ORAU Team **NIOSH Dose Reconstruction Project** Technical Basis Document for the K-25 Site – Introduction	Document Number: ORAUT-TKBS-0009-1 Effective Date: 01/06/2004 Revision No.: 00 Controlled Copy No.: _____ Page 1 of 5
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1.0 Introduction

The U.S. Congress officially recognized the hazardous nature of producing and testing nuclear weapons by enacting the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA). Workers, who have developed selected types of cancer, or their survivors may be entitled to compensation and medical benefits under the Act. The EEOICPA program is administered by the Department of Labor (DOL) Office of Worker Compensation (OWCP). The Department of Health and Human Service's (HHS) National Institute for Occupational Safety and Health (NIOSH) is responsible for determining the individual worker's dose.

EEOICPA requires the estimation of radiological doses from ionizing radiation received by workers in the nuclear weapons production programs of the various U. S. Department of Energy (DOE) and its predecessor agencies. Methods for implementing provisions of the Act have been promulgated in 42 Code of Federal Regulations Part 82 (42CFR Part 82), "Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000" (Federal Register, Vol. 67 No. 85, Thursday, May 2, 2002).

NIOSH is supported by Oak Ridge Associated Universities (ORAU) and others, the ORAU Team, in conducting dose reconstructions under the EEOICPA. This Site Profile represents a specific support mechanism to the ORAU Team concerning documentation of historical practices at the K-25 Site [also known as the Oak Ridge Gaseous Diffusion Plant (ORGDP) and the East Tennessee Technology Park (ETTP)]. This Site Profile can be used to evaluate both internal and external dosimetry data for monitored workers and can serve as a supplement to, or substitute for, individual monitoring data. This document provides a site profile of K-25 that contains technical basis information to be used by the ORAU Team to evaluate the total occupational radiation dose for EEOICPA claimants.

This document also provides supporting technical data to evaluate the total K-25 occupational radiation dose that may reasonably be associated with the worker's radiation exposure. This dose results from exposure to external and internal radiation sources in K-25 facilities; to K-25 occupationally-required diagnostic x ray examinations, and to on-site environmental releases. Also included are techniques to estimate the dose that may have occurred while the employee was not monitored, inadequately monitored, dose that may have been missed due to analytical detection limits, or whose monitoring records are incomplete are missing (i.e., missed dose). Over the years new and more reliable scientific methods and protection measures have been developed. The methods needed to account for these changes are also identified in this document.

This Site Profile can be a tool when performing dose reconstructions for K-25 workers. The Integrated Modules for Bioassay Analysis (IMBA) computer code is a tool useful for internal dose calculations. Information on measurement uncertainties is an integral component of the NIOSH approach. This document describes how to evaluate uncertainty associated with K-25 exposure and dosimetry records..

The document is divided into five major sections; Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry.

The Site Description TBD (ORAU-TKBS-0009-2) presents a brief description of the facilities and processes that have been used in processing uranium. The K-25 Site processed thousands of tons of uranium through diffusion cascades for more than 40 years beginning in February 1945. The vast majority of the uranium was natural uranium derived from ore, but some was recycled material obtained from spent reactor fuel.

The Occupational Medical Dose TBD (ORAU-TKBS-0009-3) provides information about the dose that individual workers received from x rays that were required as a condition of employment. These x rays included pre-employment, annual chest x rays during physical exams, and health monitoring x rays to determine the effect of inhalation of uranium. The frequency of required x rays varied over time. All radiation workers received annual chest x rays from 1944 through 1980, but every 5 years after 1980. Non-radiation workers received annual chest x rays until 1960, but none after 1960. workers with a potential to inhale uranium dust may have had x rays as frequently as monthly in 1944 and 1945, but bimonthly from 1946 to 1959.

