

## SEC Petition Evaluation Report

### Petition SEC-00192

Report Rev #:0

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Site Expert(s):		N/A		
<b>Petition Administrative Summary</b>				
<b>Petition Under Evaluation</b>				
Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00192	83.13	August 23, 2011	February 9, 2012	Rocky Flats Plant
<b>Petitioner-Requested Class Definition</b>				
<i>All workers employed at Rocky Flats from April 1, 1952 to December 31, 2005.</i>				
<b>Class Evaluated by NIOSH</b>				
All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors with the potential for tritium exposures while working at the Rocky Flats Plant in Golden, Colorado, during the period from April 1, 1952 to December 31, 2005.				
<b>NIOSH-Proposed Class(es) to be Added to the SEC</b>				
None				
<b>Related Petition Summary Information</b>				
SEC Petition Tracking #(s)	Petition Type	DOE Facility Name	Petition Status	
SEC-00030	83.13	Rocky Flats Plant	Two classes added to the SEC: - Apr. 1, 1952 through Dec. 31, 1958 - Jan. 1, 1959 through Dec. 31, 1966	
<b>Related Evaluation Report Information</b>				
Report Title	DOE/AWE Facility Name			
SEC Petition Evaluation Report for Petition SEC-00030	Rocky Flats Plant			
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## Evaluation Report Summary: SEC-00192, Rocky Flats Plant

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

### Petitioner-Requested Class Definition

Petition SEC-00192 was received on August 23, 2011, and qualified on February 9, 2012. The petitioner requested that NIOSH consider the following class: *All workers employed at Rocky Flats from April 1, 1952 to December 31, 2005.*

### Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class. NIOSH evaluated the following class: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors with the potential for tritium exposures while working at the Rocky Flats Plant in Golden, Colorado, during the period from April 1, 1952 to December 31, 2005.

### NIOSH-Proposed Class(es) to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has obtained documentation and data for the worst-case tritium exposure scenario at RFP for any worker, working in any area, over the applicable time period under evaluation. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

### Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of maximum dose. Information available from the site profile and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period.

### Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the evaluated class.

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## Table of Contents

1.0	Purpose and Scope.....	7
2.0	Introduction.....	7
3.0	SEC-00192 Rocky Flats Plant Class Definitions .....	8
3.1	Petitioner-Requested Class Definition and Basis.....	8
3.2	Class Evaluated by NIOSH.....	9
3.3	NIOSH-Proposed Class(es) to be Added to the SEC.....	9
4.0	Data Sources Reviewed by NIOSH to Evaluate the Class.....	9
4.1	Site Profile Technical Basis Documents (TBDs).....	10
4.2	Technical Information Bulletins and Procedures.....	11
4.3	Facility Employees and Experts.....	11
4.4	Previous Dose Reconstructions.....	13
4.5	NIOSH Site Research Database.....	13
4.6	Documentation and/or Affidavits Provided by Petitioners.....	13
5.0	Radiological Operations Relevant to the Class Evaluated by NIOSH.....	14
5.1	Rocky Flats Plant and Process Descriptions.....	14
5.2	Radiological Exposure Sources from Rocky Flats Operations.....	20
5.2.1	Tritium Exposure Sources from Rocky Flats Operations.....	20
5.2.2	Plant Operations and Radiological Programs.....	21
5.2.2.1	Tritium Operations.....	21
5.2.2.2	Radiological Programs.....	23
5.2.3	Incidents.....	24
6.0	Summary of Available Monitoring Data for the Class Evaluated by NIOSH.....	26
6.1	Available Rocky Flats Plant Tritium Monitoring Data.....	26
6.2	Available Rocky Flats Plant External Monitoring Data.....	29
7.0	Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH.....	29
7.1	Pedigree of Rocky Flats Plant Data.....	30
7.1.1	Tritium Monitoring Data Pedigree Review.....	30
7.2	Evaluation of Bounding Tritium Radiation Doses at Rocky Flats.....	31
7.2.1	Evaluation of Bounding Process-Related Tritium Doses.....	31
7.2.1.1	Tritium Urinalysis Information and Available Data.....	31
7.2.1.2	Tritium Airborne Survey Data.....	31
7.2.2	Evaluation of Bounding Ambient Environmental Internal Tritium Doses.....	32
7.2.3	Methods for Bounding Tritium Dose at Rocky Flats.....	32
7.2.3.1	Excerpts from the 1973 RFP Tritium Release Investigation.....	32
7.2.3.2	NIOSH Conclusion on the RFP Bounding Approach.....	35
7.2.4	Internal Tritium Dose Reconstruction Feasibility Conclusion.....	36
7.3	Evaluation of Bounding External Radiation Doses at Rocky Flats.....	36
7.4	Evaluation of Petition Basis for SEC-00192.....	36

7.4.1	Incidents .....	36
7.4.2	Building 460 Plutonium .....	37
7.4.3	Tritium Exposures .....	37
7.4.4	Previous Issues – RFP Site Profile .....	38
7.4.5	Information Not Provided in the Previous SEC Evaluation .....	39
7.4.6	Adequacy of Co-worker Models .....	39
7.4.7	Analysis Laboratories .....	40
7.4.8	Analysis Laboratories .....	40
7.4.9	Site and Process Information .....	41
7.5	Other Potential SEC Issues Relevant to the Petition Identified During the Evaluation .....	41
7.6	Summary of Feasibility Findings for Petition SEC-00192 .....	49
8.0	Evaluation of Health Endangerment for Petition SEC-00192 .....	49
9.0	Class Conclusion for Petition SEC-00192 .....	50
10.0	References .....	51
	Attachment 1: Data Capture Synopsis .....	59

## Tables

4-1:	No. of Rocky Flats Claims Submitted Under the Dose Reconstruction Rule .....	13
5-1:	Rocky Flats Plant Development Chronology and Population Over Time .....	15
5-2:	RFP Key Facilities with Potential Tritium Exposures .....	17
6-1:	Available RFP Tritium Data from 122 NOCTS Claims .....	28
7-1:	Summary of RFP Tritium Dose Estimates (mrem) .....	35
7-2:	Summary of Feasibility Findings for SEC-00192 .....	49

## SEC Petition Evaluation Report for SEC-00030

*ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Daniel Stempfley, Dade Moeller. The rationales for all conclusions in this document are explained in the associated text.*

### 1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for Rocky Flats Plant workers from exposures to tritium during the period from April 1, 1952 through December 31, 2005. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH. This report also does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

This evaluation was conducted in accordance with the requirements of EEOICPA, 42 C.F.R. pt. 83, and the guidance contained in the Division of Compensation Analysis and Support's (DCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, DCAS-PR-004.<sup>1</sup>

### 2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.<sup>2</sup>

42 C.F.R. § 83.13(c)(1) states: *Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose.*

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such

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<sup>1</sup> DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).

<sup>2</sup> NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at <http://www.cdc.gov/niosh/ocas>.

radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for one or more other SEC classes.

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioner(s) and the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.<sup>3</sup>

### **3.0 SEC-00192 Rocky Flats Plant Class Definitions**

The following subsections address the evolution of the class definition for SEC-00192, Rocky Flats Plant. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

#### **3.1 Petitioner-Requested Class Definition and Basis**

Petition SEC-00192 was received on August 23, 2011, and qualified on February 9, 2012. The petitioner requested that NIOSH consider the following class: *All workers employed at Rocky Flats from April 1, 1952 to December 31, 2005.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Rocky Flats workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00192 for evaluation.

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<sup>3</sup> See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available at <http://www.cdc.gov/niosh/ocas>.

The petitioner affidavit states:

*I attest that there were occasions when I was not monitored. When I worked in the 700 complex, one of my duties was to work on site returns. I clearly remember one incident at a down draft table. I was given the incorrect measurements and when the machine tool reached the given measurement the shell was breached. I remember that I had a nasal smear taken after the breach. I have requested a copy of this nasal smear report numerous times but have not received it. I was later told that I was probably exposed to tritium gas. I have no bioassay for tritium exposure. (Affidavit, 2011)*

Based on its review of Rocky Flats Plant past research and data capture efforts, specifically as it relates to the SEC-00030 RFP evaluation, NIOSH determined that it has access to personnel or area monitoring data for Rocky Flats workers specifically applicable to tritium starting from the time of the tritium incident that occurred in 1973. However, NIOSH also determined that a review of tritium records and data was necessary for all time periods. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that tritium radiation exposures and radiation doses were not adequately monitored at Rocky Flats Plant, either through personal monitoring or area monitoring. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

### **3.2 Class Evaluated by NIOSH**

Based on its preliminary research, NIOSH accepted the petitioner-requested class because NIOSH has determined there is evidence of possible tritium exposures warranting evaluation beyond that performed for SEC-00030. Therefore, NIOSH defined the following class for further evaluation: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors with the potential for tritium exposures while working at the Rocky Flats Plant in Golden, Colorado, during the period from April 1, 1952 to December 31, 2005.

### **3.3 NIOSH-Proposed Class(es) to be Added to the SEC**

Based on its research, NIOSH has obtained monitoring data and bioassay data for the worst-case tritium exposure scenario that support its ability to bound the tritium dose at the Rocky Flats Plant over the site's entire covered operational period. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate tritium radiation doses with sufficient accuracy.

## **4.0 Data Sources Reviewed by NIOSH to Evaluate the Class**

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding Rocky Flats Plant. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI

Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment 1 contains a summary of Rocky Flats Plant documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

#### **4.1 Site Profile Technical Basis Documents (TBDs)**

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document. As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Rocky Flats Plant operations or related topics/operations at other sites:

- *Rocky Flats Plant– Introduction*, ORAUT-TKBS-0011-1; Rev. 01; November 30, 2006; SRDB Ref ID: 30012
- *Rocky Flats Plant – Site Description*, ORAUT-TKBS-0011-2; Rev. 01; February 1, 2007; SRDB Ref ID: 30013
- *Rocky Flats Plant – Occupational Medical Dose*, ORAUT-TKBS-0011-3; Rev. 01; April 23, 2007; SRDB Ref ID: 31376
- *Rocky Flats Plant – Occupational Environmental Dose*, ORAUT-TKBS-0011-4; Rev. 02; April 23, 2007; SRDB Ref ID: 31377
- *Rocky Flats Plant – Occupational Internal Dose*, ORAUT-TKBS-0011-5; Rev. 02; August 17, 2007; SRDB Ref ID: 34365
- *Rocky Flats Plant – Occupational External Dose*, ORAUT-TKBS-0011-6; Rev. 02 PC-1; October 20, 2010; SRDB Ref ID: 89284

## 4.2 Technical Information Bulletins and Procedures

A Technical Information Bulletin is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. A Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following Technical Information Bulletins as part of its evaluation:

- *OTIB: Tritium Calculated and Missed Dose Estimates*, ORAUT-OTIB-0011; Rev. 00; Oak Ridge Associated Universities; June 29, 2004; SRDB Ref ID: 19430
- *TIB: Tritium Calculations with IMBA*, OCAS-TIB-002; Rev. 00; April 22, 2003; National Institute for Occupational Safety and Health (NIOSH); SRDB Ref ID: 22407

## 4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed 12 former RFP employees. NIOSH performed individual telephone interviews as well as worker outreach meetings in Colorado to obtain additional information regarding tritium exposures and monitoring at RFP.

- Personal Communication, 2012a, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 12, 2012; SRDB Ref ID: 116217
- Personal Communication, 2012b, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 12, 2012; SRDB Ref ID: 116218
- Personal Communication, 2012c, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 13, 2012; SRDB Ref ID: 116008
- Personal Communication, 2012d, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 13, 2012; SRDB Ref ID: 116009
- Personal Communication, 2012e, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 21, 2012; SRDB Ref ID: 116210
- Personal Communication, 2012f, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 21, 2012; SRDB Ref ID: 116211
- Personal Communication, 2012g, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 22, 2012; SRDB Ref ID: 116666
- Personal Communication, 2012h, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; June 26, 2012; SRDB Ref ID: 117164
- Personal Communication, 2012i, *Personal Communication with* [redacted]; Telephone Interview by ORAU staff; July 9, 2012; SRDB Ref ID: 116671

- Personal Communication, 2012j, *Personal Communication with [redacted]*; Telephone Interview by ORAU staff; July 9, 2012; SRDB Ref ID: 116672
- Personal Communication, 2012k, *Personal Communication with [redacted]*; Telephone Interview by ORAU staff; July 18, 2012; SRDB Ref ID: 116677
- Personal Communication, 2012l, *Personal Communication with [redacted]*; In-person Classified Interview by ORAU staff; August 10, 2012; SRDB Ref ID: 117245
- Worker Outreach Meeting, 2012a, *Colorado Worker Outreach Meeting with former RFP Workers 10:00 AM session*; Public outreach meeting by ORAU and NIOSH staff; May 24, 2012; SRDB Ref ID: 117357
- Worker Outreach Meeting, 2012b, *Colorado Worker Outreach Meeting with former RFP Workers 1:15 PM session*; Public outreach meeting by ORAU and NIOSH staff; May 24, 2012; SRDB Ref ID: 117358

The interviews and meetings performed in support of this evaluation were focused on collecting information specific to tritium at RFP, and more specifically, collecting tritium information for the period prior to the 1973 incident. Of the 12 interviews performed, six were with former employees who worked at RFP prior to 1973. The collective summary of the information from the interviews and meetings indicate the following:

- As a normal practice, RFP did not handle or process tritium and did not expect to have tritium-contaminated materials on site (other than tritium targets for neutron generators).
- Although they may not have been as effective, instruments for monitoring for tritium existed from the very early years at the site, including sniffers, vibrating reed instruments, and air bubblers.
- The site performed environmental monitoring for tritium, including the periods prior to the 1973 incident, with no positive results that personnel could recall.
- There were limited tritium bioassay samples performed at RFP prior to the 1973 incident; there were no known positive bioassays other than those associated with the 1973 incident.
- Radiological surveys were performed at the site that included periodic tritium smears.
- The 1973 incident involved tritium-contaminated materials from Livermore (described as pits and scrap materials) and resulted in personnel exposures, which resulted in a program change regarding tritium at the site.

The interviews listed above are referenced, as applicable, within the text of this evaluation report.

#### 4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of July 9, 2012)

<b>Table 4-1: No. of Rocky Flats Claims Submitted Under the Dose Reconstruction Rule</b>	
<b>Description</b>	<b>Totals</b>
Total number of claims submitted for dose reconstruction	1695
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	1524
Number of additional claims identified as SEC Pulled (i.e., pulled from NIOSH by the Department of Labor for final approval).	81
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	1442
Number of claims for which tritium bioassay records were obtained for the identified years in the evaluated class definition	122

<sup>1</sup> Table 4-1 totals comprise all RFP claims listed in NOCTS, including those that may be covered by other existing SECs.

#### 4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. 3399 documents in this database were identified as pertaining to Rocky Flats. These documents were evaluated for their relevance to this petition. The documents include historical background on air monitoring, urinalysis data, the radiological control program, process materials, and process description.

#### 4.6 Documentation and/or Affidavits Provided by Petitioners

In qualifying and evaluating the petition, NIOSH reviewed the following document submitted by the petitioners:

- *Affidavit from* [redacted]; October 31, 2011; DSA Ref ID: 115186, pdf p. 7 (Affidavit, 2011)

## 5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

*NOTE: This SEC-00192 Evaluation Report (ER) focuses on RFP worker exposures to tritium. However, during the feasibility evaluation for SEC-00192, NIOSH concluded that a review of SEC-00030 issues and their subsequent resolutions and closures should be documented in this report. This review is provided in Section 7.5. For discussions about all other non-tritium aspects of RFP work and their related exposures, refer to the SEC-00030 Evaluation Report. Discussion of non-tritium topics beyond those discussed in Section 7.5 will not be included in this ER.*

The following subsections summarize both tritium operations at the Rocky Flats Plant (RFP) from April 1, 1952 to December 31, 2005, and the information available to NIOSH to characterize particular tritium processes and radioactive source quantities. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

### 5.1 Rocky Flats Plant and Process Descriptions

The Rocky Flats Plant was located in Golden, Colorado on a 384-acre site, surrounded by a ~6000-acre buffer zone (RFP Overview, 2001; RFP Overview, 2011). The workforce grew from a little over 100 people at the beginning of the site's covered period to just over 6000 in 1990. After the site ended operations and entered its remediation phase, the workforce began to decrease from the 1990 employment levels until site closure in 2005. The previous Rocky Flats Plant SEC evaluation, SEC-00030, assessed all potential exposure issues with the exception of tritium (see Section 7.5 of this report). Consequently, this SEC-00192 evaluation focuses on those operations/activities with the potential for tritium exposures; therefore, only those locations and operations with the potential for tritium exposure will be discussed in this report.

