0009928

TSP **TECHNICAL STEERING PANEL**
OF THE HANFORD ENVIRONMENTAL
DOSE RECONSTRUCTION PROJECT

QUESTIONS or COMMENTS

If you want to be added to the mailing list to receive written material or if you have comments or questions about dose reconstruction, call this toll-free number

1-800-545-5581

or write to

HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT
Washington Department of Ecology
Office of Nuclear and Mixed Waste
Mail Stop PV-11
Olympia, WA 98504

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Office of Nuclear and Mixed Waste
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Initial Hanford Radiation Dose Estimates

Inside:

How radiation reached people. 5,12,15
How much radiation people received. 9,13,16
Where to get more information. 19
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This booklet provides the public with a summary of the Phase I results of the Hanford Environmental Dose Reconstruction Project. The purpose of the Project is to estimate the radiation doses that people may have received from the release of radioactive material from Hanford.

This booklet

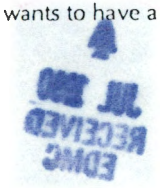
- explains how the project is conducted
- explains how radiation reached people
- helps you identify a range of doses people like you might have received.

This booklet will not

- provide final radiation dose estimates
- provide your specific, individual dose estimate
- estimate the health risk associated with any exposure you may have received.

To make this booklet useful to the public, we wrote it in general, rather than detailed, terms.

The details of the Project work are well documented in technical reports that are available to any reader who wants to have a more in-depth explanation.



This study addresses Hanford releases from many years ago. The results do not suggest practices today.

PUBLIC INVITED TO REVIEW REPORTS

Project reports and other materials documenting dose reconstruction work are publicly available at:

WASHINGTON	Yakima	Yakima Public Library
	Walla Walla	Walla Walla Public Library
	Seattle	University of Washington Government Publications
	Spokane	Gonzaga University
	Richland	Department of Energy, Richland Operations Public Reading Room
OREGON	Pendleton	Pendleton Public Library
	Astoria	Astoria Public Library
	Portland	Portland State University Science Library

Several organizations are cooperating to carry out the Hanford Environmental Dose Reconstruction Project.

An independent, 18-member Technical Steering Panel directs the work. Experts in various technical fields, as well as representatives of Oregon and Washington state governments, regional Indian tribes, and the public are members of the panel.

Battelle scientists at Pacific Northwest Laboratory in Richland, Washington, perform the study under the direction of the Technical Steering Panel.

The U.S. Department of Energy funds the work, but has no technical involvement and makes no technical decisions on the project.

PUBLIC INFORMATION MEETINGS ON PRELIMINARY DOSE ESTIMATES

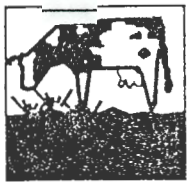
The Technical Steering Panel will host public information meetings in Washington and Oregon.

Panel members and scientists who made the preliminary dose estimates will be at these meetings to talk with the public and answer questions. Each meeting is from 7 to 9 p.m.

WASHINGTON		
Tri-Cities	Tuesday August 21	Pasco Red Lion 2525 N. 20th
Walla Walla	Wednesday August 22	Walla Walla Community College China Pavillion 500 Tausic Way
Seattle	Monday August 27	Seattle Center House Conference Center A 305 Harrison St.
Yakima	Tuesesday August 28	County Extension Service 128 N. 2nd Street Rooms 231, 232
Spokane	Wednesday August 29	Spokane Community College N. 1810 Green Street
OREGON		
Pendleton	Thursday August 23	Vert Memorial Building S.W. 4th & Dorion
Portland	Thursday August 30	Portland Building 1120 S.W. 5th Ave. Meeting Room C

PRELIMINARY RESULTS AT A GLANCE

Scientists achieved their primary goal: to develop a dose estimation method that works and that will produce increasingly reliable results as it is refined. When testing their methods, scientists made preliminary findings about possible doses from the release of radioactive materials from Hanford.



The most important radiation exposure pathway was milk produced downwind of Hanford.

The estimated radiation dose ranges given in this booklet focus on 90% of the study population. It is possible that approximately 5% of the population received doses that were higher than reported in this booklet and 5% received doses that were lower. Radiation doses for these people are not addressed in this booklet because of the uncertainty of the preliminary estimates. These doses are addressed in the technical reports.

- The largest doses are from iodine-131 released in the 1940s.
- The most important radiation exposure pathway was milk produced by cows on pasture downwind of Hanford.
- Infants and young children who drank milk from cows that ate pasture grass in counties downwind from Hanford are likely to have received the highest doses from radioactive iodine. This group contained about 1400 people. Doses for most of the people in this group ranged from about 15 rad to about 650 rad to the thyroid. The middle value radiation dose was about 70 rad.
- About 90% of the study population during 1944-1947 may have received a radiation dose to the thyroid of 15 rad or less. The thyroid absorbs radioactive iodine, which results in a thyroid dose.
- Vegetables grown downwind of Hanford also contributed to doses. More information must be analyzed before even tentative dose estimates can be made for this pathway.
- Radiation doses from releases to the Columbia River range from 5 millirem EDE to 180 millirem EDE for most of the people in the study area (primarily Richland, Kennewick, and Pasco).

