ± .11	8 ± 8	11 ± 9	- 2 ± 7	2.6 ± 0.6	5 ± 5
	12/2	1.43 ± .11	9 ± 8	5 ± 9	1 ± 7		
	12/7	1.34 ± .11	2 ± 8	10 ± 9	- 2 ± 6		
	12/9	1.43 ± .11	7 ± 8	- 7 ± 9	0 ± 6		
TX: Austin	11/24	1.36 ± .11	10 ± 8	10 ± 9	17 ± 7	2.8 ± 0.6	7 ± 5
	12/2	1.50 ± .12	2 ± 8	5 ± 9	2 ± 7		
	12/9	1.34 ± .11	3 ± 8	3 ± 9	3 ± 7		
Dallas	11/23	1.50 ± .12	11 ± 8	8 ± 9	5 ± 6		
	11/30	1.39 ± .11	7 ± 8	2 ± 9	5 ± 7		
	12/10	1.29 ± .11	- 2 ± 8	4 ± 9	1 ± 6		
UT: Salt Lake City	11/24	1.52 ± .12	8 ± 8	9 ± 9	1 ± 7		
	12/2	1.52 ± .12	5 ± 8	3 ± 9	0 ± 7		
	12/6	1.32 ± .11	7 ± 8	0 ± 9	3 ± 7		

TABLE B-2 - CONTINUED

Location	Date Collected	K g/liter ± 2-Sigma Counting Error	Radionuclide Concentration pCi/liter ± 2-Sigma Counting Error (a)				
			^{137}Cs	^{140}Ba	^{131}I	^{90}Sr	^{89}Sr
VA: Norfolk	11/26	1.48 ± .12	4 ± 8	2 ± 9	4 ± 7		
	12/3	1.50 ± .12	5 ± 8	9 ± 9	2 ± 7		
	12/9	1.45 ± .12	7 ± 8	7 ± 9	0 ± 7		
VT: Burlington	11/22	1.37 ± .11	6 ± 8	5 ± 9	7 ± 7		
	11/27	1.44 ± .11	- 2 ± 8	- 1 ± 9	2 ± 6		
	12/3	1.41 ± .11	5 ± 8	5 ± 9	3 ± 7		
	12/10	1.41 ± .11	10 ± 8	6 ± 9	3 ± 7		
WA: Seattle	12/2	1.42 ± .11	8 ± 8	6 ± 9	2 ± 7		
	12/9	1.43 ± .11	11 ± 8	2 ± 9	0 ± 7		
Spokane	11/24	1.44 ± .12	8 ± 8	10 ± 9	5 ± 7	2.8 ± 1.1	0 ± 5
	12/3	1.39 ± .11	5 ± 8	7 ± 9	4 ± 7		
	12/8	1.32 ± .11	7 ± 8	0 ± 9	- 2 ± 6		
WI: Milwaukee	11/24	1.56 ± .12	4 ± 8	0 ± 9	6 ± 7		
	12/1	1.47 ± .12	5 ± 8	2 ± 9	4 ± 7		
	12/9	1.38 ± .11	3 ± 8	0 ± 9	3 ± 7		
WV: Charleston	11/22	1.40 ± .11	13 ± 8	4 ± 9	10 ± 7		
WY: Laramie	11/24	1.32 ± .11	2 ± 8	8 ± 9	- 1 ± 6		
	12/3	1.38 ± .11	6 ± 8	5 ± 9	0 ± 7		
	12/9	1.39 ± .11	1 ± 8	11 ± 9	- 4 ± 6	2.4 ± 1.0	3 ± 5

(a) Negative values may be obtained when the actual concentration is at or near zero due to the statistical distribution of net counting results both positive and negative around zero.

APPENDIX C

Additional Information on Individual and Population Dose Calculations

This appendix provides details related to the dose calculation presented in this report.

Correction for Background for ^{131}I in Milk and Integrated Milk Concentration by Station

To obtain net milk concentrations of ^{131}I, a background milk concentration of ^{131}I was established for each station by averaging the milk concentrations reported for the August and September 1976 milk samples. This average was subtracted from the reported milk concentrations (Appendix A) for the integration period. These net milk concentrations were plotted for each station and extrapolated to November 12, 1976. The resulting curves were integrated with a planimeter to obtain the net integrated milk concentration for each station. These net integrated milk concentrations are listed in Table C-1.

