SEC Petition Evaluation Report
Sandia National Laboratories – Livermore
Petition SEC-00059

Report Rev #: 0 Report Submittal Date: 3/26/2007

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Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition B Qualification Date	DOE/AWE Facility Name
SEC-00059	83.13	October 4, 2006	Sandia National Laboratories–Livermore (SNL-L)

Petitioner Class Definition

All X-ray technologists and materials scientists who worked in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113, Building 913-Room 128, and Building 941-Room 128 from December 1, 1967 through December 31, 1990.

Proposed Class Definition

All X-ray technologists and materials scientists who worked at Sandia National Laboratory-Livermore in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113, and Building 913-Room 128 from December 1, 1967 through December 31, 1990.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
NA	NA	NA	NA

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
NA	NA

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Peer Review Completed By:	[Signature on file] *LaVon Rutherford for Sam Glover*	3/29/2007 *Date*
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Evaluation Report Summary: SEC-00059, Sandia National Laboratory – Livermore

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-00059, qualified on October 4, 2006, requested that NIOSH consider the following class: *All X-ray technologists and materials scientists who worked in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113, Building 913-Room 128, and Building 941-Room 128 from December 1, 1967 through December 31, 1990.*

NIOSH-Proposed Class Definition

Based on its research, NIOSH modified the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all X-ray technologists and materials scientists who worked at Sandia National Laboratory–Livermore in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113, and Building 913-Room 128 from December 1, 1967 through December 31, 1990. The petitioner-requested class was modified by removing Building 941-Room 128 from the proposed class definition (Section 9.0) because X-ray Diffraction activities in Building 941 commenced after 1992, which is outside of the time period covered by the petition.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose incurred by any member of the class; or (2) estimate radiation doses more precisely than a maximum dose estimate. Information available from the draft site profile and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the proposed class under plausible circumstances during the specified period. Information collected from the reviews of exposure records for the period, incident reports, periodic Health and Safety Reports, procedures, and interviews with former workers form the basis for this conclusion.

Health Endangerment Determination

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

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Table of Contents

Tables

SEC Petition Evaluation Report for SEC-00059

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all X-ray technologists and materials scientists who worked at Sandia National Laboratory-Livermore in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113 and Building 913-Room 128, from December 1, 1967 through December 31, 1990. 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 Office of Compensation Analysis and Support's *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, OCAS-PR-004.

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.[1]

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also then determine whether or not there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation 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

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

established for the class or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioners and to the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 Petitioner-Requested Class/Basis & NIOSH-Proposed Class/Basis

Petition SEC-00059, qualified on October 4, 2006, requested that NIOSH consider the following class for addition to the SEC: *All X-ray technologists and materials scientists who worked in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113, and Building 913-Room 128, and Building 941-Room 128 from December 1, 1967 through December 31, 1990.*

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-L workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00059 for evaluation:

> The basis for proposing that one or more unmonitored, unrecorded, or inadequately monitored exposure incidents occurred can be demonstrated by citing two incidents that occurred during the 23 years that this laboratory was operated: one in 1978 and one in 1979. Both incidents were due to violations of procedures and standard industry practices on the same Norelco Diffraction X-ray Generator. The petitioner has provided evidence of a potential unmonitored exposure with no personal or area monitoring data for the first exposure incident.
>
> Sandia did not provide any permanently mounted instrumentation for continuous recording of the ionizing radiation that was being emitted. In the supporting documentation, an affidavit states that "We checked with a Geiger detector to be sure there wasn't any significant radiation leakage. Health and Safety people insisted on using a scintillation counter to check for scattered radiation."

The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

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

Based on its research, NIOSH modified the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all X-ray technologists and materials scientists who worked at Sandia National Laboratory–Livermore in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113 and Building 913-Room 128, from December 1, 1967 through December 31, 1990. The petitioner-requested class was modified by removing Building 941-Room 128 from the requested class definition (Section 9.0) because X-ray Diffraction activities in Building 941 began after 1992, which is outside of the time period covered by the petition. The dose reconstruction feasibility evaluation contained in this report has been limited to the time period identified in the proposed class definition because this report concludes that dose can be estimated with sufficient accuracy for the proposed class. NIOSH has not expanded the feasibility evaluation to any subsequent classes or time period (after 1990) outside of the initially proposed class because there are no other identified class of workers for which a dose estimate is not considered feasible (based available source term information and personnel monitoring data).

