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OAK RIDGE HEALTH STUDIES
PHASE I REPORT

Executive Summary

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EXECUTIVE SUMMARY

OAK RIDGE HEALTH STUDIES BACKGROUND

The Oak Ridge Reservation was established in 1942 as part of the federal government's World War II effort to develop and produce the first atomic bombs. Production of plutonium and enrichment of uranium for weapons components were the main objectives in the beginning. For 50 years, many different research and production activities have been performed at the three large complexes, code named X-10, Y-12, and K-25.

The three main complexes used and processed radioactive materials, including iodine, uranium, and cesium, and other chemically hazardous materials including mercury and PCBs (polychlorinated biphenyls). Some contaminants were released to the environment beyond the plant boundaries as a result of routine emissions to the air and surface water; waste disposal practices including burial; accidental releases; and events such as the draining of White Oak Lake.

In July 1991, the State of Tennessee initiated the Health Studies Agreement with the United States Department of Energy. The purpose of the project is to carry out independent studies of possible adverse health effects in people living in the vicinity of the Oak Ridge Reservation. The health studies focus on those effects that could have resulted from exposures to chemicals and radioactivity released at the Reservation since 1942. To facilitate independence, a panel of experts and local citizens, the Oak Ridge Health Agreement Steering Panel, provides direction, recommendations and oversight for the Oak Ridge Health Studies. The Tennessee Department of Health, Division of Environmental Epidemiology provides staffing support.

OVERVIEW OF PHASE I

Phase I of the project began in May 1992 and was completed in September 1993. The major focus of the first phase was to complete a Dose Reconstruction Feasibility Study. This study was designed to find out if enough data exist about chemical and radionuclide releases from the Oak Ridge Reservation to conduct a second phase. The second phase will lead to estimates of the actual amounts or the "doses" of various contaminants received by people as a result of off-site releases. Once the doses of various contaminants have been estimated, scientists and physicians will be better able to evaluate whether adverse health effects could have resulted from the releases.

The Health Studies Agreement specified five goals for Phase I. To achieve these goals, the Oak Ridge Health Agreement Steering Panel and the Department of Health completed several activities. Volume I of the *Oak Ridge Health Studies Phase I Report* gives the background and an overview of the health studies, as well as a discussion of the activities undertaken by the panel to attain the Phase I goals (Table 1). The work related to the primary goal, the Dose Reconstruction Feasibility Study, is detailed in Volume II, Parts A-D, of the report.

Table 1: Contents of the Oak Ridge Health Studies Phase I Report

Volume I discusses the activities of the Oak Ridge Health Agreement Steering Panel, other than the Dose Reconstruction Feasibility Study, during Phase I of the Oak Ridge Health Studies. It includes four major items:

- **Executive Summary of the Oak Ridge Health Studies Phase I Report** summarizes Volume I and Volume II of the *Oak Ridge Health Studies Phase I Report*.
- **Health Studies Background and Overview** provides a brief history of the operation of the Oak Ridge Reservation and an overview of the Health Studies Agreement.
- **Phase I Goals** lists the initial goals stated in the Health Studies Agreement, the approach that the panel chose for attaining each goal, and a description of the activities that were necessary to achieve the goals.
- **Conclusions and Recommendations for Phase I** contains the Consensus Statement of the panel asserting the conclusions that the panel reached at the end of Phase I and the recommendations of the panel for continuing the Health Studies into the next phase.

Volume II documents the study (referred to as the Dose Reconstruction Feasibility Study) to find out if enough data exist to estimate historical doses of chemicals and radionuclides to the public living in the vicinity of the Reservation. It is comprised of four parts:

- **Part A** addresses project Tasks 1 and 2 to identify the historical operations and emissions at each of the complexes and characterize the availability of environmental sampling and research data.
- **Part B** addresses Tasks 3 and 4 to identify important environmental exposure pathways and contaminants released from the Reservation.
- **Part C** addresses Task 5 to identify information regarding historical locations and activities of off-site populations that could potentially be affected by releases from the Reservation.
- **Part D** addresses Task 6 to identify the hazards associated with substances used at the Reservation.