ABOUT THE STUDY

For more than 40 years, the U.S. government made plutonium for nuclear weapons at the Hanford Site in southeastern Washington State. Radioactive materials were released to both the air and water from Hanford.

The dose reconstruction Project is a multi-year scientific study to estimate the radiation doses the public may have received as a result of these releases. Scientists working on the study will determine how much radioactive material was released and how people near Hanford could have been exposed to this material.

The study began in 1988. During the first phase, scientists began to develop and test methods for reconstructing the radiation doses. To do this, they focused on one radioactive material (iodine-131) released to the air from 1944 through 1947 and those released into the Columbia River from 1964 through 1966.

Releases to the air from 1944 through 1947 consisted primarily of iodine-131. These releases occurred when fuel from the Hanford reactors was dissolved in acid to chemically extract plutonium.

Releases to the river from 1964 through 1966 occurred when river water was pumped through Hanford reactors to cool them. A number of radioactive materials were released at that time. Several are important to human exposure.

Phase I has just been completed. This booklet contains some of the preliminary results.

Probably the most important fact for the reader to keep in mind is that the results are preliminary. This means the material is incomplete and subject to change. The Project will continue for at least another three years. The final results will undoubtedly be different, primarily because scientists will continue to collect and analyze data. The initial results provide general information only and should not be used as the basis for any decisions or speculation about possible health effects.

Also, in response to a request from the Technical Steering Panel, Secretary of Energy James Watkins ordered declassification of all past Hanford documents relevant to dose reconstruction. The declassification process is under way. When declassified, these documents will be publicly available.

Q How can I get more information about how Hanford radiation may have affected my health?

If you are concerned about the dose estimates in this booklet or would like more information, call the Technical Steering Panel's toll-free hotline: 1-800-545-5581. You can also contact health officials in Washington at 1-800-525-0127 and in Oregon at 503-229-5797.

What's next?

Now—Materials available for review by public and scientists.

August 1990—Washington and Oregon, public information meetings on Phase I dose estimates and work.

1991 through 1994—Phases II, III, and IV, refine models and data, consider larger geographical study area and other time periods as needed.

1993 —Thyroid study results available from the Centers for Disease Control.

1994—Final dose estimates available.

ECHNICAL TERMS

Dose reconstruction is a echnical subject. We annot discuss it without sing technical terms.

Ve have tried to keep uch terms to a minimum o everyone who is nterested in the study can se this booklet.

When technical terms are ecessary, we have tried o provide brief xplanations of these rms in "boxes" like this ne beside the text.

eaders with technical ackgrounds can skip ese; other readers will nd them useful in nderstanding the ideas resented.

Q *Are people at risk today?*

No. There is little or no radiation exposure today from releases that occurred in the 1940s, 1950s, and 1960s. Most of the radiation dose people received in the past was caused by iodine-131. The iodine-131 decayed away in a few months after the largest quantities were released in the 1940s.

Operations at Hanford are now carefully monitored. Each year the Hanford Site Environmental Report tells of any releases during the year and estimates the maximum dose anyone could have received from Hanford.

The report for 1988 (the most recent year for which information is available) shows that the largest dose any member of the public could have received from Hanford was 0.08 millirem EDE. (For comparison, average natural radiation in this part of Washington is about 300 millirem EDE per year.) Most scientists and health professionals agree that a 0.08 millirem EDE dose does not present a threat to workers, the public, or the environment.

Agricultural products are carefully monitored today. Products grown near Hanford do not contain radioactive materials attributable to Hanford.

Q *How can we be sure the federal government did not withhold important information for the study? After all, aren't many of their records classified?*

Several members of the Technical Steering Panel have security clearances. That allows them to verify classified Hanford data to make sure that all information needed for dose reconstruction is used. All pertinent historical information, whether classified or not, will be investigated.

