<table>
<tr><td>ORAU Team
NIOSH Dose Reconstruction Project

Technical Basis Document for the Y-12 National Security Complex – Y-12 Site Profile</td><td>Document Number:
ORAUT-TKBS-0014-1
Effective Date: 01/06/2004
Revision No.: 00
Controlled Copy No.: _______
Page 1 of 7</td></tr>
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None</td></tr>
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RECORD OF ISSUE/REVISIONS

ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	REV. NO.	DESCRIPTION
Draft	12/01/2003	00-A	New draft document for the Y-12 National Security Complex – Y-12 Site Profile. Initiated by William E. Murray.
Draft	12/22/2003	00-B	Incorporates comments from NIOSH and internal review. Initiated by William E. Murray.
1/06/2004	1/06/2004	00	First approved issue. Initiated by William E. Murray.

ACRONYMS AND ABBREVIATIONS

Ac	Actinium
CFR	Code of Federal Regulations
CEDE	Committed Effective Dose Equivalent
Co	Cobalt
DOE	Department of Energy
DOL	Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
HEU	Highly Enriched Uranium
HHS	Department of Health and Human Services
IMBA	Integrated Modules for Bioassay Analysis
IREP	Interactive RadioEpidemiological Program
L_D	Laboratory detection limit
MED	Manhattan Engineering District
Np	Neptunium
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
OWCP	Office of Workers' Compensation Programs
Pb	Lead
TBD	Technical Basis Document
TEC	Tennessee Eastman Corporation
U	Uranium
Y-12	Y-12 National Security Complex
Zr	Zirconium

1.0 Y-12 SITE PROFILE

In enacting the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA), the U.S. Congress officially recognized the hazardous nature of producing and testing nuclear weapons. Under the Act workers, who have developed selected types of cancer or their survivors may be entitled to compensation and medical benefits. This program is administered by the Department of Labor (DOL) Office of Workers' Compensation Programs (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.

Specifically the Act 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).

Oak Ridge Associated Universities (ORAU) leads a team, the ORAU Team, to support NIOSH in conducting this major program. This Site Profile represents a specific support mechanism to the ORAU Team concerning documentation of historical practices at the Y-12 National Security Complex, referred to as Y-12. The profile can be used to evaluate both internal and external dosimetry data for unmonitored and monitored workers and serve as a supplement to, or substitute for, individual monitoring data. The document provides a Site Profile of Y-12 that contains technical basis information to be used by the ORAU Team to evaluate the total occupational radiation dose for EEOICPA claimants.

The document also provides supporting technical data to evaluate, with claimant-favorable assumptions, the total Y-12 occupational radiation dose received from Y-12 operations. This dose results from exposure to external and internal radiation sources in Y-12 facilities; to Y-12 occupationally-required diagnostic x-ray examinations, and to on-site environmental releases. Also included is the dose that may have occurred while the worker was not monitored or the dose may have been missed. 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.

The doses are evaluated using the NIOSH Interactive RadioEpidemiological Program (IREP) and the Integrated Modules for Bioassay Analysis (IMBA) computer codes. Information on measurement uncertainties is an integral component of the NIOSH approach. This document describes how the uncertainty for Y-12 exposure and dose records is evaluated.

The Site Profile is divided into five Technical Basis Documents (TBDs); Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry. Each TBD has an accompanying attachment that provides critical data for the specialists reconstructing the doses.

The Site Description TBD (ORAUT-TKBS-0014-02) presents a brief description of the facilities and processes used at Y-12 to develop nuclear weapons and weapons components since the early 1940s. Y-12 is located in the eastern section of the Oak Ridge Reservation in Oak Ridge, Tennessee. The plant occupies 811 acres and consists of 531 buildings with more than 7.5 million square feet of floor space. Construction of Y-12 was initiated in late 1942 and completed in 1943 as part of the Manhattan Engineering District (MED). Prior to completion, the operating contractor, the

Tennessee Eastman Company (TEC) moved people in to start operations. The first building to begin operations was the Calutron pilot plant/training building in the fall of 1943.

Despite technical problems, this first of a kind electromagnetic isotope separation (Calutron) plant, succeeded in its mission. In about two years, the uranium fuel was separated for the Hiroshima nuclear weapon. The gaseous diffusion process at the K-25 Site was the Manhattan Project's backup for enriching uranium. Since this process was workable and much less costly, Y-12 was shutdown in December 1946 and employment was cut drastically.

The Y-12 Plant eventually became one of twelve production facilities with a unique role. From 1947 to 1992, its new missions were to produce the key components of nuclear weapons and the test devices needed for the expanding nuclear weapons stockpile, and safeguard our Nation's highly enriched uranium (HEU) stockpile. Other tasks included the production of the enriched lithium urgently needed for the thermonuclear program in the 1950s and 1960s. Y-12 successfully carried out these missions in developing state-of-the-art technologies demanded by new weapons designs over almost 50 years.

From 1992 to the present, the Nation's stockpile of nuclear weapons was reduced by 90%. The number of operational buildings was reduced and Y-12's manufacturing technology was transferred to industry, where allowed. By the end of 1992, fifty research and development agreements were negotiated between Y-12 and governmental and commercial entities. Informally termed "Work for Others," challenging problems were successfully solved for other Federal Agencies. Ongoing missions include storing HEU for DOE, disassembling weapons/components to study aging and other effects, producing a small number of nuclear weapons parts and assemblies, decontaminating and decommissioning unused buildings, and conducting major efforts in environmental and waste management.

