

SEC Petition Evaluation Report Petition SEC-00150

Report Rev #: 0

Report Submittal Date: April 12, 2010

Subject Expert(s):		Roger Halsey, Joseph Guido, Paul Ruhter		
Site Expert(s):		N/A		
Petition Administrative Summary				
Petition Under Evaluation				
Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00150	83.13	July 22, 2009	September 22, 2009	St. Louis Airport Storage Site
Petitioner Class Definition				
All workers who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, during the operational period from January 1, 1946 through December 31, 1966, and the residual period from January 1, 1967 through December 31, 1998.				
Class Evaluated by NIOSH				
All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through December 31, 1973, and again from January 1, 1984 through December 31, 1998.				
NIOSH-Proposed Class to be Added to the SEC				
All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through November 2, 1971, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.				
Related Petition Summary Information				
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status	
N/A	N/A	N/A	N/A	
Related Evaluation Report Information				
Report Title			DOE/AWE Facility Name	
N/A			N/A	
ORAU Lead Technical Evaluator: Roger Halsey		ORAU Peer Review Completed By: Daniel Stempfley		
Peer Review Completed By:		[Signature on file] _____ <i>LaVon Rutherford</i>	4/12/2010 _____ <i>Date</i>	
SEC Petition Evaluation Reviewed By:		[Signature on file] _____ <i>J. W. Neton</i>	4/12/2010 _____ <i>Date</i>	
SEC Evaluation Approved By:		[Signature on file] _____ <i>Stuart L. Hinnefeld</i>	4/13/2010 _____ <i>Date</i>	

This page intentionally left blank

Evaluation Report Summary: SEC-00150, St. Louis Airport Storage Site (SLAPS)

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-00150 was received on July 22, 2009, and qualified on September 22, 2009. The petitioner requested that NIOSH consider the following class: *All workers who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, during the operational period from January 1, 1946 through December 31, 1966, and the residual period from January 1, 1967 through December 31, 1998.*

Class Evaluated by NIOSH

Based on a December 14th letter from the Department of Labor clarifying the covered period for the St. Louis Airport Storage site, NIOSH modified the petitioner-requested class. NIOSH evaluated the following class: All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through December 31, 1973, and again from January 1, 1984 through December 31, 1998.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through November 2, 1971, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC. NIOSH recommended this because of the uncharacterized material in residue piles during this time period. The period from November 3, 1971 through December 31, 1973, is after residues were removed and the site was cleaned up; NIOSH finds that it can bound doses for the evaluated class during this period. NIOSH also finds that it can bound the doses for the evaluated class during the January 1, 1984 through December 31, 1998 period using the *Baseline Risk Assessment for Exposure to Contaminants at the St. Louis Site, St. Louis, Missouri*.

Feasibility of Dose Reconstruction

NIOSH finds it is not feasible to estimate internal exposures with sufficient accuracy for all workers at the site from January 3, 1947 through November 2, 1971. During this time, there were many tons of raffinate residues in storage piles without cover or controls to protect personnel from internal exposures. These residues contained uranium and uranium progeny in disequilibrium that were not sufficiently radiologically characterized. Workers were not adequately monitored for internal exposure to these materials. Consequently, NIOSH lacks sufficient information, which includes

biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source information, to allow it to estimate with sufficient accuracy the potential internal exposures to various radionuclides to which the proposed class may have been subjected.

With the exception of the period from January 3, 1947 through November 2, 1971, of the evaluated class, 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; or (2) estimate radiation doses 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 from November 3, 1971 through December 31, 1973 and from January 1, 1984 through December 31, 1998. After November 3, 1971, the site was in a stable condition with all residue piles removed, all above-ground buildings removed, and with one to three feet of clean fill added. During this time period, Department of Energy (DOE) contractor and subcontractor workers were monitored for internal and external exposures. Additionally, there were detailed characterization efforts that defined site conditions after November 3, 1971.

NIOSH finds that it is likely feasible to reconstruct occupational medical dose for the St. Louis Airport Storage site workers with sufficient accuracy.

- Through the course of on-going dose reconstruction, continued data capture efforts, and investigations associated with the St. Louis Airport Storage site, NIOSH has determined the inability to estimate, with sufficient accuracy, the total internal dose for St. Louis Airport Storage site employees from January 3, 1947 through November 2, 1971. Therefore, NIOSH has determined that it is necessary to propose a St. Louis Airport Storage site Special Exposure Cohort class for the time period at the site from January 3, 1947 through November 2, 1971.
- NIOSH has determined that reconstruction of internal dose is not feasible for the time period from January 3, 1947 through November 2, 1971, due to the lack of adequate personnel monitoring data, insufficient area monitoring information, and insufficient process and radiological source term data.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at the St. Louis Airport Storage Site during the period from January 3, 1947 through November 2, 1971, but who do not qualify for inclusion in the Special Exposure Cohort, may be performed using these data as appropriate.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the proposed class from January 3, 1947 through November 2, 1971.

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation.

Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under their employment or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

For the period November 3, 1971 through December 31, 1973 and January 1, 1984 through December 31, 1998, 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.

This page intentionally left blank

Table of Contents

1.0	Purpose and Scope.....	9
2.0	Introduction	9
3.0	SEC-00150, St. Louis Airport Storage Site Class Definitions	10
3.1	Petitioner-Requested Class Definition and Basis	10
3.2	Class Evaluated by NIOSH	11
3.3	NIOSH-Proposed Class to be Added to the SEC	11
4.0	Data Sources Reviewed by NIOSH to Evaluate the Class	11
4.1	Site Profile Technical Basis Documents (TBDs)	12
4.2	ORAU Technical Information Bulletins (OTIB)	12
4.3	Facility Employees and Experts	12
4.4	Previous Dose Reconstructions	13
4.5	NIOSH Site Research Database	13
4.6	Documentation and/or Affidavits Provided by Petitioners	14
5.0	Radiological Operations Relevant to the Class Evaluated by NIOSH	14
5.1	SLAPS Description	14
5.1.1	Stored Residues/Materials	15
5.1.2	Sale and Removal of Residues and Scrap	17
5.1.3	FUSRAP Period.....	19
5.1.4	SLAPS Employees	19
5.2	Radiological Exposure Sources from SLAPS Operations.....	20
5.2.1	Internal Radiological Exposure Sources from SLAPS Operations	20
5.2.1.1	Uranium.....	20
5.2.1.2	Radium-226	22
5.2.1.3	Thorium-230.....	23
5.2.2	External Radiological Exposure Sources from SLAPS Operations	23
5.2.2.1	Photon.....	23
5.2.2.2	Beta.....	24
5.2.2.3	Neutron	25
5.2.3	Incidents	25
6.0	Summary of Available Monitoring Data for the Class Evaluated by NIOSH	26
6.1	Available SLAPS Internal Monitoring Data	26
6.2	Available SLAPS External Monitoring Data	27
7.0	Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH.....	28
7.1	Pedigree of SLAPS Data	29
7.1.1	Internal Monitoring Data Pedigree Review	29
7.1.2	External Monitoring Data Pedigree Review.....	29
7.2	Evaluation of Bounding Internal Radiation Doses at SLAPS	30
7.2.1	Evaluation of Bounding Process-Related Internal Doses.....	30
7.2.1.1	Urinalysis Information and Available Data.....	30
7.2.1.2	Airborne Levels	30

7.2.1.3	Alternative Data Sources for Bounding Internal Dose.....	31
7.2.2	Evaluation of Bounding Ambient Environmental Internal Doses.....	32
7.2.3	Methods for Bounding Internal Dose at SLAPS	32
7.2.4	Internal Dose Reconstruction Feasibility Conclusion	33
7.3	Evaluation of Bounding External Radiation Doses at SLAPS	34
7.3.1	Evaluation of Bounding Process-Related External Doses.....	34
7.3.1.1	Personnel Dosimetry Data.....	34
7.3.1.2	Area Monitoring Data.....	34
7.3.2	Evaluation of Bounding Ambient Environmental External Dose	35
7.3.3	SLAPS Occupational X-Ray Examinations	35
7.3.4	Methods for Bounding External Dose at SLAPS	35
7.3.4.1	Methods for Bounding Operational Period External Dose.....	36
7.3.5	External Dose Reconstruction Feasibility Conclusion	37
7.4	Evaluation of Petition Basis for SEC-00150	38
7.5	Summary of Feasibility Findings for Petition SEC-00150.....	38
8.0	Evaluation of Health Endangerment for Petition SEC-00150.....	39
9.0	Class Conclusion for Petition SEC-00150	40
10.0	References	41
	Attachment One: Data Capture Synopsis	47

Tables

Table 4-1:	No. of SLAPS Claims Submitted Under the Dose Reconstruction Rule.....	13
Table 5-1:	Summary of Residues Stored at SLAPS	15
Table 7-1:	Estimated Exposures to Workers from Baseline Risk Assessment	31
Table 7-2:	Summary of Feasibility Findings for SEC-00150	39

Figures

Figure 5-1:	SLAPS Residue Storage Site Map.....	17
-------------	-------------------------------------	----

SEC Petition Evaluation Report for SEC-00150

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: Roger Halsey, Oak Ridge Associated Universities (ORAU). 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 all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through December 31, 1973, and again from January 1, 1984 through December 31, 1998. 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*, OCAS-PR-004.

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.¹

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 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

¹ 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>.

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 other SEC classes (excluding aggregate work day requirements).

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 to 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.²

3.0 SEC-00150, St. Louis Airport Storage Site Class Definitions

The following subsections address the evolution of the class definition for SEC-00150, the St. Louis Airport Storage (SLAPS) site. 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 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-00150 was received on July 22, 2009, and qualified on September 22, 2009. The petitioner requested that NIOSH consider the following class: *All workers who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, during the operational period from January 1, 1946 through December 31, 1966, and the residual period from January 1, 1967 through December 31, 1998.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the St. Louis Airport Storage workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00150 for evaluation:

To the best of my knowledge, there was no internal monitoring of the St. Louis Airport Storage Site (SLAPS) employees (workers).

² 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>.

Based on its SLAPS research and data capture efforts, NIOSH determined that internal (and external) monitoring was performed for SLAPS site workers during the time period under evaluation. However, NIOSH also determined that this monitoring did not adequately assess all potential exposures (i.e., the monitoring was inadequate in that not all radionuclides were monitored during the applicable periods under the bioassay program). NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal radiation exposures and radiation doses were not adequately monitored at SLAPS, 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.

3.2 Class Evaluated by NIOSH

On December 14, 2009 the Department of Labor (DOL) issued a letter that changed the designation of St. Louis Airport Storage site from an Atomic Weapons Employer (AWE) to a DOE facility and changed the covered period from 1946 through 1966, to January 3, 1947 through 1973 and from 1984 through 1998 [EEOICPA does not provide for residual contamination periods for DOE sites.] (DOL, 2009). In addition, DOE issued a letter dated April 8, 2010, that removed the AWE designation for 1946 through 1966 (DOE, 2010). Based on these changes, NIOSH modified the petitioner-requested class. NIOSH defined the following class for further evaluation: All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through December 31, 1973, and again from January 1, 1984 through December 31, 1998.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through November 2, 1971, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding SLAPS. 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, the Atomic Energy Technical Report 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 One contains a summary of SLAPS site 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 TBD for insights into SLAPS operations or related topics/operations at other sites:

- *Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site, St. Louis, Missouri*; ORAUT-TKBS-0005; Rev. 02 PC-1; May 25, 2009; SRDB Ref ID: 67979

4.2 ORAU Technical Information Bulletins (OTIB)

An ORAU Technical Information Bulletin (OTIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIB as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006; December 21, 2005; SRDB Ref ID: 20220

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed seven individuals considered knowledgeable about the SLAPS site. NIOSH selected individuals based on their known experience and likelihood that they would be knowledgeable about (1) workplace radiation fields, hazards, and practices to control worker exposure; (2) potential radionuclide intakes as evidenced by workplace controls, monitoring policies and procedures, and bioassay data; and (3) measurements of the beta and photon exposure to workers.

- Personal Communication, 2009a, *Personal Communication with Former Mallinckrodt Chemical Works Engineer*; Telephone Interview by ORAU Team; November 18, 2009, 4:30 PM EST; SRDB Ref ID: 77841
- Personal Communication, 2009b, *Personal Communication with Former Mallinckrodt Chemical Works and Weldon Spring Plant Employee*; Telephone Interview by ORAU Team; November 23, 2009, 11:00 AM EST; SRDB Ref ID: 77844

- Personal Communication, 2009c, *Personal Communication with Former Mallinckrodt Chemical Works and SLAPS Laborer*; Telephone Interview by ORAU Team; November 24, 2009, 11:00 AM EST; SRDB Ref ID: 77843
- Personal Communication, 2009d, *Personal Communication with Former Mallinckrodt Chemical Works and Weldon Spring Plant Employee*; Telephone Interview by ORAU Team; December 2, 2009, 10:30 AM EST; SRDB Ref ID: 77837
- Personal Communication, 2009e, *Personal Communication with Former SLAPS Laborer*; Telephone Interview by ORAU Team; December 2, 2009, 5:00 PM EST; SRDB Ref ID: 77839
- Personal Communication, 2009f, *Personal Communication with Former Mallinckrodt Chemical Works, Weldon Spring, and SLAPS Laborer*; Telephone Interview by ORAU Team; December 7, 2009, 7:00 PM EST; SRDB Ref ID: 77840
- Personal Communication, 2009g, *Personal Communication with Former SLAPS Laborer*; Telephone Interview by ORAU Team; December 15, 2009, 3:00 PM EST; SRDB Ref ID: 77836

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH OCAS Claims Tracking System (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 January 6, 2010)

Table 4-1: No. of SLAPS Claims Submitted Under the Dose Reconstruction Rule	
Description	Totals
Total number of claims submitted for dose reconstruction	3
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (January 3, 1947-December 31, 1973; January 1, 1984-December 31, 1998)	3
Number of dose reconstructions completed for energy employees who meet the definition criteria for the class under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	2
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	1
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	2

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Three hundred eighty-four documents in this database were identified as pertaining to SLAPS. These documents were evaluated for their relevance to this petition. The documents include historical background on monitoring and program descriptions (e.g., dust sampling, air monitoring, urinalysis data, radiological control program, medical monitoring, process materials, and process description).