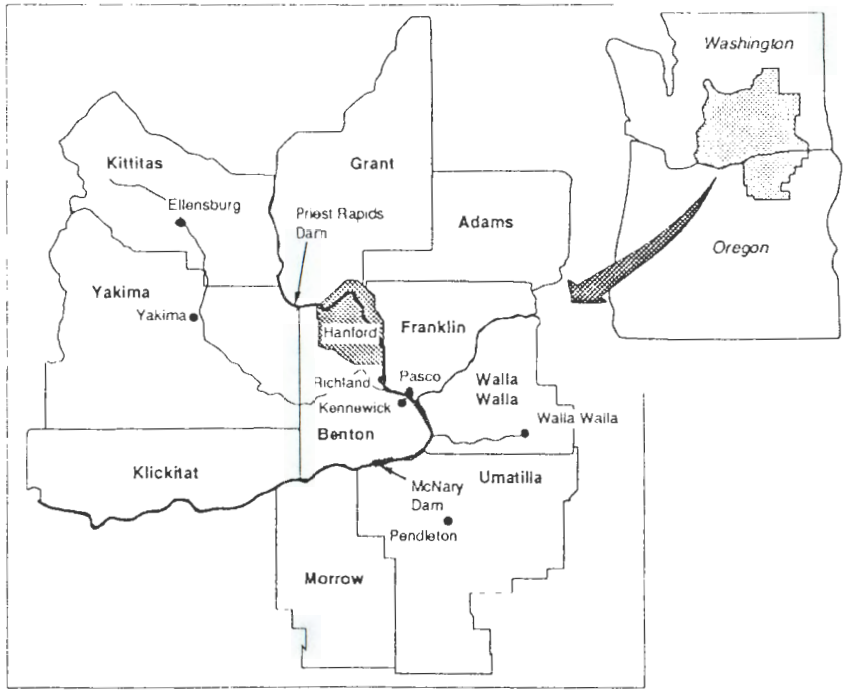
STUDY AREA AND POPULATION

In Phase I, scientists made preliminary estimates of possible radiation doses for people who lived in the ten Washington and Oregon counties closest to Hanford. Although the Hanford Site is within the study area, doses that occurred on the Site are not a part of Phase I estimates.

People who lived in the ten-county study area from 1944 through 1947 were studied for exposure from contaminated air and milk. The population in the area ranged from about 260,000 in 1944 to 310,000 in 1947. In this booklet, the 1945 population of 270,000 is used to discuss the results because the largest releases occurred that year.

People who lived in the study area from 1964 through 1966 were studied for exposure from contaminated water and fish.

The dose estimation work was begun to address concerns about impacts from more than 40 years of nuclear operations at the Hanford Site.



MEASURING RADIATION

When radiation penetrates the human body, the person who is exposed is said to have received a radiation dose. Two terms are used in this booklet to describe these radiation doses.

The rad expresses the amount of energy deposited by radiation in the body. The rad is a basic unit of radiation dose, but its use is limited because different types of radiation have different effects on different parts of the body.

A second measure of dose, the rem effective dose equivalent (rem EDE), is used to account for the fact that a radiation dose to one part of the body does not have the same potential health impact as a dose to another part. The rem EDE puts different types of radiation doses on an equivalent basis in terms of the potential health risk.

To see how these dose measures are related, we can look at one of the radioactive materials being studied in the Project. Iodine-131 entering the human body is absorbed by the thyroid. When the radioactive iodine decays, it deposits energy in the thyroid. This energy would be expressed as rad. One rad of dose to the thyroid is equal to about 1/30 rem EDE.

In this booklet, we have given iodine-131 doses to the thyroid in rad, while doses from other radioactive material are given in rem EDE. It is technically possible to convert rad to rem EDE. Project scientists did not do so for several reasons. First, use of different units to measure dose from different types of radioactive material is standard scientific practice. Second, standard factors to convert numbers from one unit to another are uncertain. Finally, as rad is converted to rem EDE, the numbers become smaller (although the dose does not). For example, 30 rad becomes 1 rem EDE.

The doses from eating fish from the Columbia River depend on the species of fish, how much was eaten, and where the fish were caught.

Columbia River fish that could have contained radioactive materials included whitefish, spiny ray, catfish, bass, trout, and sturgeon. Migrating fish, such as salmon and steelhead, pick up very little contamination as they move upstream.

People who consumed more than 20 meals per year of fish caught upstream from Hanford and got their drinking water from the Richland city water supply would have received a radiation dose averaging about 140 millirem EDE.

Q *Did the radiation affect the health of people who lived near Hanford?*

It is difficult to say whether radiation from Hanford caused a specific health effect, such as cancer, in any one group. This is because so many factors, including other sources of radiation exposure, contribute to disease.

The Centers for Disease Control and the Fred Hutchinson Cancer Research Center have begun a study to look for health effects from the iodine-131 releases in the 1940s. Scientists from this study are using preliminary dose estimates from the Project. The health effects study will be complete in 1993. Other health effects studies are not currently planned. The dose estimates may help identify the need for further studies.

Q *Will the final dose estimates be different from the Phase I estimates?*

Yes. We believe the final dose estimates will be more accurate than these preliminary estimates. A more refined computer model and data will help scientists make the ranges of the final dose estimates more accurate. In other words, the final estimates will give people a better idea of how likely they were to have received a certain amount of radiation dose.

Q *How much radiation dose did people get from exposure to contaminated milk?*

People who lived in the ten-county area from 1944 to 1947 could have received a wide range of doses. The doses depended on several things: where people lived, how old they were, where their milk came from, and what the cows that produced their milk ate.

Highest doses were to infants and young children drinking milk from cows on pasture in north Franklin County. There are about 1400 people in this group. Doses for most of this group range from 15 rad to 650 rad. The middle or median dose is about 70 rad. Adults who lived west of Hanford and got their milk from cows eating stored feed from these areas would have the lowest doses.

