SEC Petition Evaluation Report
Petition SEC-00162

Report Rev #: FINAL Report Submittal Date: May 4, 2011

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Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00162	83.13	January 19, 2010	April 13, 2010	Sandia National Laboratories-Albuquerque

Petitioner-Requested Class Definition

All employees who worked within the Sandia National Laboratory Reactor Division from January 1, 1957 through December 31, 1962.

Class Evaluated by NIOSH

All employees who worked in any area at Sandia National Laboratories, Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962.

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 at Sandia National Laboratories in Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962, 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

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Evaluation Report Summary: SEC-00162, Sandia National Laboratories

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-00162 was received on January 19, 2010, and qualified on April 13, 2010. The petitioner requested that NIOSH consider the following class: *All employees who worked within the Sandia National Laboratory Reactor Division from January 1, 1957 through December 31, 1962.*

Class Evaluated by NIOSH

NIOSH incurred internal monitoring data retrieval problems while processing individual claims and performing data capture work. The data retrieval issues appeared to affect earlier time periods and workers not associated with the Reactor Division. Considering this information, NIOSH expanded the petitioner-requested class. NIOSH evaluated the following class: All employees who worked in any area at Sandia National Laboratories, Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962. Although time constraints precluded any further expansion of the evaluated class for this report, upon completion of the current evaluation NIOSH intends to continue to examine the feasibility of performing dose reconstructions for Sandia National Laboratories workers for the post-1962 period.

NIOSH-Proposed Class to be Added to the SEC

Based on its complete 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 at Sandia National Laboratories in Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962, 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. The class under evaluation was accepted (see Section 3.0 below) because of the lack of available monitoring program details, process information, and internal monitoring data.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it does not have access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of maximum dose. Information available from the site profile and additional resources is not sufficient to document or estimate the maximum internal potential exposure to all members of the proposed class under plausible circumstances during the specified period.

The NIOSH dose reconstruction feasibility findings are based on the following:

- Principal sources of internal radiation for members of the proposed class included exposures to plutonium, tritium, uranium, americium, and fission and activation products. Potential exposure pathways could have involved the handling of these radionuclides during waste-burial operations or exposure to surface or air contamination associated with reactors and/or accelerators work. NIOSH has found that source terms and associated exposures varied over the evaluated period. Considering the potential exposure scenarios, NIOSH finds it is unable to estimate these internal exposures with sufficient accuracy for the evaluated class.

- Principal sources of external radiation for members of the proposed class included exposures to alpha, beta, gamma, and neutron radiation. Exposures could have occurred during waste-handling activities and hot cell work. Work with reactors and accelerators also involved exposure potential for workers. Samples obtained from blast experiments conducted at the Nevada Test Site and analyzed at Sandia National Laboratories could have resulted in external exposure. Additionally, medical X-rays performed onsite as a condition of employment would have resulted in external exposures to the evaluated class. NIOSH finds that it is feasible to reconstruct all occupational external dose for Sandia National Laboratories workers with sufficient accuracy for the entire evaluated period.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) 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 (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

- Although NIOSH found that it is not possible to completely reconstruct internal 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 Sandia National Laboratories during the period from January 1, 1949 through December 31, 1962, but who do not qualify for inclusion in the SEC, 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.

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 this employment or in combination with work days within the parameters established for one or more other SEC classes.

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Table of Contents

Tables

Figures

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SEC Petition Evaluation Report for SEC-00162

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: Tim Adler, 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 who worked in any area at Sandia National Laboratories, Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962. 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.[1]

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.[2]

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

[1] DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).
[2] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at http://www.cdc.gov/niosh/ocas.

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

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

3.0 SEC-00162, Sandia National Laboratories Class Definitions

The following subsections address the evolution of the class definition for SEC-00162, Sandia National Laboratories in Albuquerque, New Mexico (referred to as SNL throughout this report). When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00162 was received on January 19, 2010, and qualified on April 13, 2010. The petitioner requested that NIOSH consider the following class: *All employees who worked within the Sandia National Laboratory Reactor Division from January 1, 1957 through December 31, 1962.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the SNL workers in question. NIOSH

[3] 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.

determined that none of the petitioner-provided information supported qualification of petition SEC-00162. However, NIOSH deemed the following information sufficient to qualify SEC-00162 for evaluation:

- Monitoring data retrieval problems incurred by NIOSH while processing individual claims and performing site data capture work support an F.2 basis for qualification of this petition.

- The data retrieval problems appear to be a result of inconsistent data maintenance practices at SNL.

Based on its SNL research and data capture efforts, NIOSH determined that it has access to external monitoring data for SNL workers during the time period under evaluation. However, NIOSH also determined that access to internal monitoring data records is very limited. NIOSH concluded that there is sufficient documentation to support the petition basis that internal radiation monitoring records have been lost or destroyed and/or that there is limited information regarding monitoring, source, source term, or process information relating to SNL operations from 1949 through 1962. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH expanded the petitioner-requested class because of internal monitoring data retrieval problems incurred while processing individual claims and performing site data capture work. The data retrieval issues appeared to affect earlier time periods and workers not associated with the Reactor Division. Therefore, NIOSH defined the following class for further evaluation: All employees who worked in any area at Sandia National Laboratories, Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962. Although time constraints precluded any further expansion of the evaluated class for this report, upon completion of the current evaluation NIOSH intends to continue to examine the feasibility of performing dose reconstructions for Sandia National Laboratories workers for the post-1962 period.

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 at Sandia National Laboratories in Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962, 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 is standard practice, NIOSH completed an extensive database and Internet search for information regarding SNL. 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 SNL 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 provides 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. As part of NIOSH's evaluation detailed herein, it examined the following Site Profile for insights into SNL operations or related topics/operations at other sites:

- *Site Profile for Sandia National Laboratories in Albuquerque, New Mexico, and the Tonopah Test Range, Nevada,* ORAUT-TKBS-0037; Rev. 00; June 22, 2007; SRDB Ref ID: 32531

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

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. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIB and procedure as part of its evaluation:

- *OTIB: Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 00; January 3, 2011; SRDB Ref ID: 89563

- *Procedure: Occupational Medical X-Ray Dose Reconstruction for DOE Sites*, ORAUT-PROC-0061, Rev. 03; March 3, 2010; SRDB Ref ID: 79758

4.3 Facility Employees and Experts

There have been multiple SNL worker interviews. Some of these interviews were completed by NIOSH for purposes other than support of this evaluation report, while others were older interviews performed by other organizations that were captured by NIOSH during data capture trips. These interviews, plus two additional interviews of semi-retired SNL health physicists (conducted specifically for this evaluation) have been considered and referenced throughout this evaluation. Both interviews performed specifically for this SEC evaluation were conducted by phone and are referenced below:

- Personal Communication, 2011, *Personal Communication with SNL Employee*; Telephone Interview by ORAU Team; February 24, 2011, 12:00 PM EST; SRDB Ref ID: 93639 (Personal Communication, 2011a)

- Personal Communication, 2011, *Personal Communication with SNL Employee*; Telephone Interview by ORAU Team; February 24, 2011, 3:00 PM EST; SRDB Ref ID: 93640 (Personal Communication, 2011b)

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of March 22, 2011)

Table 4-1: No. of Sandia National Laboratories Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	346
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1949 through December 31, 1962)	193
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	154
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	11
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	88

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Of the total of 193 claims submitted for energy employees who worked during the period under evaluation, SNL/Department of Energy (DOE) has responded to 191 claims. Of these 191 claims, SNL/DOE has indicated that "there is no record of internal measurements having been made" for 180 claimants (~ 94%). Of the 191 claims receiving SNL/DOE responses, 88 (46 %) contain external monitoring data. The other 103 responses specifically state that no records exist for the claimant.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Two thousand four hundred eighty-nine documents in this database were identified as pertaining to SNL. These documents were evaluated for their relevance to this petition. The documents include historical background on internal and external dosimetry programs and evaluations, monitoring summary reports, annual environmental reports, reviews and assessments of SNL, evaluations of specific buildings, site surveys, and facility and process descriptions.

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-00162*; received January 19, 2010; OSA Ref ID: 110577, pdf pp. 1-5 (Form B, 2010)

- *Email Correspondence regarding Specific Sites*; correspondence between multiple authors; dates ranging from February 6, 2009 through January 13, 2010; OSA Ref ID: 110577, pdf pp. 6-17 (Email, 2009-2010)

- *Dosimetry Records*; records for various dates between 1957 through 1981; OSA Ref ID: 110577, pdf pp. 18-171 (Monitoring Results, 1957-1981)

- *Petitioner Consult Call Response*; March 18, 2010; OSA Ref ID: 111299 (Consult Call Response, 2010)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at SNL from January 1, 1949 through December 31, 1962, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered some process and source descriptions, information regarding the identity of each radionuclide of concern, and limited information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred.

5.1 Sandia National Laboratories Facilities and Process Descriptions

SNL is located in Albuquerque, New Mexico on an 8,642 acre land mass. SNL had its origin as a satellite support site for the Los Alamos Scientific Laboratory. In July 1945, the Los Alamos Scientific Laboratory Z-Division was established to handle weapons development, testing, and bomb assembly for the Manhattan Engineer District (Ullrich, 1998). In late fall of 1945, some units of Z-Division were moved to the current SNL site. In 1948, Z-Division became a separate branch of Los Alamos Scientific Laboratory. In 1949, "Sandia Corporation" was created and became completely separated from Los Alamos Scientific Laboratory. Sandia Corporation changed its name to Sandia Laboratories in 1971 and then again to its current name, Sandia National Laboratories in 1979.

During the earliest years of the January 1949 through December 1962 evaluation period SNL's focus was on weapons assembly, weapon ordnance engineering, and production coordination among various AEC contractors. By the early 1950s, a weapon production complex was in place and the focus was on weapons development. SNL expanded its engineering staff to accommodate the expanding number of weapon projects underway. In addition to weapons development, SNL began field testing components and supported atmospheric tests sponsored by partner laboratories. Later in the 1950s, when nuclear testing was halted temporarily due to the US/USSR test moratorium, SNL acquired accelerators and built reactors to test the responses of materials (including weapon components) to radiation and to conduct research in radiation physics and chemistry. SNL experienced rapid shifts in engineering staff to accommodate these work focus changes. Although specific SNL employee population numbers have not been captured for 1949 through 1957, available AEC annual reports show that from 1958 through 1962, the SNL workforce averaged approximately 7,000 workers.

There are five Technical Areas located on the SNL site. Figure 5-1 provides a reasonably accurate representation of the site. Electron and ion beam accelerators and the Toxic Metal Machine Shop are located in Technical Area-I. Weapons component assembly and waste handling and burial occurred in Technical Area-II. The mixed-waste landfill and the Radioactive and Mixed Waste facility were located in Technical Area-III. The Neutron Generator Test Equipment facility was located in Technical Area-IV. Reactors and the Hot Cell facility were located in Technical Area-V.