As previously discussed in the SEC-00030 ER, RFP site construction began in 1951 and initial radiological operations began in April 1952. The primary missions and general activities at the plant remained essentially the same from the time the plant opened until 1989, when the U.S. Department of Energy (DOE) suspended plutonium operations. From the beginning, the plant was a manufacturing facility making and recycling nuclear and non-nuclear components for a portion of the U.S. nuclear weapons arsenal.

In 1989, DOE suspended plutonium processing to review and upgrade the plant's safety systems. Although the site continued to prepare for restart after the 1989 shutdown, the Rocky Flats production mission ended permanently in 1992 and entered a site clean-up and remediation phase. In 1993, the Secretary of Energy formally announced the end of nuclear production at Rocky Flats. In 1994, the last defense production-related shipment left the site. The RFP site remediation was completed and the site officially closed in October 2005.

Table 5-1 summarizes the site's development.

<b>Table 5-1: Rocky Flats Plant Development Chronology and Population Over Time</b>			
<b>Years</b>	<b>Buildings</b>	<b>Comments</b>	<b>Plant Population</b>
1951-1954	991, 771, 444, 881	By April 1952, production operations reportedly had begun, but no production or shipment details are available for 1952 or the first part of 1953. By 1954, the plant was fully operational with about 700,000 square feet of building space.	Employment grew steadily during this time. In 1951, there were 133 people.
1955		A major facility expansion began, referred to as Part IV construction.	Approximately 1200 (ChemRisk 3&4, 1992, Figure 3-4, p. 50)
1956-1957	447, 776, 777, 883, 997, 998, 999, and the expansion of Bldgs. 444, 881, 771	These additions were directly related to the change of the weapon concept to a hollow unit and the anticipated production increases. A few years later, roughly coincident with the onset of the Cold War, RFP became the primary manufacturer of pits under the single-mission concept.	Approximately 1500 (ChemRisk 3&4, 1992, Figure 3-4, p. 50)
Mid-1960s	559, 779, 865	These additions were research and development facilities focusing on effects of time and field conditions on weapons.	By 1964, the workforce reached a level of about 3,000 people that remained stable for about 15 years.
Early 1980s-1990	371, 460	By 1990, total building space had grown to about 2.5 million square feet.	Significant upturn in employment, with a peak of 5,990 in 1984.
1990s-2006		Pu processing ceased in 1990. The announcement of the curtailment of nuclear weapons components for submarine-based missiles ended nuclear production. Decontamination and Decommissioning phase. Site closed in 2005.	Announcement in workforce reduction to ~4,000 by October, 1995. As of 1999, there were 280 DOE employees and 3410 contractors at the RFP site (RFP Overview, 2001).

### Tritium Related Operations

Rocky Flats dealt with pits or primary triggers for three different weapons types/pits over its history. The first two, which are the designs associated with pure fission devices (like those used in the "Fat Man" and "Little Boy" weapons), were handled through 1957 until those designs were phased out for improved, boosted fission or thermonuclear designs. The latter designs may have incorporated materials like tritium; however, operations involving coupling tritium with pits were performed at other sites (ChemRisk 3&4, 1992, p. 45.). Since 1958, pit designs at RFP remained relatively the same (ChemRisk 3&4, 1992, p. 47). Around the time of this change at RFP, the AEC began revising the weapons program so that each site focused on specific operations instead of maintaining the same production operations at multiple sites. RFP dropped most of its uranium operations as a part of this program change and became primarily focused on the plutonium pit operations (in the late 1950s and early 1960s). The program changes included construction and transformation of facilities to handle returned plutonium pits (including methods to remove Am-241 from the weapons-grade plutonium). Although it appears that the main focus of site operations shifted at the end of 1957 (ChemRisk 3&4, 1992, pp. 45-61; RFP Operations Overview, 1996, pdf pp. 11-12), NIOSH's follow-up research findings indicate that tritium-contaminated material in a form similar to the Lawrence Livermore

Laboratory (LLL, now LLNL)<sup>4</sup> materials associated with the 1973 incident, as well as pits in the form of returns contaminated with tritium, were in existence in the MED/AEC complex in the early 1950s, although there is no documented indication that those materials existed at RFP prior to 1957, and most likely, not until the late 1960s. As discussed in the 1994 ChemRisk report for Rocky Flats, a conservative assumption would be that the release of tritium from similar operations could have occurred since the time that RFP plutonium operations commenced in 1953 (LLNL Parts, 2012; Review, 2012b; ChemRisk 5, 1994, Page 119).

The main plutonium sources at RFP during the late 1950s included plutonium from Hanford and Savannah River Site (SRS), and pits from retired nuclear weapons from the Pantex Plant (ChemRisk 3&4, 1992, pp. 45-61; RFP Operations Overview, 1996, pdf pp. 11-12). Although the transuranic radioactive materials on site could have been responsible for the generation of tritium as a result of neutron interactions (mentioned below), the site deemed that the most significant source of personnel exposure was tritium-contaminated materials associated with plutonium returns.

RFP also took over the AEC's manufacture of stainless-steel tritium reservoirs in 1964. This occurred when the AEC shifted the contract from the American Car and Foundry Corporation in Albuquerque to RFP because of contract and economic reasons (ChemRisk 3&4, 1992, p. 54). It should be noted that although RFP manufactured these highly-technical components, they sent the tritium reservoirs to other locations for final assembly; therefore, although it was related, this work did not constitute a tritium activity at RFP (Tritium Reservoirs, 2012).<sup>5</sup>

The nature of the weapons work at Rocky Flats, and the specific weapons materials involved, resulted in the handling of tritium sources and the potential cross-contamination of materials, such as the materials associated with the 1968, 1973, and 1974 incidents discussed in the following section. The site's assessment indicates that these potential sources existed from the beginning of plutonium operations at the site through the end of site operations (ChemRisk 3&4, 1992; ChemRisk 5, 1994, p. 119; RFP Overview, 2001, pdf p 5). This tritium was associated with, and the result of, the receipt and reprocessing of contaminated weapons components and related waste or return products/materials sent to the site from other AEC/DOE facilities. The disassembly and reprocessing of these components had the potential to introduce tritium into air and wastewater streams, and in several documented cases, resulted in site environmental releases (Worker Outreach Meeting, 2012b).

### Other Potential Tritium Sources

Another known tritium-related operation was associated with neutron generator targets, which incorporated the use of the tritium targets starting in 1963 (Tritium Release, 1973, pdf p. 68). As reported in a 1973 incident follow-up report, the site had two types of Cockcroft-Walton neutron generators, one incorporating a sealed-tube target and one incorporating a drift-tube target. Neutron generators were located in five different locations on site (Neutron Generators, 1973): Building 886 (1963-1987) (Critical Mass Lab, 2011; Tritium Release, 1973); Building 991 (1969-1976) (Building 991, 2011; Tritium Release, 1973); Building 881 (1969-the late 1980s) (Analytical Reports, 1985-86;

<sup>4</sup> Lawrence Livermore Laboratory is now called Lawrence Livermore National Laboratory (LLNL). The historical source documents used for this evaluation refer to LLL; this report will refer to LLNL from here on.

<sup>5</sup> Classified references at OSTI supporting the conclusions of this document include: (1) P.L. Sturgill, "SP-949SL Fill Fitting Weld. (U)", LMfg-85-008, Rockwell International, 1985, and (2) R.W. Nokes, "Characterization of the SP830. (U)", CD71-101, Dow Chemical Company, Jan 05, 1971.

Building 881, 2011; Tritium Release, 1973); Building 444 (1969-1971) (Building 444, 2011; Tritium Release, 1973); and Building 123 (1964-1980s/1990s) (Building 123, 2011; Decommissioning, 1997; Tritium Release, 1973). As of the 1973 incident assessment, the site had purchased 241 Ci of tritium containing targets. Based on documentation from the site (Target Changes, 1971) regarding sealed-tube type neutron generators, maintenance could only be performed by a factory-authorized maintenance person in order to keep the warranty on the equipment valid. This was specific to maintenance on the head where the tritium target was installed (in a glass tube at a vacuum). Users/operators did, however, handle and replace the tritium targets in the drift-tube type units. Tritium contamination was also a concern in the neutron generator support systems, specifically the vacuum-pump system and the cooling-water system (Tritium Release, 1973).

There was also the potential to produce tritium at the site under normal conditions considering the various radioactive materials present (Tritium Release, 1973). Other sources discussed in the RFP Tritium release document (Tritium Release, 1973) were assessed but determined not to be a significant source or contributor to the overall tritium source term at Rocky Flats (Tritium Release, 1973).

Table 5-2 summarizes the key processes with the potential for tritium exposures. All processing buildings were demolished as of October 2005.

**Table 5-2: RFP Key Facilities with Potential Tritium Exposures**  
(This table spans four pages)

<b>Buildings</b>	<b>Facilities</b>	<b>Date of Start-up of Operations</b>	<b>Comments</b>
122	<b>Medical Services Facility:</b> This facility included a radiological decontamination facility with the potential for tritium contamination.	1953	Tritium Release, 1973, Fig VI-1, indicates Bldg 122 and 123 were in the waste transfer stream that had a potential for tritium exposures. Also see reference: Building 122, 2011, Facility Description.
123	<b>Analytical Health Physics Laboratory:</b> This facility contained a neutron generator with tritiated targets.	1953	Tritium Release, 1973, Fig VI-1, indicates Bldg 122 and 123 were in the waste transfer stream that had a potential for tritium exposures. Tritium Release, 1973, pdf p. 75, indicates Bldg 123 neutron generator tritium source exposures for dosimetry studies. Reference: Building 123, 2011 has a facility description.
374	<b>Waste Water Facility:</b> Waste waters contaminated with tritium were evaporated in this facility.	1970s	ChemRisk 3&4, 1992, p. 130, indicates tritium exposure.
440	<b>Modification Center Receiving:</b> Received tritium-contaminated scrap.	1960s	Tritium Release, 1973, Fig 1-1 p. 98, indicates Bldg 440 received scrap. ChemRisk 3&4, 1992, pp. 55-57 shows Bldg 440.

**Table 5-2: RFP Key Facilities with Potential Tritium Exposures**  
(This table spans four pages)

<b>Buildings</b>	<b>Facilities</b>	<b>Date of Start-up of Operations</b>	<b>Comments</b>
444	<b>DU and Beryllium Metallurgy:</b> This facility contained a neutron generator with tritiated targets. Tritium stripping began in 1987; the U foundry shut down in 1989.	1953	Tritium Release, 1973, Fig 1-1, indicates Bldg 444 as a potential location with tritium exposures. Tritium Release, 1973, Fig VI-1, indicates Bldg 444 was in the waste transfer stream that had a potential for tritium exposures. Reference Tritium Release, 1973, pdf p. 75, indicates Bldg 444 neutron generator tritium source exposures.
559/561	<b>Plutonium Analytical Lab:</b> Pu analytical laboratory operations are a possible source of tritium emissions from processing product. Building 561 contained the exhaust plenums for Building 559.	1968	Tritium Release, 1973, Fig VI-1, indicates Bldg 559 was in the waste transfer stream that had potential for tritium exposures. ChemRisk 3&4, 1992, p. 130.
707/707A	<b>Plutonium Fabrication Operations:</b> Bldg. 707 was originally a manufacturing facility for casting, fabricating, and assembling finished plutonium parts (as well as parts made of other materials) into nuclear weapons components. These operations had the potential for tritium contamination. Bldg. 707A was added as part of a 1972 modification.	1972	Tritium Release, 1973, Fig VI-1 indicates Bldg 707 was in the waste transfer stream that had potential for tritium exposures. ChemRisk 3&4, 1992, p. 130
771/774	<b>Pu Recovery and Liquid Waste Treatment Building:</b> Bldg. 771 was designed for Pu recovery from scrap/residue materials. Bldg. 774 was used for low-level liquid waste treatment operations. Both had the potential for tritium contamination.	1953	Tritium Release, 1973, Fig 1-1 indicates Bldg 771 was where oxide residue was sent. Indicates 774 was location of Storage Tank 207. Tritium Release, 1973, Fig VI-1, indicates Bldg 771 and 774 were in the waste transfer stream that had potential for tritium exposures. ChemRisk 3&4, 1992, p. 130.
776/777	<b>Pu Manufacturing and Assembly Complex:</b> This complex was the major Pu fabrication and assembly facility. Waste operations (initiated in 1969 to support disposition of equipment damaged by the fire as well as waste generated in the clean-up efforts) were on-going. The Supercompactor and size-reduction facilities were used to minimize the total volume of radioactive waste at the complex. Bldg. 776 housed drums containing Pu residue and supported drum-venting activities to prevent the build-up of hydrogen gas and had the potential for tritium contamination. Bldg. 777 was a foundry operations and coatings facility and also operated as a disassembly and scrap-weighing location with the potential to be the source of the most significant tritium releases at the site (i.e., the highest percentage of the site's overall tritium releases).	1957	Tritium Release, 1973, Fig 1-1 indicates Bldg 777 weighed scrap. Tritium Release, 1973, Fig VI-1, indicates Bldg 776 was in the waste transfer stream that had potential for tritium exposures. ChemRisk 3&4, 1992, p. 130.

**Table 5-2: RFP Key Facilities with Potential Tritium Exposures**  
(This table spans four pages)

<b>Buildings</b>	<b>Facilities</b>	<b>Date of Start-up of Operations</b>	<b>Comments</b>
778	<b>Building 778</b> was a support building for the Pu processing buildings (776, 777, and 707). It was located directly south of Buildings 776 / 777 and was connected to these buildings, as well as Building 707, by enclosed walkways. Over its history, Bldg. 778 was used mainly as a protective clothing (Anti-C) laundry for all the Pu process buildings, a locker room and shower area, and maintenance shops. It had the potential for tritium contamination.	1957	Tritium Release, 1973, Fig VI-1 indicates Bldg 778 was in the waste transfer stream that had potential for tritium exposures. See also reference Building 778, 2011.
779	<b>Pu Development Building:</b> This building was constructed for Pu research activities involving process chemistry technology, physical metallurgy, machining and gauging, joining technology, and hydrating operations. Glovebox activities in support of Pu storage included inspection, metal brushing, and repackaging. Hydrating operations performed at the facility to recover plutonium also resulted in tritium releases.	1965	Tritium Release, 1973, Fig 1-1 indicates Bldg 779 was location of Hydrating Lab and waste tank dump to offsite. Tritium Release, 1973, Fig VI-1, indicates Bldg 779 was in the waste transfer stream that had potential for tritium exposures. ChemRisk 3&4, 1992, p. 130.
865, 867, 868	<b>Research and Development of Uranium and Beryllium:</b> Material and process development and metallurgy laboratory. High Bay area of Building 865 supported production through research and development with a potential tritium waste stream. Buildings 867 and 868 contained filter plenums for process exhaust routed from Building 865.	1970	Tritium Release, 1973, Fig VI-1, indicates Bldg 865 was in the waste transfer stream that had potential for tritium exposures.
881	<b>Laboratories, maintenance shops, and plant support facilities:</b> The original building was designed and built for processing enriched U. Small quantities of other radioactive materials such as U-233 and Pu were also handled. The facility contained a neutron generator with tritiated targets.	1953	Tritium Release, 1973, Fig 1-1, indicates Bldg 881 as a potential location with tritium exposures. Tritium Release, 1973, Fig VI-1, indicates Bldg 881 was in the waste transfer stream that had potential for tritium exposures. Tritium Release, 1973, pdf p. 75, indicates Bldg 881 neutron generator tritium source exposures.
883	<b>Beryllium and Uranium Machining Facility:</b> Machining facility for both enriched and depleted U. The building was divided into an A side and B side. The A side rolled enriched U while the B side rolled depleted U. In 1966, the A side of Building 883 was converted to Be rolling. Depleted U rolling continued on the B side. Some indication of work with tritium shells (breaking up shells).	1957	Tritium Release, 1973, Fig 1-1, indicates Bldg 883 as a potential location with tritium exposures. Tritium Release, 1973, Fig VI-1, indicates Bldg 883 was in the waste transfer stream that had potential for tritium exposures.
886	<b>Critical Mass Laboratory/Nuclear Safety Facility:</b> This building contained a critical mass laboratory that had been used to conduct criticality experiments in support of process operations. More than 1,600 criticality experiments were performed. Short-lived fission products were produced and none were indicated as having been released to the work or outdoor environment. The isotopes decayed rapidly and were contained until stable. The facility contained a neutron generator with tritiated targets.	1965	Tritium Release, 1973, Fig VI-1, indicates Bldg 886 was in the waste transfer stream that had potential for tritium exposures. Tritium Release, 1973, pdf p. 75 indicates Bldg 886 neutron generator tritium source exposures

**Table 5-2: RFP Key Facilities with Potential Tritium Exposures**  
(This table spans four pages)

Buildings	Facilities	Date of Start-up of Operations	Comments
889	<b>Equipment Repackaging and Decontamination Facility:</b> Potential for tritium contamination.	Late 1960s	Tritium Release, 1973, Fig VI-1, indicates Bldg 889 was in the waste transfer stream that had potential for tritium exposures. See also reference Decontamination, 1997.
Solar Ponds, 207A, B, and C	<b>Reverse Osmosis Facility:</b> Bldg 910 was constructed in 1977. Solar Pond 207A constructed and put into use in 1957. It was used to store and evaporate low-level contaminated waste containing nitrates and radioactive substances (laundry wastewater containing Pu and U). Solar Ponds 207B and 207C were put into service in 1960. There was the potential for tritium contamination at these locations as the collection point for other facility discharges.	1957	Tritium Release, 1973, Fig 1-1, indicates Pond 207A as a potential location with tritium exposures. Tritium Release, 1973, Fig VI-1 indicates the 207 ponds were in the waste transfer stream that had potential for tritium exposures.
991	<b>Building 991</b> was used for weapon assembly, and later, storage and shipment of waste. Emissions data include: $^{238}\text{Pu}$ , $^{238/239}\text{Pu}$ , $^{241}\text{Am}$ , $^{233/234}\text{U}$ , and $^{238}\text{U}$ . Building 991 also provided access to underground storage vaults 996, 997, and 999. The facility contained a neutron generator with tritiated targets.	1952	Tritium Release, 1973, pdf p. 75, indicates Bldg 991 neutron generator tritium source exposures.
995	<b>Sanitary Sewage Treatment Facility:</b> There was the potential for tritium contamination at this location as the collection point for other facility discharges.	unknown	Tritium Release, 1973, Fig VI-1, indicates Bldg 995 was in the waste transfer stream that had potential for tritium exposures.