About 95% of the 270,000 people who lived in the ten county area during this time would have received a dose less than 33 rad. The remaining 5% of the people received doses greater than this value. You can get more information about dose ranges from contaminated milk by studying the figures on page 9 of this booklet.

Q *How much radiation dose did people get from exposure to contaminated river water or fish?*

Doses people could have received from radioactive materials released to the Columbia River from Hanford during 1964 through 1966 were much less than doses from contaminated milk during the 1940s.

In the Phase I study area, only Pasco, Richland, and Kennewick got their city water from the river. The middle or median radiation doses from drinking water in these cities ranged from about 10 millirem EDE in Kennewick to about 35 millirem EDE in Richland.

THE MILK PATHWAY

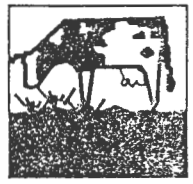
Phase I work on releases to the air dealt primarily with iodine-131. Scientists believe iodine-131 accounted for more than 90% of radiation doses to residents of the ten-county area nearest Hanford from 1944 through 1947.

Iodine-131 is a radioactive material that was released in large quantities from Hanford. It has a relatively short half-life of eight days. Most of what you read in this booklet relates iodine-131 exposure to the thyroid gland. This is because about 30% of the iodine-131 that is inhaled or ingested collects in the thyroid.

Iodine-131 was released to the air, carried by wind, deposited on plants, and eaten by animals and people. The iodine-131 eaten by a cow enters the milk that the cow produces. When humans drink the milk, the iodine in the milk collects in the thyroid.

Pinpointing people's source of milk was an important part of estimating doses. Milk from a cow that ate pasture grass in the downwind area would contain higher levels of iodine-131 than milk from cows pastured in less contaminated areas. Milk from cows that ate stored feed would also contain lower levels of contamination. The pathway narrows still further to focus on family cows. Their milk is the primary pathway because it was consumed immediately by the cows' owners or their neighbors. In contrast, milk produced commercially might be diluted at the creamery by milk from other, less contaminated, areas, resulting in a reduced dose.

The map on the following page shows the location of most of the dairies that supplied milk to the study area in the 1940s. The shaded part is the downwind area.