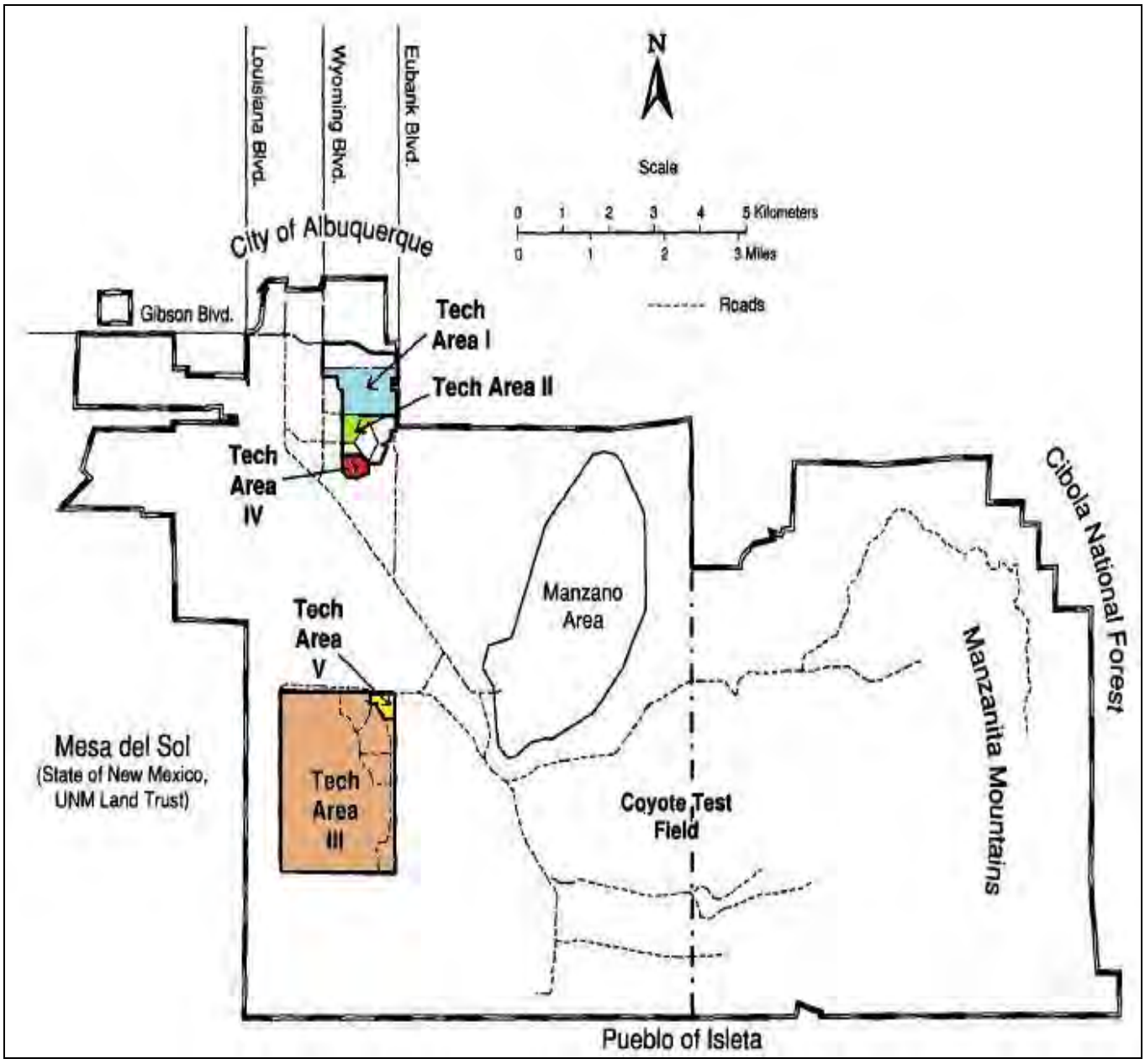

Figure 1: Map of Sandia National Laboratories

Source: This map is a modified version of the map in DOE, 1999.

Table 5-1 summarizes components of the five Technical Areas associated with SNL, their operational periods, and the exposure potentials of activities that occurred within the areas. Information on waste burial sites is presumed to be indicative of the types of activities that were occurring.

Table 5-1: SNL Potential Exposure Areas and Processes
(*Table 5-1 spans 3 pages*)

Building or Area/Description	Exposure Potential		Operational Dates	Radionuclides
	External	Internal		
Technical Area-I (Electron/Ion Beam Accelerators)				
884/Cockroft-Walton(s) electron generator/accelerator	Y	Y	Late 1950s–present	Target dependent (e.g. H-3)
803/Van de Graaff(s) electron generator/accelerator	Y	Y	1958–present	Target dependent (e.g. H-3)
891	---	Y	---	Metal Tritides
836/Nuclear Reactor and Experimental Reactor Division	---	---	1957-1960	---
802/Chemistry Labs; Radiochemicals to support research activities	Y	Y	1949-present	H-3, Metal Tritides
868/Machining uranium work Received wastes from early weapons testing; stored stockpiled nuclear cores.	Y	Y	1949-1968	U, DU
869/Toxic Metals Machine Shop	Y	Y	~1959–1994	DU, Pu
Technical Area-II (Waste Handling/Burial, Weapons Assembly)				
TA-II Burial Pits/ Items buried included: contaminated tools, clothing, wastes from Sandia Pulse Reactor (SPR) and Sandia Engineering Reactor Facility (SERF), waste from weapons components, airplane sections, residue from processing plutonium samples in 829, bioassay and soil samples, RaBe and small cobalt-60 sources, irradiated material from rocket tests, and gap tubes containing cesium-137. Note: Records and logs have been destroyed	Y	Y	1949-early 1960s	U-contaminated wastes, Pu (small amounts) and debris from Plumbob (for example, Fizeau 1957-1958). Cs-137, Sr-90, other fission products and Pu contamination. Neutron activated material from the Nevada Test Site. Tritium (booster cylinders) may have been place in waste facility.
Weapons Assembly Work	Y	Y	1948 - 1957	U
935	---	---	---	Metal Tritides

Table 5-1: SNL Potential Exposure Areas and Processes
(*Table 5-1 spans 3 pages*)

Building or Area/Description	Exposure Potential		Operational Dates	Radionuclides
	External	Internal		
Technical Area-III (Waste Destruction/Disposal/Transfer)				
6920/Radiological and Mixed Waste facility	Y	Y	1949–1986	Cs-137, DU, others
Technical Area-IV (Repair/Test Facility)				
905/Neutron Generator -Test Equipment	Y	---	1959–1997+	Only if generators, damaged: Am-241, Po-210, Pu-239
Technical Area-V (Reactors)				
6581/Sandia Engineering Research Facility (SERF). 5 MW; airborne potential after 1962 startup of operations.	Y	Y	1962-1979	MFP and MAP, U, Pu, and tritium
6580/SER Reactor	Y	---	1962-1969	MFP and MAP, U, Pu and tritium
6590, 6591 /Sandia Pulse Reactor (Godiva type).	Y	Y	1961	MFP and MAP, U, Pu and tritium
Technical Area-V (Irradiation and Calibration Support Laboratories)				
6580, 6581/Prior to reactor startup Hot Cell Facility work and Fizeau blast sample work.	Y	---	1957- 1959	Target dependent: (e.g., metals from reactor, e.g., Cs-137, Ce-144, and H-3)
Other				
School House Mesa Uranium Burn Site	---	---	1940s – 1950s	Depleted Uranium burned
Lurance Canyon Burn Site, Uranium Burn Site	---	---	---	Depleted Uranium burned

Table 5-1: SNL Potential Exposure Areas and Processes
(*Table 5-1 spans 3 pages*)

Building or Area/Description	Exposure Potential		Operational Dates	Radionuclides
	External	Internal		
Near 9820/Animals from radiation studies buried in pits	---	---	1950s – early 1960s	---
Pendulum-site burial mounds	---	---	Closed in the 1970s	Debris from classified weapons testing & depleted uranium contamination in soil

Notes:
This table is a modified version of Table 2-2 in ORAUT-TKBS-0037.
--- Three hyphens (---) in a table cell denote a lack of information.

The potential for chronic intakes in most areas of SNL has historically been less than at DOE production sites because of the nature of the tasks performed at SNL. Certain areas of the site have always been non-nuclear. Nevertheless, the nature of the research environment at SNL during the evaluated period may have resulted in intake potentials that were often unique and of short duration, and the potential for monitored and unmonitored intakes has existed throughout the site's history.

Available documentation describing site activities that occurred from January 1, 1949 through December 31, 1962, is predominantly described in general terms. The following descriptions summarize the available plant and process information by Technical Area. The summaries are meant to compliment the information supplied in Table 5-1 above. Additional details can be found in Section 2 of ORAUT-TKBS-0037.

Technical Area-I

In 1949, the site concentrated primarily on development and testing of non-nuclear components as well as weapons assembly work (ORAUT-TKBS-0037). Activities included using a Cockcroft-Walton generator/accelerator and a Van de Graaff generator/accelerator, as well as a set of chemistry laboratories that used radiochemicals to support research needs. The Toxic Metals Machine Shop was also located in Technical Area-I. Environmental sampling reports have noted the potential for release of tritium from Technical Area-I during the evaluated period (Annual Report, 1984).

Technical Area-II

In 1948 construction was initiated for the purpose of early manufacturing activities, including weapons assembly. Specifically, Technical Area-II was designed for handling and incorporating explosives into weapons. The area included two assembly buildings and a control building, all completed in 1949. Weapons assembly activities continued at Technical Area-II until 1959.

In addition to weapons assembly, activities in Technical Area-II also included significant waste handling and burial from operations in other areas of the site as well as from other DOE locations. The types of wastes buried varied considerably (see Table 5-1 of this report). Known wastes includes contaminated tools, clothing, Nevada Test Site debris, wastes from weapons components, airplane sections, and residues from processing plutonium samples in Building 829, bioassay samples, and sources such as RaBe and cobalt-60 (Haines, 1991, pdf p. 12). Wastes from the Sandia Pulse Reactor and the Sandia Engineering Reactor were also put into the waste pits. Records and logs of buried wastes have been destroyed (Haines, 1991, pdf p. 12).

Statements from long-term workers employed before 1952 in Technical Area-II indicate that after weapons assembly shifts, various personal and work items were disposed of in the burial pits. Per one of those employees (Haines, 1991, pdf p. 12):

> "The only pit I ever knew of was out there [referring to Site #1, Technical Area-II]. During the early 1950's we worked mostly at night doing weapons assembly. When clothes, coveralls, hoods, boots, watches (if we forgot to take them off), badges, tools got "hot", we would throw them in this pit. We would know they were hot because they checked us before we went out the gate. We would have to walk all the way back out there, raise a metal lid on the ground and throw the stuff in. We did this for several years. We never kept any records of this. The lid for this hole was about 4-foot across."

The worker's statement illustrates that weapons assembly involved radioactive contamination and the potential for intakes and external exposures. The weapons assembly process may have been similar in 1949, the start of the evaluated period, as it was in the "early 1950s."

Technical Area-III

The increasing use of missiles as delivery vehicles led to full-scale environmental testing of weapons with and without explosives. As a result, there was a need for complex equipment and specialized engineers to analyze the test results. This group of test devices was centralized in Technical Area-III. The first group of facilities, which consisted of a centrifuge, a rocket sled, a vibration testing facility, and instrument control center, was completed in 1953.

The mixed-waste landfill was operated at Technical Area-III from 1958 to 1988 (SNL, 1998) and was operated as a disposal site for low-level radioactive and mixed waste (Haines, 1991, pdf pp. 11-12).

Technical Area-IV

During the latter portion of the evaluated time period (1959 and later) a neutron generator repair and test facility was located in Technical Area-IV. Few details of this work have been located or captured.