## 5.2 Radiological Exposure Sources from Rocky Flats Operations

*NOTE: This SEC-00192 Evaluation Report (ER) focuses on RFP worker exposures to tritium. However, during the feasibility evaluation for SEC-00192, NIOSH concluded that a review of SEC-00030 issues and their subsequent resolutions and closures should be documented in this report. This review is provided in Section 7.5. For discussions about all other non-tritium aspects of RFP work and their related exposures, refer to the SEC-00030 Evaluation Report. Discussion of non-tritium topics beyond those discussed in Section 7.5 will not be included in this ER.*

The following subsections provide an overview of the exposure sources for the Rocky Flats class under evaluation in this report.

### 5.2.1 Tritium Exposure Sources from Rocky Flats Operations

Tritium is a radioactive isotope of hydrogen with a mass number of 3. It has a half-life of 12.262 years and emits an 18 keV  $E_{\text{max}}$  (~6 keV  $E_{\text{avg}}$ ) beta particle, with no other emissions. In the form of tritiated water (HTO), it will distribute uniformly throughout water-based body fluids. Because of the low energy of the beta particle, the dose is primarily an internal exposure concern where the dose to the whole body is equivalent to any particular organ dose.

The potential for tritium exposures from RFP operations involving tritium-contaminated materials (e.g., materials associated with the 1968, 1973, and 1974 incidents) existed from the beginning of operations to the end of operations in 1989 (ChemRisk 3&4, 1992; ChemRisk 5, 1994, p. 119; RFP Overview, 2001, pdf p 5). This tritium was associated with, and the result of, the receipt and reprocessing of tritium-contaminated weapons components returned to the site. For the most part, in cases prior to 1973, the site did not consider tritium a potential source of exposure as an equipment/material contaminant; therefore, there was not a significant monitoring program prior to the 1973 incident.

Other known tritium sources, associated with neutron generator targets, were brought on site beginning in 1963 (Tritium Release, 1973, pdf p. 68). As of the 1973 incident assessment, the site had purchased 241 Ci of tritium-containing targets. The site's assessment concluded that the release of the entire amount of tritium from all of the targets would be necessary to produce a significant exposure from the targets (a scenario that is not evident from the available information) (Release Investigation, 1973). The site concluded, and NIOSH concurs, that this source is not a significant tritium source from the perspective of a bounding exposure at RFP.

As part of its evaluation of tritium sources, the site also reviewed operations with the potential to produce tritium as a result of radiation interactions. The site concluded that the most likely and significant source of this tritium was associated with radiation interactions involving materials such as plutonium, boron, beryllium, and nitrogen. Two estimates were provided based on two evaluations performed in the early 1970s. The first estimate based on this source term determined that approximately 0.2 Ci/yr could have been produced with a worst-case production rate of 3.2 Ci/yr (although the worst-case conditions were considered unrealistic) (Tritium Release, 1973, pdf p. 70). A follow-up estimate was based on the assessment of six possible sources with a result of 5.4E-12 Ci/day (approximately 2.0E-9 Ci/yr), which was much closer to the site's measured background levels at the time (Tritium Release, 1973, pdf p. 70). The site's conclusion was that this was not a significant tritium production/emissions source at RFP from the perspective of personnel chronic exposures (Tritium Monitoring History, 1973). NIOSH evaluated this issue and concurred with the site's conclusion.

## **5.2.2 Plant Operations and Radiological Programs**

This section reviews the engineering controls and plant configurations for RFP tritium-related operations. It also compares the radiological monitoring programs over the years as they relate to tritium exposures and monitoring.

### 5.2.2.1 Tritium Operations

Based on its assessment of RFP operations, NIOSH has concluded that the operations that could have resulted in the most significant personnel exposures to tritium were associated with the receipt and processing of scrap plutonium and returned/retired plutonium pits from other sites. The site received this scrap material and other "special materials" from other sites for the purpose of recovering and recycling usable plutonium. This is the type of material that resulted in the 1973 incident that produced the highest recorded tritium contamination levels at the site. The 1973 tritium-contaminated scrap was received from LLNL and processed over a period of time from April through September of 1973. As a result of the tritium contamination incident, RFP reviewed and revised its

material receipt process. RFP records from 1970-1974 indicated that approximately 290 shipments were delivered to RFP (Review, 2012a). Of these shipments, RFP considered the four from LLNL the most likely to have been contaminated with tritium. The estimated levels of tritium contamination in each of the four shipments was: April 1969, 57 Ci; March 1971, 50Ci; December 1971, 29 Ci (Tritium Release, 1973, pdf pp. 68-71); March 1973, 500-2000 Ci. Other potential sources of tritium at RFP were also evaluated and determined to be very small in comparison to the 1973 incident levels (Tritium Release, 1973). This is exemplified in the tritium incidents that resulted in the most significant personnel tritium exposures at the site. The plutonium operations were performed in specific buildings, including Buildings 771 and 776/777. As indicated in the available documentation, the operations associated with the receipt and processing of returns and scrap did not change significantly over the early years until after the tritium incidents of 1973 and 1974.

Evaluation of 1,700 LANL 'site return' pits, retrieved from stockpile for Stockpile Laboratory Test (SLT) Evaluation, normal retirement, or with possible defective or unusual conditions, showed little or no tritium gas in the 18-month period in 1979 and 1980. Tritium gas concentrations in these pits ranged from  $<15 \mu\text{Ci}/\text{m}^3$  to  $468 \text{ mCi}/\text{m}^3$ , with most in the  $150 \text{ mCi}/\text{m}^3$  -  $350 \text{ mCi}/\text{m}^3$  range.<sup>6</sup>

Plutonium from site returns was reclaimed by acid dissolution, but parts involved in boost testing were reclaimed by a hydriding process in the Building 779A Hydriding Laboratory. Tritium levels monitored for a 40-day period in 1974 in a glovebox used for hydriding ranged from  $50 \mu\text{Ci}/\text{m}^3$  to  $300 \mu\text{Ci}/\text{m}^3$ . All other gloveboxes and the glovebox exhaust showed background ( $10 \mu\text{Ci}/\text{m}^3$ ) levels.<sup>7</sup> Radiography to determine the structural integrity of internal components was a routine part of Stockpile Laboratory Testing and was sufficient to determine that tritium contamination was likely in a pit returned for SLT evaluation in 1984. This pit was returned to LANL for disassembly.<sup>8</sup>

Building 771 was the initial and primary RFP facility constructed for plutonium operations from 1953 through 1957 (when Buildings 776/777 were placed in operation to handle the increased workload). In 1957, RFP installed an americium line in Building 771 to remove Am-241 that had grown into weapons-grade plutonium due to plutonium decay; the americium operation was most likely to involve scrap materials and returns. The americium was considered a significant contaminant in the plutonium from a weapons perspective. The americium product was a major money-maker at the site for some time based on its commercial use in items like smoke detectors. Both buildings (771 and 776/777) experienced fires that resulted in the shift of some operations to other locations. A Building 771 fire in 1957 resulted in the shift of some work to 776/777 (ChemRisk 3&4, 1992), and a Building 776/777 fire in 1969 resulted in the shift of some work to 707 (ChemRisk 3&4, 1992, p. 73).

Although changes in the individual plutonium purification process at RFP occurred over the years, the overall process remained unchanged until 1975, specifically as it related to engineering or plant configuration changes that would affect or control associated tritium exposures (Building 771, 1994). The primary airborne control implemented at the site was the use of HEPA filtration, which was

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<sup>6</sup> W.G. Scherer, "Summary Report of LANL Site-Return Pits for July 1979 through December 1980. (U)" CD81-2164, Rockwell International. (Classified Document, OSTI); cited in RefID\_117274, J.S. Bogard, "Review of Classified Documents in OSTI (deleted version)(U).

<sup>7</sup> R.P. DeGrazio, "Tritium Information from August 1 – September 9, 1974. (U)", CD74-3726. (Classified Document, OSTI); cited in RefID\_117274, J.S. Bogard, "Review of Classified Documents in OSTI (deleted version)(U).

<sup>8</sup> A.E. Hodges, III, Report no. CD84-1298, Rocky Flats Plant, March 5, 1984. (Title and document are classified, OSTI); cited in RefID\_117274, J.S. Bogard, "Review of Classified Documents in OSTI (deleted version)(U).

implemented from the beginning of operations in 1953 (ChemRisk 3&4, 1992, p. 66). RFP implemented administrative controls for tritium after the 1973 incident until engineering controls could be implemented in the processes to control potential exposures to tritium-contaminated scrap and materials; the engineering controls were completed in 1975.

Since the beginning of plutonium operations in 1953, RFP continuously upgraded its plant and systems to address the recycling of on-site and off-site scrap materials and returns as well as to align its operations with the different pit designs that RFP handled over the years. These upgrades included installation of the americium line in Building 771 that was associated with the weapons-recycling process. The most significant known source of tritium at RFP was the contaminated scrap materials received from LLNL from 1969-1973 (ChemRisk 3&4, 1992, p. 241; ChemRisk 5, 1994, p. 116). It is assumed that unmonitored levels of tritium are consistent with the 1973 incident levels, which involved the processing of tritium-contaminated materials at RFP over the period from April – September 1973 (i.e., the current maximum basis for tritium at RFP during any period). Therefore, the 1973 levels represent the maximum chronic exposure scenario for the period 1953-1973.

#### 5.2.2.2 Radiological Programs

Based on the available information reviewed by NIOSH for this evaluation, there were no reported detectable personnel exposures to tritium at RFP prior to the 1973 incident (Neutron Generators, 1973; Personal Communication, 2012a; Personal Communication, 2012f; Personal Communication, 2012g; Worker Outreach Meeting, 2012a). The 1973 incident introduced significant levels of tritium to the RFP that resulted in detectable personnel exposures. Although tritium was present at RFP prior to 1973, it was contained in sealed sources or was believed to be present at levels that did not constitute an exposure concern. Following the 1973 incident, a more rigorous bioassay program was implemented to monitor for potential tritium exposures (Urine Sampling, 1973).

A routine monitoring program was implemented that required that one-tenth of the urine samples taken as part of the Pu and Am monitoring program would be analyzed for tritium (Tritium Monitoring, 1974); however, in September 1975 this program was discontinued "... since not a single sample has measurable tritium during this testing period (1973-1975)". Consequently, the tritium monitoring program was changed to a job-specific program. The program basis document stated that RFP "... does not routinely handle tritium containing materials" (Sampling Program, 1981). The document identified the operations that would be involved in tritium sampling program, which included:

- Operations of neutron generators Building 887 (tritium/tritide targets)
- Operations of Gas Chromatograph Building 881 (tritiated foils)
- Operations of Special Disassembly Systems Building 777 (sealed sources containing tritium)
- Operations in Tritium Surveillance Laboratory Building 777 (incoming shipments)

As a result of these new criteria, workers were identified for participation in a tritium bioassay program typified in RFP memos available to NIOSH (Special Tritium Samples, 1983; Tritium Bioassay Results, 1982). As shown in Table 6-1, NIOSH also has access to RFP sample results for the post-1973 incident period (Tritium Bioassay Results, 1979; Tritium Bioassay Results, 1980; Tritium Bioassay Results, 1981; Tritium Bioassay Results, 1982).

The criteria for job-specific monitoring were subsequently reiterated in RFP procedures and technical basis documents (EG&G, 1991; Routine Bioassay, 1992; Tritium Procedure, 1986). The RFP requirement was that jobs that involved <1 mCi of tritium would not require any tritium bioassay. Jobs that involved >1 mCi of tritium would require a pre-job urinalysis, a weekly urinalysis if the job lasted longer than one week, and a post-job urinalysis, all to be analyzed for tritium. The program also included air sampling and smear surveys of ongoing operations (Tritium Procedures, 1979; Tritium Reports, 1979-1985; Tritium Reports, 1983-1984; Tritium Reports, 1984-1986; Tritium Results, 1974-1982; Tritium Results, 1976-1983; Tritium Smears, 1979; Tritium Smears, 1980; Tritium Smears, 1981).

### 5.2.3 Incidents

The most significant tritium exposure incidents being assessed in this evaluation were associated with events from 1968, 1973<sup>9</sup>, and 1974, with the 1973 incident being the most significant from the perspective of the amount of tritium involved/released. No documented tritium incidents have been identified relating to the neutron generator targets, but none of those sources were capable of producing the levels associated with the 1968, 1973, and 1974 incidents.

A 500-600 Ci tritium release occurred from a Rocky Flats special project in 1968 (details cannot be relayed due to the classified nature of the work) (Incident Summary, 1976; ChemRisk 3&4, 1992, p. 243). The site's report indicated that there was no significant off-site impact as a result of this incident. Based on NIOSH's review of the information associated with the 1968 incident, as compared to the 1973 incident where releases and personnel exposures did occur, there was no detectable environmental or workplace impact in 1968 because of differences in the chemical form (H3 versus HTO). These differences were the result of the two plutonium-recovery operations at RFP. Normal site returns (the bulk of RFP's reprocessing effort) were processed by acid dissolution in Buildings 776/777. Special returns like the ones from LLNL were processed by hydriding the plutonium in the Building 779A Hydriding Laboratory. The hydriding process for recovering plutonium (presumably having no tritium) involved burning the resulting gases before filtering and release to the atmosphere. Release of any tritium from this process is almost certainly as tritiated water from the final combustion of these gases. So when tritium was present in boost-tested parts, as in the case of the material processed at RFP<sup>10</sup> in 1973, it went up the stack as tritiated water, which very quickly got into the groundwater around RFP and was subsequently detected. The processing of normal site returns by acid dissolution of the plutonium involved no combustion stage so any existing tritium would have been vented out the building exhaust stack without a chemical change. The other evaluated incidents (i.e., the 1968 and 1974 incidents), resulted principally from the failure of tritium reservoirs during disassembly leading to the release of elemental tritium which, in turn, takes much longer to become incorporated into environmental water (Tritium Release (1968), 2012; LLNL Parts,

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<sup>9</sup> Also in 1981: "Investigation Report of Tritium Release Incident, January 6, 7, 1981," Internal letter from K.G. Tallman to R. E. Yoder, CD89-2188, January 16, 1981. (.CRF00079052\$, Denver Federal Center)

<sup>10</sup> Classified documents supporting this conclusion include the following: (1) "Extracts from Classified Section of Draft Report to Committee Investigating Rocky Flats Tritium Release (U)," Extracts from CD73-4775, pp 6-7, October 9, 1973 (Extracted from Rocky Flats Classified Document .CRF00041936%); and (2) "Investigation of the Tritium Release Occurrence at The Rocky Flats Plant – Extract," pp. 18-19, October 29, 1973 (Extracted from Rocky Flats Classified Document .CRF00536785R).

2012)<sup>11</sup>. Based on NIOSH's review of the available documentation, there is no other evidence that tritiated plutonium in any significant quantity was ever found in the normal site returns which were recovered by the acid-dissolution method.