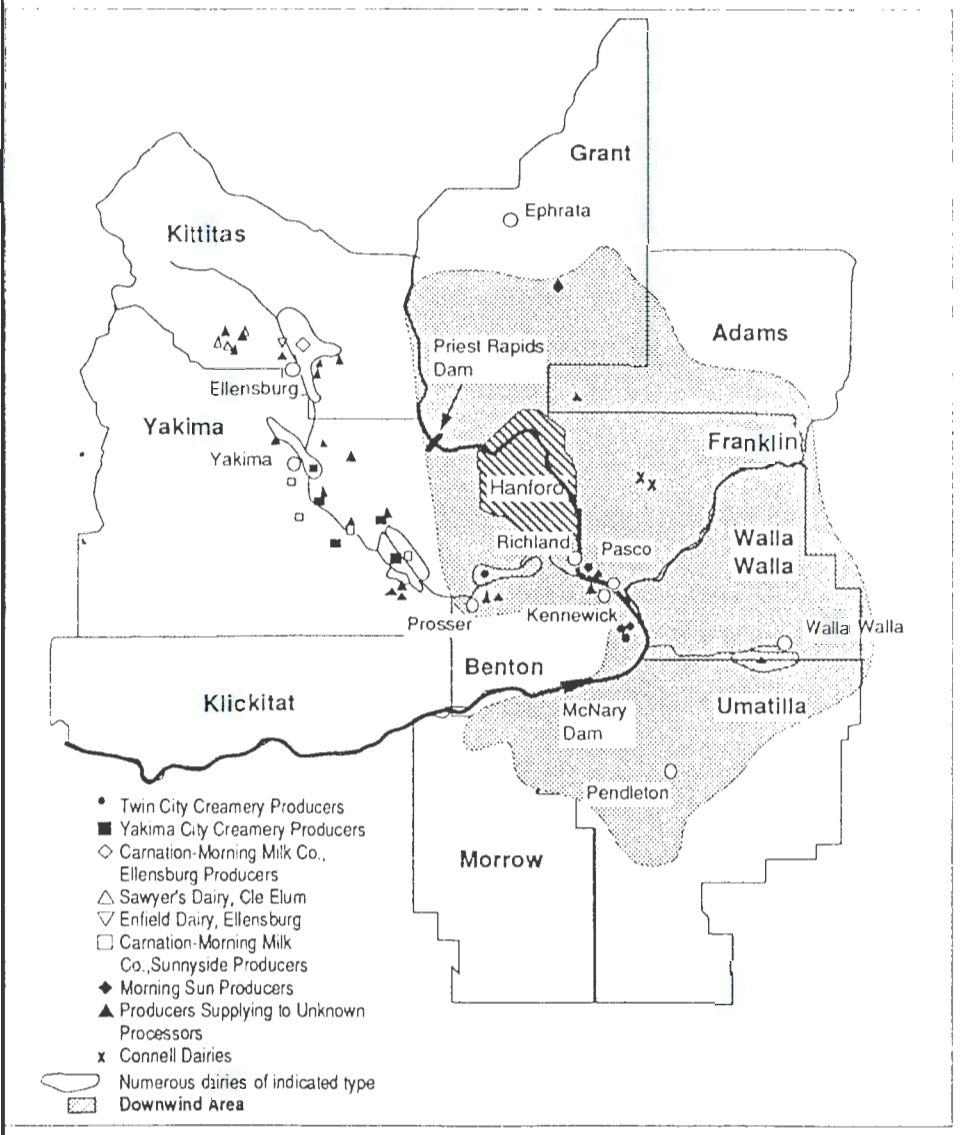


Half-life—The length of time in which any radioactive substance will lose one half of its radioactivity.

Family cow—Cow pastured in the study area in the 1944-1947 period whose milk was usually consumed by the cow's owner or by neighbors.

Downwind—In dose reconstruction, the geographic areas into which wind carries radioactive materials.

These commercial dairies supplied milk in the 1940s. Downwind areas shaded here are those where more radioactive materials were usually deposited. Iodine-131 could have been deposited on pasture grass cows ate, thus contaminating their milk.

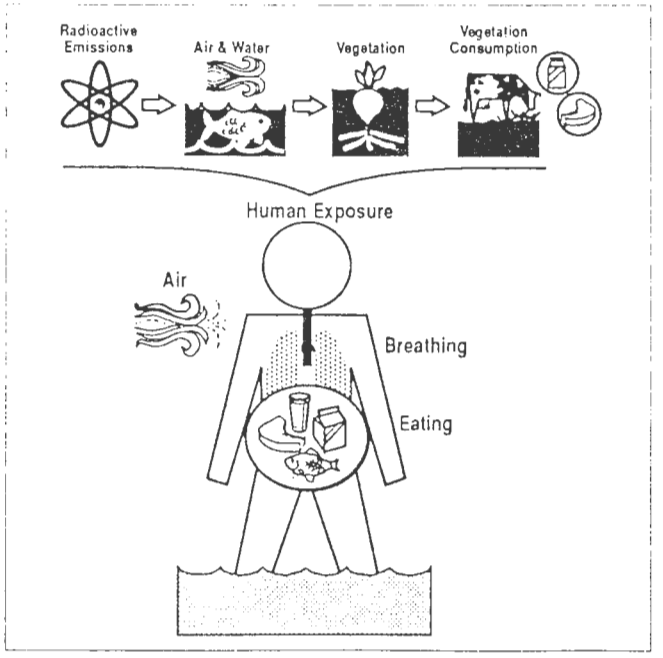


Q *How did radiation from Hanford reach people?*

Beginning in 1944, radioactive materials were released from Hanford as plutonium was produced for nuclear weapons. If you lived in the area surrounding Hanford, you could have been exposed to radiation from two kinds of radioactive materials: those released to the air (primarily radioactive iodine-131) or those released to the Columbia River.

You could have come in contact with iodine-131 by ingesting contaminated milk or food or by breathing air containing iodine-131. Drinking fresh milk was the major source of radiation exposure from airborne iodine-131.

You could also have been exposed to radioactive material by eating fish or drinking water from the Columbia River or by working or playing in or near the river.



QUESTIONS ABOUT THE STUDY

Q *How much and when was radioactive material released from Hanford?*

Curie— A unit of measure used to express the amount of radioactive material present. It measures the number of atoms of a particular radioactive element that decay each second. One curie is 37 billion atoms undergoing radioactive decay each second.

About 400,000 curies of iodine-131 were released to the air between 1944 and 1947. The radioactive materials in the water that accounted for most of the radiation doses from 1964 through 1966 were phosphorus-32, neptunium-239, zinc-65, arsenic-76, manganese-56, copper-64, sodium-24, and chromium-51. The amounts of these materials released to the river from 1964 through 1966 ranged from a few curies per day for phosphorus-32 to thousands of curies per day for sodium-24.

The first Hanford facilities, including the first three reactors and two plants that extracted plutonium and uranium, were operating in 1944 and 1945. Through 1963, six new reactors and three new extraction plants began operating. By 1972, all of the reactors that used river water directly for cooling were shut down.

The PUREX plant shut down in 1972 and restarted in 1984. It is currently on standby.

Q *How were the time periods chosen for estimating preliminary doses?*

The years 1944 through 1947 were chosen because the largest releases to air occurred then. The most important reason for choosing 1964-1966 to study releases to the river was that very good records are available for that time. Various monitoring programs provided data on radioactive material in drinking water, fish, and body tissues of Hanford workers. These records were critical for developing and checking the computer approach used in the Project. The years 1964-1966 were also chosen because some of the largest releases to the river occurred then.