Technical Area-V

Technical Area-V is home to SNL's Reactor Facility. First proposed in 1957, this facility is remote from the other SNL Technical Areas. It contains two reactors, the Sandia Pulse Reactor (SPR) and the Sandia Engineering Reactor (SER). The Sandia Pulse Reactor facility was an un-reflected, cylindrical, enriched-uranium assembly (GODIVA-type). It was first operational in May 1961. The SER was a 5-MW heterogeneous reactor fueled with aluminum-clad, uranium-235-enriched uranium fuel elements. The reactor was cooled and moderated by light water and was operational from October 1962 to June 1969.

Other facilities in Technical Area-V during this time period have included electron beam accelerators as well as a neutron irradiation facility.

5.2 Radiological Exposure Sources from Sandia National Laboratories Operations

The following subsections provide an overview of the internal and external exposure sources for the SNL class (January 1, 1949 through December 31, 1962) under evaluation.

5.2.1 Internal Radiological Exposure Sources from Sandia National Laboratories Operations

Complete details of the internal exposure sources have not been readily identified, especially for the 1949 to 1955 time frame. However, it is known that, at a minimum, radioactive wastes were being generated and buried. Contaminated coveralls and other materials (after assembling weapons) were disposed of in radioactive-waste landfills in Technical Area-II during the 1949 to mid-1950s time frame. In addition, mixed waste disposal activities occurred within TA-II from 1958 to beyond the end of the evaluation period. Although specific areas where waste materials were generated and buried are not readily identifiable from documents available to NIOSH, a potential for internal intakes is assumed to exist. Internal dose potential is also associated with the reactors, machine shops, accelerators, and other research and supporting activities.

5.2.1.1 Plutonium

Potential intakes of plutonium from activities in Technical Area-III have existed since the beginning of operations of the mixed-waste landfill. One source of plutonium in Technical Area-III is contaminated debris from the Nevada Test Site. Plutonium activities also existed in Technical Area-I and Technical Area-II, including the waste disposal pits. Table 5-1 describes the sources of the plutonium.

Plutonium bioassay results have been found as early as 1955, therefore indicating that earlier exposure potentials may yet be identified. However, according to an interview with a retired health physics manager (Personal Communication, 2011a), these bioassay were primarily performed for individuals who participated in off-site tests.

5.2.1.2 Tritium

Since 1949, activities in Technical Area-I have resulted in the potential for tritium intakes. Potential intakes may also have resulted from operations with neutron generators, accelerator targets, and reactor operations. Surveys and air samples for tritium were routinely performed as indicated by captured logbooks. Positive results have been noted for many samples within the logbooks (Monitoring Results, 1959-1970).

Exposures to metal tritides and gaseous tritium are described in several captured documents. Metal tritides have been used as components of neutron generators. Specific locations associated with metal tritides have been identified in Technical Area-I (Building 891) (ORAUT-TKBS-0037, pdf p. 55). Time frames associated with metal tritide use in these locations have not been determined.

5.2.1.3 Uranium

The use of natural uranium, depleted uranium, and enriched uranium presented internal dose potentials on the SNL site. Activities in Technical Area-I, Building 884 and Technical Area-III, Radioactive and Mixed Waste facility, indicate uranium use beginning in 1956 and 1949, respectively. Employees in the Technical Area-I, Toxic Metal Machine Shop handled uranium beginning in 1959 (ORAUT-TKBS-0037, Section 2). Depleted uranium was buried in waste areas in Technical Area-II and Technical Area-III. Uranium burn sites were identified in canyon areas (SNL, 1991, pdf pp. 50-52).

5.2.1.4 Americium-241

Potential intakes from activities with americium-241 may have existed in Technical Area-IV from work with neutron generators (1959 and later) and subsequent waste operations. Americium-241 intakes from neutron generator operations were an internal dose potential only if the generator was damaged.

5.2.1.5 Fission and Activation Products

Cesium-137 and cobalt-60 were identified in waste operations beginning in 1949 (Haines, 1991, pdf pp. 12-13). From 1957-1958, irradiated material and fission products (cesium-137 and strontium-90) were associated with materials and components exposed to weapons tests from Plumbob. Reactor operations, which began in 1961, produced mixed fission and activation products. For example, sodium-24 was identified in dust samples in reactor areas (Unknown, 1961).

5.2.1.6 Other Radionuclides

Accelerators in use by the late 1950s also produced manganese-54, zinc-65, sodium-22, and cobalt-57. Thorium, polonium-210, radium (from leak testing RaBe sources), and carbon-14 have been identified in analytical logs captured from the site. Potential exposure pathways would include handling targets.

5.2.2 External Radiological Exposure Sources from Sandia National Laboratories Operations

Work involving nuclear weapons occurred throughout SNL from 1949 through1962. A Van de Graaff and a Cockroft-Walton generator/accelerator were introduced in 1958. The SPR began operation in 1961, while the SER began operation in 1962. These accelerators and reactors were used to create radiation fields for the purpose of material and system testing. The accelerators and reactors are discussed in Section 2.4 of ORAUT-TKBS-0037 and are summarized in Tables 2.2 and 2.3 of that document. Some external exposure could also have potentially occurred during activities at hot cells and from radioactive waste-handling activities. Additionally, samples obtained from blast experiments conducted at the Nevada Test Site were analyzed at SNL. Exposure sources associated with these work environments are described below.

5.2.2.1 Photon

During the period between 1949 and 1958, activities involving nuclear weapons assembly were conducted at SNL. NIOSH has found limited information regarding these specific activities. A conservative assumption could be made that the photon exposures would have been typical of the radiations associated with bare uranium or plutonium. In reference to a summary of a letter dated December 8, 1952, the statement is made "Most of our contamination involves alpha-beta radiation and the material is in a solid form. Thus, little danger is encountered from skin contamination" (Unknown, 1952). There were also procedures in place for procurement and control of radium and radium compounds; thus, these sources would also have been available as potentials for exposure to radiation. NIOSH has not located specific documents that explain how these sources were used.

As mentioned previously, two reactors and two generators/accelerators were operational during the latter years of the evaluated period. The generators/accelerators were originally located in Technical Area-I, but were then moved to Technical Area-V sometime after 1967. Radiation areas resulting from the operation of these facilities were typically evacuated and/or interlocked to prevent personnel exposures to the potential sources of radiation. An example of this design requirement for the Sandia Pulse Reactor facility is stated in a report describing the Sandia Pulsed Reactor Facility (Burnett, 1962, pdf p. 4): "Operation of the reactor in a normal manner does not expose any personnel to hazardous radiation. The nature of the reactor is such that the production of radioactive waste is minimal, and the spread of radioactive contamination is not a problem." However, residual radiation would potentially still exist during entries to modify experimental setup, retrieve samples, or to perform maintenance. The energy ranges would have been typical of those associated with fission products or accelerator energies at other AEC/DOE facilities; these are discussed in Section 6.6 of the SNL Site Profile, ORAUT-TKBS-0037.

5.2.2.2 Beta

Known operations at SNL did not involve extensive handling of radioactive materials that would have been significant sources of beta exposure. As discussed previously, the material was in a solid form and would not have resulted in skin contamination. NIOSH has located documentation that indicates that beta radiation was involved (Unknown, 1952). After the introduction of accelerators and reactors, some exposure to beta radiation occurred during some operations; for example, maintenance at the reactor facilities and/or during experimental change-outs resulted in small exposures to workers, as

indicated from available exposure records. Energy values are detailed in Section 6.6 ORAUT-TKBS-0037, specifying that the beta energies are greater than 0.15 kev.

5.2.2.3 Neutron

Neutron sources would have existed during reactor and accelerator operations, and during operations involving the handling of weapons components. However, neutrons from the reactors would have only been available near the reactor during operation; personnel access to these areas was prohibited during operation. The Cockroft-Walton generator/accelerator, put into service in 1958, would have produced primarily high-energy neutrons, but only while operating and only in the area where access was prohibited during operation. The configuration of the nuclear weapons and associated materials at SNL presented a very limited source of neutrons. Any other operations associated with the evaluated class would have had very low potential for exposure to neutrons. The neutron energy values are discussed in more detail in Section 6.9 of ORAUT-TKBS-0037.

The SEC-00162 petition discusses the possibility of unmonitored exposure from samples returned to SNL from the Fizeau Test conducted at the Nevada Test Site (NTS) in late 1957. The practices at NTS and SNL involved monitoring any samples removed from NTS and received at SNL; the samples were alleged to be brass. The neutron exposure from the blast samples would most likely not have resulted in significant levels of radioactivity in the samples, most likely less than 100 microcuries of zinc-65 in a 100 g brass sample. Zinc-65 would be the only isotope with a half-life long enough to still exist during the time required to retrieve the samples and return them to SNL (approximately 2 months). This level of radioactivity would have resulted in negligible exposures (less than 0.1 mr/h at 1 foot).

5.2.3 Incidents

A significant radiation exposure incident occurred in 1960 at the Van de Graaff generator/accelerator resulting in one worker receiving an exposure greater than 15 rem (SNL, 1960). No reports of other incidents with significant radiation exposure during the January 1949 through December 1962 period have been identified or captured.

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

The following subsections provide an overview of the currently available internal and external monitoring data for the SNL class under evaluation. SNL's Health Physics Section was first established in 1957 within the already existing Industrial Hygiene Division (Johnson, 1997). Prior to the establishment of the Health Physics Section, the Industrial Hygiene Division (known then as the "Health Hazards Division") performed radiological monitoring and safety oversight. Some aspects of the SNL's health physics oversight were not well documented during the evaluation period, including post-1957 years. From an overall program implementation standpoint, other than the Industrial Hygiene Division being responsible for program implementation, essentially no documented details of SNL's approach to health and safety have been captured for the 1949-1957 portion of the evaluation

period. A lack of documentation availability is particularly applicable to internal exposure monitoring practices and internal record maintenance. This is likely due in part to the relatively low internal exposure potential for most work performed at SNL, and the resultant ad hoc approach to internal monitoring. Currently, SNL does not have any functioning electronic monitoring record repositories applicable to the evaluated class.

From 1957 forward it is evident that monitoring requirements at SNL were determined primarily within specific departments or divisions (e.g., Reactor Division) based on work area and activity-specific bases. Health physicists determined monitoring requirements for workers under their purview based on their judgment of exposure potential. Organization supervisors were responsible for implementing the health physicists' recommendations. Often, air monitoring was used as a decision tool for determining worker protection needs and bioassay sampling requirements.

Because of the Industrial Hygiene Division's role in performing analyses, internal bioassay monitoring results for the evaluation period were most frequently stored in files located within that Division. The majority of these paper records have now been moved into offsite, inactive record storage boxes which are not easily nor routinely searched. Approximately 50,000 boxes of records now exist within the inactive record storage area, which consist of caves within the nearby "Monzano Area." The historical personnel record management practices and decisions preclude the summarization and presentation of total internal personal monitoring data availability for the evaluated class. Therefore, in this evaluation report the presentation of internal monitoring data availability for the evaluated class predominantly reflects data captured from SNL during multiple data capture trips performed by NIOSH.

It is noteworthy that occupational external radiation monitoring records have historically been more centralized and readily available than internal monitoring data. External monitoring records are typically found within worker files and are also available in summary fashion within AEC annual summary reports, as described below in Section 6.2. However, as previously mentioned, specific procedures detailing the protocols for external monitoring during the early portion of the evaluated period (1949-1957) have not yet been located.

