



**ORAU TEAM  
Dose Reconstruction  
Project for NIOSH**

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**Rocky Flats Plant – Introduction**

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New       Total Rewrite       Revision       Page Change

**PUBLICATION RECORD**

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04/20/2004	00	New technical basis document for the Rocky Flats Plant – Introduction. First approved issue. Initiated by Robert Meyer.
11/30/2006	01	Approved Revision 01 to incorporate responses to union comments. Added Section 1.2, Attributions and Annotations. Constitutes a total rewrite of the document. Incorporates internal formal review comments. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Robert Meyer.
08/04/2020	02	Revision initiated to capture that the other sections of this TBD were revised due to Advisory Board comments and items associated with SEC-00192. Incorporates formal internal and NIOSH review comments. Constitutes a total rewrite of the document. Training required: As determined by the Objective Manager. Initiated by Mutty M. Sharfi.

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**ACRONYMS AND ABBREVIATIONS**

AWE	atomic weapons employer
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
IMBA	Integrated Modules for Bioassay Analysis
IREP	Interactive RadioEpidemiological Program
MDA	minimum detectable amount
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
PER	Program Evaluation Report
RFP	Rocky Flats Plant
SEC	Special Exposure Cohort
SRDB Ref ID	Site Research Database Reference Identification (number)
TBD	technical basis documents
USC	<i>United States Code</i>

## 1.1 INTRODUCTION

Technical basis documents (TBDs) and site profile documents are not official determinations made by the National Institute for Occupational Safety and Health (NIOSH) but are rather general working documents that provide historical background information and guidance to assist in the preparation of dose reconstructions at particular U.S. Department of Energy (DOE) or Atomic Weapons Employer (AWE) facilities or categories of DOE or AWE facilities. They will be revised in the event additional relevant information is obtained about the affected DOE or AWE facility(ies), such as changing scientific understanding of operations, processes, or procedures involving radioactive materials. These documents may be used to assist NIOSH staff in the evaluation of Special Exposure Cohort (SEC) petitions and the completion of individual dose reconstructions under Part B of the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA).

In this document the word “facility” is used to refer to an area, building, or group of buildings that served a specific purpose at a DOE or AWE facility. It does not mean nor should it be equated to an “AWE facility” or a “DOE facility.” The term “AWE facility” is defined in EEOICPA to mean “a facility, owned by an atomic weapons employer, that is or was used to process or produce, for use by the United States, material that emitted radiation and was used in the production of an atomic weapon, excluding uranium mining or milling” [42 *United States Code* (USC) 7384I(5)]. On the other hand, a DOE facility is defined as “any building, structure, or premise, including the grounds upon which such building, structure, or premise is located—(A) in which operations are, or have been, conducted by, or on behalf of, the [DOE] (except for buildings, structures, premises, grounds, or operations ... pertaining to the Naval Nuclear Propulsion Program); and (B) with regard to which the [DOE] has or had—(i) a proprietary interest; or (ii) entered into a contract with an entity to provide management and operation, management and integration, environmental remediation services, construction, or maintenance services” [42 USC 7384I(12)]. The DOE determines whether a site meets the statutory definition of an AWE facility and the U.S. Department of Labor (DOL) determines if a site is a DOE facility and, if it is, designates it as such.

Under EEOICPA, a Part B cancer claim for benefits must be based on an energy employee’s eligible employment and occupational radiation exposure at a DOE or AWE facility during the facility’s designated time period and location (i.e., a “covered employee with cancer”). After DOL determines that a claim meets the eligibility requirements under Part B of EEOICPA, DOL transmits the claim to NIOSH for a dose reconstruction. EEOICPA provides, among other things, guidance on eligible employment and the types of radiation exposure to be included in an individual dose reconstruction. Under EEOICPA, eligible employment at a DOE facility includes individuals who are or were employed by DOE and its predecessor agencies, as well as their contractors and subcontractors at the facility [42 USC 7384I(11)]. Also under EEOICPA, the types of exposure to be included in dose reconstructions for DOE employees are those radiation exposures incurred in the performance of duty. As such, NIOSH includes all radiation exposures received as a condition of employment at DOE facilities in its dose reconstructions for covered employees, which may include radiation exposures related to the Naval Nuclear Propulsion Program at DOE facilities, if applicable. This is because NIOSH does not determine the fraction of total measured radiation exposure at a DOE facility that is contributed by the Naval Nuclear Propulsion Program at the DOE facility during a specified period of time for inclusion in dose reconstruction.