In the 1973 incident, tritium-contaminated scrap from LLNL was sent to Rocky Flats for processing (Release Investigation, 1973; Release Investigation, 1974; ChemRisk 3&4, 1992). The material was processed in Building 779A at the site. As a result of the processing, tritium was released to on-site basins and ponds, to the Great Western Reservoir, and to the atmosphere (as a result of hydrating and oxidizing operations). The recovery products were also routed through other locations at the site resulting in the spread of tritium contamination to other worker areas on site. Based on the assessment of the incident, it was estimated that between 500-2,000 curies of tritium-contaminated materials were shipped from LLNL to Rocky Flats for processing.

There were varying levels of tritium exposures based on the site's assessment (Exposure Data, 1973). This incident was initially detected by the Colorado State Department of Health as a result of environmental monitoring around the site. The site had the capability to perform personnel and area monitoring for tritium; however, because it did not handle or process tritium, there was no belief that routine monitoring was needed. Although the site had developed a method of detecting tritium in urine in 1961, the method was maintained on standby and not routinely used to monitor personnel. The site commenced liquid scintillation tritium bioassay monitoring techniques in 1972. Coincidentally, the site had shifted to a more job-specific sampling program in 1972-1973 because of the lack of positive results and the need to analyze plutonium samples at the site (Tritium Sampling History, 1973). In conducting its environmental monitoring around the site, the Colorado State Department of Health (CDH) identified significantly-elevated tritium levels in waterways surrounding the site. Records indicate that CDH had been conducting environmental monitoring since 1969 (Incident Summary, 1976). The site disputed that it was the source of the tritium until it was finally confirmed later in the year. Since the 1973 incident, the RFP implemented significant improvements in the amount and types of personnel and area monitoring for tritium. NIOSH has reviewed the available CDH environmental monitoring data (which it has found only for 1970-1974) to assess the sequence of events the data represent (Surveillance, 1970-1974). NIOSH determined that the data are representative of an incident occurring in the mid-1973 period with no other indication of a release (such as that in 1973) during the period that CHD was performing environmental monitoring.

The 1974 incident (ChemRisk 3&4, 1992, p. 247) involved the release of approximately 1.5 Ci of tritium from the exhaust system of Building 777. The source of the tritium contamination in the incident was identified to be the opening of an un-surveyed shipping container (called a "pressure cooker") received from Battelle that was found to be contaminated (Building 777 Investigation, 1974). No significant environmental or personnel impact from this incident was identified by the Colorado State Department of Health or RFP as a result of this incident (Building 777 Investigation, 1974).

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<sup>11</sup> Classified documents supporting this conclusion include the following: (1) "Investigation Report of Tritium Release Incident, January 6, 7, 1981," Internal letter from K.G. Tallman to R. E. Yoder, CD89-2188, January 16, 1981 (.CRF00079052\$, Denver Federal Center); and (2) "Classified Section of Draft Report to Committee Investigating Rocky Flats Tritium Release. (U)", CD73-4775, October 9, 1973 (.CRF-00041936%, Denver Federal Center).

## 6.0 Summary of Available Monitoring Data for the Class Evaluated by NIOSH

The following subsections provide an overview of the state of the available internal and external monitoring data for the Rocky Flats Plant class under evaluation. The previous RFP evaluation (SEC-00030) that was assessed by the Board Working Group in multiple meetings and reviews assessed many facets of the RFP personnel monitoring program but it did not conclusively address issues with tritium. The extensive assessment identified no significant RFP internal monitoring program deficiencies or SEC-related issues that resulted in a recommendation for an SEC class at RFP (current SEC classes are based on external monitoring issues for neutrons). The result of the SEC-00030 assessment as it relates to internal monitoring complements the findings and recommendations in this SEC-00192 evaluation, which is exclusive to the tritium exposure issue at RFP. This section focuses solely on the available tritium data at RFP.

### 6.1 Available Rocky Flats Plant Tritium Monitoring Data

As discussed in the operations portion of this report, because tritium was not handled as part of RFP operations, it was not considered to be a significant source of personnel exposure prior to the 1973 tritium chronic exposure incident. Other than the known sources on site relating to neutron generator targets, the site did not expect tritium-contaminated materials to be on site or a source of exposure, which has been corroborated by interviews performed by NIOSH as part of this evaluation. The site acknowledged the presence of sealed tritium sources, such as those associated with the neutron generators, but concluded that those sources presented very little potential for exposure. Consequently, monitoring for tritium exposure prior to 1973 was not performed on a routine basis or as a part of the routine radiological monitoring program. After the 1973 incident, the site assessed the tritium sources on site, and the potential for personnel exposures associated with those sources. Based on the potential personnel exposure and environmental release issues, the site implemented a routine tritium monitoring program in 1973 (Tritium Monitoring History, 1973; Release Investigation, 1973).

As a result of the 1973 incident, tritium monitoring was performed on 148 individuals who were judged to have had a potential for tritium exposure. The results of that monitoring are well documented (Case Studies, 1973; Personnel, 1973; Tritium Release, 1973; Urine Sampling, 1973). Of the personnel who were monitored, five were identified as having potentially-significant exposures. The bioassay data for these individuals are provided in the documents above. One of the individuals who had positive exposures is included in the NOCTS database; the tritium bioassay results were included in the dosimetry data provided by RFP. Dose histories that include tritium monitoring results are included in the SRDB for all five of these individuals.

The 1974 incident is discussed in the *Investigation of Tritium Releases, Building 777* (Building 777 Investigation, 1974). This was primarily a release to the environment with no significant exposure to personnel.

“Special Analysis Logbooks” (Special Analyses Logbook, 1965-1969) contain sample analysis data; there are results for tritium bioassays taken in 1966. This document includes names and associated results, all of which were “0”. A notation indicates these samples were related to an “incident @ Box A-5”. There is another set of samples processed in the January 1969 period.

Air sampling and smear sampling were performed routinely where the site deemed it appropriate. The document, *Tritium Contamination*, describes the precautions to be taken to determine the presence of tritium on parts being returned for retirement and describes some of the results (Tritium Contamination, 1981). Several documents provide air sampling results for this location in late 1977, with the conclusion that it was left over from the 1973 incident (Investigation, 1977; Tritium Reports, 1983). There are also listings of smear results for the period from 1979-1980 (Tritium Smears, 1979).

Because tritium was normally present in only trace quantities in the production lines and was considered to be an insignificant source of personnel exposures, routine bioassay for tritium was not implemented. Room air samples were typically less than the limit of detection to 0.02% of Radiation Control Guides (RCG) established by AEC (Tritium Status, 1975).

As previously mentioned, a “routine” bioassay program was implemented after the 1973 incident to evaluate the potential for tritium exposures by sampling for tritium in 10% of the urine intended for Pu analysis. In 1975, this routine monitoring program was discontinued because not a single positive tritium sample was found (Bioassay Procedure, 1979). This evaluation further supports the contention that the possibility of exposure to the workers from tritium was extremely low if not non-existent.

However, procedures were implemented that specified that personnel working a job involving more than 1 mCi of tritium would be sampled. This policy is supported by letters from the site that identify the personnel who should provide tritium samples (Routine Bioassay, 1992). One document contains letters covering 1980-1983 that identify the personnel who should be sampled for tritium (Special Tritium Samples, 1983). [Sentence redacted]. Tritium bioassay results were found for 13 of the 16 individuals in NIOSH’s Site Research Database (Tritium Bioassay Results, 1979; Tritium Bioassay Results, 1980; Tritium Bioassay Results, 1982).

The post-1973 radiation protection program was aware of the presence of tritium and monitored for it in both the workplace and the workers. Based on the available RFP operational information as it relates to tritium, NIOSH believes that these available tritium data sufficiently represent the worst-case exposure scenario for any RFP operational period where tritium existed, or could have existed.

As part of its tritium assessment for this evaluation, NIOSH reviewed all available RFP health physics, industrial hygiene, and environmental monitoring reports which exist for all operational years at the site. For the years prior to the 1973 incident, there are limited results identified specifically for tritium (as expected, because the site did not handle or process tritium other than tritium targets for neutron generators). The available documentation discusses the use of tritium monitors such as tritium sniffers (used to periodically monitor incoming materials/shipments), area air monitoring systems capable of monitoring for tritium (triton portable and fixed air monitors), swipe and smear surveys (counted with instruments including, but not limited to, gas-flow proportional counters), and the use of vibrating reed and liquid scintillation monitoring/detection systems/instruments. These methods/surveys are periodically discussed in the pre-1973 documentation as it related to

environmental soil, water, and air monitoring in the areas surrounding the site, as well as RFP work area radiological monitoring.

Details regarding the various analyses used and the associated minimum detectable activities are presented in the Technical Basis Document for the Rocky Flats-Occupational Internal Dose (ORAU-TKBS-0011-5).

Table 6-1 provides the available RFP tritium data for the 122 claims noted in Table 4-1 of this report that are currently in NOCTS (as of August 20, 2012).

<b>Table 6-1: Available RFP Tritium Data from 122 NOCTS Claims</b>		
<b>Year</b>	<b>Tritium Bioassays in NOCTS</b>	<b>No. of Tritium Bioassays in SRDB - (SRDB Ref IDs)</b>
1960	None	7 - (24699; 26652)
1965	None	6 - (24630; 24691; 27048)
1966	None	13 - (24691; 26259)
1968	None	2 - (26259; 24680)
1969	None	5 - (26259; 24680; 24693)
1973	150	180 - (24388)
1974	44	11 - (8790)
1975	46	None
1976	6	None
1977	13	None
1978	10	None
1979	11	23 - (111276)
1980	30	95 - (111278)
1981	19	87 - (111153)
1982	1	24 - (111077)
1983	No info	2 - (110932)
1991	2	None
1993	7	None
1995	2	None
1996	2	None

## 6.2 Available Rocky Flats Plant External Monitoring Data

The claimant files and other documents available to NIOSH in the SRDB contain external radiological exposure data for all years under evaluation. The principal source of external radiation doses for members of the evaluated class was as evaluated in the SEC-00030 Rocky Flats Plant Evaluation Report. Because tritium is the sole focus of this current evaluation, and tritium is strictly an internal dose reconstruction issue, NIOSH has determined that there is no need to assess external exposures and the ability to reconstruct dose at RFP beyond what has already been presented and assessed in SEC-00030. NIOSH defers to the SEC-00030 RFP ER for all external and medical X-ray decisions regarding bounding of dose at RFP as well as the definition of dose reconstruction methods. Details regarding the various dosimeters used and the associated minimum detectable doses are presented in the Technical Basis Document for the Rocky Flats Plant-Occupational External Dose (ORAU-TKBS-0011-6).

## 7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the class of employees under evaluation in this report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to estimate the maximum radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class, or to estimate the radiation doses to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.6. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are available at <http://www.cdc.gov/niosh/ocas>. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00192 as submitted by the petitioner. (Section 7.4)

## **7.1 Pedigree of Rocky Flats Plant Data**

This subsection answers questions that need to be asked before performing a feasibility evaluation. Data Pedigree addresses the background, history, and origin of the data. It requires looking at site methodologies that may have changed over time; primary versus secondary data sources and whether they match; and whether data are internally consistent. All these issues form the bedrock of the researcher's confidence and later conclusions about the data's quality, credibility, reliability, representativeness, and sufficiency for determining the feasibility of dose reconstruction. The feasibility evaluation presupposes that data pedigree issues have been settled.

### **7.1.1 Tritium Monitoring Data Pedigree Review**

As discussed above in Section 6.1, RFP personnel were aware of the potential for tritium exposures from known sources of tritium, and methods existed to perform the corresponding personnel and area monitoring. Based on the site's 1973 assessment, the trace quantities of tritium that may have been present at any time in the production lines, and from other known sources, were small relative to the levels and corresponding exposure potential during routine operations with tritium-contaminated scrap and returns. Based on its review of the available information leading up to and following the 1973 tritium incident, NIOSH believes that there is sufficient information associated with site returns and scrap processing (most of which is classified) that (when coupled with the available air monitoring, radiological survey, and bioassay data) can be used to corroborate this position. Based on NIOSH's review of the available information in the SRDB and other sources, the monitoring results and data as well as other operational, source/source term, and radiological program information are available in original form and can be used to support the assessment performed for the RFP class under evaluation.

Although there were several incidents during RFP's history that involved significant quantities of tritium, only one in particular resulted in exposures to personnel. The personnel involved in this 1973 incident were carefully monitored as part of the investigation conducted after this incident. The results of the personnel and area monitoring were also included in the reports conducted for this incident. The results are numerous over a period of time after the incident. The monitoring results from this incident are available in both claimants' files and the SRDB. The information is also available in original form and can be used to support the assessment performed for the RFP evaluated class in this evaluation.

In summary, a program was in place at RFP to sample workers who had potential for exposure to tritium, especially as it applied to the site's follow-up to the 1973 tritium incident. The workers were identified and sampled. The bioassay results are available and have been provided to NIOSH as a part of the claims process. Based on its assessment of the documentation and data, NIOSH finds that RFP workers for whom tritium monitoring data was not provided had very little potential for exposure.

## **7.2 Evaluation of Bounding Tritium Radiation Doses at Rocky Flats**

As discussed in the previous sections of this evaluation, the principal source of internal tritium radiation doses for members of the class under evaluation was tritium-contaminated materials returned to RFP from other sites in the form of scrap and retired weapons returns. The following subsections address the ability to bound tritium doses, methods for bounding doses, and the feasibility of tritium dose reconstruction.

### **7.2.1 Evaluation of Bounding Process-Related Tritium Doses**

The following subsections summarize the extent and limitations of information available for reconstructing the process-related internal tritium doses of members of the class under evaluation.

#### 7.2.1.1 Tritium Urinalysis Information and Available Data

There are limited tritium bioassay data for years other than 1973 at RFP. Table 6-1 indicates the number of RFP tritium bioassay samples currently available to NIOSH. The most significant RFP tritium exposures occurred in 1973, which is also the year with the highest number of bioassay sample analyses. Based on the available information, the incident occurred between April and September of 1973. Dow (the site contractor at the time) commenced a sampling protocol that included any employee who was thought to have had the best chance of being exposed to tritium. These data are available and support NIOSH's ability to develop a bounding approach to reconstructing RFP tritium exposures for the class under evaluation. Based on the information available to NIOSH, RFP identified the capability of monitoring personnel for tritium exposures over the majority of the operational period under evaluation. Very limited bioassay results are available prior to the 1973 incident. It is expected that these available data correspond to work assignments that constituted maximum-exposure scenarios or include workers with the highest tritium exposure potential (of known RFP tritium sources); no radiologically-significant personnel exposure results are indicated in the available pre-1973 monitoring data. NIOSH has discovered no evidence of an ongoing exposure potential outside of the 1973 incident discussed in this evaluation report. Based on its reviews and the analysis performed below, NIOSH concludes that the available bioassay data are sufficient to support bounding the tritium exposures at the site.

#### 7.2.1.2 Tritium Airborne Survey Data

Environmental and operational air sample data are available for the majority of the years under evaluation in this report. There is limited information and documentation relating to tritium radiological surveys and air sampling prior to 1973. The most significant quantity of radiological survey data specific to tritium sampling are primarily available for the years after the 1973 incident. Although limited, the existence of these data over the RFP operational period, coupled with the information associated with the existence of tritium on site, does support the position that the site maintained the ability to assess tritium emissions and personnel exposures to determine if there were radiological issues or releases occurring as a result of known operations. In addition, the data corroborate the position presented in this evaluation regarding the ability to bound tritium dose based on the available bioassay data for the 1973 incident.

## 7.2.2 Evaluation of Bounding Ambient Environmental Internal Tritium Doses

The proposed bounding method for tritium defined in this evaluation accounts for, and includes the potential contribution of, doses associated with environmental tritium exposures at the site. Therefore, further assessment of the doses from environmental tritium exposure sources is not necessary for the RFP class under evaluation.

## 7.2.3 Methods for Bounding Tritium Dose at Rocky Flats

Based on NIOSH's evaluation in this report, it has been determined that the 1973 data serve as the bounding exposure scenario for tritium exposures at RFP. Therefore, these data will be used to develop a bounding approach for the purpose of reconstructing dose for unmonitored workers who may have been exposed to tritium as a result of RFP plutonium-recycling operations with tritium-contaminated materials.

### 7.2.3.1 Excerpts from the 1973 RFP Tritium Release Investigation

The following series of excerpts is from the document titled, *Investigation of the Tritium Release Occurrence at the Rocky Flats Plant*, (Release Investigation, 1973; Dosimetry Records, name1; Dosimetry Records, name2; Dosimetry Records, name3; NOCTS, 2012).