SUMMARY OF THE VOLUME I REPORT: THE OAK RIDGE HEALTH STUDIES PHASE I OVERVIEW

The three facilities at Oak Ridge, K-25 (Oak Ridge Gaseous Diffusion Plant), Y-12, and the Oak Ridge National Laboratory (ORNL, previously X-10), served as sites for nuclear material processing. After the war, they remained active in the production of radioisotopes, reactor development, nuclear weapons component production, waste management and an array of engineering and scientific support functions worldwide.

The Health Studies Agreement provides the State with $12.4 million, from the Department of Energy, to fund independent health studies. These studies are designed to assess potential human health risks of past releases from the Oak Ridge Reservation to people living in the vicinity of the Reservation. The Agreement contains five goals for the initial studies, Phase I of the Oak Ridge Health Studies.

- **Goal I** was to assemble a panel of technical experts from across Tennessee and the United States, to design a Dose Reconstruction Feasibility Study.

- **Goal II** was to complete a Dose Reconstruction Feasibility Study to identify chemicals and radionuclides released from the Oak Ridge Reservation in the past 50 years with the greatest potential for causing adverse health effects in the people living off-site. This study was designed to determine the feasibility of estimating the doses of these contaminants, given the quality of the information located in this screening study.

- **Goal III** was to assemble a panel of experts and citizens from across Tennessee and the United States to direct and oversee all of the Health Studies Agreement activities and to assure two-way communication with the public.

- **Goal IV** is to enhance the Tennessee Cancer Registry by reviewing the quality and completeness of hospital reporting and by developing and maintaining a state birth defects registry.

- **Goal V** is to review the Department of Energy's occupational medical (worker health) program.

In order to address these five goals, the Steering Panel grouped the oversight responsibilities into four major categories.

- Dose and risk assessment
- Health effects evaluation
- Public communication
- Quality assurance

The activities related to each of these categories and the conclusions reached by the Panel are described in detail in Volume I. The Oak Ridge Health Agreement Steering Panel recommendations for continuing these activities into the next phase are as follows.

Conclusions and Recommendations for Dose Reconstruction

The primary goal of Phase I, which began in May 1992, was to carry out an initial screening study, called the Dose Reconstruction Feasibility Study. The Feasibility Study indicates that a significant amount of information is available to reconstruct the past releases and potential off-site doses. Based on this, the Oak Ridge Health Agreement Steering Panel recommends that dose reconstruction activities begin for the releases of radioactive iodine and cesium, mercury, and PCBs. The Panel also recommends that a broader-based investigation of operations and contaminants be conducted to support or modify the recommended direction of future health studies. (See Volume II, Parts A-D, for the methodology and documentation that resulted in the conclusions and recommendations for dose reconstruction.)

Conclusions and Recommendations for the Evaluation of Health Effects

As the result of several meetings with the community, the Oak Ridge Health Agreement Steering Panel concludes that there is interest in health studies that not only calculate health risks, but also look for the occurrence of adverse health effects. The Panel proposes that researchers look for opportunities to conduct analytical epidemiologic studies to identify adverse health effects in exposed populations.

Continuation of Communication with the Public

The Oak Ridge Health Agreement Steering Panel believes that communication activities begun in Phase I should continue in Phase II. These activities include public meetings to receive input from the public and relay study results, the newsletter, the toll-free telephone service to the Environmental Epidemiology office, the one-on-one community feedback sessions, the speaking engagements, the technical workshops, and the interagency communications.

Continuation of Quality Assurance

The quality assurance process established and conducted in Phase I proved to be important in ensuring that the work being done is credible and accurate. The Panel recommends that significant resources continue to be devoted to the quality assurance program in all further work.

Other Recommendations

The Oak Ridge Health Agreement Steering Panel recommends that the State continue verifying cases for the Tennessee Cancer Registry and continue developing and maintaining the Tennessee Birth Defects Registry.