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Petition Form B for SEC-00150*; received July 22, 2009; OSA Ref ID: 109347, pp. 1-9 (Form B, 2009)
- *Affidavit from Former SLAPS Employee*; July 17, 2009; OSA Ref ID: 109347, p. 10 (Affidavit, 2009)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at SLAPS from January 3, 1947 through December 31, 1973 and January 1, 1984 through December 31, 1998 and the information available to NIOSH to characterize particular processes and radioactive source materials. 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 SLAPS Description

Beginning in the mid 1940s, the Manhattan Engineer District (MED) acquired a 21.7 acre site north of the St. Louis International Airport to be used as a storage site for residues resulting from the processing of uranium ores. Most of the materials stored at the site (now referred to as the St. Louis Airport Storage site or SLAPS) were residues generated by Mallinckrodt Chemical Works during uranium processing operations for the Atomic Energy Commission (AEC) from 1946³ through 1953 (Aerospace Corporation, post-1973). The residues remained at SLAPS after Mallinckrodt ceased production until they were sold to a private company in 1966. From 1966 through 1969, most of the stored materials were removed from the SLAPS site; however, some contaminated wastes were buried on site (Aerospace Corporation, post-1973).

After the removal of the residues, the St. Louis Airport Authority removed all above-ground structures and added clean fill over the remaining buried materials. The city took possession of the property in 1973. The DOE was authorized to reacquire the property in 1984, where it was managed under the Formerly Utilized Sites Remedial Action Program (FUSRAP). DOE assumed ownership in 1990 and possessed the property until the FUSRAP Program was transferred to the United States Army Corps of Engineers in 1998 (Pena, 1997).

³ A December 14th letter from DOL clarifying the covered period for the St. Louis Airport Storage site indicates that the DOE covered period begins January 3, 1947.

5.1.1 Stored Residues/Materials

Uranium extraction was performed by the Mallinckrodt Chemical Works, under a contract with the MED, at its Destrehan Street Plant in St. Louis, Missouri. For the initial years of operation, only pitchblende ores from the Belgian Congo were processed. Later, domestic ores of much lower uranium assay from western states were also processed.

Within the working draft document, *The North County Uranium Residues Historical Synopsis*, prepared by the U.S. Army Corp of Engineers for the FUSRAP Program, is a flow diagram of the chemical process used at Mallinckrodt; it shows the sources of the residues stored at the SLAPS site (Army Corps, 2002, p. 107). In general, the chemical process used at the Destrehan Street Plant separated uranium metal from other materials in the ores, including the radioactive uranium progeny. A carbonate leach process was used to remove certain metals including radium, and generated the K-65 and AJ-4 residues. The raffinates were the result of a solvent extraction process and contained thorium, notably thorium-230, and other metals and rare earths. Other residue streams were created after the uranium was purified, such as the C-liner slag.

Table 5-1 shows the residues stored at SLAPS and includes the maximum inventories and storage dates.

Material Name	Code	Max. Inventory (tons)	Uranium Inventory (tons)	Materials Received (years)	Materials Removed (years)
Pitchblende Raffinate	AM-7	74,000	113.2	1946 - 1955	1966 - 1967
Colorado Raffinate	AM-10	32,500	47.6	1946 - 1955	1966 - 1967
Barium Sulfate Cake	AJ-4	10,200	29	1946 - 1955	1966 - 1967
Radium Bearing Residues	K-65	1,757	4.6	1946 - 1948	1948 - 1949
Vitro Residues	C-6	290	1.9	1954	1966 - 1967
Interim Residue Plant Tailings	C-701	4,000	239	Late 1950s	1959
Captured Japanese Uranium-containing Sand	V-10	60	0.2	1954	1966 - 1967
C-Liner Slag	None	7,800	122.3	1946 - 1953	1959, 1966 - 1967
Scrap Metal	None	3,500	Unknown	1946 - 1959	1962

Source: This table was created with information from AEC, 1967, p. 8 and Aerospace Corporation, post-1973, pp. 56-57.

Pitchblende Raffinate (AM-7)

The AM-7 raffinate was a residue resulting from the processing of pitchblende ores at the Mallinckrodt Destrehan Street Plant that was stored in bulk at SLAPS. Between 1955 and 1957, about 350 tons of the AM-7 was returned to the Mallinckrodt Destrehan Street Plant to recover thorium-230. The resulting residues from this operation were then returned to storage at SLAPS. African Metals maintained ownership of the pitchblende raffinate residues, as they possessed significant quantities of rare earth minerals as well as other marketable metals such as nickel, cobalt, copper and radium. As a result, pitchblende raffinate residues were not disposed of as waste, but were retained (Bechtel, 1981; Army Corps, 2002, p. 21) until the 1950s when the market value of the metals contained in the residues, nickel, cobalt, and copper decreased, and the African Metals Corporation abandoned the pitchblende raffinates (Army Corps, 2002, p. 34). The AM-7 was included in the site sale of the residues in 1966 to Continental Mining and Milling Company, and was moved to the Latty Avenue site from 1966 to 1967 (Army Corps, 2002, p. 41).

Colorado Raffinate (AM-10)

The AM-10 raffinate was a residue resulting from the processing of domestic ores at the Mallinckrodt Destrehan Street Plant. It was stored in bulk at SLAPS, separately from the AM-7. It was also part of the residues sold to Continental and removed from 1966 to 1967 (Army Corps, 2002, p. 41).

Barium Sulfate Cake (AJ-4)

Barium sulfate cake residue, AJ-4, was another product of the Mallinckrodt Destrehan Street Refinery; it was stored in bulk, on the ground at SLAPS. African Metals relinquished ownership of the barium cake, which was then part of the residue sold to Continental in 1966, and moved to the Latty Avenue, Missouri site for storage. However, traces of AJ-4 remained at the SLAPS site and were removed and disposed of at the Weldon Spring quarry in 1969 by the St. Louis Lambert Airport Authority (Army Corps, 2002, p. 42).

Radium-Bearing Residues (K-65)

The procurement contract between the United States and African Metals, the supplier of pitchblende ore, required that radium-bearing residues be stored for eventual return to African Metals who retained ownership of the radium-226. For this reason, these residues, referred to as K-65, were stored in metal drums and were not subject to dispersal by wind and rain. In 1948 and 1949, the K-65 residue was shipped back to Mallinckrodt to be reprocessed for additional uranium recovery (Unknown 1959), after which it was sent to the Lake Ontario Ordinance Works. The drums in which it had been stored were returned to SLAPS for storage.

C-Liner Slag

The C-Liner slag resulted from the separation of slag from the reduction step at the Mallinckrodt Destrehan Street Plant. Shipments to SLAPS began March 10, 1946 and continued until early 1953 when the dolomite liner was replaced by a recycled magnesium-fluoride liner. As of April 11, 1959, SLAPS inventory showed 7,800 tons of C-Liner slag, containing 122.3 tons of uranium. A portion was sent to Fernald for processing in the early 1960s. As of November 1965, SLAPS inventory showed 4,000 tons containing 49 tons uranium. After an amendment to the 1966 sale, the remaining slag was transferred offsite to Continental (Aerospace Corporation, post-1973).

Interim Residue Plant Tailings (C-701)

The interim residue plant tailings were from operations at the Mallinckrodt Destrehan Street Plant site and are described as the end product from "non-uranium bearing slurry" (MCW, 1956, p. 6). The tailings were shipped to Fernald and processed in the late 1950s (Aerospace Corporation, post-1973); the material would not have been on the SLAPS site after 1959. The bulk of the material was described as having 144 tons of uranium within 7,000 tons of material (Aerospace Corporation, post-1973).

Vitro Residues (C-6) and Captured Japanese Sands (V-10)

It is believed that the Vitro residues were generated at Vitro Corporation's facility in Canonsburg, Pennsylvania, during the reprocessing of MgF₂-liner material for the recovery of uranium (Army Corps, 2002, p. 36). Vitro residues and captured-Japanese uranium-containing sands and precipitates were stored at SLAPS in approximately 2,400 drums. They were transferred to the SLAPS site from Middlesex, New Jersey, in 1954 during closeout of that site (Aerospace Corporation, post-1973). A portion of the residues were sent to Fernald for processing in the early 1960s; a November 1965

inventory indicates 4,000 tons containing 49 tons uranium. The remaining Vitro residues and Japanese sands were transferred to Continental Mining and Milling, Inc. in an amendment to the 1966 sale (Aerospace Corporation, post-1973, p. 57).

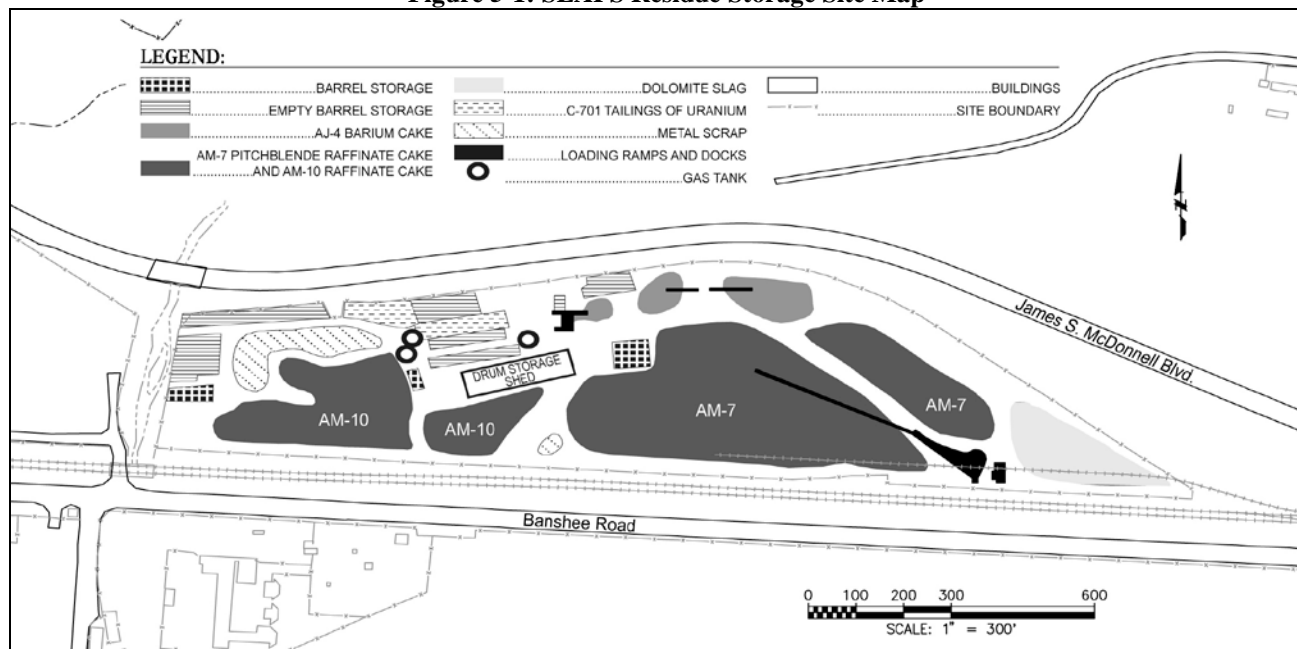
Scrap Metal

In 1952, a portion of the western part of the SLAPS plot where contaminated metal and debris were buried was filled in with six to eight feet of earth (Sapirie, 1964, p. 9). Approximately 55,000 empty 30- and 50- gallon drums and 3,500 tons of contaminated steel and alloy scrap had accumulated at the SLAPS site by 1959. Between 1959 and 1960, some of the scrap and rubble from the demolition and decontamination of the Mallinckrodt St. Louis site facilities was buried at the west end of the site (Sapirie, 1972, p. 1; DOE, 1979, p. 14). The AEC began efforts to sell and remove the residues in order to remove SLAPS from the government inventory in 1965 (Army Corps, 2002, p. 34). The scrap metal, including the empty drums were sold in 1966 to David Witherspoon Inc. and removed from the site by 1967 (Army Corps, 2002, p. 29).

No characterization information has been located for the contaminated scrap metal. There is no indication that any of the buried materials were removed from the site through the end of 1998.

Figure 5-1 shows a SLAPS site map indicating where the residues were stored. A fence surrounding the site prevented casual entry onto the site and thus limited direct exposure to members of the public.