#### *SAMPLING PROTOCOL*

*Dow began by sampling urines from all employees who were thought to have had the best chance of being exposed to tritium. As of October 15, 1973, about 250 employees have been tested. Dow is continuing to trace leads to other possible exposure and will sample them as they are found. Dow intends to sample many employees who have had only a remote chance of coming in contact with tritium. Dow also tests the urine of any employee who requests this whether or not they are candidates for exposure.*

#### *ACTION LEVELS*

*An "action level" of 10,000 pCi/l was tentatively chosen for resampling. This level was chosen for several reasons such as:*

- 1. An article by Fitzsimmons indicated that people wearing tritiated watches could excrete levels of 10,000 pCi/l.*
- 2. A calculation of worst possible circumstances indicate that an employee would have to exceed levels of 23,000 pCi/l before any permissible yearly levels of whole body radiation would be exceeded.*
- 3. The sample load was such that Dow could handle resampling only a limited number of employees on a frequent basis. It turned out that a relatively small number were over 10,000 pCi/l but a large fraction were in the 5,000 and 10,000 pCi/l range.*

4. *Without predistilling the urine samples the counting efficiency drops to about 3% and the corrections made for spectral shift can lead to abnormally high reading.*
5. *With a large sample load, counting time devoted to each sample must be restricted so that 10,000 pCi/l might be considered lowest detection limit available under the present circumstances.*

*All samples above 10,000 pCi/l are redone by counting the distillate of the original sample.*

Rocky Flats identified five workers with tritium urinalysis results exceeding the action level of 10,000 pCi/L. Results from these five workers are reviewed here. Fourteen other workers initially exceeded 10,000 pCi/L but fell below this level upon recount (as noted above, the distillates of the original samples were counted, offering better counting statistics during recount).

The document contains information, including tritium bioassay results and brief work histories about the five workers with the largest tritium sample results. This information was used to assess the doses to the affected workers and is displayed in italics in the sections below. All five cases had initial samples that were not distilled, with one to five later samples that were distilled. In general, the non-distilled and distilled sample results tended to not match up, with the distilled samples yielding lower values. This is to be expected, given the site discussion above (see Item 4).

#### Case A

*Case A worked in Room [location redacted] from [date range redacted]. He was involved in the hydrating and processing of the parts in question from [date range redacted], along with Cases [case identifiers redacted]. He was not involved in any of the following special projects:*

- a. [date, special project name redacted]
- b. [date, special project name redacted]
- c. [date, special project name redacted]

*He was involved in taking samples from a tritium-contaminated [device redacted] on [dates redacted]. On [date redacted], this was done without a [item redacted].*

*From this history, it would appear the most likely exposure occurred on [dates redacted]. If an exposure had occurred between [date range redacted], it is likely that both Cases [case identifiers redacted] would have been exposed to the same source, and subsequently, excreted the same quantities of tritium.*

The RFP document also states:

*In Case A, a history of his work assignment and his urine results for the first two weeks indicate that he sustained a recent exposure. At the present time he is excreting tritium with an elimination half life of less than 10 days. According to Sanders and Snyder, this is the pattern of elimination from an exposure up to 90-days post exposure.*

The statement that Case A's intake appears to be recent agrees with current models for HTO intakes. If an intake on [date redacted] is assumed, a very poor fit to the data is achieved when the standard model is applied to all of the data. If only the distilled sample results are used, an intake date of [date redacted] provides a somewhat reasonable fit, yielding an intake of 11,000  $\mu\text{Ci}$ , resulting in a dose of 753 mrem. This coincides with the assessment document which states:

*Case A would have a total dose of [dose value redacted] from the present levels of excretion, assuming the exposure occurred 90 days ago.*

If an intake on September 1 is assumed, the fit to Case A's early data (non-distilled) is excellent; the total intake is 132  $\mu\text{Ci}$  with a dose of 9 mrem. If just the later (distilled) data are used, the intake drops to 115  $\mu\text{Ci}$ . The site indicated that Case A's intake might have occurred on [date redacted]; in that case, the intake would be 36  $\mu\text{Ci}$ .

### Case B

*He has worked in [location redacted] since [date redacted]. He was in the room when [action redacted].*

Assuming an intake on [date redacted] (Case B's first date in the area), the worst-case scenario, and the use of only non-distilled sample results, Case B's intake is 690  $\mu\text{Ci}$ , which results in a dose of 47 mrem.

If all sample results are used, the intake is reduced to 430  $\mu\text{Ci}$  if the reported errors are applied; if all results are weighted equally, the intake is 660  $\mu\text{Ci}$  (the same as using just the non-distilled samples). A later intake date of September 1 provides a somewhat better fit but the dose drops by an order of magnitude to 1.6 mrem.

### Case C

*He worked in [location redacted] since [date redacted]. He was not in the room when [action redacted].*

Given that Case C did not start in the area until [date redacted], this was the assumed intake date. Using only the non-distilled sample results, Case C's intake is 22  $\mu\text{Ci}$ , which results in a dose of 1.5 mrem. All other combinations of data yield a lower dose.

### Case D

*He worked in [location redacted], between [date range redacted]. He has not been exposed to tritium since [date redacted].*

Case D submitted samples on only [number redacted] days, although there are [number redacted] results on [number redacted] of those days. In one instance, one of the results was distilled; on the other day, there is a note that states "repeated with sample channel ratio." On the latter day, the results differ by a factor of almost two. An assumed intake date of [date redacted] (last date of the

1973 incident) yields a reasonable fit. The resulting intake is 900  $\mu\text{Ci}$  with a corresponding dose of 61 mrem.

### Case H

*He came in contact with the possible source of tritium on [date redacted].*

Results are not consistent with an acute intake on [date redacted]. Case H's last [number redacted] results show an increasing trend and appear more representative of a chronic exposure. If an intake on [date redacted] is assumed and only the largest result is used for the calculation, the intake is 1400  $\mu\text{Ci}$ , which results in a dose of 94 mrem. This fit overestimates all of the other results, some significantly. Using all of the data and an intake date of [date redacted] yields an intake of 116  $\mu\text{Ci}$ , but this significantly underestimates the largest result.

The assumption of a chronic intake beginning [date redacted] and running until the last urine sample yields an intake rate of 0.005  $\mu\text{Ci}/\text{day}$  for a total intake of 10  $\mu\text{Ci}$  and a corresponding dose of 0.65 mrem.

#### 7.2.3.2 NIOSH Conclusion on the RFP Bounding Approach

The doses associated with the worst-case scenarios discussed in the site documents are based on the assumption of an elimination half-time of 10 days for intakes that occurred less than 90 days prior to the bioassay result. This is not representative of the current ICRP biological model, which includes an additional longer-term compartment. Because the bioassay results were collected well after the assumed intake dates for most of these cases, the intakes and doses calculated with the current model are less, sometimes significantly, than those calculated with the older model, even in the worst-case situations. Table 7-1 summarizes the RFP tritium dose estimates calculated with the current ICRP model.

Case	Worst Case	Best Fit
A	753	9
B	47	1.6
C	1.5	1.5
D	61	61
H	94	0.65

Based on this assessment, the most conservative and bounding dose value for this class would be the 753 mrem value that represents the worst-case chronic individual exposure over a year. NIOSH believes this to be representative of the maximally-exposed operations worker and could be used to bound doses for unmonitored RFP workers for the period under evaluation. Therefore, NIOSH concludes that the bounding approach for unmonitored personnel would be to assign the Case A Worst Case tritium dose estimate for each year from the beginning of plutonium operations at RFP through 1973 (the year of the most significant incident and when tritium monitoring began at RFP in

earnest). For the period from 1973 through 1989 (when operations ceased at the plant), NIOSH intends to evaluate the available monitoring data and establish a method to assign an appropriate bounding dose for that portion of the evaluated class (i.e., this will require the development of a co-worker study, or alternative dose reconstruction method, for the post-1973 period).

#### **7.2.4 Internal Tritium Dose Reconstruction Feasibility Conclusion**

Based on the assessment presented in the preceding sections of this evaluation, NIOSH concludes that there are sufficient data and knowledge of processes and operations to support bounding the associated tritium dose using the methods and information presented in this evaluation. Based on the assessment of operations, the 1973 incident associated with the processing of LLNL special return materials contaminated with significant levels of tritium represented a chronic exposure event that occurred from April through September 1973. As compared to the other known sources and previous incidents at RFP, the 1973 incident involved by far the largest tritium source term, and resulted in the most significant personnel tritium exposures recorded at RFP. Therefore, based on NIOSH's assessment, the values as discussed in Section 7.2.3 can be used to bound unmonitored doses for personnel for the period from 1953 through 1989. NIOSH does not believe there is a basis for assigning additional unmonitored tritium dose for the period before 1953 or after 1989 because of the lack of tritium-related operations outside that date range.

### **7.3 Evaluation of Bounding External Radiation Doses at Rocky Flats**

The principal source of external radiation doses for members of the evaluated class was as evaluated in the SEC-00030 Rocky Flats Plant Evaluation Report. Because tritium is the sole focus of this current evaluation, and tritium is strictly an internal dose reconstruction issue, NIOSH has determined that there is no need to assess external exposures and the ability to reconstruct dose at RFP beyond what has already been presented and assessed in SEC-00030. Therefore, NIOSH will not assess external or medical X-ray dose reconstruction methods further in this evaluation. NIOSH defers to the SEC-00030 RFP report for all external and medical X-ray decisions regarding bounding of dose at RFP as well as the definition of dose reconstruction methods.

### **7.4 Evaluation of Petition Basis for SEC-00192**

The following subsections evaluate the assertions made on behalf of petition SEC-00192 for the Rocky Flats Plant site.

#### **7.4.1 Incidents**

SEC-00192: The petitioner asserted during the consultation telephone calls on this petition that there were one or more unmonitored, unrecorded, or inadequately monitored or recorded exposure incidents at the Rocky Flats Plant site, specifically claiming an Item E.5 basis.

NIOSH's initial interpretation was that the information provided by the petitioner in one affidavit seemed to indicate a description of a radiological incident, for which additional detail was requested from the petitioner. In subsequent phone conversations and emails (DSA Ref ID: 115629), the petitioner later clarified the intent and indicated that the situation was given as an example of a worker

who should have been monitored but was not (applicable to Petition basis F.1). Based on its review, NIOSH concluded that there was no intent to include or support an Item E.5 basis.

#### **7.4.2 Building 460 Plutonium**

SEC-00192: Originally, the DOL Site Exposure Matrix showed that plutonium was present in Building 460. NIOSH was advised of this in the attached email dated December 8, 2009. According to the statement submitted in that email, a former [job title redacted] related that waste drums from the 700 complex were stored in Building 460 in 1988 when the governor of Idaho refused to allow shipments of radioactive waste from Rocky Flats into the state. Building 460 was a "cold" building and workers were not monitored for exposure to radiation. [This was specific to an Item F.1 basis.]

As stated in the Site Profile and the SEC-00030 Evaluation Report, the majority of workers at Rocky Flats were monitored for radiation exposure, and NIOSH has exposure records for most workers. Some workers may not have been monitored if it was determined that their exposure potential was below the threshold for dose monitoring to be required. Building 460 was considered a "cold" building, so dose monitoring may not have been required for workers assigned there. The affidavit regarding the stored drums describes the performance of radiological monitoring of those drums and states that there were radiological postings due to the exposure rates from the drums. This indicates to NIOSH that radiological controls were being exercised to prevent unmonitored workers outside the posted areas from receiving exposures above appropriate limits. NIOSH does not see indication that the movement and storage of these drums was controlled differently than the general waste storage activities on site. The doses associated with general waste-handling and storage activities are represented in the dose monitoring records of the RFP worker population. The adequacy of RFP worker population dose records for the development of co-worker distributions for the assignment of unmonitored internal and external does has already been evaluated by NIOSH and the ABRWH for SEC-00030.

In addition, records available to NIOSH indicate that the [job title redacted] had plutonium bioassay during the period of concern, although [redacted] stated normal work areas, including the 400 area (depleted U) and 800 area (enriched U), would likely require only uranium bioassay. The plutonium bioassay indicates to NIOSH that the site was aware of the added plutonium concern, and serves as an example that the site was monitoring individuals.

Relative to the requirements of 42 C.F.R § 83.9 (a)(5), NIOSH has determined that this information provides no substantially new information regarding unmonitored plutonium or uranium exposures beyond what NIOSH has previously addressed in its evaluation for SEC-00030.

#### **7.4.3 Tritium Exposures**

SEC-00192: Affidavit states - *I attest that there were occasions when I was not monitored. When I worked in the 700 complex, one of my duties was to work on site returns. I clearly remember one incident at a down draft table. I was given the incorrect measurements and when the machine tool reached the given measurement the shell was breached. I remember that I had a nasal smear taken after the breach. I have requested a copy of this nasal smear report numerous times but have not received it. I was later told that I was probably exposed to tritium gas. I have no bioassay for tritium exposure.* [This was specific to an Item F.1 basis.]

NIOSH has available personal or area monitoring data applicable to a tritium incident that occurred in 1973, which was evaluated as part of SEC-00030. The affiant states that he was employed from [date range redacted]. NIOSH does not have this individual's data readily available, and as of the time of the qualification review of the SEC-00192 petition, did not have a clear time period when the incident occurred. Since there was an apparent lack of personal monitoring for tritium prior to the 1973 incident and possibly during the affiant's employment period ([date range redacted]), NIOSH has determined there was evidence of possible tritium exposures warranting evaluation beyond that performed for SEC-00030. The additional evaluation is presented in this SEC-00192 evaluation report.

#### 7.4.4 Previous Issues – RFP Site Profile

SEC-00192: *NIOSH has failed to reconcile outstanding site profile issues* [These issues were specific to an Item F.1 basis]:

- a. *Accepted unsworn statement from the supervisor for the thorium strikes, which contradicts RFP-5331, which was reviewed by NIOSH and rejected.*
- b. *Only 5 individuals interviewed about thorium at RFP.*
- c. *ER's subsequent to RFP have been reversed after reviewing classified docs. RFP not afforded the same level of investigation.*
- d. *Sworn affidavits dismissed because they weren't backed up by documentation. Yet, as noted above, NIOSH readily accepted an unsworn testimony over a document.*
- e. *RFP SEC class definition is inconsistent with other SECs and difficult for DOL to administer. The class is building specific. But, it is not possible to determine all occupants.*

Issue a was extensively discussed by the ABRWH under SEC-00030. The number of individuals interviewed in previous efforts, as presented in Issue b, does not provide evidence of lost, falsified, or destroyed records; or that there is no information regarding monitoring, source term, or processes. Relative to Issue c, classified documents were available to NIOSH, SC&A, and the Advisory Board and were reviewed as necessary under SEC-00030; SEC-00030 was afforded an extensive level of investigation. Relative to Issue d, NIOSH believes this statement is inaccurate. Affidavits were not dismissed. They were extensively investigated and compared to documentary evidence and discussed with the Rocky Flats Working Group associated with SEC-00030. The statement presented in Issue e is inaccurate in that the SEC-00030 class definition is based on potential neutron exposure. Work location is one issue that is considered, but there are others (such as neutron dosimetry). The class definition is an administrative issue associated with the previously-evaluated SEC-00030.

Regarding thorium exposure reconstructions in general, extensive attention has been given to this issue during evaluation of SEC-00030, which included classified document reviews. NIOSH has determined that it is feasible to accurately bound thorium doses to RFP workers. Methodologies are discussed in detail both in the RFP Site Profile and a peer-reviewed paper, *Establishing Bounding Internal Dose Estimates for Thorium Activities at Rocky Flats*, published by the Health Physics Society in 2008 (Health Physics, 2008).

Relative to the requirements of 42 C.F.R § 83.9 (a)(5), NIOSH has determined that this information provides no substantially new information beyond what NIOSH has previously addressed in its evaluation for SEC-00030, nor does this information provide evidence of lost, falsified, or destroyed records; or that there is no information regarding monitoring, source term, or processes.

#### **7.4.5 Information Not Provided in the Previous SEC Evaluation**

SEC-00192: *Information the Board did not have when deciding the RFP SEC petition.* [These were specific to an Item F.1 basis]:

- a. *Presence of plutonium in Building 460 (waste drums stored in the building).*
- b. *Contaminated equipment present in Buildings 440, 444, & 447 (a contaminated Empire lift-a-loft was shipped from Building 371 to these buildings, which were considered “cold”).*

The issue regarding drums stored in Building 460 was previously determined to be a non-issue during the assessment of the SEC-00030 evaluation report. The contaminated equipment report states the levels of contamination found on the equipment as well as the timeframe involved; therefore, NIOSH has area monitoring data. NIOSH has developed methods to estimate intakes to unmonitored workers at the Rocky Flats. The adequacy of the RFP monitoring programs, and ability to assess unmonitored dose, was the primary focus of the evaluation of SEC-00030.