Table C-1: Integrated Milk Concentration by Station for the September Event

Location	Integrated Milk Concentration $\left(\frac{C_j}{pCi^{131}I\text{-}d/\ell}\right)$
Montgomery, AL	260
Palmer, AK	126
Phoenix, AZ	291
Little Rock, AR	448
Los Angeles, CA	79
San Francisco, CA	103
Sacramento, CA	43
Denver, CO	294
Hartford, CT	1797
Wilmington, DE	1460
Washington, DC	1454
Tampa, FL	387
Atlanta, GA	217
Honolulu, HI	203
Idaho Falls, ID	86
Chicago, IL	39
Indianapolis, IN	83
Des Moines, IA	25
Wichita, KS	44
Louisville, KY	159
New Orleans, LA	331
Portland, ME	418
Baltimore, MD	1845

Table C-1: Continued

Boston, MA	473
Grand Rapids, MI	322
Detroit, MI	99
Minneapolis, MN	675
Jackson, MS	572
Kansas City, MO	76
St. Louis, MO	77
Helena, MT	283
Omaha, NB	33
Las Vegas, NV	100
Manchester, NH	378
Trenton, NJ	1245
Albuquerque, NM	259
Buffalo, NY	148
New York, NY	1670
Syracuse, NY	32
Charlotte, NC	352
Minot, ND	193
Cincinnati, OH	7
Cleveland, OH	103
Oklahoma City, OK	150
Portland, OR	55
Pittsburgh, PA	1041
Philadelphia, PA	1406
Providence, RI	641
Charleston, SC	452
Rapid City, SD	176
Knoxville, TN	279
Chattanooga, TN	408
Memphis, TN	191

Table C-1: Continued

Austin, TX	273
Dallas, TX	53
Salt Lake City, UT	20
Burlington, VT	101
Norfolk, VA	445
Seattle, WA	70
Spokane, WA	61
Charleston, WV	301
Milwaukee, WI	10
Laramie, WY	40

Special Weighting for New York State Integrated Milk Concentration

Where there was more than one sampling station per state, the integrated milk concentrations for the stations were arithmetically averaged and applied for the state except for New York. There are milk sampling stations at Buffalo, New York City, and Syracuse. The integrated milk concentrations for these stations were:

Station	Integrated Milk Concentration pCi-d/ℓ
Buffalo, NY	148
New York, NY	1670
Syracuse, NY	32

The New York City station is more than 10 times higher than either of the other stations. For New York State, the following weighting procedure was used:

1. The populations of the "large metropolitan areas"* in New York State were summed as follows.

Area	1970 Population
Albany-Schenectady-Troy, NY	722,000
Binghamton, NY - PA	303,000
Buffalo, NY	1,349,000
Nassau-Suffolk, NY	2,553,000
New York, NY	9,019,000
Rochester, NY	883,000

*See Table 21, Reference 7

Syracuse, NY		637,000
Utica-Rome, NY		341,000
	Total	15,807,000

2. The ratio of New York City population to the total "large metropolitan area" population was calculated; i.e., Ratio = 9019/15807 = 0.571
3. The integrated milk concentrations for Buffalo and Syracuse were averaged to obtain 90 pCi-d/ℓ.
4. It was assumed that 57.1 percent of the people in New York State drank milk of the integrated concentration of New York City (1670 pCi-d/ℓ) and that 42.9 percent of the people drank milk of the average integrated concentration of Buffalo and Syracuse (90 pCi-d/ℓ). This technique yielded a New York State integrated milk concentration of 992 pCi-d/ℓ.

Estimation of Milk Consumption by State for Integration Period of October 1 - November 12, 1976.

Milk production data for October 1976 was obtained from USDA (6) as 9685 Mlbs. This milk production was multiplied by the ratio 43 days/31 days to estimate the milk production for the total integration period as 13,434 Mlbs. It was assumed that all of this milk was or would be consumed in the U. S. The 1972 population data from Table 13 of Reference 7 was used to determine the fraction of the U. S. population in each state. These fractions were multiplied

by the total milk production of 13,434 Mlbs. to obtain the estimated milk consumption for each state. This data is shown in Table C-2.