Figure 5-1: SLAPS Residue Storage Site Map



5.1.2 Sale and Removal of Residues and Scrap

In April 1959, loading facilities and a railroad siding were installed, apparently in preparation for transporting the residues and other material (Unknown, 1959, p. 1). The residues were advertised for sale on multiple occasions. In 1960, the AEC listed the inventories for AM-7, AM-10, and AJ-4 as shown in Table 5-1, along with 3,500 tons of miscellaneous material in drums containing two

additional tons of uranium (Army Corps, 2002, p. 35). On February 25, 1966, Continental Mining and Milling, Inc. purchased these residues.

In addition to the residues from processing uranium ores, a significant amount of scrap metal and drums had been stored at SLAPS. By 1960, there were approximately 50,000 empty drums and approximately 3,500 tons of contaminated steel and alloy scrap stored at the SLAPS site (Army Corps, 2002, p. 29). The majority of the scrap metals were sold for their metal salvage values. David Witherspoon, Inc. of Knoxville, Tennessee, purchased the bulk of the scrap metal on June 8, 1962. Terms of the contract specified that all metal scrap above existing ground level that was capable of being removed without excavation equipment, was to be considered part of the scrap materials offered for sale. The contract also specified that the material purchased under this contract was considered to contain source material subject to licensing requirements and AEC regulations.

A status report from February 15, 1963, indicated that the contractor (i.e., Witherspoon) was using an "electromagnet drop hammer" to crush drums on the SLAPS site. At the time of the status report, Witherspoon had been on site for approximately eight months, and it was anticipated that it would take an additional two months to complete the removal of the scrap (Army Corps, 2002, p. 32).

In 1966-1967, Continental Mining and Milling, Inc. moved the residues from SLAPS to a site at Latty Avenue in Hazelwood, Missouri (AEC, 1967, p.11; Mattingly, 2004). This was said to have required ten dump trucks operating for five months to move a total of 100,000 tons of residue (AEC, 1967, p.11). Except for the AJ-4 residue area where the surface radiation reading was about 3 mrad/hr, the removal of residue piles restored all areas to less than 1 mrad/hr (Sapirie, 1972, p. 2).

The St. Louis Airport Authority expressed interest in the SLAPS property and agreed to decontaminate the property, per an acquisition permit dated November 10, 1969. This agreement included the removal of all above-ground structures and the addition of one or more feet of clean fill dirt (Roth, 1967, p. 3). The work, apparently performed by city employees (ANL, 1981, p. 24), occurred during the period from January 1969 through December 1969, under procedures developed and monitored by the St. Louis Health Department and approved by AEC (Unknown, unknown, p. 79).

The few remaining buildings were razed and buried, leaving only a fence that surrounded the clean fill surface. These efforts effectively removed the major sources of radiation exposure and minimized the accessibility to the remaining radioactive materials that remained buried at SLAPS. In December 1969, per the criteria given in the acquisition permit, a radiation survey was conducted. Eleven areas, ranging in size from 10 square feet to 50,000 square feet, were found with gamma levels greater than 1 mR/hr. An additional two to three feet of fill dirt was placed over these areas to achieve acceptable radiation levels (DOE, 1979, p. 15). A final radiation survey of the site was completed on November 3, 1971. Beta-gamma levels at the ground surface were found to be within the agreed-upon criteria. Levels were generally less than 0.05 mrad/hr, although there were some isolated areas of 0.2 mrad/hr. No area exceeded 1 mrad/hr (Sapirie, 1972). There is no indication in any of the documents that NIOSH reviewed that the site radiological conditions changed after this survey through 1973.

On June 8, 1973, the deed to the property was transferred from the AEC to the St. Louis Airport Authority (Roth, 1967, p. 3) and the property was owned by the St. Louis Airport Authority until 1989.

5.1.3 FUSRAP Period

The 1984 Energy and Water Development Appropriations Act (Public Law 98-3060) authorized DOE to reacquire the property from the city for use as a permanent disposal site for the wastes already on the property, contaminated soil in the surrounding ditches, and the waste from the nearby Hazelwood Interim Storage Site, the location on Latty Avenue where the residues were originally transferred (Mattingly, 2004). DOE assumed ownership of SLAPS in 1990, and in addition to the environmental monitoring activities, characterization activities became more active. In 1996, nearly 50 workers were involved from April to October.

The radioactive material that remained on the SLAPS site was the buried materials remaining from the operational period. The radioisotopes of concern were uranium (uranium-235 and uranium-238), uranium-238 decay products (principally thorium-230, radium-226, and radon-222), thorium-232, and thorium-228. These materials were not disturbed except as part of the environmental monitoring activities.

The AEC/ERDA/DOE had no routine operations being conducted at SLAPS except environmental monitoring. The only exception to environmental monitoring activities took place in 1985 to repair soil bank erosion along Coldwater Creek on the west side of SLAPS, adjacent to the site. A project was completed with a gabion structure, which served to repair and prevent future erosion of this bank. Consequently, the routine activities at SLAPS did not involve any continuous occupancy. The environmental monitoring resulted in periodic (typically performed on a quarterly basis) visits for the purpose of changing out thermoluminescent dosimeters (TLDs) and collecting samples and data that was used in the production of annual environmental monitoring reports and occasional radiological characterization reports. For example, a radiological survey of SLAPS, published by ORNL in September 1979 reports the results of surveys conducted during the weeks of November 14, 1976 and August 28, 1978 (DOE, 1979); Weston Environmental also participated during the latter week. Stream sampling performed on April 14, 1979 was also reported. These dates are listed to indicate the infrequent nature of visits to SLAPS during this period.

In 1993, the SLAPS site was described as “grassy, with a slight incline to the east” (Argonne, 1993). Maintenance and surveillance, including environmental monitoring, were the only activities taking place at SLAPS. A trailer was located on the property to support environmental monitoring activities. Access into the SLAPS site was locked, so workers would not have entered without a specific purpose.

Oak Ridge National Laboratory performed the environmental monitoring activities during the first part of the FUSRAP period. Bechtel National, Inc., under a DOE contract, assumed these responsibilities in the fourth quarter of 1983. Bechtel National, Inc. also had responsibility for the remediation investigation activities that were conducted through 1997. In October 1997, the FUSRAP program was transferred to the U.S. Army Corp. of Engineers (Pena, 1997).

5.1.4 SLAPS Employees

From 1947 through July 1953, although the AEC owned the site, Mallinckrodt employees appear to have performed the residue delivery and placement-related work (ORAUT-TKBS-0005, p. 22). Placement of the residues involved truck drivers (who were reported not come into contact with the residues) and equipment operators that used caterpillar bulldozers, pay loaders, and forklifts to manipulate and place the residues and various contaminated equipment (Caplan, 1949, p. 3; Personal

Communication, 2009b). While the truck drivers were not Mallinckrodt employees, the equipment operators were all Mallinckrodt employees (Personal Communication, 2009b). In addition to the truck drivers and equipment operators, full-time guards were also located at the SLAPS site from 1946 through 1951 (Unknown, 1959, p. 1).

Removal of the scrap metal in 1962 through 1963 and the residues in 1966 through 1967 was performed by employees and subcontractors of the companies that purchased them (Army Corps, 2002, p. 29; AEC, 1967, p. 11).

Building demolition and burial in 1969 was performed by employees of the City of St. Louis, Missouri (ANL, 1981, p. 24).

Between 1984 and 1998, site activities consisted of environmental monitoring and site characterization. From April to October 1996, nearly 50 workers were involved in these activities (Bioassay Data, 1996; Bioassay Data, 1992-1996, pp. 48-139; Air Data, 1996).

The SLAPS worker population was very mobile, specifically not residing at SLAPS for any length of time during this period, but working on all the properties. SLAPS records provide a list of workers for some periods, but should not be considered a complete list.

5.2 Radiological Exposure Sources from SLAPS Operations

The following subsections provide an overview of the internal and external exposure sources for the SLAPS class under evaluation.

5.2.1 Internal Radiological Exposure Sources from SLAPS Operations

The primary internal exposure sources from SLAPS operations were the inhalation and ingestion of uranium and uranium progeny particulates, and the inhalation of radon. Materials stored at SLAPS (as noted in Table 5-1, above) existed in varying equilibrium states between the primary uranium isotopes (uranium-234, uranium-235, and uranium-238) and their associated progeny, depending on the nature of the material. Materials had higher ratios of radium-226 or thorium-230 relative to the accompanying uranium activity. The predominant radiation emitted from an internal dose perspective for all of these nuclides is alpha radiation. The following subsections provide a discussion of uranium, radium, and thorium sources in the materials stored at SLAPS.

5.2.1.1 Uranium

This subsection assesses potential internal uranium sources for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

The pitchblende raffinate, AM-7, was a product of operations at the Mallinckrodt Destrehan Street Refinery. Total uranium in the AM-7 residues was measured to be approximately 1 uCi/g, with reported values between 0.7 uCi/g (Lynch, 1949) and 1.4 uCi/g (AEC, 1949, p. 94).

The AM-10 raffinate was a residue resulting from the processing of domestic ores at the Mallinckrodt Destrehan Street Plant. For the AM-10, the total uranium was measured to be approximately 1,056 uCi/g (Unknown, 1959).

Barium sulfate cake residue, AJ-4, was another product of the Mallinckrodt Destrehan Street Refinery. Various concentrations of uranium were reported, varying between 352 pCi/g (Mound, unknown) and 1,972 pCi/g (Sargent, 1948; Eisenbud, unknown).

C-Liner slag consisted mainly of dolomite liner with less than 2% uranium content, and was stored in bulk on the ground at SLAPS. Shipments to SLAPS began March 10, 1946 and lasted until early 1953, when the dolomite liner was replaced by a recycled magnesium-fluoride liner. An April 11, 1959 inventory showed 7,800 tons of C-Liner slag containing 122.3 tons of uranium. A portion was sent to Fernald for processing in the early 1960s. A November 1965 inventory showed 4,000 tons containing 49 tons uranium (Aerospace Corporation, post-1973). The average concentration of uranium in the C-liner slag was estimated to be 122.3 tons of uranium in 7,800 tons of residue, or 1.56% by weight. Because of the chemical separation of uranium from the daughter isotopes, this material may be fully characterized by the amount of uranium present.

The vitro residues contained uranium after separation from uranium daughters. It was described as having 1.9 tons of uranium within 290 tons of material, or 0.66% by weight. Because of the chemical separation of uranium from the daughter isotopes, this material may be fully characterized by the amount of uranium present.

The Captured Japanese Sands are assumed to contain uranium in equilibrium with the uranium daughters. It was described as having 0.2 tons of uranium within 60 tons of material or 0.2% by weight (Aerospace Corporation, post-1973). Because the uranium has not been chemically separated from the daughter isotopes, this material may be fully characterized by the amount of uranium present. The activity concentration of the daughters may be assumed to be in equilibrium with the uranium activity concentration.

Interim residue plant tailings were from operations at the Mallinckrodt Destrehan Street site, which began in 1955 to scalp the uranium content from the magnesium fluoride slag. The tailings were described as the end product from "non-uranium bearing slurry" (MCW, 1956, p. 6). In the late 1950s, the tailings were shipped to Fernald and processed, with the Fernald process rate increasing to about 600 tons per month in July 1959 (Aerospace Corporation, post-1973; Army Corps, 2002, p. 36; Belcher, 1964). The magnesium-fluoride slag was contaminated with only uranium after chemical separation from the uranium daughters. The bulk of the material was described as having 144 tons of uranium within 7,000 tons of material (Aerospace Corporation, post-1973). The average concentration of uranium in the interim residue plant tailings was estimated to be 0.2/60 tons per ton, or 0.3% by weight.

November 3, 1971 through December 31, 1973

During this period, the site was covered with clean fill and was undisturbed (the radionuclides, other than radon, were contained and not readily accessible for personnel exposures). Considering the site conditions during this period, there was no potential for personnel internal radiological exposure to uranium.

January 1, 1984 through December 31, 1998

Although there is no indication that any activities occurred at SLAPS that would have disturbed the clean fill during this period, there is a potential for the remediation work and activities to have disturbed the buried radioactive materials at the site. Therefore, after 1984, the exposure sources could have included materials that were unearthed during the site's remediation activities. Considering the remediation activities during this period, the internal exposure sources at the site could have included materials contaminated with uranium and uranium progeny (which remained as a result of the operational period at the site).

5.2.1.2 Radium-226/Radon-222

This subsection assesses potential internal radium-226 and radon-222 sources for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Radium-226 produces radon-222. As radon-222 is a noble gas, it is chemically inert and outgases from any radium-226 bearing material. Radon-220 decays to a series of six short-lived daughters that collectively produce four alpha particles for each radon-220 decay and are a source of lung exposure.

Radium-226 bearing materials at the site included the K-65 residues stored between 1946 and 1949, and the AJ-4 residues which were stored between 1946 and 1967. Analyses of the material showed radium-226 concentrations ranging from 0.327 uCi/g to 0.980 uCi/g (Lynch, 1949; AEC, 1949; Eisenbud, unknown). The K-65 residues were eventually transferred to Fernald. A 1979 report indicates a total weight for the residues as 1,757 dry tons, and having a total of 10,982 pounds of U3O8 (NLCO, 1979, p. 21). Analyses for other isotopes have not been located.

Barium sulfate cake residue, AJ-4, was another product of the Mallinckrodt Destrehan Street Refinery. Radium-226 concentrations were reported as high as 1850 pCi/g (NLCO, 1979).

Radon-222 air concentrations at SLAPS exceeded contemporary standards while the K-65 residues were present.