Relative to the requirements of 42 C.F.R § 83.9 (a)(5), NIOSH has determined that this information provides no substantially new information regarding plutonium or other exposures beyond what NIOSH has previously addressed in its evaluation for SEC-00030.

#### **7.4.6 Adequacy of Co-worker Models**

SEC-00192: *Co-worker models are inaccurate for some buildings* [These were specific to an Item F.1 basis]:

- a. *Site profile does not include the 1980 fire in Building 771’s incinerator; in 1980 53% of badges had zero. If there was a release from the fire, then the coworker badge readings may not be accurate or reflect this incident.*
- b. *The site profile does not include the plutonium recovery system in Building 440 post 1996.*
- c. *The site profile does not consider high exposures at the stacker retriever. (Attached email states potential exposure rate of a “couple hundred” millirem per hour. Criticality engineers had to make sure spacing was maintained).*
- d. *The highest number of zero readings occurred during the D&D period (2004).*

As presented in the NIOSH responses above, extensive personnel monitoring data are available to assess internal and external doses. NIOSH has stated that it will estimate incident-related dose based on individuals’ personal data since most workers were routinely monitored. For unmonitored workers, NIOSH contends that exposures from incidents would be covered by the co-worker approach

because incident doses are represented in the worker population dose. Specific to Issues a and d, the zero-dose issue was previously evaluated as a part of the SEC-00030 Evaluation.

Relative to the requirements of 42 C.F.R § 83.9 (a)(5), NIOSH has determined that this information provides no substantially new information beyond what NIOSH has previously addressed in its evaluation for SEC-00030.

#### **7.4.7 Analysis Laboratories**

SEC-00192: *Documents show evidence that the laboratories responsible for radiation readings were not in compliance with DOE criteria for radiation monitoring. It is likely they were also deficient when analyzing personnel dosimeters and breathing zone samples.* [This was specific to an Item F.3 basis]

The referenced compliance audits were performed specifically to evaluate the RFP environmental programs. Records do not indicate any correlations between the environmental and personnel dosimetry programs.

#### **7.4.8 Analysis Laboratories**

SEC-00192: *An Assessment of Criticality Safety at RFP document, dated June-Sept 1989, shows* [These were specific to an Item F.3 basis]:

- a. Additional incidents from 1983 that are not reflected in the site profile.*
- b. Deficient or outdated safety practices.*
- c. Contamination in the ducts in Building 881 (Issue raised by plant mgrs out of concern for employee health.).*
- d. Building 881 issue indicated significant amounts of radioactive materials, including one instance of 288 grams of U-235 in an old laundry line.*

As presented in the NIOSH responses above, extensive personnel monitoring data are available to assess internal and external doses. As part of the SEC-00030 evaluation, NIOSH has stated that it will estimate incident-related dose based on individuals' personal data since most workers were routinely monitored. For unmonitored workers, NIOSH contends that exposures from incidents would be covered by the co-worker approach because incident doses are represented in the worker population dose. This would also apply to the situations described. Issues c and d were discussed by the Board in a previous meeting in Westminster. In addition, the current SEC as implemented by DOL includes Building 881 workers. Therefore, further assessment of the Building 881 issues in regard to bounding dose is not productive from a SEC evaluation perspective.

#### 7.4.9 Site and Process Information

SEC-00192: RFP Site-wide Process Descriptions, Material Mass Balances, and Operational Emissions Support Document, dated Apr 12, 1994 not represented in the site profile, indicates that “radiography occurs in Buildings 122, 444, 460, 707, 777, and T371J”. The site profile does not indicate that X-rays were present in Building 460. Workers in Building 460 were not monitored for radiation exposure. [This was specific to an Item F.3 basis]

Where radiography is performed, regulations require specific protocols to prevent inadvertent exposure to unmonitored personnel, such as: radiological posting at area boundaries, constant radiation monitoring during the activities, and personnel monitoring for individuals performing the work. The Rocky Flats Plant had a standard operating procedure, *Radiation Safety for Field Radiography*, for performing radiographic testing, which states that “the personnel access boundary location shall not exceed 2 mR/hr”. Therefore, the dose reconstruction methodologies for unmonitored workers described in the Site Profile would be adequate for this circumstance.

#### 7.5 Other Potential SEC Issues Relevant to the Petition Identified During the Evaluation

During the feasibility evaluation for SEC-00192, NIOSH concluded that a review of the SEC-00030 issues and subsequent resolutions and closures should be documented in this evaluation. Only the primary issue title and associated resolution/response are provided here – specific details of the sub-tasks of the issue can be found in the Board Working Group’s *Rocky Flats Site Profile Review: Matrix of Priority Issues Potentially Relevant to SEC Petition Review* (available on the NIOSH website at: <http://www.cdc.gov/niosh/ocas/pdfs/dps/rockymatrix010807.pdf>). The issues and their status are as follows:

- ISSUE: The approaches regarding solubility need to be reviewed, particularly for Type “S” or “Super-S” plutonium compounds whose high insolubility may lead to more exposure to gastrointestinal and respiratory tract organs. The sensitivity of the bioassay methods was not adequate to detect incidental intakes of insoluble compounds, and also the bioassay methods applied at that time were not appropriate.

RESPONSE: ORAUT-OTIB-0049 addresses Super-S and RFP fire particle size in Section 4.2. The concurrence that this issue was closed is presented in the March 7, 2007 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, page 193 of 269).

- ISSUE: Uncertainties are not addressed in the TBD regarding the Am-241 assay of plutonium processed at RFP and how lung counting was calibrated to these values, especially in view of different Am-241 proportions at different processing steps and different plutonium ages.

RESPONSE: See ORAUT-TKBS-0011-5, *Rocky Flats Plant – Occupational Internal Dose*, Section 5.3, Bioassay Data; and Attachment B, Section 5.3.2, Lung Count Data, which states:

*In vivo lung counts have been performed at RFP since 1964 to determine the activity of plutonium in the lungs of workers who were exposed, or had the potential to be exposed, to airborne plutonium. The method of in vivo lung counts was to place one or more detectors over the chest of the subject and count the photons emitted from the plutonium mixture, if any, in the chest. Plutonium was not detected directly because of the low abundance of gamma photons and the severe attenuation of the more abundant L X-rays. Instead, the 59.5-keV gamma photon from <sup>241</sup>Am was used to detect <sup>241</sup>Am, which is present to some extent in all WG plutonium at RFP. The activity of plutonium was then calculated from the detected <sup>241</sup>Am by measuring, calculating, or assuming the fraction of the <sup>241</sup>Am in the plutonium mixture on the date of the lung count (see Section B.11 in Attachment B). At RFP, the fraction of the <sup>241</sup>Am in the plutonium mixture has historically been characterized in terms of parts per million by weight. Direct in vivo measurement of plutonium in the lungs, although investigated, was never implemented at RFP.*

ORAUT-TKBS-0011-5, Attachment B, Table B-11 summarizes the americium MDAs for RFP *in vivo* lung counts.

- ISSUE: Interpretation of NTA film data and correction of recorded dose for workers who were not included in the Neutron Dose Reconstruction Project (NDRP) is not evident.

RESPONSE: Neutron information and approaches were incorporated into ORAUT-TKBS-0011-6, *Rocky Flats Plant - Occupational External Dose*. In addition, it has been discussed in past working group meetings that the NDRP documentation indicates that workers who wore NTA film were part of the NDRP (NDRP, 2005, pdf p. 9). Possible sources of errors are addressed in the TBD. However, a result of the SEC-00030 evaluation was the recommendation of an SEC class based on neutron exposures for the period from April 1, 1952 through December 31, 1966.

- ISSUE: There is a need to use neutron-to-photon ratios and/or film/TLD comparisons to correctly determine past neutron doses. Workers were exposed to neutrons in the NTA film period at lower energy levels than the dosimeter is capable of measuring. It is important to generate correction factors for under-monitored workers or for monitored-worker missed dose. This is especially important for non-Pu workers covered by the NDRP, and for workers involved with the Pu tetrafluoride and Pu-machining operations during the early period.

RESPONSE: A default neutron-to-gamma ratio is provided in Tables 6-21 and 6-22 in Section 6.7.3.4 of ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*. However, a result of the SEC-00030 evaluation was the recommendation of an SEC class based on neutron exposures for the period from April 1, 1952 through December 31, 1966.

- ISSUE: The RFP Site Profile, while incorporating methodologies for assignment of missed dose, has not adequately bounded exposure conditions, compensated for calibration errors and technical deficiencies, and addressed possible data integrity issues, including possible zero entries in the dose records when badges were not returned, all of which may contribute to missed dose.

RESPONSE: There were eight subtopics assessed as part of this issue. The results of those subtopic assessments were:

1. Provide NDRP data (ORAUT-OTIB-0050): Completed and closed as indicated in the May 30, 2006 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr053006.pdf>, page 73 of 276).
  2. Ruttenberg job exposure matrix: Not an SEC issue, as indicated in the March 28, 2006 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr032806.pdf>, page 101 of 259).
  3. Completeness of external exposure monitoring data was explicitly discussed over several working group meetings.
  4. Co-worker model provided and agreed upon, as indicated in the April 30, 2007 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr043007.pdf>, page 113 of 153); incorporated into the RFP TBD, ORAUT-TKBS-0011 in August 2007.
  5. Zeros in badge readings were listed separately as two different issues (#12 and #28).
  6. Correction factor from DNFSB report: Completed and closed, as indicated in the July 26, 2006 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr072606.pdf>, page 168 of 381).
  7. Criminal and security investigations: No supporting evidence of this based on NIOSH's reviews. Completed and closed, as indicated in the July 26, 2006 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr072606.pdf>, page 173 of 381).
  8. Demonstration of the reliability of the bioassay and external database was explicitly discussed over several working group meetings.
- ISSUE: Only "roll-up" penetrating doses exist for individuals prior to 1976. It is not clear how the neutron and photon doses will be determined from the roll-up dose.

RESPONSE: Neutron information and approaches were incorporated into ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*. For pre-1971, the approach proposes the use of the method defined in the NDRP; for 1971-1976, the method incorporates a neutron-to-photon ratio approach. As a result of the SEC-00030 evaluation was the recommendation of an SEC class based on neutron exposures for the period from April 1, 1952 through December 31, 1966.

- ISSUE: Zero entries in dose record when badges were not returned. This issue is divided into two periods: 1) Pre-1964, when badges were not issued to all workers; 2) 1964 and after when badges were issued to all workers. The dose record may also contain blanks or “no data available.” Methods to separate these kinds of entries or blanks from zeros that denote a value below the LoD are needed.

RESPONSE: See False Entries response below. This issue was also addressed in ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*, Section 6.5, Table 6-2, Interpretation of Reported Data.

- ISSUE: Chips fell out of TLDs and readings were not included in worker records. Allegation in SEC petition.

RESPONSE: See False Entries response below. This issue was also addressed in ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*, Section 6.6.5.2.1, Loose-Chip Thermoluminescent Dosimeters; and Section 6.8.5.2.1, Loose-Chip Thermoluminescent Dosimeter.

- ISSUE: Hair and body oils on TLD chips cause inaccurate readings (SEC-00030 Petition, Part a, p. 45)

RESPONSE: See False Entries response below.

- ISSUE: Deliberately false entries were made into dose record: there is a charge of deliberate falsification of data. For instance, a worker alleges that his supervisor “would advise the dosimeter worker that the dose shown was too high to be possibly correct,” and the worker was advised to change or delete the reading. (SEC-00030 Petition, Part a, p. 57.). Further in Part b, p. 501, a worker alleges that zeros were entered into dose records when the TLD reader failed.

RESPONSE: False entries, along with other issues such as zero dose entries, chips falling out of TLDs, and other data reliability issues constitute the “Rocky Flats Data Integrity Issues. The working group’s discussion over several meetings culminated in a discussion that addressed and/or resolved the issue, as indicated in the March 7, 2007 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, page 154 of 269).

- ISSUE: Unauthorized work practices: the petition provides examples of unauthorized work practices (e.g., SEC-00030 Petition, Part a, p. 54)

RESPONSE: The associated issues were addressed in the SEC-00030 evaluation report and were completed and closed, as indicated in the April 12, 2006 RFP working group meeting transcript (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wg041206.pdf> , pages 233-239 of 347).

- ISSUE: Workers frequently did not wear badges in production areas and did not report non-use of badge (SEC-00030 Petition, Part a, p. 53). This raises a question of how missed dose is to be interpreted.

RESPONSE: This issue is addressed in ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*, Section 6.6.3, Missed Dose (photon); Section 6.7.3, Missed Dose (neutron); Section 6.8.3, Missed Dose (electron); and Appendix C.4, Adjustment for Missed Dose.

- ISSUE: Badge did not properly record organ dose due to organ being closer to the source than the badge or due to workers wearing the badge under their lead aprons. Petition provides examples where dose to head and other areas would be much greater than badge reading (SEC-00030 Petition, Part a, p. 53.). Some workers wore their badge under their lead aprons leading to under-recording of doses to some organs, such as the head, arms, and face. (SEC-00030 Petition, Part a, p. 53; Part b, p. 23). Note that these examples are also part of the suggestion that co-worker models for Rocky Flats worker external dose would not be valid.

RESPONSE: This issue is addressed in ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*, Section 6.5.4, Exposure Geometry; and Section 6.5.5, Lead Aprons.

- ISSUE: Missing dose record in areas of high exposure: one worker has provided an affidavit saying that an entire year's dose record is missing from a time he worked in an area with radiation dose rates that ranged up to 8 R/hour. He was an [redacted] in the Stacker Receiver area of Building 371, and [redacted], he was not rotated out of the area since he was an [redacted] (SEC-00030 Petition, Part b, p. 32). A worker affidavit including this problem is provided on p. 539 of SEC-00030 Petition, Part b.

RESPONSE: See False Entries response above.

- ISSUE: Bioassays redone when they indicated high exposure. There are two examples cited that claim that bioassays were redone or individuals were recounted when the readings were high and subsequent results were declared as having no exposure or false positives (SEC-00030 Petition, Part a, p. 47; Part b, p. 32).

RESPONSE: Missed dose is addressed in ORAUT-TKBS-0011-5, *Rocky Flats Plant – Occupational Internal Dose*, Attachment D, Internal Coworker Dosimetry Data For Rocky Flats Plant.

- ISSUE: Most exposed workers were not monitored for neutrons. The petition cites [redacted] as saying that until July 1958, the most exposed workers were not monitored for neutrons (SEC-00030 Petition, Part a, p. 71), raising a question about how the neutron data in the NDRP study are to be used, even if the re-reading of the badges is accepted as sound.

RESPONSE: These methods are now part of ORAUT-TKBS-0011-6, *Rocky Flats Plant – Occupational External Dose*. See Section 6.3.5.2, Neutron Dose Reconstruction Project File; Section 6.5, Common Issues; Section 6.7.3, Missed Doses; Section 6.7.3.3, Neutron Dose Reconstruction Project; and Section 6.7.3.4, Default Neutron-to-Gamma Ratio.

The neutron-to-photon ratio for the period prior to 1970 is not included. In Section 6.1.2, the Scope states:

*Only a limited assessment of neutron doses can be performed prior to 1970. Unmonitored and notional neutron doses from 1952 through 1966 cannot be reconstructed under the Energy Employees Occupational Illness Compensation Program Act. Between 1967 and 1970, unmonitored and notional neutron doses should be replaced with external coworker doses. Reported NDRP and non-affected original neutron dose can be used during all years.*

Section 6.7.3.3, Neutron Dose Reconstruction Project, Page 49:

*Only a limited portion of the NDRP neutron dose components can be used in dose reconstructions – 1952 through 1966: Only reported non-affected original neutron dose and NDRP neutron dose should be used in the reconstruction. Original and notional doses should not be used in the reconstruction of neutron doses. During periods where only original and notional doses are reported, the worker should be treated as an unmonitored worker. Unmonitored neutron dose cannot be reconstructed during this period.*

However, a result of the SEC-00030 evaluation was the recommendation of an SEC class based on neutron exposures for the period from April 1, 1952 through December 31, 1966.

- **ISSUE:** Many incidents were not reported or recorded. The petition claims, “Throughout the history of the site it was common practice for incidents in the workplace to be handled at the floor or building level and not reported” (SEC-00030 Petition, Part a, p. 19). This goes to whether missed internal dose due to unreported and unrecorded incidents causes a problem in regard to adequacy of data for dose reconstruction. Tab E.5 has a detailed example of this and refers to others. Also, SEC-00030 Petition, Part a, p. 139 cites an unreported incident discovered during a routine bioassay. There are other examples of undocumented exposures in the pages that follow p. 179; Part a is an example of a worker who was in an explosion involving Pu but there is no film badge.

