ORAU Team **NIOSH Dose Reconstruction Project** Technical Basis Document for the Rocky Flats Plant – Introduction	Document Number: ORAUT-TKBS-0011-1 Effective Date: 04/20/2004 Revision No.: 00 Controlled Copy No.: _____ Page 1 of 7
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ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DOE	U. S. Department of Energy
DOL	U.S. Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
HHS	U.S. Department of Health and Human Services
ICRP	International Commission on Radiological Protection
IREP	Interactive RadioEpidemiological Program
IMBA	Integrated Modules for Bioassay Analysis
MDA	minimum detectable activity
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
OWCP	Office of Worker Compensation
PA	posterior-anterior
RFP	Rocky Flats Plant
TBD	Technical Basis Document

1.0 INTRODUCTION

The purpose of the Site Profiles is to assist with the evaluation of site-specific data in the dose reconstruction process. Each profile provides the rationale and historic background information required for dose reconstruction related to a particular site that participated in the manufacture or assembly of nuclear weapons or their components.

Technical Basis Documents 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 if 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. § 7384l (5) and (12)).

This Site Profile provides specific information concerning documentation of historical practices at the Rocky Flats Plant (RFP). Dose reconstructors can use this Site Profile to evaluate internal and external dosimetry data for unmonitored and monitored workers, and to serve as a supplement to, or substitute for, individual monitoring data. This document provides an RFP site profile that contains technical basis information the ORAU Team can use to evaluate the total occupational radiation dose for EEOICPA claimants.

In addition, this document also provides supporting technical data to evaluate, with claimant-favorable assumptions, the total RFP occupational radiation dose that can reasonably be associated with a worker’s radiation exposure. This dose results from exposure to external and internal radiation sources in RFP facilities, occupationally required diagnostic X-ray examinations, and onsite environmental releases. In addition, this document includes the dose that might have occurred while the worker was not monitored or the dose that might have been missed. Over the years new and more reliable scientific methods and protection measures have been developed. This document identifies methods needed to account for these changes.

Doses are evaluated using the NIOSH Interactive RadioEpidemiological Program (IREP) and Integrated Modules for Bioassay Analysis (IMBA) computer codes. Information on measurement uncertainties is an integral component of the National Institute for Occupational Safety and Healh (NIOSH) approach. This document describes the evaluation of uncertainty for RFP exposure and dose records.

The Site Profile consists of five major technical basis documents (TBDs): Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dosimetry. The TBDs may have attachments to provide detailed information for the specialists reconstructing the doses.

The Site Description TBD (ORAUT-TKBS-0011-2) describes RFP facilities and processes used in the development of nuclear weapons since the early 1940s. RFP operations played an important role in the U.S. nuclear weapons program; these operations included production of weapons components. This TBD contains documentation to assist in the evaluation of worker dose from RFP operations and processes.

In March 1951, the U.S. Atomic Energy Commission announced its decision to build the Rocky Flats Plant in Colorado, and groundbreaking occurred in July 1951. From the beginning, the plant was a manufacturing facility. The primary mission and general activities at the plant remained essentially the same from the time the plant opened until 1989, when DOE suspended plutonium operations. RFP had two major missions – production of plutonium triggers (or "pits") for nuclear weapons, and processing of weapons for plutonium recovery. Early designs that were solid units made mostly of uranium gave way to a plutonium pit design in the mid-1950s. Plutonium pits or triggers are components of fission bombs, and can be used to initiate the second-stage fusion reaction in hydrogen bombs. Plutonium was received from the Savannah River and Hanford production sites, and from retired warheads and residues.

Parts were formed and machined from plutonium, uranium, beryllium, stainless steel, and other materials. Plutonium and uranium recovery and waste handling facilities were present on the site to handle radioactive wastes produced in these processes.

The Occupational Medical Dose TBD (ORAUT-TKBS-0011-3) provides information about doses received by individual workers from X-rays that were required as a condition of employment. Entrance, exit, and periodic physical examinations were performed on all employees as part of the requirements for employment at RFP. These examinations could include radiographic examinations of the lungs and, for some employees, possible radiographs of the lumbar spine.

Doses to other exposed organs from the chest X-ray have also been calculated. The calculated dose takes into account the uncertainty associated with machine type, exam frequency and job classification. This TBD presents doses received by the various organs in the body in tabular form for convenient reference by dose reconstructors.