November 3, 1971 through December 31, 1973

During this period, the site was covered with clean fill and was undisturbed (the radionuclides, other than radon, were contained and not readily accessible for personnel exposures). Considering the site conditions, there was no potential for internal radiological exposures to radium.

January 1, 1984 through December 31, 1998

Although there is no indication that any activities occurred at SLAPS that would have disturbed the clean fill during this period, there was a potential for the remediation work and activities to have disturbed the buried radioactive materials at the site. Therefore, after 1984, the exposure sources could have included materials that were unearthed during the site's remediation activities. Considering the remediation activities during this period, the internal exposure sources at the site could have included materials contaminated with radium (which remained as a result of the operational period at the site).

5.2.1.3 Thorium-230

This subsection assesses potential internal thorium-230 sources for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

The various isotopes that were present in the uranium ore went in varying concentrations to the wastes and residues that were generated at the Mallinckrodt Destrehan Street Plant. The chemistry of thorium caused thorium-230 to be preferentially concentrated in the raffinate residues, AM-7 and AM-10. Although the AM-7 and AM-10 raffinates contained uranium and uranium daughters, the primary isotope that existed in the residues was thorium-230. An analysis showed thorium-230 to have an activity concentration that was 100 times greater than uranium and all of its longer-lived daughters (Bechtel, 1991, p. 15). Although this analysis was performed on contamination at the site after the residues were removed, it is expected that the isotopic ratios are representative of the raffinates as they were stored at SLAPS. These residues were removed from SLAPS between 1966 and 1967.

Thorium-230 was measured to be 76.760 uCi/g in AM-7 residues (Figgins, 1966).

November 3, 1971 through December 31, 1973

During this period, the site was covered with clean fill and was undisturbed (the radionuclides, other than radon, were contained and not readily accessible for personnel exposures). Considering the site conditions during this period, there was no potential for personnel internal radiological exposure to thorium.

January 1, 1984 through December 31, 1998

Although there is no indication that any activities occurred at SLAPS that would have disturbed the clean fill during this period, there was a potential for the remediation work and activities to have disturbed the buried radioactive materials at the site. Therefore, after 1984, the exposure sources could have included materials that were unearthed during the site's remediation activities. Considering the remediation activities during this period, the internal exposure sources at the site could have included materials contaminated with thorium (which remained as a result of the operational period at the site).

5.2.2 External Radiological Exposure Sources from SLAPS Operations

Uranium and its daughters provide both gamma (photon) and beta exposure. The residue piles and contaminated materials provided exposure to employees working on or near the materials. After the residues were removed, the source of external radiation exposure was the radioactive material buried beneath the surface of SLAPS. Clean fill was added to the surface to provide shielding that would ensure that the radiation levels would remain below accepted criteria levels.

5.2.2.1 Photon

This subsection assesses potential external photon sources for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Radium-226 was the primary source of external photon exposure. Other gamma-emitting uranium progeny were present, but in lesser concentrations.

A survey taken in March 1948 indicated a reading of 2.2 mR/hr at a distance two feet from the K-65 storage shed (Soil Data, 1948). This shed contained the greatest amounts of radium-226 and represented the highest gamma exposure potential at the site; these residues were removed between 1948 and 1949.

A survey taken in 1949 to measure exposures around the raffinate heaps indicated levels of 3-10 mrep/hr [sic] on top of an aged heap, taken at waist level. Other readings taken near aged and fresh raffinates ranged from 0.3 to 2.5 mrep/hr (Caplan, 1949, p. 2).

November 3, 1971 through December 31, 1973

In 1971, the Oak Ridge Operations Office documented (Lenhard, 1971) the radiation levels above the surface at SLAPS to be within the criteria previously transmitted to the St. Louis Airport Authority by the Oak Ridge Manager. The levels were characterized as “generally less than 0.05 mrad/h,” and none in excess of 1 mrad/h. The memo stated that a minimum depth of 1 foot of clean fill had been added to the SLAPS area (Lenhard, 1971).

January 1, 1984 through December 31, 1998

In 1979, ORNL documented the results of surveys conducted in 1976 and 1978; the external gamma values were similarly low, with the maximum measured value being 0.3 mR/h (DOE, 1979). There are no indications that the radiological conditions were changed after the addition of the clean fill in 1971; that is, there were no additions to or removal from the buried contaminated inventory, and there are no indications that any construction activities occurred.

Environmental monitoring data from the 1980s were consistent with this value. The maximum value reported in 1984 was 0.26 mrem/h (Bechtel, 1985), in 1985 was 0.24 mrem/h (Environmental Report, 1985), in 1987 was 0.12 mrem/h (TLD Data, 1987b), and in 1989 was 0.19 mrem/h (TLD Data, 1989).

5.2.2.2 Beta

This subsection assesses potential external beta sources for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Beta exposure from uranium daughters was a recognized and monitored hazard. Uranium metal that has been chemically separated will rapidly begin to have associated short-lived daughters as it ages. One of these, protactinium-234m is a significant source of beta exposure. Much further down the decay chain is bismuth-214 and bismuth-210, each releasing high-energy beta particles upon decay. These would be found along with the other uranium decay progeny.

A survey taken in 1949 to measure exposures around the raffinate heaps indicates levels of 70 mrep/hr at one foot from a fresh raffinate heap. A reading taken in the cab of a bulldozer while pushed into the heap indicates a reading of 2.7 mrep/hr beta, the most probable routine work exposure scenario (Caplan, 1949, p. 2).

November 3, 1971 through December 31, 1973

There would not be a significant source of beta exposure after November 1971, as the sources were covered with a minimum of 1 foot of clean fill that would have attenuated any beta radiation. The razing and burial of potentially contaminated buildings would have been accompanied by exposure to low-level contamination, but would not have been a significant exposure to beta radiation.

January 1, 1984 through December 31, 1998

Although there is no indication that any activities occurred at SLAPS that would have disturbed the clean fill during this period, there is a potential for the remediation work and activities to have disturbed the buried radioactive materials at the site. Therefore, after 1984, the exposure sources could have included materials that were unearthed during the site's remediation activities. Considering the remediation activities during this period, the external shallow exposure sources at the site could have included beta exposure from uranium daughters.

Characterization activities such as collecting soil samples may have had the potential to expose FUSRAP employees to some level of beta radiation.

5.2.2.3 Neutron

The storage of the raffinate piles may have the potential to generate neutrons from the α -n reaction from nitrogen or oxygen compounds that may have been present along with the thorium-230. The potential neutron source at SLAPS was eliminated when the site was demolished and buried at the end of SLAPS operations in November 1971.

January 3, 1947 through November 2, 1971

Although NIOSH does not have access to neutron monitoring data or complete source term information, NIOSH believes there was not a significant neutron exposure that would require further review or evaluation in this report. Therefore, further consideration of neutrons (or neutron dose) has not been included in this evaluation report.

November 3, 1971 through December 31, 1973 & January 1, 1984 through December 31, 1998

Based on the radioactive material present at the site and the conditions of the site during these periods, NIOSH finds that there was not a significant neutron exposure that would require further review or evaluation in this report. Therefore, neutrons (or neutron dose) have not been included in this evaluation report.

5.2.3 Incidents

NIOSH has found no evidence of significant radiological incidents occurring at SLAPS that impact this evaluation.

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 SLAPS class under evaluation.

6.1 Available SLAPS Internal Monitoring Data

This subsection assesses the available internal monitoring data at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Mallinckrodt bioassay data, obtained by the Center for Epidemiological Research (CER), includes 17 bioassay samples for three individuals with a job title that includes the word "airport" (Bioassay Data, 1948-1966). These are reported in the database as either "285 AIRPORT S" or "WHSE AIRPORT," the latter being consistent with employee interviews and documents that indicate Mallinckrodt warehouse employees were the workers who unloaded and distributed the residues at SLAPS. These bioassay samples were taken from 1955 through 1962; dates on these samples include one sample taken in 1955, one taken in 1956, and the other 15 samples taken from 1959 through 1962. These results are for uranium in urine and range from 0 to 0.032 mg/L; the bioassay samples were not analyzed for any materials other than uranium (Bioassay Data, 1948-1966).

In 1948, radon samples were taken with the results reported in percentage of the tolerance level; results ranged from non-detectable at the guard shack to 2,380% within the K-65 storage shed (Air Data, 1948). Between January 10 and February 17, 1949, radon samples were taken over several days at various distances downwind from the storage shed. These samples typically showed non-detectable levels at the guard shack and increasing levels approaching the storage shed. The highest value listed was 5.15×10^{-10} Ci/L (Air Data, 1948-1949).

November 3, 1971 through December 31, 1973

Although NIOSH currently does not have access to any personnel monitoring data for the November 3, 1971 through December 31, 1973 period, one to three feet of clean fill had been placed over all remaining contamination. Additionally, NIOSH has identified no information or documentation that would indicate site activities that would have required air sampling or personnel monitoring during the November 3, 1971 through December 31, 1973 period. There is no indication that site radiological conditions changed after the survey dated November 3, 1971 (performed after the demolition and burial of site contaminated materials [Lenhard, 1971]) through the end of 1973; thus, NIOSH considers the radiological conditions as of the date of this survey representative for the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

From 1984 through 1998, urine samples were taken from SLAPS employees involved in characterization and remedial action activities. These data are available for most of the years from 1984 through 1996. Urine samples were analyzed for thorium-230, thorium-232, radium-226, as well as thorium-228 during some periods. In addition, an analysis was performed in 1991 that calculated the isotopic ratios of the SLAPS soils (Bechtel, 1991, p. 15); this analysis allows urinalysis results from this time period to be extended to other, long-lived uranium daughters that were present at the SLAPS site.

Air samples were also taken, both personnel breathing zone samples and area samples (Stone & Webster, 2000); however, only data for the years 1993 and 1996 have been located (Air Data, 1993; Air Data, 1996). The total exposure for nearly 170 samples was 3.1 DAC-h, indicating a very low exposure rate from airborne particulates.

Several evaluations have documented the potential exposures to workers and the public from SLAPS; these studies were based upon characterization data and environmental monitoring activities (Ryan, 1978; DOE, 1979; Environmental Report, 1985; Wallo, 1986; Environmental Report, 1987; Argonne, 1993). The most thorough of these evaluations is the *Baseline Risk Assessment for Exposure to Contaminants at the St. Louis Site, St. Louis, Missouri* (referred to as *Baseline Risk Assessment* throughout this report) published by Argonne National Laboratory in November 1993 (Argonne, 1993).

6.2 Available SLAPS External Monitoring Data

This subsection assesses the available external monitoring data at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

No external monitoring data specifically associated with the SLAPS site have been identified for the years 1947 through November 2, 1971. However, Mallinckrodt employees who worked at SLAPS during these years were monitored through a film badge program while working at the Mallinckrodt Destrehan Street Plant (ORAUT-TKBS-0005). Some employee interviews indicate that employees wore the Mallinckrodt film badges while at SLAPS, whereas other interviews do not. In either case, the dose associated with SLAPS was not accounted for or reported separately. One reference from 1949 indicated that bulldozer and crane operators were not issued film badges "because the radiation from the aged raffinate was known to be a very low order of magnitude" (Caplan, 1949, p. 2).

A 1949 reference included ambient beta and gamma measurements at and near the raffinate residue piles. The highest beta measurement was 70 mrep/hr, taken one foot from a "fresh raffinate heap." The highest gamma measurement was 3-10 mrep/hr (sic), taken on an "aged BC heap (top of pile at waist height)" (Caplan, p. 2). The data table notes that the tolerance dose for eight hours a day, five days a week was 6 mrep/hr (Caplan, 1949, p. 2).

During 1969, decontamination and demolition work was performed by the St. Louis Airport Authority, presumably by employees from the City of St. Louis, Missouri. No external monitoring data have been identified for these employees.

November 3, 1971 through December 31, 1973

Although NIOSH currently does not have access to any personnel monitoring data for the November 3, 1971 through December 31, 1973 period, a survey dated November 3, 1971 (the survey performed after the demolition and burial of site contaminated materials), documented that no location on at SLAPS exceeded 1 mrad/hr. There is no indication that site radiological conditions changed after that survey through the end of 1973; thus, NIOSH considers the radiological conditions as of the date of this survey representative for the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

During the years 1984 through 1998, workers involved in characterization and remedial action activities used external radiation monitoring equipment. NIOSH has access to documents that identify the workers that were issued TLDs for the years 1985, 1987, 1988, and 1990. However, the results of these TLDs were not documented as completely. Consequently, the data do not cover all the workers identified as being present at SLAPS, nor cover all the periods and should not be considered complete.

A summary document from April 1986 estimates the exposure to a worker to be less than 20 mrem/y (Wallo, 1986).

NIOSH has not found any indication of monitoring after 1990. Such a situation could be the result of the site deciding that after several years of results indicating essentially no exposure above background, external monitoring was discontinued (i.e., no longer being necessary and/or required). Such a decision would have been consistent with the results and regulatory guidance, considering that the data that have been recovered indicate that external radiation exposure to SLAPS employees from the activities during these years was very low, not distinguishable from background radiation.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determinations for the class of employees under evaluation in this report are 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. 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-00150 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of SLAPS 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 Internal Monitoring Data Pedigree Review

NIOSH has access to copies of original, handwritten urinalysis records for Mallinckrodt employees. In the 1970s, the results from the original records were entered into the CER's computer database for research purposes and have been used in the database format by Oak Ridge Associated Universities and other research groups (Bioassay Data, 1948-1966). The urinalysis data that do exist for Mallinckrodt employees did not monitor isotopes other than uranium.

