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THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT: OVERVIEW

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The Hanford Environmental Dose Reconstruction Project: Overview

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Abstract

In a multi year effort that began in 1988, researchers at the Pacific Northwest Laboratory are estimating radiation doses that people could have received since 1944 from nuclear operations at the U.S. Department of Energy's Hanford Site. Known as the Hanford Environmental Dose Reconstruction Project, the work has required the development of new methods and tools for dealing with unique technical and communication challenges. Scientists are using probabilistic dose assessment--rather than the more typical deterministic approach--to generate dose distributions rather than single-point estimates. Uncertainties in input parameters are reflected in the dose results. Sensitivity analyses are used to optimize project resources in defining the project's scope. An independent technical steering panel directs and approves the work in a public forum.

Dose estimates are based on several factors, including

- review and analysis of historical data related to operations, effluents, and monitoring
- determination of important radionuclides
- reconstruction of source terms; environmental conditions that affected transport; concentrations in environmental media; and human elements such as population distribution, agricultural practices, food habits, and lifestyles.

A companion paper, "The Hanford Environmental Dose Reconstruction Project: Technical Approach," describes the computational framework for the work.

Introduction

The objective of the Hanford Environmental Dose Reconstruction Project (HEDR) is to estimate radiation doses that the public could have received from nuclear operations at the U.S. Department of Energy's (DOE's) Hanford Site since 1944. The HEDR dose estimates will also be used by the Centers for Disease Control for a thyroid morbidity study being conducted in counties adjacent to the Hanford Site. HEDR Project staff are dealing with several of the issues this symposium addresses: evaluating the value of past monitoring and assessment efforts, deciding when we have enough monitoring data, and identifying ways to make monitoring and assessment more cost-effective.

Confirming the experiences of scientists recently working in the hazardous waste area, our HEDR experiences demonstrate that addressing dose assessment issues requires a technical and sociopolitical framework. We need to move from deterministic to probabilistic radiological assessments and involve the interested public in the process. A dose assessment that is accepted by the scientific community but not understood or accepted as credible by the interested public is strictly a scientific exercise. A truly successful dose assessment must also provide potentially affected people with information to independently evaluate impacts to themselves.

Historical Background

The study was prompted by mounting public concern about potential health effects to the public from more than 40 years of operations at the Hanford Site. Of particular concern was the period from startup until environmental monitoring reports were made publicly available in the late 1950s. In 1986, the Hanford Health Effects Review Panel

--convened by the Centers for Disease Control at the request of the Washington State Nuclear Waste Board and the Indian Health Service--recommended that potential doses from radioactive releases at Hanford be reconstructed. The states of Oregon and Washington, representatives of three regional Indian Tribes, and the DOE agreed that an independent technical steering panel (TSP) should direct the HEDR Project, which is managed and conducted by the Pacific Northwest Laboratory. A TSP was subsequently selected by representatives from four Northwest universities and the project formally began in 1988, funded by the DOE.

The TSP reviews, evaluates, and approves all project technical decisions and reports. Panel members include experts in various technical fields as well as individuals who represent the states of Washington and Oregon, Indian tribes, and the public. The TSP conducts periodic public meetings (about every two months) and provides public access to the data used in reconstructing doses.