FINDING A RANGE OF RADIATION DOSES FROM THE MILK PATHWAY

Preliminary data from Phase I allowed scientists to establish some general categories of exposure. If you lived in the ten-country study area during the years 1944 through 1947, you can use the guide on the next two pages to find your category. You will see a preliminary range of radiation doses for people in your category.

The dose estimates you see on the chart will be refined later. Also, a computer program will estimate your personal radiation dose. Personal information that you provide will be used to estimate the amount of radiation you received.

Finding your preliminary range of doses is a two-step process. First, you will need to answer some questions (Part 1 of the guide on page 8) that will help you identify the category that most nearly reflects your circumstances during the 1944-1947 period. You will then match the number of your category with information on Part 2 of the guide (page 9) to see the range of doses that people in your category may have received.

An example case will illustrate how to use the guide.

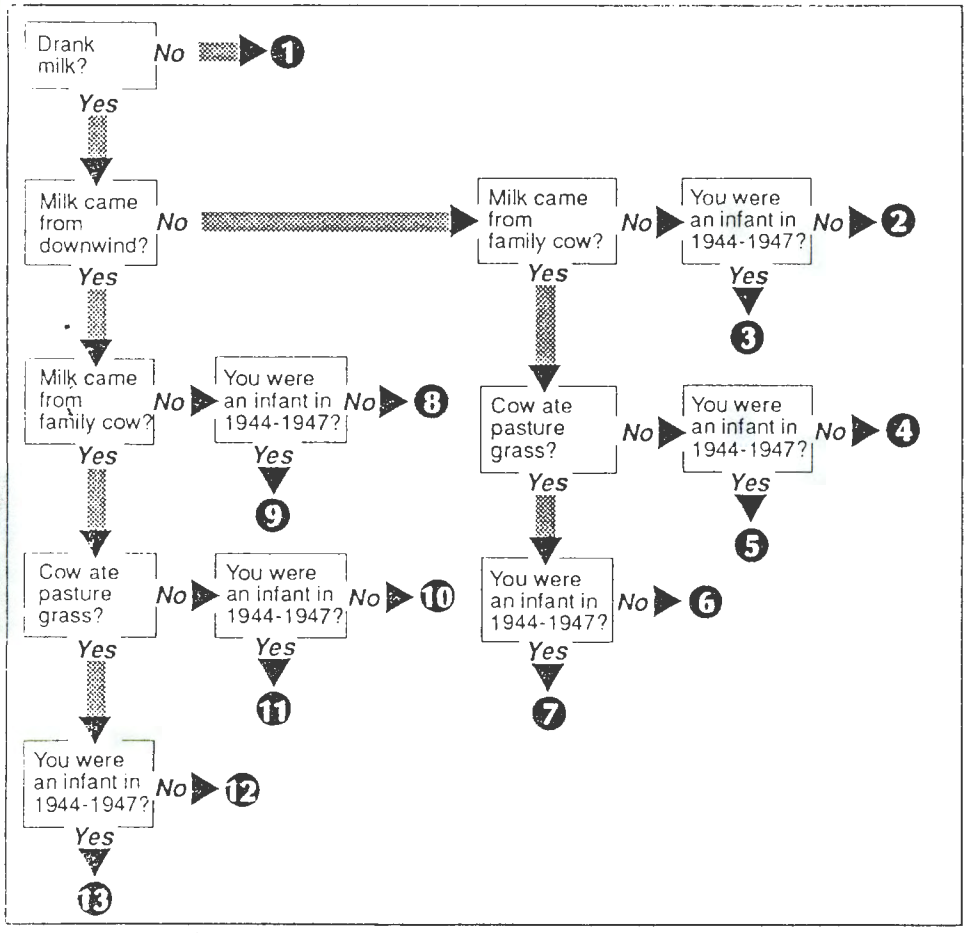
Assume you were a 20-year-old female living in Walla Walla from 1944 through 1947. You drank milk from a family cow that ate pasture grass. To find the preliminary estimate of the dose you could have received, you should answer the questions in Part 1, following the arrows that direct you to the next question. In your case, all your answers are "yes" until you reach the question, "Were you an infant in 1944-1947?" Your "no" answer to this question directs you to number 12, which is the category that best describes your history.

You would then go to Part 2 where you will see that most people in category 12 may have received a radiation dose of 1 to 50 rad. The middle or median dose for this category is 5 rad. This means that half the people in this category received a dose greater than 5 rad, and half received a dose less than 5 rad. More people would be expected to receive doses near the middle value than at either end of the range.

If you lived in the ten-county study area during the years 1944 through 1947, use the guide below. If you drank milk, use the dairy map on page 6 to determine whether it came from a downwind area.