The data available from 1984 through 1998 are copies of the original bioassay results. However, the data do not appear to cover all workers or all periods completely.

The data that are available reflect very small to negligible exposures, which is consistent with the exposure assessments that were made periodically during the period from 1984 through 1998. The most complete assessment was the *Baseline Risk Assessment* completed by Argonne National Laboratory in November 1993 (Argonne, 1993), see Table 6-1. This *Baseline Risk Assessment* was based on site contamination levels and addresses all uranium and progeny isotopes. Calculations were performed for several scenarios, including construction workers performing site remediation.

7.1.2 External Monitoring Data Pedigree Review

No individual external monitoring data have been located for the years 1947 through 1973. There are ambient survey reports from 1948 and 1949 that summarize site gamma and beta levels, apparently taken to document the highest and most likely exposure levels (Soil Data, 1948, p. 16; Caplan, 1949, p. 2). In 1971, the Oak Ridge Operations Office documented the radiation levels above the surface at SLAPS to be less than 1 mrad/hr for all locations (Lenhard, 1971).

The external monitoring data that are available for the years 1984 through 1998 are copies of the original reports. However, the data do not cover all workers over all the time periods. The data that are available reflect exposures that are very small, essentially background, and are consistent with assessments that were made periodically during the same time period.

7.2 Evaluation of Bounding Internal Radiation Doses at SLAPS

The principal source of internal radiation doses for members of the class under evaluation was the inhalation and ingestion of radioactive materials. The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding Process-Related Internal Doses

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

7.2.1.1 Urinalysis Information and Available Data

This subsection assesses the available urinalysis information at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Seventeen bioassay samples that are linked with job titles that include the word “airport” for three individuals have been located within the Mallinckrodt data contained in the CER database. Most of these were samples taken after 1957, when Mallinckrodt terminated production at their Destrehan Street plant.

November 3, 1971 through December 31, 1973

There are no known bioassay sample results for the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

Many bioassay results for multiple individuals exist for the years 1984 through 1998. Even though urine bioassay data may not be available for all workers for all periods, the information that is available accurately characterizes the potential for internal exposure at SLAPS during this time period. Isotopic ratios that were calculated for the SLAPS soils allow the bioassay data to be extended to other isotopes that are expected to be present but not specifically analyzed for in bioassay samples. The data that are available indicate that exposures were very low or non-existent and can be used to support the internal bounding analysis for this period at SLAPS.

7.2.1.2 Airborne Levels

This subsection assesses the available air data at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

For the period from January 3, 1947 through November 2, 1971, few air sampling records have been discovered. Radon samples for 1948 and 1949 were taken and show elevated radon levels near the K-65 storage shed (Soil Data, 1948; Air Data, 1948-1949).

November 3, 1971 through December 31, 1973

There are no known air sample results for the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

For the period from January 1, 1984 through December 31, 1998, air sampling was performed as part of the environmental monitoring program and as part of the personnel radiation protection program. The environmental monitoring data covers the period in numerous environmental reports and data reports (Bechtel, 1985; Environmental Report, 1985; Environmental Report, 1987; Environmental Report, 1989; TLD Data, 1985; TLD Data, 1987a; TLD Data, 1988; TLD Data, 1990). Personnel air monitoring is covered in two reports; one report covers one individual in 1993 (Air Data, 1993) and a 1996 report covers a large number of workers in 1996 (Air Data, 1996). The data consistently indicate very low levels of airborne radioactivity; the total exposure recorded for over 170 worker samples in 1996 was only 3.1 DAC-h. The evaluation of DAC-h was based on thorium-230 as the isotope of concern. NIOSH believes that these data can be used to supplement the bounding assessment of internal dose for this period at SLAPS.

7.2.1.3 Alternative Data Sources for Bounding Internal Dose

This subsection assesses the available alternative data sources at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

NIOSH has not identified sufficient radiological source or source term data for this period at SLAPS.

November 3, 1971 through December 31, 1973 & January 1, 1984 through December 31, 1998

There were two pathways evaluated that are pertinent to this SEC Evaluation Report. One scenario was developed for a worker who performed remediation work at SLAPS. The other was for a construction worker remediating ditches contaminated with materials from SLAPS. The *Baseline Risk Assessment* evaluates exposures from soil ingestion, of airborne particulate inhalation, and radon daughter product inhalation. The pathway scenarios assume very conservative values for stay times and exposures. The data are based on site conditions and use isotopic results from soil samples collected at SLAPS and consider all uranium and progeny isotopes. The estimated exposure for these worker scenarios are presented in Table 7-1.

Table 7-1: Estimated Exposures to Workers from Baseline Risk Assessment

Worker Scenario	Soil Ingestion (mrem/y)	Particle Inhalation (mrem/y)	Total Dose (non-radon exposure) (mrem/y)	Inhalation of Radon Daughter (WLM)
Maintenance Worker	9	3	52	0.04
Ditch Construction Worker	5.7	730	740	0.014

Notes: All values are rounded to two significant digits, as consistent with the practice in the reference.

Source: Argonne, 1993

The *Baseline Risk Assessment* used soil sample results to estimate exposure for several scenarios, two of which were developed based on expected SLAPS worker activities. The report includes soil concentrations for SLAPS at the upper 95th percentile for all of the uranium and progeny isotopes. Models were used to provide inhalation, ingestion, and direct exposure estimates. Additionally, the report includes the re-suspension values, occupancy assumptions, and work activity assumptions that

were used in the scenarios. These data may be used to re-create the whole-body exposure estimates or to model doses to organs of interest that were not presented in the report.

The two scenarios described in Table 7-1 are based on higher ingestion and inhalation rates than those used for the general public to account for greater physical activity. The site occupancy factors were based on expected work duration and assumed that workers would be moving between all of the St. Louis FUSRAP sites.

Because the radiological status of the site did not change after November 2, 1971, this same report may be used to bound employee exposures for any onsite worker after that date.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

The internal exposures associated with SLAPS are not process/operations-related exposures, but are the result of activities performed outdoors, and therefore are essentially due to exposure to ambient environmental conditions. For the period from January 3, 1947 through November 2, 1971, NIOSH has not discovered or identified data to support bounding any internal dose at the site. The internal assessment methods and approaches evaluated in this report, for the periods after November 2, 1971, would account for any ambient exposures at SLAPS. Based on this information, further assessment of ambient environmental dose at SLAPS is not included in this report.

7.2.3 Methods for Bounding Internal Dose at SLAPS

This subsection assesses the methods for bounding operational period doses at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Based on the lack of personnel or area monitoring data, as well as source or source term data, NIOSH has determined that it cannot bound internal dose for the evaluated class during the period from January 3, 1947 through November 2, 1971.

November 3, 1971 through December 31, 1973

During this period, the site remained undisturbed with a layer of clean fill at the surface. With the exception of potentially increased radon levels, these site conditions provided no potential for internal exposure.

The *Baseline Risk Assessment* completed by Argonne National Laboratory in November 1993 (Argonne, 1993) includes ambient radon levels, expressed in working level months, that were based on the 95th percentile of the SLAPS sampling data. These data may be used to bound internal exposure from radon and its progeny.

January 1, 1984 through December 31, 1998

Original bioassay data exist for many workers during this period. The results may be applied to all uranium and uranium daughter isotopes. For isotopes that were not measured directly, site-specific ratios may be used (Bechtel, 1991, p. 15). Data from the *Baseline Risk Assessment* may be used to calculate doses to unmonitored workers. Based on the available personnel monitoring data, and the data and information in the *Baseline Risk Assessment*, NIOSH has concluded that there is sufficient information to support bounding the internal dose for the evaluated class in this report.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

This subsection assesses internal dose reconstruction feasibility at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

The residues, particularly AM-10, were not characterized for all longer-lived isotopes in the uranium chains. Limited air sampling and air monitoring data exist for radon-222, but not for any other radionuclides present during this time. Further confounding accurate estimates of internal exposure is the fact that fresh raffinates exhibited higher beta levels than aged, and the reverse for gamma levels, indicating the ingrowth and decay of uncharacterized short-lived daughters, a likely source of exposure for workers in the years between 1947 and 1957, during Mallinckrodt's production of the residues. Therefore NIOSH has concludes that, for the period January 3, 1947 through November 2, 1971, it lacks access to sufficient data to support bounding the internal dose for this portion of the evaluated class.

November 3, 1971 through December 31, 1973

After November 3, 1971, the above-ground residues and contaminated materials had been removed, all structures were demolished and buried, and there was one to three feet of clean soil added to the site. These conditions did not change through this period and remained the same throughout the 1984 through 1998 time period.

Considering the information in the *Baseline Risk Assessment*, coupled with the available information for this time period, NIOSH believes that there is sufficient information to support its ability to bound the internal dose as the worker scenarios were based on remediation activities and represent work performed in close contact with the exposed materials.

January 1, 1984 through December 31, 1998

After 1984, there are many individual bioassay results. Based on the available personnel monitoring information and the information in the *Baseline Risk Assessment*, where worker exposure scenarios were calculated for remediation activities and represent work in close contact with the exposed materials, NIOSH believes that it can bound internal dose for the evaluated class during this period at SLAPS.

7.3 Evaluation of Bounding External Radiation Doses at SLAPS

The principal source of external radiation doses for members of the evaluated class was uranium daughters, primarily radium-226 (ORAUT-TKBS-0005).

The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

7.3.1 Evaluation of Bounding Process-Related External Doses

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

7.3.1.1 Personnel Dosimetry Data

This subsection assesses the available personnel dosimetry data at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

Mallinckrodt workers were provided film badges for their work at the Destrehan Street Plant. There are no film badge data specifically for the SLAPS site for January 3, 1947 through November 2, 1971 period.

November 3, 1971 through December 31, 1973

There is no known personnel dosimetry for the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

Remediation workers wore TLDs up through 1990. Data after 1990 have not been located.

7.3.1.2 Area Monitoring Data

This subsection assesses the available air monitoring data at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

NIOSH has access to limited area monitoring data for SLAPS. As indicated in the available data, the highest beta measurement was 70 mrep/hr, taken one foot from a "fresh raffinate heap." The highest gamma measurement was 3-10 mrep/hr (sic), taken on an "aged BC heap (top of pile at waist height)" (Caplan, 1949, p. 2).

November 3, 1971 through December 31, 1973

As discussed earlier in this report, there was limited personnel exposure potential during this time period at SLAPS. Although there is limited data for this period, the available data taken in 1971 indicate that the external gamma radiation levels were low, "generally less than 0.05 mrad/h," with no levels greater than 1 mrad/h (Lenhard, 1971). Considering the condition of the site during this period

and this information, NIOSH believes that the data support its ability to bound external dose for the November 3, 1971 through December 31, 1973 period at SLAPS.

January 1, 1984 through December 31, 1998

The area monitoring data was collected regularly during the January 1, 1984 through December 31, 1998 period. The data were compiled into annual environmental monitoring reports. Radiation surveys were also performed periodically. Data taken in 1971 indicate that the external gamma radiation levels were low, "generally less than 0.05 mrad/h," with no levels greater than 1 mrad/h (Lenhard, 1971). This survey may be considered representative of the later periods, as the site radiological conditions are not known to have changed after that date. Similar data were documented in 1979 in SLAPS radiological survey reports (DOE, 1979). These data are consistent with the personnel monitoring data that are available, which indicated that the workers did not receive exposures in excess of background levels.

Data exist for individual dose reconstructions in the form of TLD dosimetry reports. NIOSH believes that these data, coupled with the information in the *Baseline Risk Assessment*, may be used to support bounding the external dose for this period at SLAPS (Argonne, 1993).

7.3.2 Evaluation of Bounding Ambient Environmental External Dose

The external exposures associated with SLAPS are not process/operations-related exposures, but are the result of activities performed outdoors, and therefore are essentially due to exposure to ambient environmental conditions. The external assessment methods and approaches evaluated in this report, for the periods after November 2, 1971, would account for any ambient exposures at SLAPS. Based on this information, further assessment of ambient environmental dose at SLAPS is not included in this report.

7.3.3 SLAPS Occupational X-Ray Examinations

No information has been located that indicates any X-ray requirements specifically associated with the SLAPS site workers, but this exposure should be addressed and bounded as discussed in ORAUT-OTIB-0006.

FUSRAP workers may be assumed to have had initial, annual, and termination X-rays primarily due to the Occupational Safety and Health Administration's medical requirements contained in the Hazardous Waste Operations and Emergency Response standard (29 CFR 1910.120) implemented in 1986.

7.3.4 Methods for Bounding External Dose at SLAPS

There is an established protocol for assessing external exposure when performing dose reconstructions (these protocol steps are discussed in the following subsections):

- Photon Dose
- Beta Dose
- Neutron Dose
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon Dose

This subsection assesses photon dose at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

External photon exposure may be bound for the period from January 3, 1947 through November 2, 1971, using guidance from the document, *Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site, St. Louis, Missouri* (ORAUT-TKBS-0005). The document contains direct gamma and beta exposure measurements that were made on and near the storage piles and the K-65 storage sheds when the Destrehan Street Plant was still operating and sending materials to SLAPS (Caplan, 1949, p. 2). These measurements were taken to determine the maximum potential exposure to unbadged personnel who were working closely with the materials and may be considered bounding for all workers for the period from January 3, 1947 through November 2, 1971.