Table C-2: Estimated Milk Consumption

State	1972 State Population (in thousands)	Fraction of 1972 U. S. Population	Estimated Milk Consumption, Mlbs
Alabama	3,510	0.0169	226
Alaska	325	0.0016	21
Arizona	1,945	0.0093	125
Arkansas	1,978	0.0095	128
California	20,468	0.0983	1,320
Colorado	2,357	0.0113	152
Connecticut	3,082	0.0148	199
Delaware	565	0.0027	36
DC	748	0.0036	48
Florida	7,259	0.0349	468
Georgia	4,720	0.0227	305
Hawaii	809	0.0039	52
Idaho	756	0.0036	49
Illinois	11,251	0.0537	721
Indiana	5,291	0.0254	341
Iowa	2,883	0.0138	186
Kansas	2,258	0.0108	146
Kentucky	3,299	0.0158	213
Louisiana	3,720	0.0179	240
Maine	1,029	0.0049	66
Maryland	4,056	0.0195	262
Massachusetts	5,787	0.0278	373
Michigan	9,082	0.0436	586
Minnesota	3,896	0.0187	251
Mississippi	2,263	0.0109	146
Missouri	4,753	0.0228	307
Montana	719	0.0035	46

Table C-2: Continued

Nebraska	1,525	0.0073	98
Nevada	527	0.0025	34
New Hampshire	771	0.0037	50
New Jersey	7,367	0.0354	475
New Mexico	1,065	0.0051	69
New York	18,366	0.0882	1,185
North Carolina	5,214	0.0250	336
North Dakota	632	0.0030	41
Ohio	10,783	0.0518	696
Oklahoma	2,634	0.0126	170
Oregon	2,182	0.0105	141
Pennsylvania	11,926	0.0573	769
Rhode Island	968	0.0046	62
South Carolina	2,665	0.0128	172
South Dakota	679	0.0033	44
Tennessee	4,031	0.0194	260
Texas	11,649	0.0559	752
Utah	1,126	0.0054	73
Vermont	462	0.0022	30
Virginia	4,764	0.0229	307
Washington	3,443	0.0165	222
West Virginia	1,781	0.0086	115
Wisconsin	4,520	0.0217	292
Wyoming	345	0.0017	22
Total U. S.	208,232		

Estimation of Food Group Fractions and Marketing-to-Consumption Delay Times

Table C-3 lists USDA milk utilization data for 1975 (9). A verbal estimate of the delay times between marketing and consumption of the dairy products was obtained from USDA personnel (8). These times are also shown in Table C-3. Based on a review of this data, it was decided that sufficient precision would be maintained in the calculations if two food groups were established. The food groups established are described in Table C-4.

Table C-3: Milk Utilization for 1975 and Estimated Marketing-to-Consumption Times for Various Milk Products[8, 9]

Product	1975 Usage, Mlbs	Estimated Marketing-to-Consumption Time, d
Manufactured Products		
1. Creamery butter	19,603	14 d min., 30 d average
2. Cheese	24,080	30 d min., 1-6 mo. average
3. Cottage cheese	1,049	1 week
4. Evaporated and dry whole milk	3,008	6 mo. average
5. Ice cream & other frozen dairy products	12,042	14 d min., 1-6 mo. average
6. Other manufactured products	821	
Fluid Products		
7. Sold by dealers & producers	51,400	1 day
8. Used for human consumption where produced	1,654	1 day
9. Residual	406	
	114,063	

Table C-4: Food Groups for Population Dose Calculations

Food Group Description	Fraction for 1975 Usage	Estimated Marketing-to-Consumption time, d
1. Includes creamery butter, cheese, ice cream, canned and condensed milk, dry milk, and other manufactured products (includes items 1, 2, 4, 5, & 6 for a total of 59,554 Mlbs)	0.52	30 d
2. Includes cottage cheese, and all fluid milk products (includes items 3, 7, 8, & 9 for a total of 54,509 Mlbs)	0.48	1 d

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