NIOSH does not consider the following types of exposure as those incurred in the performance of duty as a condition of employment at a DOE facility. Therefore these exposures are not included in dose reconstructions for covered employees [NIOSH 2010]:

- Background radiation, including radiation from naturally occurring radon present in conventional structures, and
- Radiation from X-rays received in the diagnosis of injuries or illnesses or for therapeutic reasons.

### 1.1.1 **Purpose**

This site profile provides specific information about documentation of historical practices at the Rocky Flats Plant (RFP). Dose reconstructors may use this information 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 site profile contains technical basis information the Oak Ridge Associated Universities (ORAU) Team can use to evaluate the total occupational radiation dose for EEOICPA claimants. It provides supporting technical data, with assumptions that are favorable to claimants, for the evaluation of 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 exposures.

NIOSH uses the NIOSH Interactive RadioEpidemiological Program (IREP) and Integrated Modules for Bioassay Analysis (IMBA) computer programs to evaluate dose. Information on measurement uncertainties is an integral component of the NIOSH approach. This site profile describes the evaluation of uncertainty for RFP exposure and dose records.

### 1.1.2 **Scope**

The site profile consists of the latest revisions of five technical basis documents (TBDs) in addition to this Introduction: Site Description, Occupational Medical Dose, Occupational Environmental Dose, Occupational Internal Dose, and Occupational External Dose. Attributions and annotations, indicated by bracketed callouts and used to identify the source, justification, or clarification of the associated information, are presented in Section 1.7.

### 1.1.3 **Special Exposure Cohort**

The Secretary of the U.S. Department of Health and Human Services has designated the following class of RFP workers as an addition to the SEC [Sebelius 2013]:

*All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Rocky Flats Plant in Golden, Colorado, from April 1, 1952 through December 31, 1983, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort.*

NIOSH has determined that doses to unmonitored RFP workers from neptunium, thorium, and  $^{233}\text{U}$  (and its associated  $^{232}\text{U}$  and  $^{228}\text{Th}$  progeny) cannot be reconstructed from April 1, 1952, through December 31, 1983, inclusive [NIOSH 2013]. The class includes all workers during the SEC period.

Based on the inability to reconstruct unmonitored doses from 1952 through 1983, as described above, all dose reconstructions for monitored workers during the SEC period are considered partial dose reconstructions. If monitoring data are available for workers in the SEC, dose is to be assigned as appropriate based on that data. It is not feasible to reconstruct unmonitored neutron doses, in a bounding manner, before 1967; therefore, this TBD does not provide dose reconstruction guidance for unmonitored neutron doses before 1967. For all other years, external dose records and/or an unmonitored external dose reconstruction approach are provided. However, such dose reconstructions are still considered partial dose reconstructions because of the determination that exposure to neptunium, thorium, and  $^{233}\text{U}$  (and its associated  $^{232}\text{U}$  and  $^{228}\text{Th}$  progeny) during the SEC period cannot be bounded [NIOSH 2013].

The principal sources of external radiation doses, including medical X-ray dose, for members of the proposed class were evaluated in the evaluation report for petition SEC-00030 [NIOSH 2006]. In that report, NIOSH concluded that all external dose, except neutrons, could be estimated with sufficient accuracy.

## 1.2 SITE DESCRIPTION

The Site Description TBD [ORAUT 2020a] describes RFP facilities and processes involved in the development of nuclear weapons. 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 RFP 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 it opened until 1989, when DOE suspended plutonium operations. RFP had two major missions: (1) production of plutonium triggers (or "pits") for nuclear weapons and (2) 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 fusion reaction in hydrogen bombs. Plutonium was received from the Savannah River and Hanford 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.

## 1.3 OCCUPATIONAL MEDICAL DOSE

The Occupational Medical Dose TBD [ORAUT 2019a] provides information about doses to 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 exposed organs from the chest X-rays have also been calculated. The calculated doses take into account the uncertainty associated with machine type, examination frequency, and job classification. This TBD contains tables of the doses to the various organs in the body for convenient reference by dose reconstructors.