November 3, 1971 through December 31, 1973

The *Baseline Risk Assessment* provides a bounding estimate of the potential photon exposures received by workers during the November 3, 1971 through December 31, 1973 period at SLAPS (Argonne, 1993). Although the risk assessment was developed after this time, the radiological conditions at the site are not known to have changed after the site was stabilized, confirmed by the survey dated November 3, 1971.

January 1, 1984 through December 31, 1998

The available personnel monitoring data coupled with the *Baseline Risk Assessment* provides a bounding estimate of the potential photon exposures received by workers during the January 1, 1984 through December 31, 1998 period at SLAPS (Argonne, 1993).

Beta Dose

This subsection assesses beta dose at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

External beta exposure may be bound for the period from January 3, 1947 through November 2, 1971, using guidance from ORAUT-TKBS-0005. The document references the direct beta exposure measurements that were made on and near the storage piles and the K-65 storage sheds when the Destrehan Street Plant was still operating and sending materials to SLAPS (Caplan, 1949, p. 2). These measurements were taken to determine the potential exposure to unbadged personnel who were working closely with the materials and may be considered bounding for all workers for the period from January 3, 1947 through November 2, 1971.

November 3, 1971 through December 31, 1973

The AEC survey on November 3, 1971 (Lenhard, 1971) documented that all locations had at least one additional foot of clean fill added. There would be no beta exposure during the November 3, 1971 through December 31, 1973 period.

January 1, 1984 through December 31, 1998

The available personnel monitoring data coupled with the *Baseline Risk Assessment* provides a bounding estimate of the potential photon exposures received by workers during the residual period at SLAPS (Argonne, 1993).

Medical X-ray Dose

Organ doses from posterior-anterior chest X-rays for all time periods are available in ORAUT-OTIB-0006. NIOSH believes that by using this methodology, occupational medical X-ray doses can be bound for the entire class evaluated in this report.

7.3.5 External Dose Reconstruction Feasibility Conclusion

This subsection assesses external dose reconstruction feasibility at the SLAPS site for three time periods evaluated throughout this report: (1) January 3, 1947 through November 2, 1971; (2) November 3, 1971 through December 31, 1973; and (3) January 1, 1984 through December 31, 1998.

January 3, 1947 through November 2, 1971

NIOSH believes that there are sufficient data to provide bounding levels for external dose. External exposure may be bound for the period January 3, 1947 through November 2, 1971 using guidance from ORAUT-TKBS-0005, *Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site, St. Louis, Missouri*. The document references the direct beta exposure measurements that were made on and near the storage piles and the K-65 storage sheds when the Destrehan Street Plant was still operating and sending materials to SLAPS (Caplan, 1949, p. 2). These measurements were taken to determine the potential exposure to unbadged personnel who were working closely with the materials and may be considered bounding for all workers for the period from January 3, 1947 through November 2, 1971.

November 3, 1971 through December 31, 1973

After November 3, 1971, the above-ground residues and contaminated materials had been removed, all structures were demolished and buried and there was one to three feet of clean fill added to the site. A site survey indicated that no location exceeded 1 mrad/hr at SLAPS.

Worker dose may be estimated using the *Baseline Risk Assessment*. This would be bounding, as the worker scenarios were based on remediation activities and represent work in close contact with the exposed materials. Based on this information, NIOSH finds that it can bound external doses for the class evaluated during this time period at SLAPS.

January 1, 1984 through December 31, 1998

After 1984, there are many individual external dosimetry results.

NIOSH believes that external dose may be bound using the available data coupled with the scenarios developed by the Argonne National Laboratory in their 1973 *Baseline Risk Assessment* (Argonne, 1993).

7.4 Evaluation of Petition Basis for SEC-00150

This subsection evaluates the internal monitoring assertion made on behalf of petition SEC-00150 for the SLAPS site.

Issue: *To the best of my knowledge, there was no internal monitoring of the St. Louis Airport Storage Site (SLAPS) employees (workers).*

Response: Based on the review provided in this evaluation, NIOSH has identified that monitoring (including internal) was performed for all covered periods at the site. NIOSH has identified a limited amount of monitoring data for the period from January 3, 1947 through November 2, 1971, which has resulted in the recommendation of a proposed SEC class for this period in this evaluation. However, for the period from November 3, 1971 through December 31, 1973 and January 1, 1984 through December 31, 1998, NIOSH has identified a sufficient personnel and area monitoring data, as well as source term data and process information, to support bounding the internal (and external) dose for these later periods at the SLAPS site.

7.5 Summary of Feasibility Findings for Petition SEC-00150

This report evaluates the feasibility for completing dose reconstructions for employees at the SLAPS site from January 3, 1947 through December 31, 1973 and January 1, 1984 through December 31, 1998. NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete dose reconstructions for the entire evaluated class of employees.

Table 7-2 summarizes the results of the feasibility findings at SLAPS for each exposure source during the time periods from January 3, 1947 through December 31, 1973 and January 1, 1984 through December 31, 1998.

Table 7-2: Summary of Feasibility Findings for SEC-00150						
January 3, 1947-December 31, 1973; January 1, 1984-December 31, 1998						
Source of Exposure	Jan. 3, 1947-Nov. 2, 1971		Nov. 3, 1971-Dec. 31, 1973		Jan. 1, 1984-Dec. 31, 1998	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal^{1,2}		X	X		X	
Uranium		X	X		X	
Radium-226		X	X		X	
Thorium-230		X	X		X	
Radon-222		X	X		X	
External²	X		X		X	
Gamma	X		X		X	
Beta	X		X		X	
Neutron	N/A	N/A	N/A	N/A	N/A	N/A
Occupational Medical X-ray	X		X		X	

Notes:

¹ Internal includes an evaluation of urinalysis (in vitro), airborne dust, and lung (in vivo) data.

Partial Dose Reconstructions

² NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures) for the purpose of partial dose reconstructions during the operational period from January 3, 1947 through November 2, 1971.

As of January 6, 2010, a total of three claims have been submitted to NIOSH for individuals who worked at SLAPS and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for two individuals (~66.6%).

8.0 Evaluation of Health Endangerment for Petition SEC-00150

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 not feasible to estimate radiation dose for all time periods of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is required.

9.0 Class Conclusion for Petition SEC-00150

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area and in any job capacity at the St. Louis Airport Storage Site in St. Louis, Missouri, from January 3, 1947 through November 2, 1971, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort. NIOSH recommended this because of the uncharacterized material in residue piles during this time period. The period from November 3, 1971 through December 31, 1973, is after residues were removed and the site was cleaned up; NIOSH finds that it can bound doses for the evaluated class during this period. NIOSH also finds that it can bound the doses for the evaluated class during the January 1, 1984 through December 31, 1998 period using the *Baseline Risk Assessment for Exposure to Contaminants at the St. Louis Site, St. Louis, Missouri*.

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-00150. 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 concludes 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

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p 22,296; May 2, 2002; SRDB Ref ID: 19391

42 C.F.R. pt. 82, *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 2, 2002; SRDB Ref ID: 19392

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*; Final Rule; May 28, 2004; SRDB Ref ID: 22001

42 U.S.C. §§ 7384-7385 [EEOICPA], *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended

AEC, 1949, *Health Hazards in NYOO Facilities Producing and Processing Uranium*; Atomic Energy Commission (AEC), New York Operations Office; April 18, 1949; SRDB Ref ID: 3931

AEC, 1967, *Historical Review of the Mallinckrodt Airport Cake*; Atomic Energy Commission (AEC); August 15, 1967; SRDB Ref ID: 9485

Aerospace Corporation, post-1973, *History of Material Storage at the St. Louis Airport Storage Site*, includes a printout of inventory records for various dates from 1959 through 1965; The Aerospace Corporation; exact date is unknown, but the report is post-1973; SRDB Ref ID: 10244, pp. 56-64; SRDB Ref ID: 15275, pp. 5-8; and SRDB Ref ID: 74555

Affidavit, 2009, *Affidavit from Former SLAPS Employee*; July 17, 2009; OSA Ref ID: 109347, p. 10

Air Data, 1948, *Radon Samples Taken in Airport Area-March 1948*, source being K-65 and storage shed; air samples taken on March 21 and March 29, 1948; SRDB Ref ID: 11180

Air Data, 1948-1949, *Various Air Sample Analyses*; air samples taken on various dates from September 24, 1948 through February 17, 1949; SRDB Ref ID: 11181

Air Data, 1993, *Air Particulate Sample Reporting Logs-1993*; vendor-TMA/Eberline; samples taken April 27-28, 1993; SRDB Ref ID: 66897

Air Data, 1996, *Air Particulate Sample Reporting Logs-1996*; various dates throughout 1996; vendor-Thermo NUtech; April-November 1996; SRDB Ref ID: 66917

ANL, 1981, *DRAFT Environmental Assessment Relating to the St. Louis Airport Storage Site Stabilization Research and Development Project*, select portions only; Division of Environmental Impact Studies of Argonne National Laboratory (ANL); November 1981; SRDB Ref ID: 10244, pp. 16-27

Argonne, 1993, *Baseline Risk Assessment for Exposure to Contaminants at the St. Louis Site, St. Louis, Missouri*, DOE/OR/23701-41.1; Environmental Assessment Division of Argonne National Laboratory (Argonne); November 1993; SRDB Ref ID: 62450

Army Corps, 2002, *Working Draft-The North Country Uranium Residues Historical Synopsis, St. Louis, Missouri*; Army Corps of Engineers (Army Corps), St. Louis District Office, Formerly Utilized Sites Remedial Action Program; February 2002; SRDB Ref ID: 43353

Bechtel, 1981, *Radiological Characterization of Off-Site Ditches at the Former St. Louis Airport Storage Site Survey Plan*, select portions only; Submitted to Bechtel National, Inc. (Bechtel); September 1981; SRDB Ref ID: 10244, pp. 29-33

Bechtel, 1985, *St. Louis Airport Storage Site (SLAPSS) Environmental Monitoring Summary for Calendar Year 1984*; Bechtel National, Inc. (Bechtel); July 1985; SRDB Ref ID: 63208 and SRDB Ref ID: 15274

Bechtel, 1991, *Resolution of EPA Comments on the St. Louis Site Work Plan*; Bechtel National, Inc.; July 26, 1991; SRDB Ref ID: 74572

Belcher, 1964, *Study of Disposal of the St. Louis Airport Storage Site*, correspondence to S. R. Sapirie; F. H. Belcher; June 23, 1964; SRDB Ref ID: 71666

Bioassay Data, 1948-1966, *Mallinckrodt Urinalysis Data from 1948-1966*, research file with results accessed from ORISE in 2005; CER database; various dates from February 1948 through November 1966; SRDB Ref ID: 71306

Bioassay Data, 1992-1996, *Bioassay Sample Routine Logs*; vendor-TMA/Eberline; samples taken from 1992 through 1996; SRDB Ref ID: 66915

Bioassay Data, 1996, *Bioassay Report Parameters for April-May, 1996*; vendor-Thermo Nuclear Services; samples taken April-May 1996; SRDB Ref ID: 66908

Caplan, 1949, *Health Problems at the Airport Properties*, correspondence to H. E. Thayer; K. J. Caplan; August 11, 1949; SRDB Ref ID: 11193

DOE, 1979, *Formerly Utilized MED/AEC Sites Remedial Action Program, Radiological Survey of the St. Louis Airport Storage Site, St. Louis, Missouri*, final report DOE/EV-0005/16 UC-70; U.S. Department of Energy (DOE); September 1979; SRDB Ref ID: 10302

DOE, 2010, *Scope of Coverage for SLAPS Site*, correspondence to Rachel P. Leiton; Patricia R. Worthington with Office of Health, Safety and Security, Department of Energy (DOL); April 8, 2010; OSA Ref ID: 111371

DOL, 2009, *SLAPS Covered Site Clarification*, correspondence to Stuart Hinnefeld and Patricia R. Worthington; Rachel P. Leiton with Department of Labor (DOL); December 14, 2009; OSA Ref ID: 110572

Eisenbud, unknown, *Early Occupational Exposure Experience with Uranium Processing*; Merrill Eisenbud; unknown date; SRDB Ref ID: 10629

Environmental Report, 1985, *St. Louis Airport Site Annual Site Environmental Report for Calendar Year 1985*, Rev. 1, DOE/OR/20722-100; Bechtel National, Inc. (Bechtel); April 1986, Revised September 1986; SRDB Ref ID: 15276 & 63212

Environmental Report, 1987, *St. Louis Airport Site Annual Site Environmental Report for Calendar Year 1987*; Bechtel National, Inc. (Bechtel); April 1988; SRDB Ref ID: 63173

Environmental Report, 1989, *St. Louis Airport Site Environmental Report for Calendar Year 1989*; Bechtel National, Inc. (Bechtel); May 1990; SRDB Ref ID: 63214

Figgins, 1966, *Survey of Sources of Ionium (Thorium-230)*; P. E. Figgins and H. W. Kirby; August 1, 1966; SRDB Ref ID: 42057

Form B, 2009, *Petition Form B for SEC-00150*; received July 22, 2009; OSA Ref ID: 109347