Both the x ray equipment and the techniques used for taking x rays have changed over the years covered by this SITE PROFILE. These factors were taken into account in estimating the dose that a worker would have received from the x ray. Favorable assumptions were made to ensure the worker's dose was not underestimated when there was a doubt about the technique used. The parameters considered included the tube current and voltage, exposure time, filtration, source to skin distance, the view (posterior-anterior or lateral), and any other factor that could affect the dose received by the worker.

The doses to other exposed organs from the chest x ray have also been calculated. The calculated dose also takes into account the uncertainty associated with each of the parameters mentioned above. The doses received by the various organs in the body are presented in the tables for convenient reference for dose reconstruction.

The Occupational Environmental Dose TBD (ORAU-TKBS-0009-4) applies to workers who were not monitored for external or internal radiation exposure. The environmental dose is the dose workers received when working outside the buildings on the site from inhalation of radioactive materials in the air, direct radiation from plumes, contact with particles on the skin, and from direct exposure to radionuclides incorporated in the soil.

Inhalation of environmental radionuclides results in internal dose to the whole body or body organs. Whole- or partial-body external dose results from deposited radionuclides or submersion in a cloud of radioactive material.

The internal dose for workers outside of the facilities was determined from the air concentrations resulting from the releases from stacks, individual building releases, and from the purge cascade and other operations at K-25. Unmonitored workers may have been exposed to occupational doses internally from on-site releases into the air.

The air concentration of radionuclides was determined using use well-documented source terms developed for the Oak Ridge Dose Reconstruction (Burmeister 1996; Burmeister 1997A; Burmeister 1997B), coupled with some documented environmental monitoring data, to estimate radionuclide-specific airborne concentrations for $^{234, 235, 238}U$, $^{238, 239, 240, 241, 242}Pu$, ^{237}Np, and ^{99}Tc (Shonka 2003). These radionuclides were determined to account for the majority of the potential missed dose from inhalation and submersion pathways.

The external dose to workers from the ambient radiation levels on-site and from submersion in a cloud of radioactive material were estimated from onsite environmental dosimeters.

The Occupational Internal Dosimetry TBD (ORAU-TKBS-0009-5) describes the internal dosimetry program at the K-25. A bioassay program based on urinalysis for uranium was instituted when K-25 began processing uranium. The urinalysis techniques employed over the years followed the technology development for uranium detection. Urinalysis was preferred over *in vivo* techniques

because the *in vivo* minimum detectable activities were relatively high and thus of limited use for detecting uranium intakes. The processing of recycled uranium from spent reactor fuel introduced other radionuclides to K-25, in particular plutonium, americium, curium, neptunium, and ^{99}Tc. These additional radionuclides were also best analyzed in urine. In general, the fraction of dose from these radionuclides relative to uranium was very small and usually immeasurable if the uranium dose was small.

Interferences that may be encountered in the collection and analysis of bioassay samples are discussed, as are the uncertainties in the bioassay measurements. Also presented is information that may be useful in estimating possible missed doses due to monitoring practices that were inadequate when compared to modern standards. Methods for evaluating potential doses that may fall in this category are presented.

The Occupational External Dosimetry Program TBD (ORAUT-TKBS-0009-6) discusses the program for measuring skin and whole body doses to the workers. The methods for evaluating external doses to workers evolved as new techniques and equipment were developed. Changes in techniques also changed as concepts in radiation protection changed. The dose reconstruction parameters, K-25 practices and policies, and dosimeter types and technology for measuring the dose from the different types of radiation are discussed in this section. Attention is given to the evaluation of doses measured from exposure to beta, gamma, and neutron radiation.

Sources of bias, workplace radiation field characteristics, responses of the different beta/gamma and neutron dosimeters in the workplace fields, and the adjustments to the recorded dose measured by these dosimeters during specific years are discussed in detail.

There are sources of potential dose that could be missed because of the limitations of dosimetry systems and the methods of reporting low doses. This missed dose is discussed as a function of dosimeter type, year, and type of radiation.

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