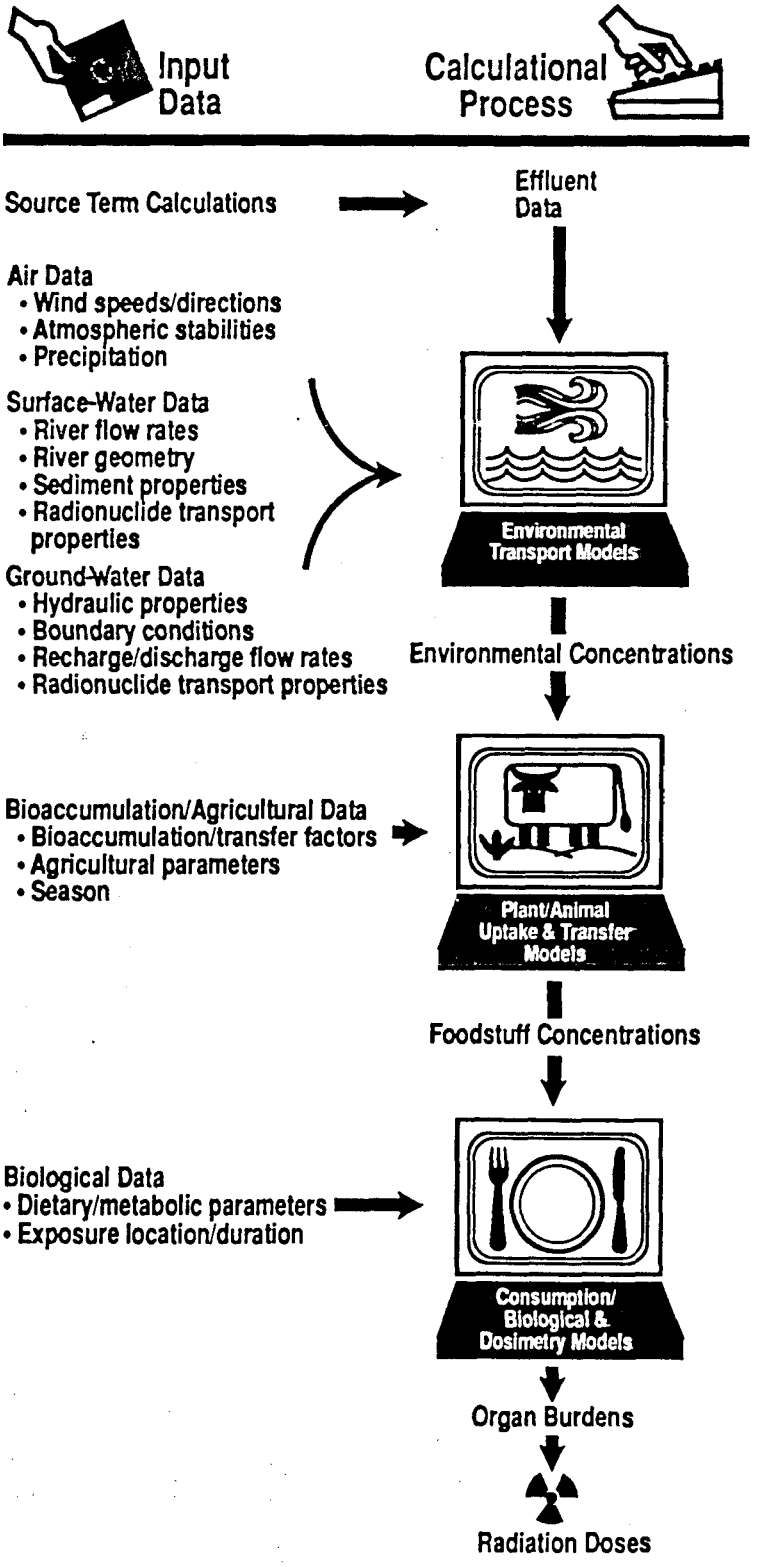
Technical Approach

The HEDR Project uses an approach similar to a typical deterministic radiological dose assessment; however, the Project differs in that it uses distributions rather than point estimates as the input and produces distributions rather than point estimates as the results (dose estimates). The Project also differs from the typical dose assessment in that it encompasses many years of operations and literally must reconstruct past conditions.

Figure 1 shows the flow of information required to estimate doses, which are based on

- identification, review, and analysis of historical data relating to nuclear operations

Figure 1 here


Input Data
Calculational Process
Source Term Calculations
Effluent Data
Air Data
• Wind speeds/directions
• Atmospheric stabilities
• Precipitation
Surface-Water Data
• River flow rates
• River geometry
• Sediment properties
• Radionuclide transport properties
Ground-Water Data
• Hydraulic properties
• Boundary conditions
• Recharge/discharge flow rates
• Radionuclide transport properties
Environmental Transport Models
Environmental Concentrations
Bioaccumulation/Agricultural Data
• Bioaccumulation/transfer factors
• Agricultural parameters
• Season
Plant/Animal Uptake & Transfer Models
Foodstuff Concentrations
Biological Data
• Dietary/metabolic parameters
• Exposure location/duration
Consumption/ Biological & Dosimetry Models
Organ Burdens
Radiation Doses

- determination of radionuclides that could have contributed significantly to dose
- reconstruction of the types and quantities of radioactive materials released to the atmosphere, Columbia River, and soils
- reconstruction of atmospheric, river, and ground-water conditions that affected the transport of radioactive materials from operating facilities to offsite populations
- delineation of study areas
- review of historical measurements of radionuclides of Hanford origin in environmental media
- reconstruction of agricultural practices
- reconstruction of general and specific population distributions
- reconstruction of food consumption patterns and lifestyles.