The Oak Ridge Health Agreement Steering Panel recommends that a formal plan to review the Department of Energy's Oak Ridge Reservation workers' health program be developed and carried out in Phase II.

During Phase I, some information provided by the public and external reviewers about contaminants was not completely investigated. The Oak Ridge Health Agreement Steering Panel recommends that an investigation of this information be pursued in Phase II.

SUMMARY OF THE VOLUME II REPORT: THE DOSE RECONSTRUCTION FEASIBILITY STUDY

The Phase I feasibility study has focused on determining the availability of information for estimating exposures of the public to chemicals and radionuclides released as a result of historical operations of the facilities at the Oak Ridge Reservation. The estimation of such past exposures is frequently called dose reconstruction. The Phase I researchers examined both the feasibility of performing dose reconstruction and a portion of the enormous volume of historical data to identify the releases from the facilities in the past having the highest potential to have caused harm to the health of the public.

The project work was composed of a number of individual tasks designed to meet the overall objectives of the Phase I studies. The study tasks are numbered 1 through 7. The initial project tasks, Tasks 1 and 2 were designed to identify and collect information that documents the history of activities at the Reservation that resulted in the release of contamination and to characterize the availability of data that could be used to estimate the magnitude of the contaminant releases and public exposures. **Task 7: Compilation and Indexing of Project Documents** was designed to support the collection of many of the documents and data identified in Tasks 1 and 2 in a library that could then be used in any future health studies. These three tasks represent the information collection portion of the project and included qualitative evaluations of the potential for activities to have produced significant contaminant releases. Further details of Task 1 and Task 2 efforts are described here.

Task 1: Identification of Historical Operations and Emissions

A history of operations that likely generated off-site releases was the product of Task 1 activities that are documented in Volume II, Part A of the *Oak Ridge Health Studies Phase I Report*. This history is based on extensive reviews of records of historical operations and interviews with present and past employees and other knowledgeable individuals. The investigative process is documented in the report. The time period covered is the 50-year span from 1942, when the federal government acquired 58,000 acres of land for what became the Oak Ridge Reservation, through 1992 when the study began. Four large, separate complexes code-named X-10, Y-12, K-25, and S-50 were operated on the Reservation. The Y-12, K-25, and S-50 complexes were dedicated to the production of enriched uranium during their early years of operation. S-50 was built near K-25 and operated for only a single year. Uranium enrichment involves the separation of the type of uranium required for nuclear weapons (uranium-235) from the uranium that is most abundant in nature (uranium-238). Y-12 later produced and dismantled nuclear weapon components and enriched lithium for use in thermonuclear weapons.

Activities at X-10, which were much more varied than those of the other plants, included:

- development of the world's first full-scale nuclear reactor,
- a chemical separation pilot plant to recover plutonium, and
- a wide range of activities related to applied research and development focused primarily on energy and the environment.

Volume II, Part A of the Health Studies Report presents information with respect to each of the major complexes, as well as a number of off-site areas of concern related to contamination from the Oak Ridge Reservation. While large volumes of information and documentation were found to be available for each of the major complexes, the nature and quality of the documentation differed considerably among the complexes. The complex that appears to have the largest amount of information relevant to dose reconstruction efforts is X-10. While considerable information is available for the K-25 and Y-12 sites, historical activities involving the use and release of hazardous materials do not appear to be as well documented at these complexes. Much of the information that is available for K-25 and Y-12 remains in classified documents, many of which were reviewed for the purposes of the study by individuals with appropriate security clearance. Priority is being given to the request for declassification of the information relating to off-site health impacts.

Task 1 investigations documented the historical activities of the major complexes, including routine operations, waste management, special projects, and accidents and incidents. Historical activities that appear to warrant the highest priority in any further investigations were identified based on their likely association with off-site emissions of hazardous materials as indicated by the documentation reviewed or information obtained in interviews.

Task 1 efforts identified the following activities as having the highest priority for future studies.

