ORAU Team **NIOSH Dose Reconstruction Project** Technical Basis Document for Portsmouth Gaseous Diffusion Plant - Introduction	Document Number: ORAUT-TKBS-0015-1 Effective Date: 05/11/2004 Revision No.: 00 Controlled Copy No.: _____ Page 1 of 7
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ACRONYMS AND ABBREVIATIONS

EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
DOE	Department of Energy
DOL	Department of Labor
GM	Geiger-Muller
HHS	Department of Health and Human Services
ICPMS	Inductively Coupled Plasma Mass Spectrometry
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
OWCP	Office of Worker Compensation
PORTS	Portsmouth Gaseous Diffusion Plant
TBD	technical basis document
TLD	thermoluminescent detectors

1.0 PURPOSE

This Site Profile represents a specific support mechanism concerning documentation of historical practices at the Portsmouth Gaseous Diffusion Plant (PORTS). This Site Profile can be used to evaluate both internal and external dosimetry data for monitored workers and can serve as a supplement to individual monitoring data. For unmonitored workers, information is present in this document that will provide for estimations of internal and external doses. This document provides a site profile of PORTS that contains technical basis information to be used to evaluate the total occupational radiation dose for EEOICPA claimants.

This document also provides supporting technical data to evaluate the total PORTS 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 PORTS facilities, to PORTS 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 an employee was not monitored, inadequately monitored, dose that may have been missed due to analytical detection limits, or whose monitoring records are incomplete or missing (i.e., missed dose). Over the years new and more reliable scientific methods and protection measures have been deployed. The methods needed to account for these changes are also identified in this document.

The doses are evaluated using the NIOSH Interactive RadioEpidemiological Program and the Integrated Modules for Bioassay Analysis (IMBA) computer program. Information on measurement uncertainties is an integral component of the NIOSH approach. This document describes how to evaluate uncertainty associated with PORTS exposure and dosimetry records.

Technical Basis Documents (TBD) and Site Profile Documents are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist NIOSH in the completion of the individual work required for each dose reconstruction.

In this document the word "facility" is used as a general term for an area, building or group of buildings that served a specific purpose at a site. It does not necessarily connote an "atomic weapons employer facility" or a "Department of Energy facility" as defined in the Energy Employee Occupational Illness Compensation Program Act of 2000 (42 U.S.C. § 73841 (5) and (12)).

2.0 SCOPE

The document is divided into six major sections: this Introduction, Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry. Some sections are accompanied by an attachment that provides the critical data for the specialists reconstructing the doses.

The Site Description TBD (ORAUT-TKBS-0015-2) presents a brief description of the facilities and processes that have been used in processing and enriching uranium. PORTS processed thousands of tons of uranium through diffusion cascades for 47 years beginning in 1954. The majority of the uranium feed materials PORTS received was slightly enriched from Paducah, but some was recycled material obtained from spent reactor fuel.

The Occupational Medical Dose TBD (ORAUT-TKBS-0015-3) 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 and annual chest x-rays. All employees were required to have annual chest x-rays from 1954 to 1989. In 1990, chest x-rays were offered on a frequency based on the age of the employee but asbestos/beryllium workers were still required to have annual chest x-rays.

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. 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 (ORAUT-TKBS-0015-4) 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 PORTS. 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 the annual environmental reports from 1972 and 2001 and a special study of historic radiological releases (Goslow 1986) to estimate radionuclide-specific airborne concentrations for $^{234, 235, 236, 238}$U, Pu, Np, ^{99}Tc, and uranium daughters ($^{231, 234}$Th, ^{234m}Pa). The uranium isotopes were monitored from the onset of plant operations with the Np, Pu, Tc, and uranium daughters being added to the monitoring program at later dates beginning in 1967.

The external dose to workers from the ambient radiation levels on-site and from submersion in a cloud of radioactive material were estimated from on-site environmental monitoring equipment such as Geiger-Muller (GM) tubes and thermoluminescent detectors (TLDs).

Several accidental releases of uranium occurred during the operational period of PORTS. The largest of these releases occurred in 1978 when a 14-ton feed cylinder fell and cracked open, releasing an estimated 4,820 kg of uranium to the atmosphere and an additional 680 kg of uranium to the plant sewers. In addition, a string of accidental releases of mostly depleted uranium during the first five years of plant operation accounted for essentially all of the uranium lost to the atmosphere from 1955 through 1958 and 20% of the losses in 1959.

The Occupational Internal Dosimetry TBD (ORAUT-TKBS-0015-5) describes the internal dosimetry program at PORTS. The PORTS internal dosimetry program for uranium isotopes started when the site began operations in 1954. Routine monitoring for ^{99}Tc began in 1965 in vivo and 1975 in vitro. Transuranics have not been monitored routinely with the exception of ^{237} Np.

Urine analysis for total alpha activity began at the start of operations in 1954. Fluorimetry and gas flow proportional counting was employed until 1995 when Inductively Coupled Plasma Mass Spectrometry (ICPMS) was utilized. The frequency of urine analysis at PORTS varied considerably and was based on the potential for the individual to come into contact with radioactive materials. Additional urine analyses were performed based on recalls (lost or inadequate samples, or abnormal results) or supervisor's request. Urine analysis for ^{99}Tc began in 1965 using a liquid scintillation method and subsequent subtraction of the uranium/thorium complement to yield the ^{99}Tc results. Routine monitoring for transuranics has not been conducted at PORTS. In vivo analyses began in 1965 to detect non-transportable or insoluble compounds such as U_3O_8 and ^{99}Tc in the lungs.

Interferences that may be encountered in the collection and analysis of urine samples are discussed, as are the uncertainties in the urine analysis measurements. Also presented is information that may be useful in estimating possible missed doses due the limitation of the monitoring practices as well as the limitations of the equipment and techniques for radiation detection and measurement. Methods for evaluating potential doses that may fall into this category are presented.

The Occupational External Dosimetry Program TBD (ORAUT-TKBS-0015-6) discusses the program for measuring skin and whole body doses to the workers. The methods for evaluating external doses to workers have also evolved over the years as new techniques and equipment have been developed. In addition, concepts in radiation protection have changed. The dose reconstruction, PORTS 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 to 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 potentially missed dose is discussed as a function of dosimeter type, year, and type of radiation.

REFERENCES

Goslow, G. A., 1986. *Historical Radionuclide Release Report*, GAT-1124, Goodyear Atomic Corporation, Piketon, Ohio, January.