GUIDE FOR 1944-1947 RESIDENTS

Part 1: Finding Your Category

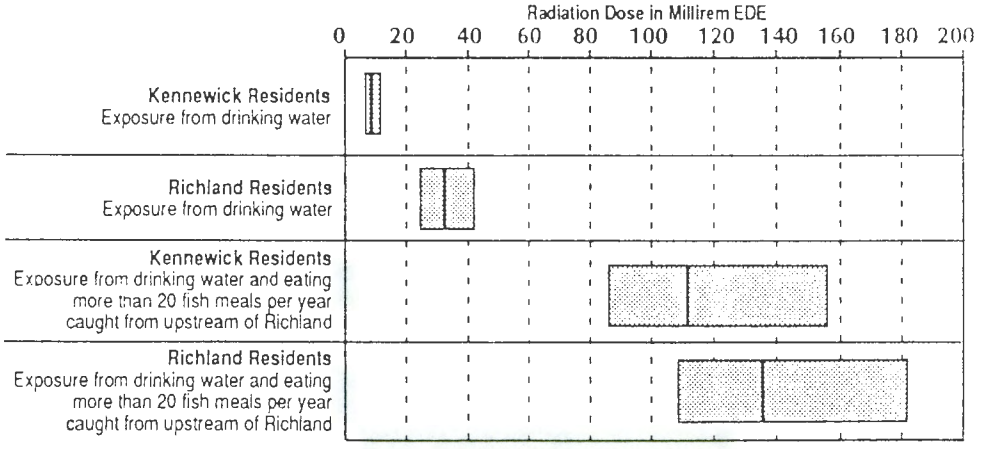


people would be expected to receive doses around the median than at either end of the range.

Again, as in the case of the milk pathway, these estimates will be refined later in the project. You will then be able to provide more specific information to a computer and obtain a personal estimate of radiation dose.

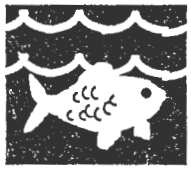
The river exposures can also be related to background radiation to provide some frame of reference. The average river dose to a Richland resident is less than 15% of the 300 millirem EDE that the average American receives from naturally occurring radiation each year. The highest dose shown for these four categories—180 millirem EDE—is also less than the 300 millirem EDE a person might receive each year from natural sources.

GUIDE FOR 1964-1966 RESIDENTS



Vertical lines in the bars are the medians. The median is the dividing point showing where half the people in that category received a larger dose than the median dose and half the people received a smaller dose.

Each bar in the chart covers 90% of the people in that category. Estimated radiation doses for people in both the lowest and highest 5% of each category are not included because the numbers are much less accurate.



THE RIVER PATHWAY

The radiation doses from the Columbia River are much smaller than those from the air. More than 80% of total dose to people in the Phase I study area from 1944 to the present is estimated to come from exposure to iodine-131 released to the air.

Many different radioactive materials were released to the Columbia River from Hanford. The most important in terms of radiation dose to people were phosphorus-32, neptunium-239, zinc-65, arsenic-76, manganese-56, copper-64, sodium-24, and chromium-51. These were the elements studied in Phase I.

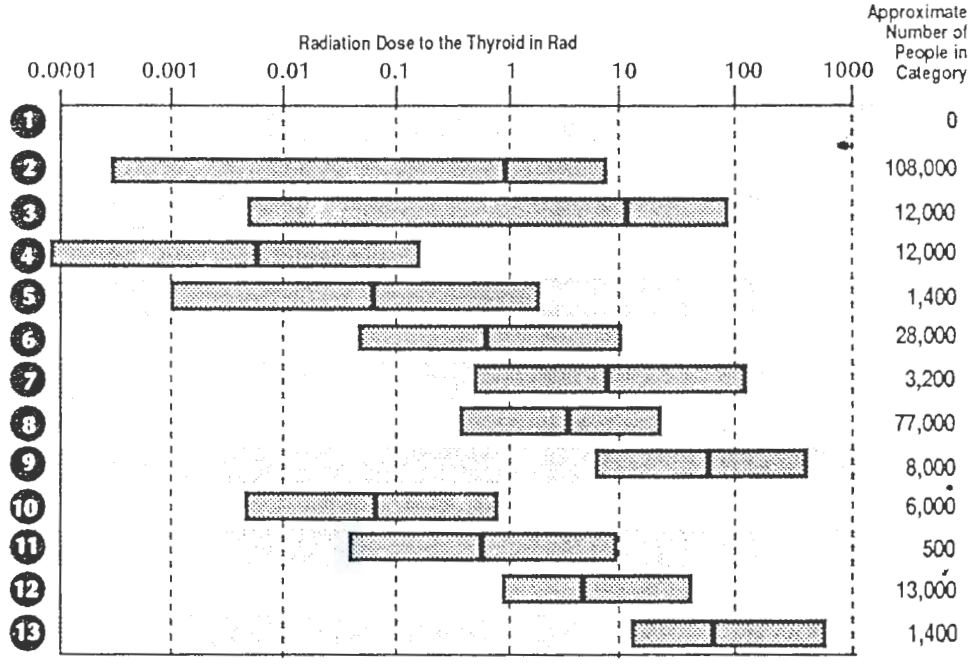
The Phase I study area covered the Columbia River between Priest Rapids Dam and McNary Dam for 1964-1966. People in the study area could have been exposed by eating fish or drinking water from the river, or by working or playing near or in the river. In the Phase I study area, the only people whose city drinking water came from the river were residents of Pasco, Richland, and Kennewick (the Tri-Cities). A few small communities downstream from the study area may have used the river as a source of drinking water. Even adding these communities, Tri-City residents still account for 80% of the population between Hanford and the mouth of the Columbia whose drinking water came from the river.