Microfilm and Microfiche Record Set

In January 2010, NIOSH requested SNL to perform additional data searches to address known data gaps in information that SNL had been providing NIOSH in response to specific EEOICPA-records requests. In response to the identified gaps, SNL located a specific collection of records that it believes holds additional worker radiological records and information. The identified data is primarily stored on microfiche, with some of the records stored on microfilm and other forms of media. It is apparent from archived site newspaper articles and interviews with SNL employees that in the early 1960s, in an effort to conserve current and future record storage space, SNL made the decision to switch from a paper record-storage method to microfilm and microfiche; this resulted in the SNL microfilm/microfiche collection. It appears that during this time SNL not only switched their record storage method to the microfilm/microfiche media, but also made an effort to collect older, existing paper records and convert them over too.

Based on SNL's initial review of the microfilm/microfiche records, they believe many of the EEOICPA claimant data deficiencies identified by NIOSH would be addressed by this collection

(Worthington, 2011). They also realize that without indexing the entire record collection, it is not be feasible to completely respond to NIOSH requests for claimant exposure data or SEC evaluation data requests, nor is it possible to determine precisely the extent of the EEOICPA relevant data available within these records.

SNL has been working closely with NIOSH, DOE, the National Nuclear Security Administration, and select DOE records experts to identify a path forward to address NIOSH's concerns and need for improved data access. Due to the difficulty indexing material on microfiche, microfilm, and multiple formats, SNL has decided on an approach which involves scanning all of the media into a digital format. This effort will then be followed by indexing the digital collection to specific data points necessary to facilitate identification of individual records; thus resulting in prompt and hopefully more complete responses to records requests from NIOSH and the Department of Labor.

Currently, all records in the identified collection have been scanned and are available in digital format. However, the indexing portion of the project has been significantly more challenging than expected. Complete indexing is necessary for the data to be useful for making decisions with regards to determining the feasibility of dose reconstruction for the SEC-00162 evaluated class. Although approximately 42% of the indexing is complete, approximately 1.1 million entries still require indexing.

At the time of this writing, current Federal budgetary unknowns preclude the ability to accurately determine an indexing completion date. As such, the following discussions of data availability and its sufficiency for bounding internal and external exposures for the evaluated class are based solely on data currently available from NIOSH data capture work and other SNL record retrieval sources. NIOSH further concludes that complete access to the microfiche and microfilm records would not change the dose reconstruction infeasibility conclusion proposed for the evaluated class for the time period from 1949 through 1962 because of unknowns regarding source terms, pathways, and selection of monitoring criteria and implementation during these early years at SNL.

6.1 Available Sandia National Laboratories Internal Monitoring Data

For much of the site's operational history, using professional judgment, health physics representatives designated personnel for participation in internal dosimetry monitoring (urinalysis). Whole-body counting and lung counting had not become common place until after the period under evaluation and as such, no applicable whole-body counting or lung *in vivo* results are available. Limited internal monitoring results have been captured from logbooks, paper copy, and microfiche or microfilm records. Radiochemical and chemical analysis of *in vitro* bioassay samples was performed by the Industrial Hygiene Department during the time frame under evaluation. Although no analytical procedures have been found, a retired Health Physics Manager stated that most of the sampling protocol and analytical techniques were based on Los Alamos Scientific Laboratory procedures (Personal Communication, 2011a).

As described in Section 6.0 above, internal monitoring data currently available to NIOSH and applicable to the evaluated period still exist in hard-copy format and in multiple locations, one of which isn't easily or routinely searched (inactive archived records storage). No internal data from the evaluated period are stored in databases. Because of this, a definitive assessment of total monitoring

data availability would only be possible through a search of all possible record locations (for each individual employee), including searching the inactive records storage location. The logistical constraints associated with retrieving all available internal data from the site preclude NIOSH's ability to accomplish this task. However, NIOSH has extracted and electronically entered monitoring data found within the almost 2,500 documents captured from the site and other sources during the course of this evaluation. Table 6-1 presents a summary of the urinalyses monitoring data pulled from these documents and applicable to the evaluated class period. Captured data include bioassay results for gross beta/gamma, tritium, uranium, plutonium, and polonium-210 performed during the evaluated time frame.

Table 6-1: Summary of Individual *In Vitro* Bioassay Results

Year	Beta/Gamma[1]	Tritium	Uranium[2]	Plutonium	Polonium-210
1949	-	-	-	-	-
1950	-	-	-	-	-
1951	-	-	-	-	-
1952	-	-	-	-	-
1953	-	-	-	-	-
1954	-	-	-	-	-
1955	-	52	-	28	-
1956	-	1	-	42	-
1957	-	1	-	-	-
1958	-	-	-	-	-
1959	4	18	3	80	-
1960	40	41	67	96	-
1961	6	30		3	6
1962	7	91	16	3	2

Notes:
- Indicates no data.

[1] Number of results for beta, beta/gamma, and gamma are summed in the beta/gamma column.

[2] Number of results for total uranium, enriched uranium, and isotopic uranium are summed in the uranium column.

The number of results captured by NIOSH show that although a site-wide program was not in place until 1992, *in vitro* bioassay was being performed for workers within the evaluated class. As seen in Table 6-1 above, no results have been captured for the earliest years. Tritium and plutonium bioassay were most frequently captured for the evaluated time frame. Though not currently captured by NIOSH, an initial check performed by SNL of the microfilm/microfiche record set (described in Section 6.0) identified results as early as 1948.

Correlating currently available sample results with specific work areas or processes is not possible. Organizational identification is possible for many workers, but according to a long-time health physicist interviewed, the identifiers are often not representative of actual exposure potential or the work being performed (SNL, 1980).

Only a small number of ambient air and stack sample results have been captured for the period from 1957 through 1962.

6.2 Available Sandia National Laboratories External Monitoring Data

SNL employees assigned to operations involving radiation sources were monitored for exposure to radiation during the period evaluated in this report (January 1949 through December 1962).

1949-1957 Period

A memo dated August 26, 1949, discusses an arrangement whereby a Sandia employee was to be assigned to the Los Alamos Laboratory film badge group to receive training in "film exposure techniques…to initiate a similar program here at Sandia Base" (Kingsley, 1949). The dosimetry program's initiation is described in the memo. Additionally, many pre-1957 film badge results have been captured and AEC summary reports are available. Documentation similar to that described below for the 1957 and later health physics program have not yet been located for the 1949-1957 period. However, it is apparent that an external monitoring and reporting program was in place due to the availability of monitoring results within available annual AEC reports and within worker's files.

1957-1962 Period

The SNL film badge dosimetry program from 1957 and later is described in Sandia Corporation Instructions 2043 (SNL, 1957-1963). These instructions document that the Industrial Hygiene Division was "responsible for the overall administration of the film badge dosimetry program to insure, by centralized control, proper and uniform application of its provisions," including the decisions about which employees should be monitored and maintaining a permanent historical dosimetry record on each SNL employee (SNL, 1957-1963, pdf p. 24). Also documented is the 1957 designation of the "Health Physics Section" as well as that section's responsibilities to implement the Industrial Hygiene organizational goals. The scope of the radiation dosimetry program stipulated that all SNL employees working in locations designated as "Radioactive Areas" or working with radioactive materials are to wear film badges. It also stipulated that visitors were to be furnished with film badges accordingly (SNL, 1957-1963, pdf p. 20). This practice was implemented through the organization as witnessed by a memo to all members of Section 1626-1 and 1626-2 (Radiation Effects and Radiation Special Studies Sections) dated June 25, 1957 (Colp, 1957), which stated that all who handled or were around radiation material were required to wear film badges. The memo further stated that "in the case of our two Sections, this applies to everyone assigned to work in our area."

Table 6-2 below discusses the dosimeters that were used at SNL.

Table 6-2: Dosimeters Used at Sandia National Laboratories	
Time Period	**Beta/Photon Dosimeters Used**
1949-1958	Film Badge 1: Metal holders were used that had a brass clip that covered one end of the film packets. The brass clip was intended to attenuate beta rays, but not stop gamma rays. This holder was also issued as a wrist badge.
1959-April 1971	Film Badge 2: Plastic holders had four windows: open window, 0.035-in. Al filter for beta/gamma, Tungsten/Cd and Sn filters for thermal neutrons. Used DuPont 558 film packets for the beta/gamma exposures based on calibrations with cobalt-60 and 70 keV Xrays. These packets contained DuPont 519 film (stated range 30 mR to 10 R) and 1290 film (stated range 10R to 3000 R) (ORAUT-TKBS-0037).
Neutron Dosimeters Used	
1945-1958	No neutron dosimeters were used.
1959-April 1971	Film Badge 2: In a plastic holder with four windows: ones with cadmium and tin filters were used to measure thermal neutrons. Used DuPont film for thermal neutron dose and Kodak Personnel Monitoring Film, Type A film (NTA) for fast neutron dose based on calibrations with Van de Graaff generator/accelerator at energies of 1, 5, and 14 MeV (ORAUT-TKBS-0037).

Source: The information for this table was extracted from Tables 6-1 and 6-2 of ORAUT-TBKS-0037 for the period under evaluation.

A document issued in May 1962 (Unknown, 1962) describes the calculations used to evaluate the four-window film badge in use during the period from 1957-1962. Calculation procedures are included for gamma exposures, beta exposures, and thermal neutron exposures. The thermal neutron exposure was evaluated by using the differential exposure density under the cadmium filter, which was being commonly used throughout the AEC complex at that time. The technical basis for this process was published in "Capture Gammas for Neutron Dosimetry with a Film Badge" in Volume 10 of the 1964 *Health Physics* Journal (Caruthers, 1964). If the exposure estimate from the cadmium filter portion of the film was 1.25 times greater than the exposure estimate under the lead filter portion of the dosimeter's film, a thermal neutron determination was completed. The determination was made by subtracting the cobalt-60 equivalent exposure under the lead filter from that measured under the cadmium filter and assigning half the difference as the thermal neutron dose.

Data presented in Table 6-3 summarize the dose-related quantities that have been reported in SNL annual dose summaries for the period of interest. These data confirm that both beta and gamma exposures were monitored and reported, as well as thermal and fast neutron exposures. The data also confirm that extremity (wrist) exposures were also monitored.

Table 6-3: Dose Quantities Reported in SNL Annual Reports to AEC			
Dose Quantities in Annual Dose Reports	**1949-1957**	**1958**	**1959-1965**
"Total Body"	X		
"Total Wrist"	X		
Total Dose (Total)		X	X
Total This Period			X
Total This Quarter			X
Year to Date			X
Cumulative Total			X
Gamma			X
Fast Neutron			X
Thermal Neutron			X
"Beta"			X
Wrist			X

Source: The information for this table was extracted from Table 6-3 of ORAUT-TBKS-0037 for the period under evaluation.

A memo dated August 21, 1996, specifically mentions that, "film badge records have existed since Sandia came into existence" (Perez-Romo, 1996). It describes the storage location for these dosimetry records and indicates that data extracted from the gamma and neutron film were initially manually entered on index cards. Later in the process history, a semi-automatic system was developed to replace the index cards (Perez-Romo, 1996). NIOSH has access to microfiche images of personnel exposure records for this period; they list annual exposures by person and year (Monitoring Results, 1949-1957).

6.2.1 Photon Exposure Data

Table 6-4 lists whole-body gamma exposure data submitted as part of the annual radiation exposure report to AEC. To depict trends, a few years of data after the evaluation period have been included, additional data from other years are also available. It is apparent that the external exposure reporting criteria required by AEC changed periodically; thus, the same external exposure information is not available for all the years in question. Generally, the data specify how many workers were monitored, sometimes an indication of how many were not monitored, the number of workers with exposures within specific ranges, and sometimes a listing of the maximum exposure for that particular year. Table 6-4 also indicates the SRDB reference from which the information was obtained. The data show that exposures to the vast majority of the workers were typically low, generally less than 1 rem/yr. Only a few workers exceeded the annual guideline of 5 rem during this period, and those were incident-related exposures.