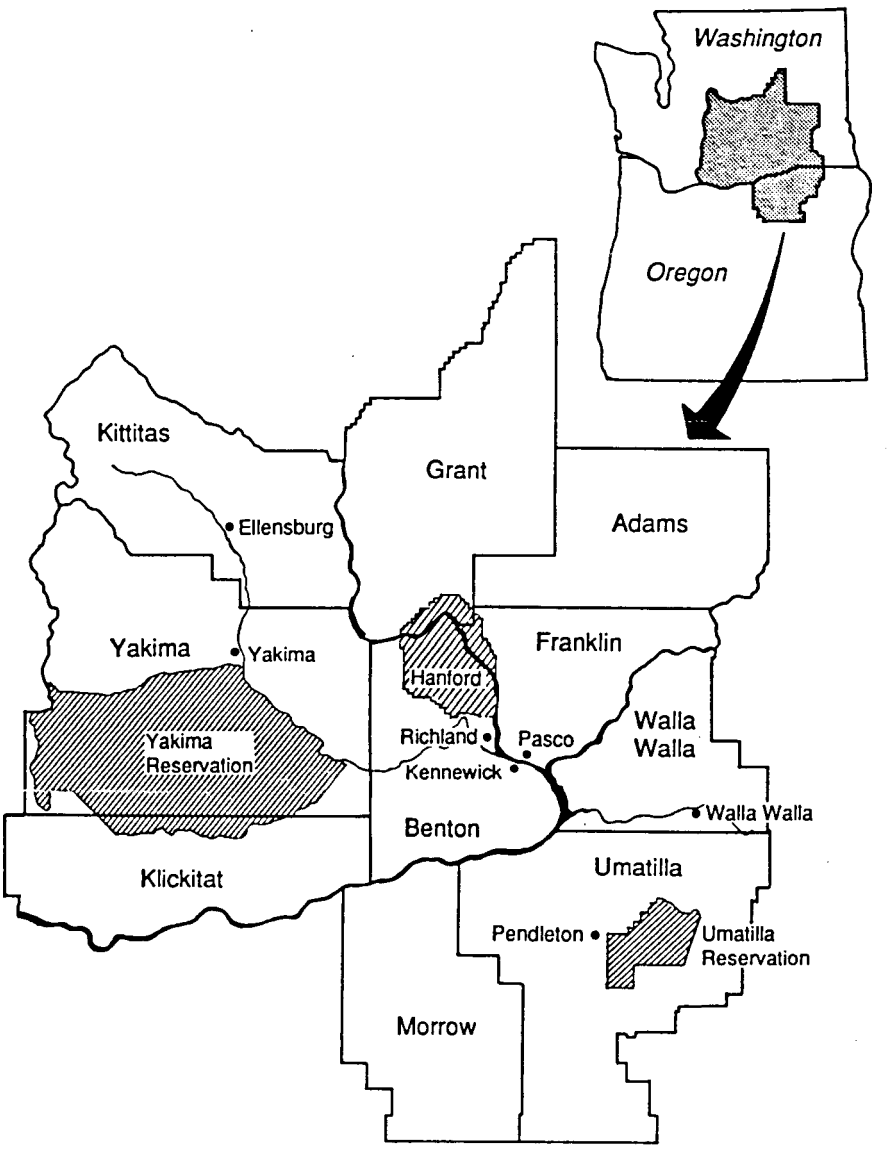
A phased approach will enable initial efforts to focus on developing "tools" for the rest of the study--such as identifying the most significant radionuclides, selecting appropriate computer models, identifying key parameters for model input, and developing preliminary dose estimates and their uncertainties for people who lived closest to the Hanford Site. Results from the initial work phase will be used in making cost/benefit decisions to determine how far to expand the study area and time, to identify methods for improving models, and to identify additional data sources.

All major technical decisions concerning the scope and approach of the work, including selection of radionuclides, exposure pathways, study areas and populations, time periods, computer models, methods for assessing uncertainties in dose estimates, key input parameters, and dose threshold levels are reviewed and

approved by the TSP in a public forum. The public is thereby able to become part of the decision process.

For the first phase of the Project, work focuses on the 10 counties surrounding the Hanford Site (Figure 2; about a 150-km radius), for air emissions from 1944 through 1947 and for liquid emissions from 1964 through 1966. Preliminary doses are being

Figure 2 here


Washington
Oregon
Kittitas
Ellensburg
Grant
Adams
Yakima
Yakima
Yakima Reservation
Franklin
Hanford
Richland
Pasco
Kennewick
Walla Walla
Walla Walla
Benton
Klickitat
Umatilla
Pendleton
Umatilla Reservation
Morrow