The X-10 Complex

- The production of radioactive barium/lanthanum (RaLa processing)
- Processing of short-decayed irradiated thorium by the Thorex process
- Graphite reactor operations
- Processing of graphite reactor fuel for plutonium recovery
- Waterborne and airborne waste disposal activities

The K-25 Complex (including S-50)

- Gaseous diffusion processing, the primary source of uranium and technetium emissions
- Feed facility and product and tails withdrawal, likely the primary sources of releases of uranium hexafluoride
- Abnormal or accidental releases of uranium hexafluoride
- Liquid waste disposal of a complex waste stream
- Further investigation of the short-lived (1 year) S-50 plant

The Y-12 Complex

- Electromagnetic separation and enrichment of uranium
- Lithium separation and enrichment operations, the primary source of mercury releases to the environment

- Uranium weapon component manufacturing
- Beryllium operations
- Waste disposal operations
- Further evaluation of the use and release of substances which cannot be publicly discussed because their presence at Oak Ridge is classified

Information that is available to support the reconstruction of historical releases of hazardous materials and possible off-site exposures for these high priority activities is summarized in Volume II, Part A of the Health Studies Report.

Task 2: Environmental Sampling and Research Data Availability

Task 2 focused on the development of an understanding of the environmental sampling and research data that are available to support any future dose reconstruction efforts. Information on the availability of environmental data was obtained from document reviews and personnel interviews. Sources of information are identified below.

- Plant libraries and archives
- DOE Oak Ridge Operations files
- The Tennessee Valley Authority
- The United States Environmental Protection Agency
- The United States Geological Survey
- The Tennessee Department of Health
- The Tennessee Division of Radiological Health
- The Tennessee Division of Water Pollution Control
- Interviews with current and former investigators

Abstracts were developed to summarize approximately 100 environmental monitoring and research projects that characterize the historical presence and behavior of contaminants near the Oak Ridge Reservation. Data availability is summarized for the following environmental media.

- Surface water
- Sediment
- Air or atmosphere
- Aquatic and terrestrial food items (biological monitoring)
- Soil
- Drinking water derived from off-site surface waters/groundwater wells and water from wells on the Reservation

The large volume of information reviewed in the 100 studies is summarized in tables in Volume II, Part A of the Health Studies Report. The tables indicate:

- the time period during which samples were taken,
- the approximate location of the samples,
- the contaminants that were measured,
- the Oak Ridge facility that was most likely the source of the contaminant, and
- the relative quantity of sampling data available in the study.

These table summaries, as well as the abstracts of the studies, are designed to be used to identify data that can be used to support any further studies to quantify the historical exposure of the public to specific contaminants released from the Oak Ridge facilities.

Tasks 3, 4, 5 and 6: Quantitative Evaluation of Potential Impacts

In structuring the Phase I studies, there was a desire to attempt to use the quantitative data on releases from the facilities and contamination present in the environment as another means of identifying those plant activities that should receive the highest priority in any further health studies. Project Tasks 3 - 6 support a more quantitative evaluation of the potential impacts of facility releases.

This quantitative evaluation is a very rough and preliminary analysis of the large quantity of information and data identified in Tasks 1 and 2 to rank those activities and contaminants having the greatest potential to cause harm to the public's health. The evaluation follows the basic steps necessary to evaluate potential human health hazards. However, the evaluation uses data and

information that have not been thoroughly established or independently verified, as would be done in any subsequent, more lengthy and detailed study. Therefore, this evaluation must be considered preliminary and subject to revision by any future health studies. The basic steps performed in a quantitative health hazard assessment are:

- **Hazard identification**— identification of the materials that were released and capable of causing harm to health. These materials were identified in Tasks 1 and 2.

- **Dose-response assessment**— characterization of the toxicity of the released contaminants by identifying the health effects that can result from exposure and the amount or dose of the contaminant required to produce the various health effects. This step of the process is primarily addressed by Task 6 in Volume II, Part D of the Health Studies Report. Project **Task 6: Hazards Summaries for Important Materials** was accomplished by relying on, and in large part reproducing, summary-level information available in documents produced by various regulatory agencies, government health agencies, and other authoritative bodies that publish guidelines and information on the toxicity and behavior of contaminants in the human body.