**RESPONSE:** The information responding to this issue has been incorporated into ORAUT-TKBS-0011-5, *Rocky Flats Plant – Occupational Internal Dose*, Attachment D, Internal Coworker Dosimetry Data For Rocky Flats Plant.

- **ISSUE:** Concern over potential exposures to other radionuclides. There were potentials for occupational exposure to tritium (gas, HTO and others), <sup>233</sup>U, <sup>241</sup>Am, <sup>237</sup>Np, <sup>244</sup>Cm and <sup>210</sup>Po. Purification of <sup>241</sup>Am began in 1962 and continued to 1979. <sup>233</sup>U processing at RFP was conducted from 1965-1982. Operations involving <sup>233</sup>U included metal processing, component manufacturing, material recovery, and waste handling. Curium, neptunium, and polonium were used as tracer for the purpose of testing components and were handled in small quantities.

RESPONSE: The issues associated with this topic were addressed and closed, or otherwise determined to be other than a SEC issue, at the April, 12, 2006 working group meeting, January 26, 2007 working group meeting, and the March 3, 2007 working group meeting (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wg041206.pdf>, starting at page 307 of 347; <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr012607.pdf>, page 149-192 of 274; <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 157-177 of 269).

- ISSUE: Safety Concern Reports indicate concerns with dosimetry results.

RESPONSE: The issues were discussed at multiple working group meetings and NIOSH addressed the issues and closed, or otherwise determined them to be other than SEC issues, at the March 3, 2007 working group meeting. No further transcript discussions have been identified. (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 177-192 of 269).

- ISSUE: Concerns were expressed over discrepancies between log books and personnel dosimetry records.

RESPONSE: The issues were discussed at multiple working group meetings and NIOSH address the issues and closed, or otherwise determined to be other than a SEC issue, at the March 3, 2007 working group meeting – no further transcript discussions have been identified (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 177-192 of 269).

- ISSUE: Concern that secondary dosimetry logs, contamination control logs, or foreman logs include exposure information (possibly individual specific data) which is inconsistent with individual personnel dosimetry records.

RESPONSE: The issues were discussed at multiple working group meetings and NIOSH address the issues and closed, or otherwise determined to be other than a SEC issue, at the March 3, 2007 working group meeting – no further transcript discussions have been identified (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 177-192 of 269).

- ISSUE: Concern was raised as to whether adequate information was available for reconstructing internal doses for D&D workers (including all subcontractors).

RESPONSE: OCAS-TIB-014, *Rocky Flats Internal Dosimetry Coworker Extension*, extends ORAUT-OTIB-0038, *Internal Dosimetry Coworker Data for Rocky Flats Environmental Technology Site*. In order to extend the analysis beyond 1988, data were obtained from RFP's HIS-20 database. The purpose of OCAS-TIB-014 is to extend the previous ORAUT-OTIB-0038 using the same methodology.

- ISSUE: ORAUT-TKBS-0011-5, *Rocky Flats Plant – Occupational Internal Dose*, indicates that urinalysis log books are available for purposes of assessing MDAs. These log books may be useful in assessing the reliability of the electronic data.

RESPONSE: Log books were scanned and entered. The draft SC&A Logbook Analysis, Section 1.1.4, Field and Urinalysis Logbook Data Comparison, has a discussion of the analysis. The issues were discussed at multiple working group meetings and NIOSH addressed the issues and closed, or otherwise determined them to be other than SEC issues, at the March 3, 2007 working group meeting. No further transcript discussions have been identified (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 177-192 of 269).

- ISSUE: Concerns raised about whether other radionuclides which were not specifically monitored for were an exposure concern. Radionuclides include: Th-232, U-233, Cm-244, Np-237, Am-241, Pu-238, and Po-210.

RESPONSE: ORAUT-TKBS-0011-5, *Rocky Flats Plant – Occupational Internal Dose*, Section 5.2.5.2.4, Mold-Coating and Analytical Procedures, states:

*The uses of thorium in analytical procedures have been described as numerous but involving small (gram or less) quantities. Accounts of several small, laboratory procedures have been found in progress reports about research and development. Therefore, using the NUREG-1400 approach, with a release fraction R of 0.01, including a confinement factor C of 1, a dispersibility factor D of 10 and a quantity Q of <100 g ( $4 \times 10^5$  Bq), a quantity <100 g would result in potential intake of <0.04 Bq and is considered inconsequential.*

The issues associated with this topic were addressed and closed, or otherwise determined to be other than an SEC issue, at the April, 12, 2006 working group meeting, January 26, 2007 working group meeting, and the March 3, 2007 working group meeting (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wg041206.pdf>, starting at page 307 of 347; <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr012607.pdf>, page 149-192 of 274; <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/wgtr030707.pdf>, pages 157-177 of 269).

- ISSUE: An allegation was made that records related to occupational exposure were brought to the T-690 trailer and then removed and put in a landfill.

RESPONSE: The issues associated with this topic were addressed in a document presented by NIOSH and closed, or otherwise determined to be other than an SEC issue, at the August 31, 2006 working group meeting. No further transcript discussions have been identified (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr083106.pdf>, starting at page 317 of 367).

- ISSUE: Other Specific data integrity concerns (not detailed in above actions), including: [Redacted] case; neutron film blackening.

RESPONSE: The issues associated with this topic were addressed in a document presented by NIOSH and closed, or otherwise determined to be other than an SEC issue, at the August 31, 2006 working group meeting. No further transcript discussions have been identified (<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/tr083106.pdf>, starting at page 317 of 367).

## 7.6 Summary of Feasibility Findings for Petition SEC-00192

This report evaluates the feasibility for completing dose reconstructions for employees with the potential for tritium exposures while working at the Rocky Flats Plant from April 1, 1952 to December 31, 2005. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-2 summarizes the results of the feasibility findings at Rocky Flats for each exposure source during the time period April 1, 1952 to December 31, 2005.

<b>Table 7-2: Summary of Feasibility Findings for SEC-00192</b> April 1, 1952 to December 31, 2005		
<b>Source of Exposure</b>	<b>Reconstruction Feasible</b>	<b>Reconstruction Not Feasible</b>
<b>Internal<sup>1</sup></b>	<b>X</b>	
- Tritium	X (For relevant years, as discussed in Section 7.2.4)	
- Other radionuclides	Refer to SEC-00030 RFP Evaluation Report	
<b>External</b>	Refer to SEC-00030 RFP Evaluation Report	Refer to SEC-00030 RFP Evaluation Report

<sup>1</sup> Internal includes an evaluation of bioassay data.

As of August 20, 2012, a total of 1695 claims have been submitted to NIOSH for individuals who worked at Rocky Flats during the period under evaluation in this report. Dose reconstructions have been completed, or otherwise addressed via the SEC process, for 1605 individuals (~95%).

## 8.0 Evaluation of Health Endangerment for Petition SEC-00192

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. Section 83.13 requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is

required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH's evaluation determined that it is feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Therefore, a health endangerment determination is not required.

## **9.0 Class Conclusion for Petition SEC-00192**

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate tritium radiation doses with sufficient accuracy. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors with the potential for tritium exposures while working at the Rocky Flats Plant in Golden, Colorado, during the period from April 1, 1952 to December 31, 2005.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database (SRDB), for information relevant to SEC-00192. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

These actions are based on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing dose for the class under evaluation.

## 10.0 References

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Worker Outreach Meeting, 2012b, *Colorado Worker Outreach Meeting with former RFP Workers 1:15 PM session*; Public outreach meeting by ORAU and NIOSH staff; May 24, 2012; SRDB Ref ID: 117358

## Attachment 1: Data Capture Synopsis

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
<p><u>Primary Site/Company Name:</u> Rocky Flats Plant; DOE 1951-2006</p> <p><u>Alternate Site Names:</u> Rocky Flats Environmental Technology Site</p> <p><u>Operating Contractor Names:</u> Dow Chemical 1951-1975 Rockwell International 1975-1989 EG&amp;G Rocky Flats, Inc. 1989-1995 Kaiser-Hill Company 1995-2006</p> <p><u>Physical Size of the Site:</u> 6,500 acres. Operations were conducted in the 300 acre Industrial Area, which contained over 800 structures, at the center of the site. The surrounding 6,200 acres were known as the Buffer Zone.</p> <p><u>Site Population:</u> In 1973 the average site population was 3192. In 1993, at the time of the workforce reduction, there were approximately 6,800 employees on site.</p>	<p>Dosimetry databases, neutron dosimetry, site external dosimetry technical basis documents, dosimetry data, dosimetry software validations, radiological control procedures, training, tritium releases, tritium investigations, incident investigations, internal dosimetry manuals, radiological surveys, tritium monitor instruction manuals, air monitoring records, dosimetry audits and surveillances, corrective action plans, DOELAP testing results, TLD system descriptions, TLD response studies, plutonium bioassay studies, in vivo system studies, decommissioning closeout reports, log books, safety concerns, progress reports, epidemiologic reports, slide presentations, individual employee records, explanation of the HIS-20 database, Company/Union Safety Committee concerns, urinalysis records, and curium research.</p>	03/22/2011	635
State Contacted: NA	The state was not contacted as its holdings either duplicate DOE holdings or concentrate on off-site contamination issues.	05/22/2012	0
Argonne National Laboratory - East (ANL-E)	Decontamination and disposal of plutonium gloveboxes and a 1961 weekly radiation safety summary.	03/26/2008	3
Brookhaven National Laboratory (BNL)	Ambient air monitoring at DOE sites and a draft preliminary hazard analysis.	10/24/2008	2
Cincinnati Public Library	Volume 3 of "A History of the U.S. Atomic Energy Commission".	02/18/2009	1
Claimant Provided	Environmental monitoring data, links between occupational exposures and workforce illnesses, a New York State worker's compensation hearing, nuclear material codes, a claimant's job descriptions and dosimetry results, and a safety concern regarding neutron dosimetry results.	10/30/2007	6
College Hill Library, Westminster, CO	Investigation of the 1969 fire in Building 776-777.	08/09/2006	4
Colorado Mesa University Tomlinson Library	The Health and Safety Laboratory quarterly fallout report from January 1972.	04/18/2011	1

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
Colorado State University Library	Am-241 in soils around the site and a report on characterizing environmental plutonium by nuclear track techniques.	01/05/2007	2
Curtiss-Wright, Cheswick, PA	Reference to the 1969 Rocky Flats fire and a trip report to Rocky Flats.	05/01/2009	2
Department of Labor / Paragon	A 1971 announcement of construction to take place at Rocky Flats, waste inventory, and treatment reports.	01/23/2012	3
DOE / SC&A	Tritium removable contamination limit at Rocky Flats.	02/22/2012	1
DOE Albuquerque Operations Office	The use of data from the 1969 fire to develop plutonium release factors and nonreactor hazard level classifications.	04/15/2010	2
DOE Environmental Information Center	A Paducah Gaseous Diffusion Plant metals recovery report including the recovery of silver from Rocky Flats film.	07/20/2011	1
DOE Environmental Measurements Laboratory	Beryllium reports.	02/10/2009	3
DOE Germantown	Beryllium reports and the 1965 weapons plant specific missions policy.	08/08/2012	2
DOE Hanford Public Reading Room	A 1991 assessment of Building 559.	02/15/2006	1
DOELAP Office Idaho National Laboratory	1988 Albuquerque Operations Office applications for Department of Energy Laboratory Accreditation Program.	06/11/2009	1
DOE Legacy Management - Grand Junction Office	Progress reports, performance evaluations, long range planning, uranium scrap processing, plutonium in soil, accountability station symbols, a waste disposal report, and a Neutron Dose Reconstruction Project spreadsheet.	01/24/2012	15
DOE Legacy Management - Morgantown	Fernald progress reports, material transfer reports, recycle uranium reports, all of which reference Rocky Flats, health and mortality studies of DOE employees, and Grand Junction Office employee exposure histories including Rocky Flats exposures.	09/19/2011	69
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Review of the environmental program, incineration of radioactive wastes, summaries of unusual occurrences, long range plans, bioassay and analytical chemistry meeting reports, plutonium internal depositions, material transfers from Fernald, a brief description of criticality dosimetry at Rocky Flats, and Mound incident reports referencing Rocky Flats.	04/22/2010	46
DOE Legacy Management - RFP Mountain View Office	Logbooks and logbook excerpts, internal dosimetry description and assessments, internal and external dosimetry reports, radiological surveys, dosimetry procedures, dosimetry progress and status reports, health physics progress and status reports, material transfers, terminated employee records, and thorium reports.	11/16/2006	127

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
DOE Legacy Management - Westminster Office	Tritium procedures, tritium monitoring, tritium analysis reports, thorium reports, the 1973 tritium release, processing of Los Alamos and Lawrence Livermore plutonium scrap, tritium surveys and air monitoring, tritium in water, effluent monitoring programs, environmental reports, urinalysis reports, tritium bioassay results and exposure data, Hot Man Books, packaging of tritium wastes, and individual dosimetry records. An additional 21 documents which required classification review have been received and are in the process of uploading to the Site Research Database.	OPEN	175
DOE Oak Ridge Operations Office	Former radiation worker medical surveillance files and radiation exposure history requests for workers starting at Rocky Flats.	11/18/2011	26
DOE Oak Ridge Operations Records Holding Task Group	1953 and 1954 production division progress reports.	04/05/2011	2
DOE Office of Scientific and Technical Information (OSTI)	Technical papers from the 1968 Metallographic Group meeting, Pacific Northwest National Laboratory's description of source term data sources for contaminated buildings and sites, and the method by which the Rocky Flats site was selected.	09/05/2008	3
DOE Rocky Flats Reading Room - Front Range Community College	Occurrence reports, 1994 Radiological Control Manual, health monitoring, beryllium surveillance, medical monitoring reports, neutron dose reconstruction project reports, contamination incident reports, high bioassay results, environmental surveillance reports, minutes of meetings with the Colorado Department of Health, and remedial action closeout reports.	04/07/2006	256
Dr. Henry Spitz	The Pacific Northwest National Laboratory dosimetry system performance comparison for several DOE sites.	08/13/2003	1
Energy Technology Engineering Center	Rockwell International's annual reviews of the Energy Systems Group's radiological controls.	11/03/2005	4
Federal Records Center (FRC) - Chicago	A radioactive waste management working group meeting and a reference to Rocky Flats decontamination efforts as a learning tool for the termination of Mound's Special Metallurgical Building.	09/27/2006	2
Federal Records Center (FRC) - Denver	Dosimetry procedures, health physics procedures, health and mortality studies, chronological log of the Building 771 fire, and site problem areas.	02/01/2012	20
Federal Records Center (FRC) - Fort Worth	Exposure report for Pantex personnel while at Rocky Flats.	07/27/2006	1
Federal Records Center (FRC) - Kansas City/Bannister	ANL-E's consideration of Rocky Flats as a transuranic waste consolidation center.	08/15/2008	1
Federal Records Center (FRC) - San Bruno	Shielding design for a shipment of Na-24 to Rocky Flats.	01/10/2006	1

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
General Atomics	Material transfer reports.	11/02/2005	1
Hagley Museum and Library	Trip reports regarding transuranic waste incineration and exposures exceeding the DOE standard.	09/30/2010	5
Hanford	Hanford monthly reports referencing Rocky Flats, material transfers, plutonium feed and fuel specifications and incident reports.	01/25/2012	39
Hanford / SC&A	Volume III of the investigation of the 1969 Building 776-777 fire.	08/09/2006	1
Interlibrary Loan	Proceedings of a criticality safety short course, survey of DOE mixed waste HEPA filters, proceedings of a conference on incinerating wastes, and environmental reports.	05/29/2012	14
Interlibrary Loan / SC&A	The December 1971 report of environmental levels of radioactivity at Rocky Flats.	01/21/2010	1
Internet	A history of the site by a former worker.	06/20/2012	1
Internet - Defense Technical Information Center (DTIC)	Defense Nuclear Facility Safety Board reports, Los Alamos actinide research reports, plutonium machining and handling reports, and plutonium stabilization and disposition reports.	01/09/2012	37
Internet - Defense Technical Information Center (DTIC) / SC&A	The 1995 Idaho National Laboratory environmental report, which discusses Rocky Flats waste at INL.	01/09/2012	1
Internet - DOE	The review of solutions stabilization at Rocky Flats, a DOE guide of good radiological protection practices at plutonium facilities, and the data analysis from the DOE's handbook of airborne release fractions.	12/04/2008	3
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	05/22/2012	0
Internet - DOE Environmental Management	Chapter 3 of Linking Legacies.	10/28/2007	1
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford monthly reports referencing Rocky Flats and a reference to Rocky Flat's use of a shrouded probe stack sampler.	09/01/2010	11
Internet - DOE Legacy Management Considered Sites	No relevant documents identified.	04/03/2012	0
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	04/03/2012	0
Internet - DOE OpenNet	A plutonium uptake incident description, U.S. Transuranium Registry summary reports, a summary history of the nuclear weapons program, and Appendix B of Linking Legacies.	12/11/2011	10
Internet - DOE OSTI Energy Citations	Proceedings of the ERDA D&D conference, an inventory of contaminated concrete in the DOE complex, an assessment of Rocky Flats criticality safety, plutonium processing experimental reports, and the decontamination and decommissioning waste estimate validation.	03/27/2012	17