Table 6-4: Exposure Data Submitted as Annual report to AEC												
Year	**Total No. Employees**	**No. Employees NOT monitored**	**No. Employees Monitored**	**< 1 rem**	**1-2 rem**	**2-3 rem**	**3-4 rem**	**4-5 rem**	**5-15 rem**	**>15 rem**	**Max. Dose**	**SRDB Ref. ID**
1949	-	-	51	45	5	1					2.09	23833
1950	-	-	182	175	3	2	1	1			4.063	23833
1951	-	-	293	291	2						1.293	23833
1952	-	-	312	308	1	2	1				3.072	23833
1953	-	-	322	321	1						1.823	23833
1954	-	-	370	369			1				3.841	23833
1955	-	-	534	530	3	1					2.52	23833
1956	-	-	669	608	42	10	4	2	3		6.022	23833
1957	-	-	1,262	1,178	84						4.570	23864
1958	7,828	7,000	828	769	41	13	5				<4	23833
1959	7,133	5,950	1,183	1,169	13	1					<3	23833
1960	6,780	5,509	1,271	1,256	10	2		1		2	>15	13786/ 23833
1961	6,903	4,997	1,906	1,889	12	4					<3	13789/ 23833
1962	6,983	4,451	2,532	2,501	17	12	1	1			<5	23833
1963	7,104	4,022	3,082	3,066	14	2					<3	23833
1964	7,172	3,797	3,375	3,367	4	4					<3	14442/ 23833
1965	7,089	3,393	3,696	3,685	10	1					<3	23833
1966	7,036	3,116	3,920	3,896	17	7					<3	23833
1967	7,165	5,267	1,898	1,876	12	8	2				<4	23833
1968	7,067	5,090	1,977	1,952	12	7	3	3			<5	23833
1969	6,945	5,071	1,874	1,854	8	6	6				<4	23833
1970	6,550	4,727	1,823	1,800	16	5	2				<4	23833

Notes:

- indicates that this information was undocumented

6.2.2 Beta Exposure Data

The radiation dosimetry devices in use at SNL during the period under evaluation had the capability to monitor beta exposures. The devices were also used as wrist badges to monitor for extremity exposures. Records of these exposures have been retained and appear in data request responses submitted by SNL for specific claims. Table 6-5 summarizes the dosimeters used during the evaluated period.

Table 6-5: Potential Annual Missed Doses				
Period of Use	**Dosimeter**	**Deep MDL[a] (mrem)**	**Nonpenetrating MDL[a] (mrad)**	**Exchange Frequency**
1949~1958	Film in metal holder -open window -lead filter	40	Not measured separately	Biweekly(n=26)[b] Monthly (n=12) Quarterly (n=4)
1959-April 1971	Film in plastic holder -open window -aluminum, cadmium, and tin filters	40	40	Biweekly(n=26)[b] Monthly (n=12) Quarterly (n=4)

Notes:

Source: The information for this table was extracted from Table 6-7 of ORAUT-TBKS-0037 for the period under evaluation.

[a] Estimated MDLs for each dosimeter technology in the workplace.

[b] Dosimeters in reactor areas and for organizations handling radioactive materials.

6.2.3 Neutron Exposure Data

Neutron monitoring began in 1958, which coincides with the beginning of accelerator operations. Neutron exposures were monitored as described in SNL procedures. Nuclear Track Emulsion Type-A film was used to measure fast neutrons; thermal neutrons were measured using the film density differences under the cadmium shielded versus tin shielded portions of the film badge. This protocol has been described in the "Capture Gammas for Neutron Dosimetry with a Film Badge" in Volume 10 of the 1964 *Health Physics* Journal (Caruthers, 1964). A 1962 calculation procedure document describes this process as well as the process for determining gamma and beta doses from the film badge readings (Unknown, 1962). The requirements for use of radiation dosimetry and the related records are described in August 21, 1996, correspondence regarding film badge and TLD records (Perez-Romo, 1996). Neutron exposures were recorded in the records of the individual workers. The doses to workers were also reported to the AEC, as shown in "Summary of External Whole Body Radiation Exposures for the Calendar Year 1959" from a collection of annual film badge and radiation exposure reports (Monitoring Results, 1949-1984, pdf p. 53).

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

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

information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. 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-00162 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Sandia National Laboratories 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.

Though workers at SNL have been monitored for radiation exposures since 1949, the site's first formally designated "Health Physics Section" was first formed within the Industrial Hygiene Division in 1957. It was initially created to perform radiation safety for workers participating in atmospheric testing; it quickly expanded to provide radiation safety services throughout the site as needed. For 1957 forward, NIOSH has been able to obtain several "Sandia Corporation Instructions" (SCI) that detail various health and safety oriented roles and responsibilities, including proper handling of radioactive material and the dosimetry program. The SCI documents show that the Industrial Hygiene Division had "overall administration of the Film Badge Program to insure, by centralized control, proper and uniform application of its provisions" (SNL, 1957-1963). Per this SCI, within the Industrial Hygiene Division, the newly formed Health Physics Section was tasked with the day-to-day implementation of the program goals. This included furnishing consulting services on all aspects of radiation protection, surveillance of all radiation activities, distribution and processing of monitoring equipment, maintaining exposure records and submitting reports, scheduling urinalysis measurements,

evaluating suspected overexposures assessing and eliminating hazards, supervision and coordination of the waste disposal program, etc.

Available 1957 documentation (SNL, 1957-1963) indicates that during that time organization supervisors were responsible for informing the Health Physics section when they were engaged in work involving radiation or when storing radioactive materials. The Health Physics Section would then recommend safe working practices and emergency procedures for all the employees whose duties necessitated the handling of radioactive materials, or the operation of a machine that produced radiation in amounts that could lead to excessive radiation dose. All working practices and emergency procedures adopted by the organization were approved by the Supervisor of Health Physics and were jointly signed by the Supervisor of the Health Physics Section and organization supervisor. When an operation changed such that the original conditions were appreciably changed, the supervisor was responsible for contacting the Health Physics Section again for review of the prescribed protection and monitoring practices. During daily operations, supervisors were responsible for ensuring Health Physics Section recommendations were being implemented.

Little program-execution documentation has been captured for the 1949-1957 portion of the evaluation period; therefore, organization and implementation of SNL's Radiation Protection program for these earlier years is not as clear. Prior to the establishment of the Health Physics Section in 1957, the Industrial Hygiene Division (known then as the "Health Hazards Division") performed radiological monitoring and safety oversight. Some aspects of the SNL's health physics oversight were not well documented during the evaluated period, including post-1957 years. From an overall program implementation standpoint, other than the Industrial Hygiene Division being responsible for program implementation, essentially no documented details of SNL's approach to health and safety have been captured for the 1949-1957 portion of the evaluated period.

No database containing internal or external monitoring data for the evaluation period exists. Records associated with the evaluation period were all originally on paper, the very early monitoring records were on Cardex cards (Personal Communication, 2007b). Paper monitoring records (and apparently other records) were converted to and replaced with microfilm for a short time, and then to microfiche. Specific details regarding the information that is and is not available on the microfilm and microfiche records will not be known until they are completely processed (see discussion in Section 6.0). It is known that a large portion of the original paper records from the evaluation period have been archived in long-term "inactive records storage" in mountain caves for storage purposes. Currently there are approximately 50,000 boxes of records in this long-term storage repository. Though these records are technically still available, efficient retrieval methods are not. Per the head of the Health Physics Section hired in 1957 (Personal Communication, 2007a), urinalysis for uranium, plutonium, and tritium was performed by on-site chemistry laboratories in the 1950s and afterwards. Records of these analyses are currently in paper copy or microfiche form and stored with non-radioactive bioassay records in the SNL in long-term storage.

Active, current, or recently requested radiological records are held in a centralized repository called the ES&H Records Center (also known as Customer Funded Records Center) on the first floor of Building 869. The Industrial Health Division is located on the first floor of the building as well. Health Physics records stored in the Environmental Safety and Health (ES&H) Records Center include radiation monitoring, contamination surveys, and air sample data. The ES&H Records Center

allows the originating organization to determine the content of the submissions. Documents are retained in the ES&H Records Center for three years from the date they are received, not from the date the documents were originated. Afterwards, the records holdings are archived into the long-term storage location (also referred to as inactive record storage). Currently there are three finding aids for inactive records. They include:

- The Versatile database, which is site-wide in scope.
- The SHEARS (Safety Health Environmental Automated Records System), which is unique to the ES&H Records Center.
- The Inactive Record Transfer (IRT) binder, which catalogs stored records that were submitted prior to the establishment of the ES&H Records Center.

To conduct a thorough search for records it is necessary to know the name of the organization that created the record at the time of the record's creation. The oldest records, such as those applicable to the evaluated time frame and kept in long-term storage, are searchable via the index within the IRT binder listed above. However, this index does not provide the detail needed for targeted data capture nor determining total data availability. In addition to the ES&H Records Center and inactive records holdings, employee records may be located in Medical Records and Industrial Hygiene Records.

7.1.1 Internal Monitoring Data Pedigree Review

As noted in Subsection 6.1, few internal monitoring data have been captured for the evaluated time frame. Most of the internal data known to exist are from 1957 and later. Though very few pre-1957 records have been captured, they are known to exist. For example, bioassay data from this era have occasionally been returned during EEOICPA claimant data requests, have been found in captured documents, and found in records selected from inactive storage. Additionally, initial reviews of the microfilm/microfiche data (see Section 6.0) indicate the presence of early *in vitro* bioassay data within that set.

The total quantity of internal monitoring data potentially available from SNL is likely low, due to the ad hoc nature of the monitoring performed. Difficulty locating detailed work process and radiation protection program information for the earlier years, as well as personnel monitoring data retrievability problems create uncertainty regarding the ability to confidently bound internal doses that might have occurred. Access to air monitoring data appears just as difficult as access to personal monitoring data.

Difficulty retrieving and receiving SNL occupational internal monitoring data has been an ongoing problem while processing EEOICPA claimant records requests. To address data gaps identified during claims processing, NIOSH requested monitoring data searches to be repeated for 249 SNL claimants. To date, 4 responses have been returned. Completion of the microfilm/microfiche data review is necessary in order to make significant progress on this task.

Another assessment of internal data retrievability was accomplished by comparing data obtained by NIOSH during data-capture work with data supplied by SNL for specific EEOICPA claimant data

requests. Through data capture, NIOSH retrieved 150 internal monitoring data results associated with 28 current SNL claimants for whom EEOICPA monitoring data requests had already been processed.

Comparing NIOSH-captured internal monitoring data for these claimants to SNL-supplied internal monitoring data, SNL was able to retrieve the following:

- Equivalent data to NIOSH captured data for 3 out of the 28 claimants (~11% of the claimants).
- A subset of NIOSH-captured data for 2 additional claimants.
- 21 results out of the possible 150 possible data results that NIOSH captured (14% of the results).