The river exposures have been broken into four categories that cover most of the study population. The guide on the next page shows the range of doses for each category. Doses are shown for Kennewick and Richland residents. Doses for Pasco residents are between the values for Kennewick and Richland.

If you were a resident of the study area from 1964 through 1966, you should use the guide to find your category and range of doses. For example, assume you lived in Kennewick during 1964-1966. You ate at least 20 meals per year of fish caught in the Columbia upstream of Richland. The radiation dose for most of the people in your category would be between 85 millirem EDE and 155 millirem EDE. The median or middle dose for this category is approximately 110 millirem EDE. This means that half the people in this category received more than 110 millirem EDE, and half the people received less. More

GUIDE FOR 1944-1947 RESIDENTS

Part 2: Finding Your Range of Possible Radiation Doses.



Vertical lines in the bars are the medians. The median is the dividing point showing where half the people in that category received a larger dose than the median dose and half the people received a smaller dose.

Each bar in the chart covers 90% of the people in that category. Estimated radiation doses for people in both the lowest and the highest 5% of each category are not included because the numbers are much less accurate.

PUTTING MILK DOSE ESTIMATES INTO PERSPECTIVE

The information in this booklet will help you evaluate the amount of radiation dose you may have received. Some framework to help you interpret dose estimates, however, may be helpful.

Millirem EDE—One-thousandth of a rem EDE.

Radiation is a natural part of our environment. The air, soil, and water all emit natural radiation. Small amounts of radioactive material are also present in the human body. Cosmic radiation, which originates from the sun and from sources outside our solar system, bombards the earth continuously. These natural sources of radiation produce a dose that varies from 200 millirem EDE to 2000 millirem EDE. The average person in the United States receives a dose of about 300 millirem EDE per year from natural radiation.

About two thirds of this dose is from radon gas that accumulates in buildings. The dose from radon changes from place to place. For example, in the Phase I study area, typical doses from radon are about 150 millirem EDE per year. In the Spokane River Valley, typical radon doses are up to ten times higher.

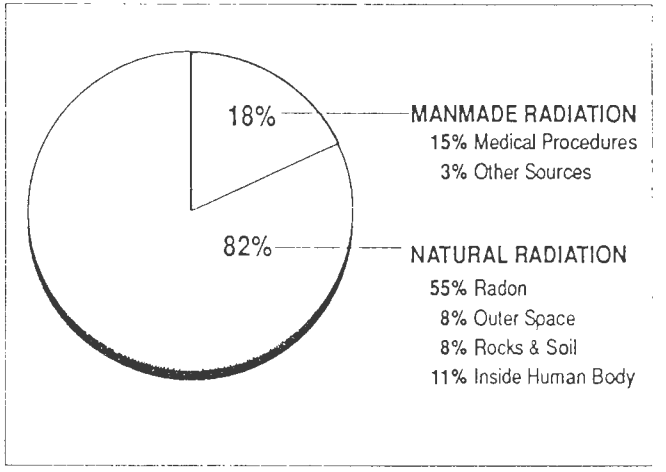
In addition to naturally occurring radiation, the average person gets about 60 millirem EDE per year from "manmade" sources, such as x rays and other medical procedures. For example, doctors have used iodine-131 for many years to diagnose and treat thyroid disease.

In the past, doctors used radioactive iodine-131 in diagnostic procedures to see whether the thyroid was functioning properly. In this procedure, the thyroid typically received a radiation dose of 50 to 100 rad. Ten rad to the thyroid is roughly equivalent to the 360 millirem EDE of background exposure that the average person receives in a year.

Doctors use larger amounts of iodine-131 to treat patients whose thyroids are not working properly. These therapeutic procedures, which are intended to make the thyroid stop functioning, typically result in a dose of 5,000-10,000 rad to the thyroid.

A number of studies have been conducted to see whether these medical uses of iodine-131 increase the risk of thyroid cancers. Health effects from iodine-131 exposure are not well understood. These studies have found no conclusive evidence that patients who received iodine-131 in medical procedures are at increased risk for thyroid cancer. The studies did not examine risks for other thyroid diseases.

It is important to note that doses from medical exposures are received in a short time. Doses from Hanford were spread out over years. For high doses, health effects are less when doses are spread out. For low doses, timing is not a factor.



Each year the average American receives a dose of 300 millirem EDE from naturally occurring radiation and 60 millirem EDE from manmade radiation. Radiation doses received from releases at Hanford were in addition to such background doses.