The Occupational Environmental Dose (described in TBD ORAUT-TKBS-0011-4) is the dose workers receive when working outside buildings, from inhalation of or direct exposure to radioactive materials in the air, and from direct exposure to radionuclides that might have become incorporated in the soil.

Exposure to these sources can result in an internal dose to the whole body or body organs from inhaling radioactive materials, or could result in a whole- or partial-body external dose from deposited radionuclides or submersion in a cloud of radioactive material. Although plutonium ($^{239/240}$Pu, ^{241}Pu) is the primary material of concern for offsite exposures, tritium, natural thorium, enriched uranium, depleted uranium and Americium-241 (^{241}Am) were the radionuclides of concern identified in historical public exposure studies, and were the significant radionuclides encountered in the environment by site workers.

External doses to workers from onsite ambient radiation levels are determined from measurements reported in and estimated from site annual environmental reports.

The Occupational Internal Dosimetry TBD (ORAUT-TKBS-0011-5) discusses the RFP internal dosimetry program, and develops estimates of potential intakes. Workers at RFP had the potential to take in plutonium, americium, enriched uranium, depleted uranium, and tritium, as well as smaller quantities of other radionuclides. This TBD describes available source term information, including isotopic composition, solubility and particle size for plutonium, americium, enriched uranium, depleted uranium, and tritium (^{3}H). Site-specific internal dosimetry information for other radionuclides, such as thorium, curium and neptunium, is either rare or not available.

Primary modes of intake were chronic or acute inhalation or through breaks in the skin (wounds). Bioassay data estimate radionuclide activity excreted in the urine following an inhalation or wound

intake. Lung count data estimate the radionuclide present in the lungs after an inhalation intake. The TBD discusses these two data sets in detail, including history, sensitivity, and pertinent nuances of methods and data.

The internal exposure record for a specific worker consists of records of his/her bioassay data, and reports of involvement in incidents, accidents, or special situations. This TBD examines samples of records and reports, providing explanations of aspects and terms important to dosimetry.

The TBD discusses minimum detectable activities (MDAs), the analytical methods and reporting protocols related to urinalysis methods for the radionuclides encountered at RFP. Such parameters changed over the years for each radionuclide evaluated (i.e., plutonium, americium, curium, tritium, uranium, strontium, promethium, polonium, neptunium, and fission products). The TBD discusses details of these variables.

The TBD also discusses minimum detectable activities (MDAs), analytical methods, and reporting protocols for *in vivo* lung counts for X- and gamma-ray-emitting radionuclides. Such *in vivo* measurement equipment and techniques, which were developed in the late 1950s, have been in routine use at RFP since 1964. The TBD contains a detailed discussion of the lung counter, including ^{241}Am-specific MDAs and reporting levels for the various periods during which these parameters changed. It provides detailed information to assist dose reconstructors in interpreting data they might encounter in worker records.

The Occupational External Dosimetry TBD (ORAUT-TKBS-0011-6) describes the methods and concepts of measuring occupational external dose to workers, and how the methods have evolved since the beginning of RFP operations. It provides supporting technical data to evaluate, with claimant-favorable assumptions, external RFP occupational doses that can reasonably be associated with worker radiation exposures covered under the EEOICPA. These doses include occupational external exposures in RFP facilities, and onsite exposures to RFP environmental releases. The TBD evaluates unmonitored and monitored worker exposure, and missed dose. Consistent with NIOSH Implementation Guidelines, it provides guidance on the adjustment of occupational external recorded dose to parallel current scientific methods and protection factors.

In addition, this TBD presents the technical basis for methods used to prepare RFP worker external dose records for input to the NIOSH IREP system used to evaluate worker dose. Information on measurement uncertainties is an integral component of the NIOSH approach. This TBD describes the evaluation of uncertainty for RFP exposure records.

In summary: all five technical TBDS for the Rocky Flats Plant provide detailed information, data, explanations, and references for use during the reconstruction of RFP worker doses. In addition, the Rocky Flats TBD Users Guide will combine key data from each TBD, to create a single document allowing more efficient use of the information by dose reconstructors.

REFERENCE

ICRP (International Commission for Radiological Protection), 1996, *Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 5, Compilation of Ingestion and Inhalation Coefficients*, Publication 72, Pergamon Press, Oxford, England.