7.1.2 External Monitoring Data Pedigree Review

There was external radiation exposure monitoring throughout the evaluated period at SNL. External radiation exposure data were supplied to AEC/ERDA/DOE annually in accordance with reporting requirements and these reports are available. External monitoring records for monitored SNL workers within the evaluated time frame are typically available within EEOICPA claims as well; SNL has supplied data for 88 of 193 workers from this period. This monitoring ratio is consistent with the data supplied by SNL to the AEC during this period, indicating external records have been properly retained in repositories in a retrievable manner.

NIOSH has also determined that the external exposure data were obtained from badges with known, sufficient performance characteristics and that the data exist as either primary data records or as photo copies (microfilm or microfiche) of the primary data. The dosimeters in use were properly calibrated with radiations that were appropriate for the fields that were likely to exist at SNL. Neutron monitoring did not begin until 1958, which coincides with the introduction of an accelerator that had the potential to produce neutrons.

Program procedures are available from 1957 forward and they detail an effort to assure that all workers who should have monitored were monitored, that is, any worker that entered a “radiation area.” It is also known that there were a large number of workers at SNL that would not have entered a radiation area and would not have been monitored, due to the remote nature of the areas which contained reactors and accelerators. Based on the continuity and consistent availability of external records throughout the evaluated time period, NIOSH assumes that an appropriate external monitoring program has also been in place for the entire evaluated period. It is noteworthy however that only limited program documentation have been captured for the 1949 through early-1957 time frame.

Based upon NIOSH’s assessment of the SNL external dosimetry program, the results of its extensive data captures and document reviews, and interviews with SNL personnel, NIOSH concludes that the SNL external monitoring data pedigree is sufficient to support bounding external dose for the class under evaluation during the January 1, 1949 through December 31, 1962 time frame.

7.2 Evaluation of Bounding Internal Radiation Doses at Sandia National Laboratories

The principal sources of internal radiation doses for members of the class under evaluation were likely associated with handling wastes and reactor work. Other potential doses could have been received from neutron generator work (if damaged) and from working with accelerator targets. Lack of access to complete, detailed information creates uncertainty regarding the presence of other potential internal exposure sources. The following subsections address the ability to bound internal 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

NIOSH data capture efforts have identified several documents containing urine bioassay results for a portion of the period under investigation. Few results have been captured overall, with none captured prior to 1955. NIOSH currently has no means of efficiently accessing internal monitoring data within individual workers' files or the long-term record storage repository; therefore, determining total data availability for any of the bioassay analytes is not possible. Similarly, obtaining efficient access to complete potential internal dose source-term documentation is not possible. As a result, data sufficiency for determining the feasibility of bounding internal doses for the evaluation period must be based on the captured bioassay data currently available. NIOSH has concluded that sufficient urinalysis data are not currently available to bound internal dose for the evaluated class.

7.2.1.2 Airborne Levels

NIOSH has captured very little air monitoring data for the evaluated period. No air sampling results have been identified prior to 1957. In most cases, sampling and analysis parameters necessary for proper interpretation of the little data available are not known. As such, NIOSH has concluded that sufficient air monitoring data are not currently available to estimate a bounding internal dose for the evaluated class.

7.2.1.3 Alternative Data Sources for Bounding Internal Dose

Beginning in 1959, annual reports to AEC state that no workers received greater than 50% Maximum Permissible (MP) annual limit for these years (Monitoring Results, 1959-1969; Monitoring Results, 1959; Monitoring Results, 1960; Monitoring Results, 1961; Monitoring Results, 1962). Additionally, other semi-annual reports indicate that no workers received >25% MP (Dickason, 1967) during the 1957-1966 time frame. Missed doses based on the limiting values could technically be calculated and used as a significant overestimate of the dose applied to members of the evaluated class. However, because NIOSH does not have access to the relevant supporting data, validation of these reported

results is currently not possible. As such, NIOSH has concluded that sufficient alternative data sources are not available to support the assessment of bounding internal dose for the evaluated class.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

Because NIOSH has determined that data are insufficient to bound operational internal dose, an exhaustive analysis of ambient environmental internal dose reconstruction has not been pursued for this evaluation. NIOSH intends to use any available data and applicable methods/assessments as defined in the Technical Basis Documents (including environmental dose assessments) for the purpose of partial dose reconstructions.

7.2.3 Methods for Bounding Internal Dose at Sandia National Laboratories

NIOSH has determined that data are insufficient to bound operational internal dose, thus methods for bounding internal doses have not been developed for this evaluation. However, NIOSH intends to use any available data and applicable methods/assessments as defined in ORAUT-TKBS-0037 and/or other NIOSH documents (including environmental dose assessments) for the purpose of partial dose reconstructions.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH has determined that monitoring data, process information, and monitoring program information are insufficient to support bounding internal doses for the evaluated class. There are indications that additional data exist (microfilm/microfiche record set), but these data are not readily accessible. Based on a lack of internal monitoring program documentation and source term information data for the evaluated period, NIOSH feels it cannot establish a bounding approach even if the microfilm/microfiche records were to become available. Therefore, NIOSH concludes it cannot bound internal doses for the period from January 1, 1949 through December 31, 1962, but will continue to assess post-1962 dose reconstruction feasibility in a subsequent evaluation for SNL.

Although NIOSH found that it is not possible to reconstruct internal radiation doses for the period from January 1, 1949 through December 31, 1962, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at SNL during the period from January 1, 1949 through December 31, 1962, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at Sandia National Laboratories

The principal source of external radiation doses for members of the evaluated class was reactors and accelerators being used to provide radiation environments for testing components and systems. 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

From the beginning of activities in 1949, employee radiation monitoring was an integral part of the SNL Radiation Protection program. Radiation exposure data have been provided for claimants employed during the period from 1949-1962. The information presented in Section 6.2 indicates that external dosimetry records exist for the period under evaluation. Table 6-4 lists the data submitted annually to AEC, demonstrating that a significant number of personnel were monitored each year during the evaluated period. A review of the NOCTS claims indicates that such data have been successfully retained over the years, are retrievable, and are being provided by SNL when requested.

Photon

Radiation exposure data have been provided for claimants employed during the period of 1949-1962. Data presented in annual, semi-annual, and quarterly film badge exposure summaries, as well as in annual summary reports and summary whole-body radiation exposure reports are summarized in Table 6-4 of this document. The data in Table 6-4 indicate the number of workers monitored and the maximum exposure occurring each year. These records are available and, when adjusted for missed dose and the dosimeter uncertainty correction factor (as described in ORAUT-TKBS-0037), provide a reasonable method to bound dose for monitored and unmonitored workers using standard NIOSH methods.

Based on the information available regarding the SNL monitoring program and the available monitoring data, NIOSH concludes that sufficient data are available to bound external photon doses for the class under evaluation.

Beta

The preceding general discussion about personnel dosimetry and record-keeping applies equally well to the beta component of the dosimeter data. Non-penetrating exposures were monitored during this time period as well as extremity exposures using wrist badges. The dosimeters were calibrated with uranium slabs, which would be appropriate for the radiation fields that may have been encountered at SNL. For an unmonitored worker with a work history that indicated the worker should have been monitored, the information in Table 6-5 of ORAUT-TKBS-0037 can be used to assign a beta exposure.

The monitoring records were retained and are available in the employee files. The missed dose and bias and uncertainty factors described in ORAUT-TKBS-0037 should be applied. With these adjustments, the data available should be sufficient to establish a bounding shallow dose estimate for the class period in question.

Neutron

The neutron radiation monitoring program began in 1958, and continued for the duration of the time frame under evaluation, and the resulting data are available in worker files. Fast neutron exposures were measured with NTA film during this period. Prior to 1958, there were no significant sources of neutron exposure, although there is information that "nuclear cores" were stockpiled in Building 868 at SNL (SRDB 90562). Without specific knowledge of the configuration of these "nuclear cores," the potential for neutron exposure is difficult to estimate. In a storage configuration, handling should have been minimal and exposures would have been negligible to any workers passing by the area. There should not be significant neutron exposure for unmonitored workers since the necessary source for neutrons only existed within reactor areas or near neutron sources which would have been designated as radiation areas (for example, Area V). Radiation dosimetry was required for all workers entering such areas.

Monitoring records have been available in the employee files based upon DOE-provided records for claims. The missed dose and bias/uncertainty factors derived in ORAUT-TKBS-0037 should be applied. With these adjustments, the available data should be sufficient to establish a bounding neutron dose estimate for the evaluated class.

7.3.1.2 Area Monitoring Data

Environmental monitoring data for external radiation exposure do not exist for this period. An evaluation of the ambient external radiation exposures is discussed in Section 4.4.1 of ORAUT-TBKS-0037. The values provided in Table 4-2 of ORAUT-TKBS-0037 are consistent with the nature of the facilities and the operations occurring during this period. However, the availability of personnel monitoring data obviates the need for area monitoring data as a substitute for personnel monitoring information.

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

Available occupational external monitoring data would include ambient environmental exposures; therefore, no further assessment of external ambient environmental exposures is necessary.

7.3.3 Sandia National Laboratories Occupational X-Ray Examinations

Although NIOSH has not located specific parameters associated with occupational medical X-rays, information concerning the frequency and type of X-ray exams should be available in individual worker files. Conservative default values and dose reconstruction techniques are detailed in ORAUT-TKBS-0037. The default values are upper limit values developed from review of patient doses as reported in literature, machine characteristics, and knowledge of X-ray procedures used during different time periods. Therefore, NIOSH concludes that it is likely feasible to reconstruct occupational medical dose for SNL workers with sufficient accuracy.

7.3.4 Methods for Bounding External Dose at Sandia National Laboratories

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 (as applicable per Section 7.3.3)

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon, Beta, and Neutron Dose

Photon, beta, and neutron exposures for monitored workers have been measured with sensitive dosimeters throughout SNL's history. The dosimetry used to monitor neutron exposures reflected the state-of-the-art technology available for the SNL operations during the period in question. SNL workers were required to wear film badges when entering a "radiation area." The resultant monitoring data have been retained for the class period under consideration and are available.

With the methods described in ORAUT-TKBS-0037, including the missed dose and bias corrections, available data permit adequate estimation of bounding photon, beta, and neutron exposures for individual monitored workers with complete monitoring records. Although unmonitored exposed workers should not exist, in the case of a claimant without exposure records who should have been monitored on the basis of his work history, the maximum values, adjusted for bias and uncertainty as discussed in ORAUT-TKBS-0037, provide a bounding value that could be used. Additionally, neutron exposures possible from stockpiled nuclear cores and weapon assembly work could be bound using n/p ratios from similar components and operations measured at other facilities. For unmonitored workers who did not enter radiation areas, a bounding approach would be to assign the environmental external dose which is specified in Table 4-2 of ORAUT-TBKS-0037.

Medical X-ray Dose

The medical records are being made available through the claims process, and therefore, should be sufficient to provide a bounding estimate of any doses associated with medical X-ray procedures. In the absence of medical records, the dose associated with medical X-ray exams, if required as a condition of employment, can be bounded by using the assumptions in ORAUT-TKBS-0037. NIOSH believes this methodology supports its ability to bound the occupational medical X-ray doses for the SNL class under evaluation

7.3.4.2 Methods for Bounding Ambient Environmental External Doses

ORAUT-TKBS-0037 provides a discussion and method for evaluating the ambient environmental external dose at SNL for the period from January 1, 1949 through December 31, 1962. This information is typically sufficient for evaluating potential external doses in the case of dose reconstruction for unmonitored workers. However, for the purpose of the bounding assessment in this evaluation, NIOSH concludes that the ambient environmental dose is included in the available dosimetry data, which represent the bounding external exposure scenario for the SNL class under evaluation. Therefore, further assessment of the ambient environmental dose is not included in this report.