The Occupational Medical Dose TBD (ORAUT-TKBS-0014-03) provides information about the dose that individual workers received from chest X-rays taken as a condition of employment. These included chest X-rays taken during pre-employment (pre-placement), periodic, and termination physical examinations. All workers received chest X-rays prior to employment or placement and at termination from 1943 through the present. However, the frequency of periodic chest X-rays varied over time and with the worker's age.

Both the X-ray equipment and the techniques used for taking x rays have changed over the years. These factors have been considered in determining the dose that a worker received from the x ray. When there was a doubt about the technique used, the most claimant favorable assumptions have been made to ensure the worker's dose has not been underestimated. The technique parameters considered include 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 by the dose reconstructors.

The Occupational Environmental Dose TBD (ORAUT-TKBS-0014-04) applies to workers who were not monitored for external or internal radiation exposure. The occupational environmental dose received by unmonitored workers is limited to exposures received while outside buildings and within the perimeter of the Y-12 Plant. Buildings and other operational units occupy the vast majority of the land area at Y-12. The two exposure pathways identified are inhalation of uranium in ambient air from operational releases and direct external radiation from radionuclides in soils and outdoor surfaces, as well as shine from buildings and operational units.

Other radionuclides have been used at Y-12, but the primary source of airborne radioactive material is uranium from operations that have occurred over the years. Due to the complexity of the terrain surrounding Y-12 and the release mechanisms from the production facilities compounded by the limited dispersion distances, traditional dispersion and transport models were considered unsuitable. An empirical approach based on the limited ambient air monitoring data was used to estimate $^{234, 235}$U and ^{238}U air concentrations for all years. This approach used the annual release estimates independently reconstructed by previous studies to generate annual air concentrations for four locations within Y-12. Annual intakes were then calculated for $^{234/235}$U and ^{238}U.

There are two potential sources of external exposures received by workers at the Y-12 facility: exposures from the deposition of radionuclides released as a consequence of facility operations, and exposures received from radiation levels emanating from buildings and storage areas. External exposures were estimated using the results of a comprehensive radiological scoping survey. The analysis of the results from the scoping survey was used to generate a statistical range of exposure values.

The Occupational Internal Dose TBD (ORAUT-TKBS-0014-05) discusses the internal dosimetry program. Uranium isotopes in various chemical and physical forms have been the primary contributors to the workers' internal radiation dose but other radionuclides were also handled. At times the uranium compounds processed may have contained impurities with radiological health implications. But the primary focus on internal dose control has been on uranium compounds and alloys over a wide range of ^{235}U enrichment.

Uranium compounds handled at Y-12 range from highly soluble to very insoluble. Several particle size studies in uranium process areas have been conducted. For different processes, particle sizes ranged from less than one to over 10 μm. A positive correlation was reported between uranium octoxide particle size and process temperature.

During and immediately after World War II, a uranium urinalysis program based on fluorometry was used in conjunction with medical examinations to control for kidney damage from exposure to soluble uranium compounds. In 1950, production workers were placed on a uranium urinalysis program to estimate internal exposure. The program was expanded to include certain maintenance workers in 1954. Currently, workers with a potential for internal exposures in excess of 100 mrem y^{-1} committed effective dose equivalent (CEDE) are required to participate in the urinalysis program. Until 1989, routine urinalysis focused on enriched, normal and depleted uranium, tritium, and plutonium. Analyses for other radionuclides were performed on an as needed basis. Laboratory detection limits (L_D) are provided for all urinary bioassay methods over time, where available. Fecal samples were used in follow-up investigations when urinalysis or *in vivo* measurements indicated the likelihood of a substantial intake. Fecal sampling was discontinued several times in the past, but was reinstated in 1998 due to changes in workplace exposure conditions. If a work area has predominantly insoluble airborne uranium, current workers with a moderate to high exposure potential submit urine and fecal samples. The detection limit for fecal analysis is provided.

Whole body counting was not routinely practiced at Y-12. The primary *in vivo* detection method was chest counting that was put into routine use in 1961. Chest counting was done for ^{235}U, ^{238}U, thorium (inferred from ^{228}Ac and/or ^{212}Pb), ^{237}Np, ^{60}Co, and ^{95}Zr. Reported detection limits are provided.

The Occupational External Dosimetry TBD (ORAUT-TKBS-0014-06) discusses the program for measuring skin and whole body doses to the workers. The methods for evaluating external doses to workers have evolved over the years as new techniques and equipment have been developed. The dose reconstruction parameters, Y-12 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. Test results are tabulated for various dosimeters exposed to different exposure geometries and radiation energies.

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 facility location, dosimeter type, year, and energy range. The uncertainty in photon and neutron dose is discussed and standard error is given over time for various dosimeters. The complexities and uncertainties in applying organ dose conversion factors to the adjusted dose of record are discussed. In Attachment F, the use of the parameters presented in Section 6 is discussed to aid the dose reconstructor in preparing dose reconstructions for long-term Y-12 workers.