4.0 Data Sources Reviewed by NIOSH

NIOSH identified and reviewed numerous data sources to obtain information relevant to determining the feasibility of dose reconstruction for the class of employees proposed for this petition. 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

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. As part of NIOSH's evaluation here, it examined the following Site Profile for insights into SNL-L operations or related topics/operations at other sites:

- *DRAFT Summary Site Profile for Sandia National Laboratories in Livermore, California*, ORAUT-TKBS-0053, 00-B; October 20, 2006; Draft—not available in SRDB

4.2 ORAU Technical Information Bulletins (OTIBs)

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

- ORAUT-OTIB-0002, *Maximum Internal Dose Estimates for Certain DOE Complex Claims,* Rev. 2; February 7, 2007; SRDB Ref ID: 29947

- ORAUT-OTIB-0006, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures,* Rev. 03, PC-1; December 21, 2005; SRDB Ref ID: 20220

- ORAUT-OTIB-0060, *Internal Dose Reconstruction*, Rev. 0, February 6, 2007; SRDB Ref ID: 29984

4.3 Facility Employees and Experts

To obtain additional information, NIOSH conducted telephone interviews with five former SNL-L employees.

- *Personal Communication with Former X-ray and Fluorescence Lab Employee*; Telephone Interview by Ray Clark; January 9, 2007; SECIS Ref ID: 121

- *Personal Communication with Former X-ray and Fluorescence Lab Employee*; Telephone Interview by Ray Clark, Jack Beck, and Riasp Medora; January 8, 2007; SECIS Ref ID: 120

- *Personal Communication with Former Head of Health and Safety*; Telephone Interview by Ray Clark; January 15, 2007; SECIS Ref ID: 122

- *Personal Communication with Former ES&H Manager/Sandia HP*; Telephone Interview by Riasp Medora; January 22, 2007; SECIS Ref ID: 124

- *Personal Communication with Former Tritium Research Lab Employee*; Telephone Interview by Ray Clark and Riasp Medora; January 30, 2007; SECIS Ref ID: 123

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH OCAS Claims Tracking System (NOCTS) dose reconstruction database to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review for the period of December 1, 1967 through December 31, 1990. (NOCTS data available as of January 31, 2007)

Table 4-1: No. of SNL-L Claims Submitted Under the Dose Reconstruction Rule
(December 1, 1967 through December 31, 1990)

Description	Totals
Total number of claims submitted for energy employees who meet the proposed class definition criteria	1
Number of dose reconstructions completed for energy employees who were employed during the years identified in the proposed class definition	0
Number of claims for which internal dosimetry records were obtained for the identified years in the proposed class definition	1
Number of claims for which external dosimetry records were obtained for the identified years in the proposed class definition	1

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

dose reconstruction. A Computer Assisted Telephone Interview (CATI) was conducted with a claimant to determine whether he had additional relevant information for dose reconstruction. The interview provided some information that might be useful for future dose reconstructions (i.e., work locations, work hours, and hazards/incidents encountered).

4.5 NIOSH Site Research Database

The NIOSH Site Research Database was also reviewed to locate documents supporting the evaluation of the proposed class. One hundred forty-eight documents in this database were identified as pertaining to SNL-L. These documents were evaluated for their relevance to this petition and include some historical background on urinalysis data, radiological control programs, dosimetry program descriptions, environmental reports, monthly and quarterly Health Physics Reports, external radiation incident reports, Standard Operating Procedures, and individual external and internal monitoring data.