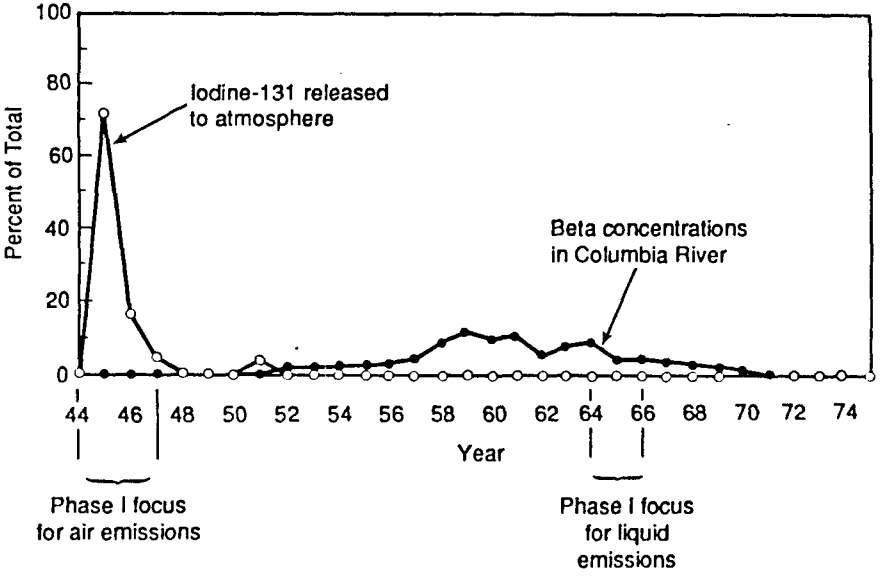
6-A

estimated for the general population and Native American populations within the study area, primarily the Yakima and Umatilla tribes.

Surface-water pathway investigations focus on the portion of the river between two dams: Priest Rapids Dam immediately upstream of the Hanford Site and the first downstream dam, McNary, a reach of about 100 river miles. For the water pathway, the dose estimates will be compared with historical dose estimates for 1964 through 1966.

Figure 3 shows the initial study period as related to historical radionuclide releases to the atmosphere and radionuclides in the river. The time period of 1944 through 1947

Figure 3 here


100
80
60
40
20
0
Percent of Total
Iodine-131 released
to atmosphere
Beta concentrations
in Columbia River
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
Year
Phase I focus
for air emissions
Phase I focus
for liquid
emissions

was selected for study of airborne emissions because more than 90% of the iodine-131 released between 1944 and 1988 was estimated to have been released during that time. Work focuses on iodine-131 because it had the greatest potential for contributing to radiation doses received by people; however, all other important radionuclides are being investigated as part of the first phase.

The time period of 1964 through 1966 was selected for study of releases to the Columbia River primarily because extensive water monitoring data were collected during that period. In addition, releases to the Columbia River from 1944 through 1947 were relatively low because only one to three reactors were operating (of the nine production reactors that were operating on the Hanford Site in 1964) and because they were operated at lower power levels than reactors were in later time periods. Therefore, relatively higher releases of water-transported radionuclides occurred during the late 1950s through the mid-1960s. Moreover, all reactors were shut down for about 50 days in 1966 and then restarted. This event provided an unusual opportunity to assess the rate of change of radionuclide concentrations in fish, water, and sediments as related to changes in reactor emissions.

Pacific Northwest Laboratory will submit a report summarizing the first phase--including preliminary dose estimates and associated uncertainties--to the TSP for review and approval by December 29, 1989. The report will document the rationale for the radionuclides, models, parameters, study areas, and time periods selected for the first phase, including a comparison and evaluation of methods for analyzing sensitivity and uncertainty of the preliminary dose results. The project is scheduled for completion in 1993.

Conclusions

The HEDR Project uses a probabilistic approach to dose assessment that incorporates explicit evaluations of uncertainties in input parameters and dose estimates, assesses the relative importance of input parameters with the use of sensitivity analyses, and thereby optimizes project resources in selecting radionuclides, pathways, geographic areas, time periods, and critical sub-populations. And this entire process is conducted under the direction of a TSP and an interested public who will ultimately judge the success of the work.

Key works: Dose reconstruction
Hanford Site
Sensitivity analyses
Dose distributions

Anderson, J. D. 1974. Emitted and Decay Values of Radionuclides in Gaseous Wastes Discharged to the Atmosphere from the Separations Facilities through Calendar Year 1972, ARH-3026. Atlantic Richfield Hanford Company, Richland, Washington.

Figure 1. Calculational Process for Dose Reconstruction

Figure 2. Ten Counties Closest to Hanford Site - Initial Study Area for Dose Reconstruction

Figure 3. Iodine-131 Releases from the Separations Plants and Total Beta Concentrations in the Columbia River Expressed as Percents of Totals from 1944-1975 [(based on Anderson (1974) and Hanford Site environmental monitoring reports)]--basis for time periods selected for initial phase of dose reconstruction