7.3.5 External Dose Reconstruction Feasibility Conclusion

The data sources for photon, beta, and neutron doses, as well as occupational X-ray examinations and ambient environmental external doses have been examined and found to be adequate for bounding external doses for monitored SNL workers during the period in question. NIOSH notes that although it was unable to locate documentation identifying all potential source terms and program specifics, it appears, based on the available external monitoring data, reconstructing external dose is feasible. The assessment of doses for unmonitored workers can be determined from the ambient environmental external dose methods defined in ORAUT-TKBS-0037. Based on NIOSH's assessment of the available external data and the dose calculation methods available in ORAUT-TKBS-0037, NIOSH concludes that it is feasible to bound all external dose for the class period under evaluation.

7.4 Evaluation of Petition Basis for SEC-00162

The following subsections evaluate the assertions made on behalf of petition SEC-00162 for Sandia National Laboratories.

7.4.1 Monitoring Associated with Fizeau Blast Fireball Temperature Assessment Work

SEC-00162: *These workers were exposed to brass samples and other materials recovered from Ground Zero of the Fizeau blast with minimal short term external monitoring (limited to the excursion period to Ground Zero with no subsequent attention to exposures from these materials in the Sandia Laboratory environments), and no internal monitoring while handling these samples. There was incomplete exposure assessment especially to inhalational and ingestion routes for these scientists machining radioactive samples from ground zero. Samples were recovered from the Nevada Test Site in order to determine the fireball temperature of the Fizeau site.*

Response: Exposures incurred while recovering the brass samples at the Nevada Test Site are not included in this report as SEC evaluations are site-specific. NIOSH has determined that external exposures associated with the sample-machining work performed at SNL were monitored and these data are known to be available for at least one of the sample handlers (the petitioner). Potential internal doses associated with this work are not known however, and access to internal monitoring data is limited as described in Sections 6.0 and 6.1 of this report. This limited access to internal monitoring data precludes NIOSH's ability to definitively bound doses associated with the Fizeau sample-machining work.

7.4.2 DOE Records on Radiation Exposures

SEC-00162: The petitioner supplied an e-mail correspondence from a health physicist documenting the limitations of existing DOE radiation exposure records for SNL; however, the email lacked specific details regarding the data limitations.

Response: While processing individual SNL EEOICPA claims, NIOSH has experienced data retrieval problems regarding internal monitoring data. These known problems resulted in NIOSH expanding the evaluated class beyond the petitioner-requested class. As summarized throughout this report,

NIOSH has insufficient access to the monitoring data needed to bound exposures to the evaluated class.

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

During the feasibility evaluation for SEC-00162, a number of issues were identified that needed further analysis and resolution. The issues and their current status are:

- ISSUE: *Potential Shortcomings Exist in Completeness and Adequacy of Dosimetry Records*

  RESPONSE: SNL does not have an electronic database containing occupational monitoring records for the evaluated class. *In vitro* bioassay records have been found in paper or microfiche format in archives; however, the records are limited and are not typically located and incorporated by SNL as a part of claimants' files. Additionally, workers' records lack data regarding the specific radionuclides to which they may have been exposed. Data provided to NIOSH for EEOICPA dose reconstruction are limited to summary reports, including dose information in some years for tritium, plutonium, and uranium.

- ISSUE: *Inaccurate Dose Record for Pulse Reactor Personnel*

  RESPONSE: Inaccurate dose records for SPR operators resulted from the under-recording of external gamma/neutron dose received during shutdown maintenance activities. This under-recording resulted from inadequate dosimetry at the time for a severe gradient of exposure levels experienced by personnel working close to the reactor vessel, leading to an underestimate of whole-body dose. 1961 survey data (paired gamma and neutron measurements) for various locations in the SPR facility have been captured by NIOSH. The data's usefulness for determining actual worker exposures has been assessed and corrections can be made enabling conservative estimation of bounding exposures. It is noteworthy that wrist badges were used, ostensibly to measure the non-uniform fields. The primary issue associated with severe gradients/non-uniform fields is unmonitored exposure to extremities (normally hands); the wrist badges were likely used to measure that exposure.

- ISSUE: *Site-Wide Workers Not Bioassayed for Potential Internal Intakes Before 1992*

  RESPONSE: This issue is applicable to the 1949-1962 evaluated period; NIOSH has found no documentation supporting the existence of a routine, site-wide internal monitoring program. Internal monitoring for the evaluated class was performed on an ad hoc basis. Bases used to determine monitoring needs, as well as the actual monitoring results have predominantly not been located. Details regarding potential internal source term information are also unavailable for all years. As a result, NIOSH concludes that workers in areas containing radioactive materials may have had the potential for internal exposures that were not monitored. Additionally, assigning potential missed dose by work location is questionable, particularly in the absence of complete work history records.

- ISSUE: *Use of Air Monitoring Data in Dose Estimation is Problematic*

  RESPONSE: Worker bioassay monitoring was often dependent on air monitoring results. However, only limited air monitoring data have been captured. No centralized or easily accessed repository exists. With only limited air monitoring data availability for many periods and areas of operation, proper use of the data as a substitute for bioassay sampling is not possible for the 1949-1962 evaluated period.

- ISSUE: *Inadequate Identification of Potential Radiological Exposure Sources*

  RESPONSE: NIOSH has been unable to capture complete source term information for the evaluated period. Examples of obstacles for determining the existence and retrievability of all source term information include: (1) multiple large and vaguely indexed SNL records repositories, (2) limited access to classified electronic and hard copy repositories, (3) inability to efficiently redact information collected from classified repositories, and (4) inability to definitively demonstrate all SNL activities involving exposure potential were documented and that those documents were retained.

- ISSUE: *Criteria for Badging Workers are Not Defined*

  RESPONSE: Criteria for badging workers at SNL during the latter part of the evaluated period (1957–1962) have been captured. However, the criteria that were used to determine who was badged, for what type of exposure (i.e., photon, beta, and neutrons), and how the badging policy varied as a function of work location/facility for earlier years of the evaluated period (1949-1956) have not been found. Based on interviews and the availability of external monitoring data however, NIOSH concludes that an appropriate external monitoring program was in place for all evaluation years.

- ISSUE: *Limited Number of "Old Timers" to Obtain Historical Information From*

  RESPONSE: Although this situation remains applicable, NIOSH has succeeded in conducting interviews with one individual with direct knowledge of the evaluated time period (first employed at SNL in 1949) and another with indirect knowledge (first employed at SNL in 1967). References for these interviews can be found in Section 4.3.

- ISSUE: *Some Claimant Data Supplied by SNL has been Incomplete*

  RESPONSE: This issue is primarily applicable to internal monitoring data. NIOSH has compared internal monitoring data captured during site visits to data that were supplied by SNL for EEOICPA claims monitoring data requests. The results are presented in subsection 7.1.1. They demonstrate that efficient, complete retrieval of internal monitoring data for SNL employees remains problematic.

7.6 Summary of Feasibility Findings for Petition SEC-00162

This report evaluates the feasibility for completing dose reconstructions for employees at SNL from January 1, 1949 through December 31, 1962. NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete internal dose reconstructions for the evaluated class of employees. A lack of internal monitoring data has precluded a detailed assessment for each radionuclide; therefore, a specific feasibility finding for each is not presented.

Table 7-1 summarizes the results of the feasibility findings at Sandia National Laboratories for each exposure source during the time period January 1, 1949 through December 31, 1962.

Table 7-1: Summary of Feasibility Findings for SEC-00162
January 1, 1949 through December 31, 1962

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal		**X**
External	**X**	
- Gamma	X	
- Beta	X	
- Neutron	X	
- Occupational Medical X-ray	X	

As of March 22, 2011, a total of 193 claims have been submitted to NIOSH for individuals who worked at SNL during the period under evaluation in this report. Dose reconstructions have been completed for 154 individuals (~78%).

Although NIOSH found that it is not possible to completely reconstruct internal 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 SNL during the period from January 31, 1949 through December 31, 1962, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00162

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 members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Therefore, the resulting NIOSH-proposed SEC class must include a minimum required employment period as a basis for specifying that health was endangered.

9.0 Class Conclusion for Petition SEC-00162

Based on its complete 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 at Sandia National Laboratories in Albuquerque, New Mexico, from January 1, 1949 through December 31, 1962, 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 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-00162. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

10.0 References

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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

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Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
Primary Site/Company Name: Sandia National Laboratories, New Mexico (SNL/NM) Physical size of the site: The physical size of Sandia National Laboratories, NM is 8642 acres. The site contains 847 buildings with a total of 5,822,908 square feet under roof. Size of the workforce during the SEC related periods: In 1960 the site population, as reported to the AEC, was 6,778, of which 5,509 were not monitored for radiation exposure. The most recent site population number is 8,168 FTEs in FY-09.	Routine and special dosimetry reports, neutron spectra, research, and dosimetry, tritium, uranium, polonium, and actinide bioassay reports, internal dosimetry results, procedures, and technical basis documents, environmental reports and dosimetry, Technical Area descriptions, SAND reports, incident reports, facility safety analyses, special facility surveys, dosimetry calibrations, descriptions of radiological monitoring, counting, and detection systems and equipment, waste management documentation, inactive records storage box inventories, health physics logs, Tiger Team appraisals and responses, Operation Gumdrop plans and procedures, DOELAP documentation, site history, process knowledge interview notes, Reactor Division search results, tritide research reports, Technical Area 5 radiation survey data, laboratory surveys, Ross Aviation aircraft and shipment surveys performed by SNL, NM, and a 1957-1962 Reactor Division individual telephone listing. NOTE: NIOSH and the ORAU Team are awaiting SNL/NM's evaluation and indexing of the approximate 2,700,000 entry database, and identification of site repositories for Reactor Division exposure data from 1957-1962.	Ongoing	1952
State Contacted: Bureau Chief, Radiation Control Bureau	The State of New Mexico has never regulated Sandia National Laboratories and does not hold records regarding the site.	09/27/2010	0
Claimant Provided	An inter-agency working group report on links between exposure to occupational hazards and disease.	04/18/2005	1
Colorado State University Library	Site environmental reports and a Lawrence Livermore study on the costs and benefits of a formal safety program.	04/10/2006	6
Department of Labor/Paragon	A 1952 Tonawanda area progress reports which indicate that 30 radium sources were imported for Sandia.	12/30/2008	1
DOE Albuquerque	Internal dosimetry programmatic documents, 1982 Technical Area V safety appraisal, 1982 dose reduction proposal for SPR-III, 1972 exemption request for plutonium storage facilities, and fallout measurements from the Gravel Gertie test.	07/12/2010	7
DOE Brookhaven National Laboratory	Description of air monitoring parameters at DOE facilities, an assessment of external dosimetry services, 1992 annual exposure report to DOE, 1950 report of Brookhaven personnel who worked on other AEC projects, and urinalysis reports.	10/24/2008	5