4.6 Documentation and/or Affidavits Provided by Petitioners

In qualifying and evaluating the petition, NIOSH reviewed the following documents submitted by the petitioners (received 05/15/2006):

- *Submission Form B*, [Name Redacted]; May 15, 2006; SECIS Ref ID: 9730
- *Letter Accompanying Submission Form B*, explanation of what is being included with the submission, [Name Redacted]; May 10, 2006; SECIS Ref ID: 9729, page 1
- *Letter Accompanying Submission Form B*, explanation of experiences working with [Name Redacted] in Sandia Livermore's X-ray Laboratory, [Name Redacted]; September 2, 2005; SECIS Ref ID: 9729, page 13
- *Record of Occupational Radiation Dose Received at Sandia National Laboratories*, 1989-1994, Sandia National Laboratories; February 27, 2006; SECIS Ref ID: 9729, page 19
- *Recommendation for Consideration of EEOICPA Compensation*, discusses five episodes of non-Hodgkin's Lymphoma, M. Willkom of Livermore Primary Care Medical Associates, Inc.; December 8, 2005; SECIS Ref ID: 9729, page 21
- *Letter Discussing Deteriorating Health*, Kurt Alexander of Alexander Chiropractic Health Center; March 21, 2006; SECIS Ref ID: 9729, page 23
- *Lymphoma Case History*, [Name Redacted]; May 1, 2006; SECIS Ref ID: 9729, page 25
- *Laboratory of Surgical Pathology*, Stanford University Medical Center; October 19, 2004; SECIS Ref ID: 9729, page 27
- *Laboratory of Surgical Pathology*, Stanford University Medical Center; October 11, 1996; SECIS Ref ID: 9729, page 31

- *Laboratory of Surgical Pathology*, Stanford University Medical Center; January 20, 1989; SECIS Ref ID: 9729, page 34

- *Letter Regarding the Submission of Additional Qualifying Criteria and Corrections of Deficiencies Pertaining to the Qualification Phase of the SEC Petition*, [Name Redacted]; August 21, 2006; SECIS Ref ID: 10076, page 2

- *Letters Verifying Health Conditions*, letters from various doctors and health organizations; SECIS Ref ID: 10076 and 10092

5.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize both radiological operations at the SNL-L from December 1, 1967 through December 31, 1990 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing both processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 SNL-L Building 913-Rooms 113 and 128 Process Descriptions

The SNL-L site was established in 1956 to provide direct support for Lawrence Livermore National Laboratory (LLNL) nuclear weapons designs. The primary mission from 1956 through 1989, coinciding with the Cold War, was the design and testing of non-nuclear components of LLNL nuclear weapons. While SNL-L engineered or "weaponized" the nuclear physics packages that were designed by LLNL, production of parts and final weapons was completed at other weapons-complex sites (ORAUT-TKBS-0053). However, this evaluation report is based only on Building 913, the class that is defined in this petition evaluation.

The X-ray Diffraction and Fluorescence Laboratory was located in Building 913-Rooms 113 and 128 during the covered period included in the class definition.

5.2 SNL-L Building 913-Rooms 113 and 128 Weapons Laboratory Facility Complex

SNL-L operations included the Weapons Laboratory Facility Complex, which included Building 913. Tasks performed in Building 913-Rooms 113 and 128 included sample preparation, X-ray diffraction and X-ray fluorescence sample analyses, X-ray diffractometer and powder camera calibrations, design and installation of X-ray shielding devices, and maintenance of the X-ray generators and X-ray fluorescence units. Radioactive sources in Building 913-Rooms 113 and 128 included depleted uranium, small sealed sources, and X-rays from the diffraction and fluorescence units (ORAUT-TKBS-0053, Table 6-4, and Attachment A).

Additional information regarding the functional areas of the SNL-L can be found in the Draft Summary Site Profile for Sandia National Laboratories in Livermore, California (ORAUT-TKBS-0053).