Lenhard, 1971, *Final Radiation Survey of St. Louis Airport Site*, correspondence to Thomas H. Hardin with attachment regarding procedures for monitoring radioactivity; Joseph A. Lenhard; November 17, 1971; SRDB Ref ID: 6871

Lynch, 1949, *Waste Disposal, Mallinckrodt Plants*, memo to file; D. E. Lynch; February 9, 1949; SRDB Ref ID: 11173, p. 2

Mattingly, 2004, *Status of SLAPS*, email correspondence in response to request from EEOICPA project; Jackie Mattingly; July 20, 2004; SRDB Ref ID: 24421

MCW, 1956, *Mallinckrodt Chemical Works Plant 7 and Slag Separation Plant Occupational Exposure to Airborne Contaminants*, HASL-MCW-28; Health and Safety Laboratory of Mallinckrodt Chemical Works (MCW); October 25, 1956; SRDB Ref ID: 20650

Mound, unknown, *Process and Characteristics of Major Isotopes Handled at Mound*; Mound; unknown date; SRDB Ref ID: 12328

NLCO, 1979, *Informational Report on the U.S. Department of Energy-Niagara Falls Site*, NLCO-003EV Special; National Lead Company of Ohio (NLCO); July 1979; SRDB Ref ID: 4243

OCAS-PR-004, *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, Rev. 0, National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; September 23, 2004; SRDB Ref ID: 32022

ORAUT-OTIB-0006, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, Rev. 03 PC-1; Oak Ridge Associated Universities (ORAU) Team Dose Reconstruction Project for NIOSH; December 21, 2005; SRDB Ref ID: 20220

ORAUT-TKBS-0005, *Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site, St. Louis, Missouri*, Rev. 02 PC-1; Oak Ridge Associated Universities (ORAU) Team Dose Reconstruction Project for NIOSH; May 25, 2009; SRDB Ref ID: 67979

Pena, 1997, *Correspondence regarding FUSRAP*, correspondence to William S. Cohen; Federico Pena with Department of Energy; October 10, 1997; SRDB Ref ID: 37545

Personal Communication, 2009a, *Personal Communication with Former Mallinckrodt Chemical Works Engineer*; Telephone Interview by ORAU Team; November 18, 2009, 4:30 PM EST; SRDB Ref ID: 77841

Personal Communication, 2009b, *Personal Communication with Former Mallinckrodt Chemical Works and Weldon Spring Plant Employee*; Telephone Interview by ORAU Team; November 23, 2009, 11:00 AM EST; SRDB Ref ID: 77844

Personal Communication, 2009c, *Personal Communication with Former Mallinckrodt Chemical Works and SLAPS Laborer*; Telephone Interview by ORAU Team; November 24, 2009, 11:00 AM EST; SRDB Ref ID: 77843

Personal Communication, 2009d, *Personal Communication with Former Mallinckrodt Chemical Works and Weldon Spring Plant Employee*; Telephone Interview by ORAU Team; December 2, 2009, 10:30 AM EST; SRDB Ref ID: 77837

Personal Communication, 2009e, *Personal Communication with Former SLAPS Laborer*; Telephone Interview by ORAU Team; December 2, 2009, 5:00 PM EST; SRDB Ref ID: 77839

Personal Communication, 2009f, *Personal Communication with Former Mallinckrodt Chemical Works, Weldon Spring, and SLAPS Laborer*; Telephone Interview by ORAU Team; December 7, 2009, 7:00 PM EST; SRDB Ref ID: 77840

Personal Communication, 2009g, *Personal Communication with Former SLAPS Laborer*; Telephone Interview by ORAU Team; December 15, 2009, 3:00 PM EST; SRDB Ref ID: 77836

Roth, 1967, *Requirements for Surface Cleanup of the Airport Site*, correspondence to R. H. Miller; Herman M. Roth; July 25, 1967; SRDB Ref ID: 43351

Ryan, 1978, *Radiological Survey of the Former AEC-St. Louis Airport Storage Site, St. Louis, Missouri*, final report; M. T. Ryan, F. F. Haywood, R. W. Leggett, R. W. Doane, W. M. Johnson, and W. H. Shinpaugh; August 1978; SRDB Ref ID: 74546

Sapirie, 1964, *Disposal of AEC Storage Site at Middlesex, New Jersey, and St. Louis Airport Site*, correspondence to F. P. Baranoski, includes attachments of findings and estimates; S. R. Sapirie; August 13, 1964; SRDB Ref ID: 6594

Sapirie, 1972, *Radiological Synopsis of the Airport Site*, correspondence to David E. Leigh with attached synopsis; S. R. Sapirie; January 17, 1972; SRDB Ref ID: 43348

Sargent, 1948, *Study of Unaccounted For Material-Uranium*, memo to files; E. C. Sargent; November 24, 1948; SRDB Ref ID: 21785

Soil Data, 1948, *Health Physics Survey of Airport K-65 Storage Area, Soil Data*; March 3, 1948; SRDB Ref ID: 11184, p. 16

Stone & Webster, 2000, *Radium Pits Removal Action Work Plan FUSRAP St. Louis Airport Site St. Louis, Missouri, Total Environmental Restoration*, Rev. 0, DACA 45-96-D-0007; Stone & Webster Environmental Technology & Services (Stone & Webster); February 28, 2000; SRDB Ref ID: 52603

TLD Data, 1985, *TLD Occupational Radiation Exposure Reports for Badges Issued and Returned between March and August 1985*; vendor-Eberline; SRDB Ref ID: 63223

TLD Data, 1987a, *TLD Occupational Radiation Exposure Reports for Badges Issued and Returned between July and October 1987*; vendor-Thermo Analytical Inc.; SRDB Ref ID: 46916

TLD Data, 1987b, *TLD Occupational Radiation Exposure Reports for Badges Collected and Reported between April and August 1987*; vendor-Eberline; SRDB Ref ID: 50182

TLD Data, 1988, *TLD Occupational Radiation Exposure Reports for Badges Issued and Returned between July and October 1988*; vendor-Thermo Analytical Inc.; SRDB Ref ID: 46907

TLD Data, 1989, *TLD Occupational Radiation Exposure Reports for Badges Issued and Returned between October and November 1989*; vendor-Thermo Analytical Inc.; SRDB Ref ID: 46611

TLD Data, 1990, *TLD Occupational Radiation Exposure Reports for Badges Issued and Returned between January and April 1990*; vendor-Thermo Analytical Inc.; SRDB Ref ID: 46605

Unknown, unknown, *Discussion Regarding Acquisition of St. Louis Airport Storage Site*, partial correspondence, first page missing; unknown author; unknown date; SRDB Ref ID: 9442, pp. 79-82

Unknown, 1959, *General Information on the St. Louis Airport Storage Site*; unknown author; April 11, 1959; SRDB Ref ID: 10300

Wallo, 1986, *Summary of Potential Doses from St. Louis Airport Site*, interoffice correspondence to file; A. Wallo; April 22, 1986; SRDB Ref ID: 74556

This page intentionally left blank

Attachment One: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for SLAPS			
Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
<p><u>Primary Site/Company Name:</u> St. Louis Airport Storage Site (SLAPS) AWE 1946-1966; Residual Radiation 1967-1998</p> <p><u>Other Site Names:</u> Robertson Airport Robertson Storage Area</p>	On 12/02/2009 Jim Cain of Cotter Corp responded to the ORAU Team and indicated relevant documentation may exist at their Colorado location. A request has been drafted for Cotter Corp documentation. Subsequent data capture or other means will be planned to obtain the documentation when Cotter Corp receives official request.	Ongoing	0
<p>State Contacted: Rhonda Loveall (Records Custodian) Missouri Department of Natural Resources 573-751-3043</p>	Background information for St. Louis Airport Site (SLAPS) and vicinity properties, contaminated dirt at St. Louis Airport Site, engineering evaluation and cost analysis for the Hazelwood Interim Storage Site, FUSRAP newsletters, leaching of radionuclides from St. Louis Airport Site soils, oldest atomic waste found in the St. Louis area, radium pits removal plan, SLAPS discharging to Coldwater Creek, excavation air monitoring summary, and a site summary.	10/02/2009	37
Department of Labor/Paragon	Hazard ranking system calculations, visit of Cotter Corporation personnel, Health and Safety Plan for the Niagara Falls Storage Site, release of scrap steel, and routine environmental monitoring activities.	12/30/2008	10
DOE Germantown	Review of the Mallinckrodt Airport Cake, radioactive wastes at Mallinckrodt Chemical Works, film badge reports, health hazards at Mallinckrodt Chemical Plant, K-65 residues, ground water conditions, air and radon samples, maps and drawings showing exposure readings, and health problems at the St. Louis Airport Site.	03/09/2004	15
DOE Legacy Management - Grand Junction Office	AEC preliminary proposal for disposal of residue storage area, source material license No. SMA-862, liquid and soil samples, application for a source material license by Contemporary Metals Corporation for uranium and thorium residues, bill of sale to Continental Mining & Milling Co. for residues stored at St. Louis Airport Site, site chronology, disposal of Mallinckrodt Chemical Works residue stored at St. Louis Airport Site, draft report environmental impact assessment of the former Airport Storage Site, environmental compliance summary, radiological survey, summary of St. Louis sites, Mallinckrodt site description, potential environmental issues, ground water monitoring, mobile gamma scanning results, sale of residues, source material license SNM-654 for uranium and thorium, St. Louis Airport Cake residues, summary of potential doses, and a summation of raffinate cake sampling at St. Louis.	11/16/2009	70

Table A1-1: Data Capture Synopsis for SLAPS			
Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	K-65 raffinate compositions, soil and water uranium and radium survey progress reports, decontamination criteria, and Lake Ontario Ordnance Works residues information including a chronology.	05/30/2008	6
Interlibrary Loan	Achievements in the Formerly Utilized Sites Remedial Action Program.	10/23/2009	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	09/20/2009	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	09/20/2009	0
Internet - DOE OpenNet	Monthly status and progress report for April 1949.	09/20/2009	2
Internet - DOE OSTI Energy Citations	Determination of ecologically vital groundwater at selected sites in the Formerly Utilized Sites Remedial Action Program.	09/20/2009	1
Internet - DOE OSTI Information Bridge	Stewardship challenges and a strategy for success at the St. Louis FUSRAP sites.	10/01/2009	2
Internet - Google	Contaminants of concern at St. Louis Airport/Hazelwood Interim Storage/Futura Coatings Company, EPA superfund record of decision, site characterization, St. Louis sites contamination chronology, and a feasibility study.	11/12/2009	57
Internet - Missouri Department of Natural Resources	Site summary, feasibility studies, hazardous waste quarterly and annual reports, 20 month plan, and cleanup information.	10/11/2009	9
Internet - National Academies Press (NAP)	No relevant data identified.	09/20/2009	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	09/20/2009	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	St. Louis sites contamination chronology, Shiprock Ground Water Compliance Action Plan, and a weekly information report.	10/01/2009	3
Internet - US Army Corps of Engineers	Feasibility study for the St. Louis North County Site, remedial design and remedial action, St. Louis North County sites map, fact sheets regarding radiation basics, release, and assessments.	10/11/2009	20
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	09/20/2009	0
NARA Atlanta	Extraction Plant design criteria and health program information, summary of the Mallinckrodt Chemical Works uranium division off-site environmental sampling programs, sale of residues, dust samples, and an annual health protection status report.	05/23/2008	7

Table A1-1: Data Capture Synopsis for SLAPS			
Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
NARA Kansas City	Administrative record for the St. Louis Airport and Latty Avenue Sites, air particulate sample reporting logs, area surveys and maps, environmental monitoring reports, bioassay sample routing log sheets, TLD occupational radiation exposure reports, decontamination and decommissioning of facilities, description of material stored, environmental TLD results, radiological surveys, historical synopsis, HP policies, radiological and limited chemical characterization report, radon data, and a site suitability study for the St. Louis Airport Site.	03/27/09	84
ORAU Team	Basis for development of an exposure matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site.	06/10/2009	6
ORO Vault	Correspondence on the Mallinckrodt badge program, soil and water uranium and radium survey report, and K-65 storage data.	10/28/2005	5
Southern Illinois University	Environmental and Health Legacy of the Mallinckrodt Chemical Works.	10/18/2008	6
Unknown	Documents related to St. Louis area properties (1953-1976), explosion incident at Mallinckrodt, general site information, pitchblende AM-7 raffinate at St. Louis Airport, radiological surveys, radiological survey status, and uranium contamination information.	08/09/2004	34
US Army Corps of Engineers	Cotter Corporation decontamination of storage site, Government property sale of 21-acre tract, radiological synopsis of the St. Louis Airport Site, requirements for surface cleanup, environmental sampling data, and site maps.	04/11/2008	9
TOTAL			384

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
DOE CEDR http://cedr.lbl.gov/ COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis	0	0

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis		
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis	24	2
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation"	275	1

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis		
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 10/01/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis	239	2
Google http://www.google.com COMPLETED 11/12/2009	"St. Louis Airport Storage Site" OR "SLAPS" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "St. Louis Airport Storage Site" OR "SLAPS" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"	77,267	57