## 1.4 OCCUPATIONAL ENVIRONMENTAL DOSE

Occupational environmental dose [ORAUT 2020b] is the dose that workers receive when working on the site, but outside its buildings, from inhalation of or direct exposure to radioactive materials in the air and from direct exposure to radionuclides incorporated in the soil.

Internal dose can result from inhalation of radioactive materials, and whole- or partial-body external dose can result from deposited radionuclides or submersion in a cloud of radioactive material. Although plutonium ( $^{239/240}\text{Pu}$ ,  $^{241}\text{Pu}$ ) is the primary material of concern for onsite exposures, tritium, natural thorium, enriched uranium, depleted uranium, and  $^{241}\text{Am}$  were other radionuclides of possible concern.

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

## 1.5 OCCUPATIONAL INTERNAL DOSE

The Occupational Internal Dose TBD [ORAUT 2020c] 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, and depleted uranium, as well as smaller quantities of other radionuclides. This TBD describes available source term information including isotopic composition, solubility, and particle size (where applicable) for those sources.

The primary modes of intake have been via chronic or acute inhalation and breaks in the skin (wounds). Urinalyses provide data reflecting such intakes. Lung counts provide estimates of radionuclide quantities present in the lungs. The TBD discusses these two datasets in detail, including history, sensitivity, and pertinent methods.

The internal exposure record for a specific worker consists of bioassay data and reports of involvement in incidents, accidents, or special situations. The TBD contains samples of records and reports that provide explanations of terms important to dosimetry.

The TBD discusses minimum detectable amounts (MDAs), analytical methods, and reporting protocols in relation to urinalysis methods for the radionuclides at RFP. Those parameters changed over the years for each radionuclide. The TBD discusses details of these variables.

The TBD also discusses MDAs, analytical methods, and reporting protocols for in vivo lung counts for X-ray and gamma-emitting radionuclides. The in vivo measurement equipment and techniques that were first developed in the late 1950s were in regular use at RFP since 1964. The TBD contains a discussion of the lung counter systems including <sup>241</sup>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 in worker records.

## 1.6 OCCUPATIONAL EXTERNAL DOSE

The Occupational External Dose TBD [ORAUT 2019b] describes the methods, concepts, and evolution of systems for measuring occupational external dose to workers. It provides supporting technical data to evaluate, with assumptions that are favorable to claimants, external RFP occupational doses 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 in light of the best information available.

## 1.7 ATTRIBUTIONS AND ANNOTATIONS

All information requiring identification was addressed via references integrated into the reference section of this document.

## REFERENCES

NIOSH [2006]. Special exposure cohort petition evaluation report petition SEC-00192 Rev. 0 Rocky Flats Plant qualified June 16, 2005. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. SEC-00192 Rev. 0, April 7. [SRDB Ref ID: 132776]

NIOSH [2010]. Radiation exposures covered for dose reconstructions under Part B of the Energy Employees Occupational Illness Compensation Program Act. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DCAS-IG-003 Rev. 1, October 5. [SRDB Ref ID: 88929]

NIOSH [2013]. Special exposure cohort petition evaluation report petition SEC-00192 Rev. 1 Rocky Flats Plant qualified February 9, 2012. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. SEC-00192 Rev. 1, September 30. [SRDB Ref ID: 132777]

ORAUT [2019a]. Rocky Flats Plant – occupational medical dose. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-TKBS-0011-3 Rev. 02, August 19. [SRDB Ref ID: 177867]

ORAUT [2019b]. Rocky Flats Plant – occupational external dose. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-TKBS-0011-6 Rev. 03, January 14. [SRDB Ref ID: 175317]

ORAUT [2020a]. Rocky Flats Plant – site description. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-TKBS-0011-2 Rev. 02, August 20. [SRDB Ref ID: 180380]

ORAUT [2020b]. Rocky Flats Plant – occupational environmental dose. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-TKBS-0011-4 Rev. 03, September 1. [SRDB Ref ID: 180379]

ORAUT [2020c]. Rocky Flats Plant – occupational internal dose. Oak Ridge, TN: Oak Ridge Associated Universities Team. ORAUT-TKBS-0011-5 Rev. 04, September 1. [SRDB Ref ID: 178626]

Sebelius K [2013]. HHS designation of additional members of the special exposure cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000 designating a class of employees from Rocky Flats Plant Golden, Colorado. Washington, DC: U.S. Department of Health and Human Services, Office of the Secretary. December 12. [SRDB Ref ID: 166855]