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
DOE Germantown	A 1949 report on difficulties with RaBe sources, plea agreement from the CEP case, and Manhattan District History detailing the establishment of Sandia.	03/12/2008	3
DOE Hanford	The 1978 guidelines for diagnostic X-rays, 1958 Hanford report which mentions a visit by Sandia personnel on vacuum etching, and a description of destructive testing of neutron sources performed by Sandia personnel at Pantex.	07/31/2008	3
DOE Lawrence Livermore National Laboratory (LLNL)	Nevada Test Site external exposures 1957-1958, Sandia temporary film badge records 1959, exposure records for LBNL personnel visiting Sandia 1970, external exposure of Sandia personnel at Livermore 1958, and tritium results for Sandia personnel at Livermore 1962.	05/18/2007	8
DOE Los Alamos National Laboratory (LANL)	Sandia environmental monitoring reports, 1975-1977.	09/10/2007	3
DOE LANL LAHDRA	Process knowledge interview, 1949 progress reports, radioactive waste disposal reports, and guidelines for the disposal of contaminated personal property.	12/06/2007	8
DOELAP Office, Idaho National Laboratory	Listing of Albuquerque Operations Office facilities applying for DOELAP accreditation.	06/11/2009	1
DOE Legacy Management - Grand Junction Office	A 1982 Fernald long range plan which mentions supplying depleted uranium to Sandia, 1952 Tonawanda area progress reports which mention radium sources being imported for Sandia, and notes on early Middlesex Sampling Plant operations which mention Sandia.	03/11/2011	4
DOE Legacy Management - Morgantown	A 1988 DOE site summary of environmental, safety, and health needs and a report which documents the shipment of normal UO_3 to Sandia.	06/30/2010	2
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Complex-wide waste management and effluent discharge reports, unusual occurrence reports, report of the DOE precious metals program, a metallographic examination of a milli-watt generator manufactured for Sandia, and a report of a bioassay and analytical chemistry conference sponsored by Sandia.	02/02/2009	13
DOE Lovelace Respiratory Research Institute	Descriptions of analysis of thorotrast solutions at Sandia, correspondence and results, and Lovelace dosimetry services provided by Sandia.	09/09/2008	2
DOE Nevada Test Site	Shipping documents with smear results for radioactive materials shipments from Sandia to Nevada Test Site.	06/03/2009	12
DOE Office of Scientific and Technical Information (OSTI)	Survey of irradiation facilities including the Sandia Pulsed Reactor and a presentation on the benefits of preserving laboratory notebooks.	10/26/2010	2
DOE Paducah Gaseous Diffusion Plant	Film badge work sheets including visitors from Sandia.	01/25/2005	1

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
DOE Pantex	Records transfer forms, report on Tweezer Operations, and a request from Sandia for Pantex to irradiate rocket motors.	12/31/2008	3
DOE Sandia National Laboratories/California	Dosimetry results from 1965, 1970, 1989, 1992, 1993, 1997, a draft external dosimetry program manual, procedure for the assembly and testing of the rapid deployment test payload, positive exposure reports, and a procedure for the Co-60 calibration facility.	03/28/2007	26
Dr. Denise DeGarmo Personal Files	Listing of high level radioactive waste sites.	11/24/2009	1
Federal Records Center (FRC) Denver	Finding of no significant environmental impact from heat source testing on the Sandia sled track, finding of no significant environmental impact from the new gamma irradiation facility, safe operating procedures for the gamma irradiation facility, and a LANL request for Sandia to participate in an external dosimetry survey.	06/15/2010	4
General Atomics	Radioactive materials shipments from Sandia to General Atomics, and a radiation exposure report cover letter with limits and definitions.	11/02/2005	2
Interlibrary Loan	Environmental radioactivity levels at Sandia 1971.	01/21/2010	1
Internet	Environmental monitoring reports, brief history of the site, report on the need to develop source term estimates for sabotaged spent fuel casks, and parameter and pathway analysis for residual contamination from decommissioning activities.	11/16/2009	13
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	05/27/2010	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	05/27/2010	0
Internet - DOE Legacy Management Considered Sites	Tonawanda Area Progress Report that mentions radium sources imported for Sandia. NOTE: This document was added by Site Association Review.	05/27/2010	1
Internet - DOE OpenNet	Sandia monthly progress reports and R&D board minutes, a Z-Division report, descriptions of radiation and fusion research facilities, Armed Forces Special Weapons Project history, history of the nuclear weapons program. NOTE: 3 documents were added by Site Association Review.	05/27/2010	17
Internet - DOE OSTI	Environmental monitoring reports, environmental assessment for Technical Area IV, tritium in soils at the Technical Area III mixed waste landfill, and the production of specialty glass for Sandia at Pinellas.	11/30/2009	7

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
Internet - DOE OSTI Energy Citations	A report on the characterization and segregation of legacy mixed waste, a citation for the characterization plan for the Sandia Livermore tritium research laboratory, and a 1995 waste minimization and pollution prevention program report. NOTE: 2 documents were added by Site Association Review.	05/27/2010	3
Internet - DOE OSTI Information Bridge	Environmental reports, 1991 Tiger Team assessment, source characterizations, personal accident dosimetry, radioactive material package testing, site history, waste packaging reports, remediation of Technical Area II uranium calibration pits, ERDA radioisotope production and customer lists, transuranic and mixed waste reports, nuclear facility decommissioning report, and a report on starting production of neutron generators. NOTE: 16 documents were added by Site Association Review.	05/27/2010	42
Internet - Google	Environmental reports and planning, safety bases corrective actions, epidemiologic surveillance, site histories and descriptions, nuclear materials storage report, long term stewardship plan, Z-division progress report, site capabilities descriptions, complex-wide reports on site clean-up, transuranic waste disposal, nuclear materials management, Congressional budget information on site clean-up costs, workforce transition report, and a neutron generator facility safety information document. NOTE: 23 documents were added by Site Association Review.	05/27/2010	130
Internet - Health Physics Journal	Behavior of plutonium aerosols, neutron dosimetry at the Sandia Pulsed Reactor, and Potter's review of internal dosimetry.	09/28/2010	4
Internet - Journal of Occupational and Environmental Hygiene	No relevant data identified.	09/27/2010	0
Internet - National Academies Press (NAP)	A citation for The Nuclear Weapons Complex: Management for Health, Safety, and the Environment.	05/27/2010	1
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	05/27/2010	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	The 1991 and 1992 U.S. spent fuel and radioactive waste inventories, projections, and characteristics. NOTE: Both documents were added by Site Association Review.	05/27/2010	2
Internet - USACE/FUSRAP	No relevant data identified.	05/27/2010	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	05/27/2010	0
Iron Mountain	Operating manual for the Jordan Radector.	09/12/2006	1

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
Mound Museum	Milli-watt generator and heat sources proposals submitted to Sandia, Mound newsletter articles regarding items designed by Sandia and produced at Mound, and Mound newsletter articles that mention Sandia.	05/18/2010	13
National Archives and Records Administration (NARA) Atlanta	Radiation doses received by Sandia personnel at Pinellas, neutron source information, neutron source shipments to Sandia, a truck contamination survey, and a search proposal for the dissolution of metal tritides in biological systems.	07/01/2006	20
National Archives and Records Administration (NARA) College Park	Researcher notes documenting the presence of Sandia correspondence in the Oak Ridge Series 6 collection and a listing of box contents.	07/26/2010	3
NIOSH	Worker outreach meeting sign-in sheets, minutes, correspondence, and emails, SC&A data capture plan with associated emails, and Sandia records retention and disposal schedule.	10/20/2010	23
NIOSH/SC&A	Working group reports on highly enriched uranium.	02/16/2006	3
ORAU Team	Radiation exposure reports 1977-1986, 2005 data capture notes, Project spreadsheet, Project analyses of dose results and neutron/photon ratios, site profile, external coworker dosimetry data, a documented communication on the availability of pre-1992 internal dosimetry records, notes on records box contents, and a letter from DOE to NIOSH with the current status of indexing the 2,700,000 entry dosimetry database.	03/22/2011	23
RETN, Inc.	Correspondence with Sandia personnel and process knowledge expert regarding internal dosimetry issues.	03/10/2008	6
SAIC	Radiation exposure summaries 1960, 1961, 1964, 1972, 1973.	09/02/2004	5
SC&A	Tritide studies, tritium studies, DOELAP reports, urinalysis intercomparison, environmental radiation dosimetry reports, dosimetry blind audit results, internal dosimetry TBD, records information and reports, 1997 ESH report, 1994 incident data sheet, neutron response testing of Harshaw Model 8801 TLD, and Idaho National Laboratory inventory statements including Sandia material.	06/24/2010	52
Southern Illinois University	AEC construction cost differentials report and a description of the AEC cryptographic telecommunications network.	10/16/2008	2
University of Colorado - Norlin Library	Environmental monitoring plans and report, characterization of low-level waste, a study of increasing the film badge exchange interval, Sandia performance indicators, and a 1977 ERDA workshop on neutron dosimetry.	04/18/2006	8
University of Rochester - Miner Library	Dose estimates from the accidental exposure at the Van De Graaff facility.	10/14/2008	1

Table A1-1: Summary of Holdings in the SRDB for Sandia National Laboratories			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**# Uploaded into SRDB**
University of Tennessee Library Stannard Papers	Report of the Operation Plumbbob field release of plutonium aerosols.	03/15/2010	1
Unknown	Environmental monitoring reports, history of Technical Area II, Operations Grommet and Toggle radiological safety reports, Linking Legacies excerpt, Operation Gumdrop re-entry instructions, beryllium reports, and a Pinellas records report identifying a microfilm reel with Sandia contracts.	01/25/2006	37
TOTAL			**2,489**

Table A1-2: Database Searches for Sandia National Laboratories			
Database/Source	**Keywords/Phrases**	**Hits**	**# Uploaded into SRDB**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Data Capture Synopsis for Sandia National Laboratories."			
DOE CEDR http://cedr.lbl.gov/ COMPLETED 05/27/2010	See Note above	4	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 05/27/2010	See Note above	38	0
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 05/27/2010	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 05/27/2010	See Note above	113	14
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 05/27/2010	See Note above	1,121	1
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 05/27/2010	See Note above	2,393	26

Table A1-2: Database Searches for Sandia National Laboratories			
Database/Source	**Keywords/Phrases**	**Hits**	**# Uploaded into SRDB**
Google http://www.google.com COMPLETED 05/27/2010	See Note above	2,787,919	107
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 09/28/2010	See Note above	146	4
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 09/27/2010	See Note above	0	0
National Academies Press http://www.nap.edu/ COMPLETED 05/27/2010	See Note above	2,229	1
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 05/27/2010	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 05/27/2010	See Note above	772	0
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 05/27/2010	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 05/27/2010	See Note above	0	0

Table A1-3: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
SAND96-2152C REF ID 89687	Thar's Gold in Them Thar Notebooks: Benefits of Laboratory Notebooks in the Government Archive	10/25/2010	10/26/2010
RHO-HS-ST-5 REF ID 77087	Seven Health Physics Calculator Programs for the HP-41CV, 1984	08/18/2009	11/30/2009
SAND-78-0620 REF ID 77102	Environmental Monitoring Report, Sandia Laboratories, 1977, Health Physics Division 3312 dated 1978	08/18/2009	10/08/2009
SAND-81-0566 REF ID 77091	1980 Environmental Monitoring Report, Sandia National Laboratories, Albuquerque, New Mexico, Environmental Health Department 3310, April 1981	08/18/2009	10/08/2009
SAND-83-0789 REF ID 77089	1982 Environmental Monitoring Report, Sandia National Laboratories, Albuquerque, New Mexico, Environmental Health Department 3310, April 1983	08/18/2009	10/08/2009
SAND-84-0429 REF ID 77100	1983 Environmental Monitoring Report, Sandia National Laboratories, Albuquerque, New Mexico, Environmental Health Department 3310, April 1984	08/18/2009	10/08/2009