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"St. Louis Airport Storage Site" OR "SLAPS" AND polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"St. Louis Airport Storage Site" AND palm OR palmolive "SLAPS" AND palmolive "SLAPS" AND palm</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND H3 OR H-3 OR HTO "St. Louis Airport Storage Site" AND mint "SLAPS" AND mint</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"St. Louis Airport Storage Site" OR "SLAPS" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND C-216 OR C-616 OR C-65 OR C-211 OR U3O8 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND plutonium</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"St. Louis Airport Storage Site" OR "SLAPS" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR or alloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"St. Louis Airport Storage Site" OR "SLAPS" AND accident "St. Louis Airport Storage Site" OR "SLAPS" AND "air count" OR "air dust" OR "air filter" OR "airborne test" "St. Louis Airport Storage Site" AND alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ "SLAPS" AND alpha "SLAPS" AND "belgian congo ore" "SLAPS" AND beta "SLAPS" AND bioassay OR bio-assay "SLAPS" AND breath "SLAPS" AND "breathing zone" OR BZ "St. Louis Airport Storage Site" OR "SLAPS" AND "body burden" "St. Louis Airport Storage Site" OR "SLAPS" AND calibration "St. Louis Airport Storage Site" OR "SLAPS" AND "chest count" OR columnation OR contamination "St. Louis Airport Storage Site" OR "SLAPS" AND curie OR denitration OR "denitration pot" "St. Louis Airport Storage Site" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment "SLAPS" AND derby OR regulus OR "derived air concentration" OR DAC OR dose "SLAPS" AND dosimeter or dosimetric OR dosimetry OR electron OR environment "St. Louis Airport Storage Site" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"SLAPS" AND exposure "SLAPS" AND "Ether-Water Project" OR "exposure investigation" OR "radiation exposure" "SLAPS" AND external "SLAPS" AND "F machine" OR fecal OR "feed material" OR femptocurie "SLAPS" AND film "St. Louis Airport Storage Site" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health "SLAPS" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP "SLAPS" AND gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" "SLAPS" AND health "St. Louis Airport Storage Site" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo" "SLAPS" AND "health instrument" OR "health physics" "SLAPS" AND H.I. "SLAPS" AND HI "SLAPS" AND HP "SLAPS" AND "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo" "St. Louis Airport Storage Site" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"SLAPS" AND incident "SLAPS" AND internal OR investigation OR isotope "SLAPS" AND ingestion OR inhalation "SLAPS" AND isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation" "St. Louis Airport Storage Site" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie "SLAPS" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU "SLAPS" AND "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie "St. Louis Airport Storage Site" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear "SLAPS" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear "St. Louis Airport Storage Site" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate" "SLAPS" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate" "St. Louis Airport Storage Site" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"SLAPS" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie "St. Louis Airport Storage Site" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological "SLAPS" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure "SLAPS" AND radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological "St. Louis Airport Storage Site" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample" "SLAPS" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate "SLAPS" AND reactor OR respiratory OR "retention schedules" OR roentgen "SLAPS" AND sample OR "air sample" OR "dust sample" "St. Louis Airport Storage Site" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source" "SLAPS" AND "general area air sample" OR sampling "SLAPS" AND "air sampling" OR "dust sampling" OR "general area air sampling" "SLAPS" AND "solvent extraction" OR "sealed source" "SLAPS" AND source		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"St. Louis Airport Storage Site" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"SLAPS" AND spectra OR spectrograph OR spectroscopy OR spectrum "SLAPS" AND standard "SLAPS" AND operating "SLAPS" AND processing</p> <p>"St. Louis Airport Storage Site" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"SLAPS" AND survey "SLAPS" AND "building survey" OR "routine survey" OR "special survey"</p> <p>"SLAPS" AND "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"St. Louis Airport Storage Site" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p> <p>"SLAPS" AND "Tiger Team" OR "tolerance dose" "SLAPS" AND urinalysis "SLAPS" AND urine "SLAPS" AND "whole body count" OR WBC "SLAPS" AND "working level" "SLAPS" AND WL "SLAPS" AND X-ray OR "X ray" OR Xray</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" OR palm OR palmolive OR polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" OR tritium OR H3 OR H-3 OR mint OR HTO</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND C-216 OR C-616 OR C-65 OR C-211 OR U3O8 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" OR Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND accident OR "air count" OR "air dust" OR "air filter" OR "airborne test" OR alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "body burden" OR calibration OR "chest count" OR columnation OR contamination OR curie OR denitration OR "denitration pot"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source"</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"Robertson Airport" OR "Robertson Storage Area" AND "St. Louis" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" OR palm OR palmolive OR polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" OR tritium OR H3 OR H-3 OR mint OR HTO</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND C-216 OR C-616 OR C-65 OR C-211 OR U3O8 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" OR Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND accident OR "air count" OR "air dust" OR "air filter" OR "airborne test" OR alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "body burden" OR calibration OR "chest count" OR columnation OR contamination OR curie OR denitration OR "denitration pot"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source"</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"Commerical Discount Corporation" OR "St. Louis Airport Authority" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" OR palm OR palmolive OR polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" OR tritium OR H3 OR H-3 OR mint OR HTO</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND C-216 OR C-616 OR C-65 OR C-211 OR U3O8 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" OR Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND accident OR "air count" OR "air dust" OR "air filter" OR "airborne test" OR alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "body burden" OR calibration OR "chest count" OR columnation OR contamination OR curie OR denitration OR "denitration pot"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p> <p>"Commerical Discount Corporation of Chicago" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation of Chicago" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" OR palm OR palmolive OR polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"Commerical Discount Corporation of Chicago" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"Commerical Discount Corporation of Chicago" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p> <p>"Commerical Discount Corporation of Chicago" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" OR tritium OR H3 OR H-3 OR mint OR HTO</p> <p>"Commerical Discount Corporation of Chicago" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"Commerical Discount Corporation of Chicago" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p> <p>"Commerical Discount Corporation of Chicago" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"Commerical Discount Corporation of Chicago" AND C-216 OR C-616 OR C-65 OR C-211 OR U308 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation of Chicago" AND plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" OR Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"Commerical Discount Corporation of Chicago" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"Commerical Discount Corporation of Chicago" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"Commerical Discount Corporation of Chicago" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p> <p>"Commerical Discount Corporation of Chicago" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"Commerical Discount Corporation of Chicago" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p> <p>"Commerical Discount Corporation of Chicago" AND accident OR "air count" OR "air dust" OR "air filter" OR "airborne test" OR alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ</p> <p>"Commerical Discount Corporation of Chicago" AND "body burden" OR calibration OR "chest count" OR columnation OR contamination OR curie OR denitration OR "denitration pot"</p> <p>"Commerical Discount Corporation of Chicago" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation of Chicago" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film</p> <p>"Commerical Discount Corporation of Chicago" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health</p> <p>"Commerical Discount Corporation of Chicago" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo"</p> <p>"Commerical Discount Corporation of Chicago" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"</p> <p>"Commerical Discount Corporation of Chicago" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie</p> <p>"Commerical Discount Corporation of Chicago" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear</p> <p>"Commerical Discount Corporation of Chicago" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate"</p> <p>"Commerical Discount Corporation of Chicago" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie</p> <p>"Commerical Discount Corporation of Chicago" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Commerical Discount Corporation of Chicago" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample"</p> <p>"Commerical Discount Corporation of Chicago" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source"</p> <p>"Commerical Discount Corporation of Chicago" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"Commerical Discount Corporation of Chicago" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"Commerical Discount Corporation of Chicago" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND americium OR Am241 OR Am-241 OR "Am 241" OR "241Am" OR 241-Am OR "241 Am" OR ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" OR palm OR palmolive OR polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND thorium OR thoria OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR Z-metal OR myrnalloy OR "chemical 10-66" OR "chemical 1066" OR "chemical 10 66"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "chemical 18-12" OR "chemical 1812" OR "chemical 18 12" OR "chemical 10-12" OR "chemical 1012" OR "chemical 10 12" OR UX1 OR UX2</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" OR tritium OR H3 OR H-3 OR mint OR HTO</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND C-216 OR C-616 OR C-65 OR C-211 OR U3O8 OR "uranium extraction" OR "uranium dioxide" OR "uranium hexafluoride" OR "uranium tetrafluoride" OR "uranium trioxide"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" OR Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "239 Pu" OR Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" OR Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR "226 Ra" OR Ra-228 OR Ra228 OR "Ra 228" OR 228Ra</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND 228-Ra OR "228 Ra" OR radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "222 Rn" OR thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" OR protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" OR oralloys OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND accident OR "air count" OR "air dust" OR "air filter" OR "airborne test" OR alpha OR "belgian congo ore" OR beta OR bioassay OR bio-assay OR breath OR "breathing zone" OR BZ</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "body burden" OR calibration OR "chest count" OR columnation OR contamination OR curie OR denitration OR "denitration pot"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND derby OR regulus OR "derived air concentration" OR DAC OR dose OR dosimeter or dosimetric OR dosimetry OR electron OR environment</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure" OR external OR "F machine" OR fecal OR "feed material" OR femptocurie OR film</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND fission OR fluoroscopy OR "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gamma ray" OR "gas proportional" OR "gaseous diffusion" OR health</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "health instrument" OR "health physics" OR H.I. OR HI OR HP OR "highly enriched uranium" OR HEU OR hydrofluorination OR "in vitro" OR "in vivo"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND incident OR ingestion OR inhalation OR internal OR investigation OR isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU OR "lung count" OR "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe" OR nuclear</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion type A" OR NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "PC Project" OR permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP OR "phosphate research" OR photon OR picocurie</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND pitchblende OR "pocket ion chamber" OR PIC OR problem OR procedure OR radeco OR radiation OR radioactive OR radioactivity OR radiograph OR radiological</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor OR respiratory OR "retention schedules" OR roentgen OR sample OR "air sample" OR "dust sample"</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "general area air sample" OR sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" OR "solvent extraction" OR source OR "sealed source"</p>		

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	<p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND spectra OR spectrograph OR spectroscopy OR spectrum OR standard OR operating OR processing</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND survey OR "building survey" OR "routine survey" OR "special survey" OR "technical basis" OR "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD</p> <p>"Continental Mining and Milling Company" OR "Cotter Corporation" AND "Tiger Team" OR "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC OR "working level" OR WL OR X-ray OR "X ray" OR Xray</p>		
Missouri Department of Natural Resources http://www.dnr.mo.gov/ COMPLETED 10/11/2009	<p>"St. Louis Airport Storage Site"</p> <p>SLAPS</p> <p>"Robertson Airport" AND "St. Louis"</p> <p>"Robertson Storage Area" AND "St. Louis"</p> <p>"Commercial Discount Corporation"</p> <p>"Commercial Discount Corporation of Chicago"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport"</p> <p>"St. Louis Airport Authority"</p> <p>"Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago"</p> <p>"Cotter Corporation"</p> <p>"St. Louis Airport Storage Site"</p>	153	9
National Academies Press http://www.nap.edu/ COMPLETED 09/20/2009	<p>SLAPS</p> <p>"Robertson Airport" AND "St. Louis"</p> <p>"Robertson Storage Area" AND "St. Louis"</p> <p>"Commercial Discount Corporation"</p> <p>"Commercial Discount Corporation of Chicago"</p> <p>"First National City Bank" OR Citibank AND "St. Louis Airport"</p> <p>"St. Louis Airport Authority"</p> <p>"Continental Mining and Milling Company"</p> <p>"Continental Mining and Milling Company of Chicago"</p> <p>"Cotter Corporation"</p>	2,623	0

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis		
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 10/01/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority"	1,010	3

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis "Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis		
US Army Corps of Engineers http://www.mvs.usace.army.mil/eng-con/expertise/fusrap-stl-sites.html COMPLETED 10/11/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation"	24	20
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 09/20/2009	"St. Louis Airport Storage Site" SLAPS "Robertson Airport" AND "St. Louis" "Robertson Storage Area" AND "St. Louis" "Commercial Discount Corporation" "Commercial Discount Corporation of Chicago" "First National City Bank" OR Citibank AND "St. Louis Airport" "St. Louis Airport Authority" "Continental Mining and Milling Company" "Continental Mining and Milling Company of Chicago" "Cotter Corporation" "St. Louis Airport Authority" "Louis Airport Storage Site" "Robertson Airport" AND Louis	0	0

Table A1-2: Database Searches for SLAPS			
Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
	"Robertson Storage Area" AND Louis "Commercial Discount" "First National City Bank" OR Citibank AND "Louis Airport" "Louis Airport Authority" "Continental Mining and Milling" Cotter +Louis		

Table A1-3: OSTI Documents Requested for SLAPS			
Document Number	Document Title	Requested	Received
NA Ref ID: 76039	Preliminary Public Health Assessment St. Louis Airport Hazelwood Interim Storage/Futura Coatings Company Appendix A - Dose Calculations	10/12/2009	11/12/2009
NA Ref ID: 76040	Preliminary Public Health Assessment St. Louis Airport Hazelwood Interim Storage/Futura Coatings Company Appendix B - Public Comments	10/12/2009	11/12/2009

Table A1-4: Cincinnati Public Library Documents Ordered for SLAPS			
Document Number	Document Title	Requested	Received
NA Ref ID: 74425	Radionuclide Leaching from Residual Soils: Screening Study - Practical Periodical of Hazardous, Toxic and Radioactive Waste Management Vol 6(3):184-191 July 2002	10/12/2009	10/12/2009
NA Ref ID: 75052	Program Achievements in the Formerly Utilized Sites Remedial Action Program - Federal Facilities Environmental Journal Vol 13(1):77-83	10/12/2009	10/23/2009