- **Exposure/Hazard Assessment**— quantification of the exposures that the public could have received. This was accomplished by identifying complete exposure pathways using information developed in Tasks 3 and 5 and calculating the potential relative magnitude of off-site exposures and health hazards for each of the contaminants for which data were available in Task 4.

Additional details of the activities associated with the completion of project Tasks 3 and 4 (documented in Volume II, Part B) and Task 5 (documented in Volume II, Part C) follow.

Task 3: Identification of Complete Exposure Pathways was performed to identify plausible exposure pathways based on environmental conditions (e.g., locations of surface water and groundwater, meteorology), potential for a contaminant to move from one medium (e.g., soil, water, or air) to another, and by the life-styles, activities, and locations of the exposed population (e.g., gardening, water recreation). **Task 5: Identification of Populations** was performed to support the analysis of complete exposure pathways by evaluating the likelihood of human contact with contaminated media and the existence of human activities leading to contaminant intake or exposure. Task 5 efforts began the process of identifying available information on local historical populations and land uses near the Oak Ridge facilities, as well as addressing other specific concerns of dose reconstruction. Other specific dose reconstruction concerns included the potential for: consumption of locally produced crops, beef, dairy products, fish, and game; the use of surface water for drinking, irrigation, and recreation; ground water use for drinking and irrigation; and river dredging and sediment spreading.

Task 3 examined the combinations of contaminated media, transport mechanisms, and routes of contact that characterized complete exposure pathways in the past for each of the Oak Ridge complexes. The task work led to the preliminary conclusion that exposure pathways associated with the direct intake of contaminated groundwater are not believed to have been complete in the past. However, various complete pathways were identified for contaminants released to the air, surface waters, and soils or sediments.

While Task 3 identified all the potentially complete exposure pathways, not all complete pathways make a significant contribution to the total potential health hazard. The activities of **Task 4: Evaluation of Complete Exposure Pathways** were designed to identify the most important pathways of exposure and, where possible, past activities that appear to be associated with the greatest health hazards.

The most important exposure pathways were identified by calculating the health hazards that would result from the presence of fixed concentrations (unit concentrations) of each of the contaminants in each environmental medium, for each of the complete exposure pathways (i.e., comparisons *within* environmental media). These analyses identified those pathways that will receive emphasis in any further studies of a particular contaminant release.

The second, and much more difficult analysis was the estimation of the magnitude of the health hazards that exposure to contaminants in each of the media may have posed to the public in the past (i.e., comparisons *between* environmental media). This type of comparison required the estimation of actual contaminant concentrations in environmental media. In some cases, making these estimates was very difficult or impossible as part of this first phase of the health studies. When contaminant concentrations or releases could be identified, the year or period of highest emission or the highest environmental concentrations were used in the analyses. These analyses between media identified what we currently believe to be the activities and contaminant releases that should receive the highest priority for any further health studies, because they appear to have the highest potential to cause a health hazard to the public. The contaminants and activities receiving the highest priority included:

- the release of **iodine–131 & iodine–133** during the years of 1944 through 1956 from Radioactive Lanthanum (RaLa) processing at X-10;
- the release of **cesium–137** (primarily in liquid wastes) during the period of 1943 through the 1960s as a result of various chemical separation activities at X-10;
- the release of **mercury** during the years of 1955 through 1963 from lithium separation and enrichment operations at Y-12; and

- the general release of **polychlorinated biphenyls (PCBs)** from electrical transformers and machining operations at K-25 and Y-12. (The period of time over which these releases occurred has not been established, but is likely associated with operations occurring more than ten years ago.)

It is important to note that this evaluation should not be considered the definitive assessment of health hazards resulting from toxic materials released from the Oak Ridge Reservation. The findings of this feasibility study are useful for the purpose of focusing any future studies and are subject to change during future phases of the health studies.

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