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
Internet - DOE OSTI Information Bridge	Environmental reports, U.S. radioactive waste inventories, Hanford reports referencing Rocky Flats, material transfers, AEC and DOE radioisotope customers, Health and Safety Laboratory environmental reports, transuranic waste disposition, evaluations of beryllium exposures, assessment of airborne plutonium, waste stabilization reports, remediation of plutonium contaminated components, Savannah River Site reports referencing Rocky Flats plutonium waste, and meteorological reports.	05/04/2012	125
Internet - Google	Environmental reports and plans, air monitoring program and reports, offsite dose assessment, DOE complex histories and descriptions, DOE occupational radiation exposure reports, transuranic inventories, management, and disposition, DOE 5 year plans, building histories and descriptions, groundwater monitoring, EPA records of decision, an EPA report on radioactive emissions from DOE facilities, component closure plans, public hearings and meetings, radiological surveys, environmental remediation of transuranics, site remediation plan assessments, preparing and transporting radioactive waste, air emissions reports, the toxicology of uranium, radium disposition options, an ALARA analysis for hazardous waste disposal, improving tritium exposure reconstructions, the finding aid for the K.Z. Morgan papers at the University of Tennessee Hodges Library, and decommissioning gloveboxes.	07/23/2012	493
Internet - Health Physics Journal	No relevant tritium-related articles identified. Other relevant articles not already in the SRDB will be downloaded.	OPEN	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant tritium-related articles identified. Other relevant articles not already in the SRDB will be downloaded.	OPEN	0
Internet - National Academies Press (NAP)	An analysis of cancer risks in populations near nuclear facilities including Rocky Flats.	03/27/2012	1
Internet - NRC Agencywide Document Access and Management (ADAMS)	U.S. spent fuel and radioactive waste inventories, long-term surveillance and maintenance program reports, disposition of plutonium environmental impact statement, disposition of highly enriched uranium environmental impact statement, Hanford waste disposition environmental impact statements referencing Rocky Flats, an intervenor petition referencing Rocky Flats, and stockpile stewardship documents.	03/27/2012	35
Internet - Oak Ridge National Laboratory (ORNL) Library	ORNL progress reports and an air filtration report referencing Rocky Flats.	03/09/2012	5

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
Internet - Rocky Flats Environmental Technology Site (RFETS)	Air monitoring reports, radiological surveys, decommissioning closeout reports, project closeout reports, and site newsletters from closure period.	07/05/2006	70
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	04/03/2012	0
Kansas City Plant	Mention of Rocky Flats closure during testimony on pits production.	10/01/2004	1
Lawrence Livermore National Laboratory (LLNL)	Individual exposure files and a summary of LLNL employee internal doses at Rocky Flats.	06/10/2009	4
Los Alamos National Laboratory (LANL)	Trip reports, analysis of Rocky Flats environmental samples, support of FBI/EPA investigation at Rocky Flats, report of the 1969 fire, storage and disposition of plutonium, and plutonium body burdens.	09/06/2007	21
Lovelace Respiratory Research Institute (LRRI)	LRRI annual reports referencing Rocky Flats and the analyses of cancer patterns around Rocky Flats.	05/22/2007	3
Mesa County Libraries, Grand Junction, CO	A newspaper article about rocky Flats waste inventories.	01/06/2011	1
Missouri Department of Natural Resources	The Plutonium Working Group report on plutonium storage environmental, safety, and health vulnerabilities.	10/01/2008	1
Mound Museum	Material transfers, plutonium accountability and shipments, the Mound Laboratory index which mentions Rocky Flats, and newsletters mentioning Rocky Flats.	02/01/2012	21
National Archives and Records Administration (NARA) - Atlanta	The DOE indoor radon study, summaries of AEC accidents and high exposures, and a directory of AEC consultants to contractors.	06/07/2004	5
National Archives and Records Administration (NARA) - College Park	A 1974 summary report from the U.S. Transuranium and Uranium Registry, environmental plutonium contamination, and a report of the 1973 tritium release.	04/16/2010	6
National Institute for Occupational Safety and Health (NIOSH)	Plutonium excretion study, the investigation of thorium handling at Rocky Flats, a logbook, interviews, affidavits from former workers, radiological surveys, worker outreach meeting minutes, SEC focus group meeting sign-in sheets, the protocol for the site epidemiological study, an amended NIOSH referral summary showing a visit to Rocky Flats, a claimant's public testimony to NIOSH, soil and leachate monitoring, a cost-saving plan for decontamination and demolition of tritium contaminated facilities, a NIOSH researcher's notes from document reviews at DOE headquarters, and responses to union requests for data.	07/26/2012	47

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
National Institute for Occupational Safety and Health (NIOSH) / SC&A	The Ohio Field Office Recycled Uranium Project report, highly enriched uranium working group reports, the former worker medical surveillance program, radiation protection program reviews, disposition of plutonium and U-233, a summary of Rocky Flats problems, and personnel protection requirements.	02/16/2006	25
Nevada Test Site (NTS)	The NTS Environmental Impact Statement, and an area closure report detailing waste shipments from Rocky Flats.	04/14/2008	4
Nuclear Regulatory Commission Public Document Room	<b>Rocky Flats records at the Public Document Room have not been reviewed at this time.</b>	<b>OPEN</b>	0
Oak Ridge	A Freedom of Information Act request and responses.	11/09/2007	4
Oak Ridge Institute for Science and Education (ORISE)	Chelation DTPA data for DOE including Rocky Flats employees.	08/06/2009	115
Oak Ridge Library for Dose Reconstruction	Identification of radionuclides used at Rocky Flats, the Rocky Flats exposure pathway study, and Oak Ridge Gaseous Diffusion and National Laboratory reports referencing Rocky Flats.	05/23/2011	5
ORAU Library	A nuclear weapons databook showing shipments from Fernald to Rocky Flats.	10/12/2006	1
ORAU Team	ORAU Team technical basis documents and information bulletins, Rocky Flats' approaches to dose reconstruction, bioassay documentation, documented communications, analyses of cancer risks, annual DOE radiation exposure reports, external dosimeter characteristics, instrument descriptions and instructions, reviews of releases, Rocky Flats technical basis documents and procedures, reference to the 1985 completion of the Rocky Flats Custom Campaign at the INL Chemical Processing Plant Hot Chemistry Lab, and ORAU Team researchers' notes from reviews of classified documents at the Office of Scientific and Technical Information and the Denver office of the DOE Environmental Management Consolidated Business Center.	08/15/2012	430
Paducah Gaseous Diffusion Plant	Paducah radiological reports referencing Rocky Flats.	09/18/2006	1
Pantex Plant	Confirmation that Rocky Flats was the back-up dosimetry processor for Pantex, the results of lead apron studies, and the development of diagnostic x-ray dose estimates.	11/01/2005	7
Pantex Plant / SC&A	A discussion of tritium contamination of returned pits.	06/23/2011	1
Sandia National Laboratories, New Mexico	The Rocky Flats exposure histories for Sandia employees and material transfers handled by Ross Aviation.	02/17/2012	4

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
Savannah River Site (SRS)	Material transfers, FOIA responses, SRS progress reports referencing Rocky Flats, a discussion of plutonium in soil around Rocky Flats, the record of a californium shipment to Rocky Flats, and the flow of materials to and from Rocky Flats.	02/07/2012	45
S. Cohen & Associates (SC&A)	Confirmation that Rocky Flats personnel attended dosimetry training at Hanford, a Lawrence Livermore National Laboratory paper on dose reconstruction, discussions of neutron dosimetry, the analyses of Rocky Flats material returned to Y-12 and Mound, interactions between Sandia-Livermore and Rocky Flats, and the vulnerabilities of plutonium storage.	02/16/2009	14
SC&A / Idaho National Laboratory (INL)	Discussions of Rocky Flats transuranic waste treated and stored at INL, reports of Rocky Flats waste incidents, and Rocky Flats waste data.	06/24/2010	34
SC&A / Nevada Test Site (NTS)	A 1950-1954 Santa Fe Operations report which summarizes Rocky Flats operations.	06/24/2010	1
SC&A / NIOSH	Highly enriched uranium and plutonium working group reports.	02/16/2006	2
SC&A / Y-12	Inclusion of the Rocky Flats 1969 fire report in the investigation of the 1969 Y-12 thorium fire.	07/28/2010	1
Science Applications International Corp (SAIC)	Radiation exposure summaries.	09/02/2004	5
Southern Illinois University, Edwardsville, IL	Material transfers, a U.S. Transuranium and Uranium Registries report of a Rocky Flats whole body donation, Advisory Board on Radiation and Worker Health (ABRWH) meeting minutes, and a review of the Rocky Flats Special Exposure Cohort petition.	11/08/2008	9
University of Colorado Norlin Library	Air monitoring data, environmental reports, site cleanup activities, plutonium releases, release points, trends in plutonium environmental monitoring, draft tritium release investigation report, waste disposal reports, public doses from the 1969 fire, Rocky Flats 1998 internal dosimetry technical basis document, environmental surveys, thorium and U-233 handling reports, a 1992 subpoena, and historical radionuclide inventories.	11/16/2006	129
University of Tennessee Hodges Library	U.S. Transuranium and Uranium Registries reports, the distribution of transuranics in food chains, and a fact sheet on DTPA.	03/18/2010	5

<b>Table A1-1: Data Capture Synopsis for Rocky Flats Plant</b>			
<b>Data Capture Information</b>	<b>General Description of Documents Captured</b>	<b>Date Completed</b>	<b>Uploaded To SRDB</b>
Unknown	Environmental reports, internal deposition of plutonium, site histories, a guide to Rocky Flats records series, air emissions annual reports, the angular dependence of NTA film, a dose control procedure, studies of plutonium particle size distribution, recycle uranium transfers, employee statements on exposure reporting and radiation controls, a history of Dayton Project and Mound dosimetry which mentions Rocky Flats dosimetry, mention of Rocky Flats as a weapons production site, DOE occupational exposure reports, and x-ray machine records.	04/26/2005	151
U.S. Transuranium and Uranium Registries	A review of a Rocky Flats whole body donor case.	08/22/2005	1
Westinghouse Site (United Nuclear Corporation), Hematite, MO	A trip report to Rocky Flats.	03/13/2009	1
Y-12	A 1983 description of Y-12 extremity monitoring provided to Rocky Flats.	06/30/2006	1
Y-12 / SC&A	Y-12's transuranics sampling frequency for castings from Rocky Flats returns.	07/28/2010	1
<b>TOTAL</b>			<b>3397</b>

<b>Table A1-2: Databases Searched for Rocky Flats Plant</b>			
<b>Database/Source</b>	<b>Keywords / Phrases</b>	<b>Hits</b>	<b>Selected</b>
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Rocky Flats Plant Rev 01, (83.13) 08-22-12"			
Defense Technical Information Center (DTIC) <a href="https://www.dtic.mil/">https://www.dtic.mil/</a> COMPLETED 12/23/2011	See Note above	1,319	62
DOE CEDR <a href="https://www.orau.gov/cedr">https://www.orau.gov/cedr</a> COMPLETED 05/22/2012	See Note above	9	0

<b>Table A1-2: Databases Searched for Rocky Flats Plant</b>			
<b>Database/Source</b>	<b>Keywords / Phrases</b>	<b>Hits</b>	<b>Selected</b>
DOE Hanford DDRS <a href="http://www2.hanford.gov/declass/">http://www2.hanford.gov/declass/</a> COMPLETED 04/03/2012	See Note above	0	0
DOE Legacy Management Considered Sites <a href="http://www.lm.doe.gov/considered_Sites/">http://www.lm.doe.gov/considered_Sites/</a> COMPLETED 04/03/2012	See Note above	38	0
DOE NNSA - Nevada Site Office <a href="http://www.nv.doe.gov/main/search.htm">www.nv.doe.gov/main/search.htm</a> COMPLETED 04/03/2012	See Note above	0	0
DOE OpenNet <a href="http://www.osti.gov/opennet/advancedsearch.jsp">http://www.osti.gov/opennet/advancedsearch.jsp</a> COMPLETED 04/03/2012	See Note above	160	0
DOE OSTI Energy Citations <a href="http://www.osti.gov/energycitations/">http://www.osti.gov/energycitations/</a> COMPLETED 04/03/2012	See Note above	7,811	5
DOE OSTI Information Bridge <a href="http://www.osti.gov/bridge/advancedsearch.jsp">http://www.osti.gov/bridge/advancedsearch.jsp</a> COMPLETED 04/03/2012	See Note above	5,038	19
Google <a href="http://www.google.com">http://www.google.com</a> COMPLETED 04/03/2012	See Note above	4,141,787	399
HP Journal <a href="http://journals.lww.com/health-physics/pages/default.aspx">http://journals.lww.com/health-physics/pages/default.aspx</a> COMPLETED 05/31/2012	See Note above	158	0
Journal of Occupational and Environmental Health <a href="http://www.ijoh.com/index.php/ijoh">http://www.ijoh.com/index.php/ijoh</a> COMPLETED 05/22/2012	See Note above	82	0
National Academies Press <a href="http://www.nap.edu/">http://www.nap.edu/</a> COMPLETED 04/03/2012	See Note above	12,974	0
NRC ADAMS Reading Room <a href="http://www.nrc.gov/reading-rm/adams/web-based.html">http://www.nrc.gov/reading-rm/adams/web-based.html</a> COMPLETED 04/03/2012	See Note above	90	0
USACE/FUSRAP <a href="http://www.lrb.usace.army.mil/fusrap/">http://www.lrb.usace.army.mil/fusrap/</a> COMPLETED 04/03/2012	See Note above	10	1

<b>Table A1-2: Databases Searched for Rocky Flats Plant</b>			
<b>Database/Source</b>	<b>Keywords / Phrases</b>	<b>Hits</b>	<b>Selected</b>
U.S. Transuranium & Uranium Registries <a href="http://www.ustur.wsu.edu/">http://www.ustur.wsu.edu/</a> COMPLETED 04/03/2012	See Note above	8	0

<b>Table A1-3: DTIC Documents Requested for Rocky Flats Plant</b>			
<b>Document Number</b>	<b>Document Title</b>	<b>Requested Date</b>	<b>Received Date</b>
ARCCD-CR-87011	Roll Forming Process For Cannon Caliber Depleted Uranium Penetrators	01/10/2012	
NA	Indoor Air Modeling Dated January 1998, Author Kogan, Vladimir; Odasso, James	01/10/2012	05/21/2012
NA Ref ID: 107537	Swaging The Xm774 Depleted Uranium-0.75 Titanium Penetrator	01/10/2012	01/19/2012

<b>Table A1-4: Interlibrary Loan Documents Requested for Rocky Flats Plant</b>			
<b>Document Number</b>	<b>Document Title</b>	<b>Requested Date</b>	<b>Received Date</b>
SA-93-010	Statistical Applications: Statistical Methodology for Determining Contaminants of Concern by Comparison of Background and Site Data with Applications to Operable Unit 2	06/02/2011	

<b>Table A1-5: OSTI Documents Requested for Rocky Flats Plant</b>			
<b>Document Number</b>	<b>Document Title</b>	<b>Requested Date</b>	<b>Received Date</b>
RFP-4317; CONF-8905122-4 Ref ID: 106431	Pilot-Scale Production of Dicesium Hexachloroplutonate (Cs2/PuCl6) and Filtrate Recovery Dated 3/15/1989	01/11/2012	01/17/2012
RFP-4203 Ref ID: 106432	Preliminary Molten Salt Extraction Experiments with Dicesium Hexachloroplutonate (Cs2/PuCl6) Dated 1/30/1989	01/11/2012	01/17/2012
RFP-2134 Ref ID: 107471	An Evaluation of the Cryofit Tube Joining System in Selected Plutonium Chemical Processing Solutions	01/10/2012	01/13/2012
RFP-3780 Ref ID: 107472	Measurement Control For Plutonium Isotopic Measurements Using Gamma-ray Spectrometry	01/10/2012	01/13/2012