5.3 Radiological Exposure Sources from SNL-L Operations in Building 913-Rooms 113 and 128

Activities in Building 913-Rooms 113 and 128 included testing and analysis (using X-ray diffraction and fluorescence equipment) of materials, sealed sources, and metals that included depleted uranium. Radiation sources for Building 913-Rooms 113 and 128 were limited to alpha-beta-gamma exposures (from uranium samples present in these rooms for the purpose of X-ray diffraction and fluorescence analysis) and X-ray exposures (from operation of the X-ray diffraction and fluorescence equipment). The radiation sources included radiation-producing X-ray machines with energies up to 420,000 volts (ORAUT-TKBS-0053).[3]

5.3.1 Alpha Particle Emissions

Alpha particle emissions present the greatest potential for exposure through internal deposition via inhalation and ingestion (alpha particles do not present an external exposure hazard). The principal alpha-emitting radioactive material associated with potential exposures for the class of workers that worked at SNL-L in Building 913-Rooms 113 and 128 was uranium, most likely from the handling/analysis of uranium materials and samples in these locations (IT Corporation, 2001).

A review of the internal data associated with the individual claim identified in Table 4.1 (Section 4.4) and descriptions of work performed by the class evaluated in this report support the conclusion that alpha emissions were not a significant internal exposure issue in Building 913-Rooms 113 and 128. Information from a former worker interview indicates the worker class did not process or directly prepare uranium samples for analysis. In addition, the former worker indicated that workers only received and analyzed pre-prepared samples, that no grinding or machining of uranium occurred, and that all uranium samples were sealed. Finally, the former worker explained that all radioactive machining work was performed using glove boxes elsewhere at SNL-L (Boehme, 2007).

5.3.2 Beta Radiation Fields

There was a potential for beta radiation exposure from uranium-238 decay products in Building 913-Rooms 113 and 128. The sources of the beta radiation were associated with small sealed sources that were used and/or analyzed (Boehme, 2007).

5.3.3 Neutron Exposures

There were no sources of neutron exposure in Building 913-Rooms 113 and 128 (ORAUT-TKBS-0053, Section 2.3.3).

[3] The summary provided in the Draft Sandia National Laboratory-Livermore Site Profile was based on the following primary source document: DOE, 1992.

5.3.4 Photon Exposures

The majority of photons from uranium metals are in the 30 to 250 keV energy range. Solid uranium objects (e.g., a billet or rod) provide considerable self-shielding of the lower-energy photons resulting in an increase (i.e., "hardening" of the spectrum) in the average energy. In addition, the Norelco X-ray Generator was typically operated at settings of 40 keV and 20 milliamps.

5.3.5 Incidents

Two incidents (one in 1978 and another in 1979) have been evaluated in this report. The first incident occurred shortly before February 1978, the exact date is unknown (Petition Form B, 2006). The second incident occurred on December 7, 1979. Both incidents were due to violations of procedure and standard industry practices on the same Norelco Diffraction X-ray Generator. The failures occurred on the Norelco X-ray generator while it was operating in Building 913-Room 113. The first incident occurred while calibrating a refractometer. The operator received an accidental elevated exposure of ionizing radiation when the X-ray beam safety interlock shutoff failed. In the second incident the shutter was removed, which allowed the full intensity beam, without any shielding or collimation, to reach the operator. A NIOSH investigation into the first incident resulted only in anecdotal evidence, but NIOSH has verified that exposure information is available in a report for the second incident (Lovell, 1980).

6.0 Summary of Available Monitoring Data for the Proposed Class

SNL-L had a dosimetry program in place from the start of operations in 1956 (Hanzel, 1960). This section provides a summary of available monitoring data for the proposed class for the time period from December 1, 1967 through December 31, 1990.

SNL-L maintained all monitoring data for its employees prior to 1989. Starting in 1989, all SNL-L monitoring records were sent to Sandia National Laboratory-Albuquerque (SNL-A) for incorporation into the SNL-A dosimetry database (Hallman, 1989). Because all SNL-L data requests (for individual dose reconstructions) are directed through the Albuquerque office, NIOSH generally only received post-1988 data when requesting individual claimant data from the DOE. NIOSH is currently coordinating with SNL-L and SNL-A to gain access and capture the remaining, uncollected SNL-L dosimetry records, which primarily include individual dosimetry analysis data.

The individual data, including pre-1989 external data and bioassay data, evaluated for this proposed class were collected by NIOSH as part of the data capture conducted at SNL-L to develop the Sandia National Laboratory-Livermore Site Profile.

6.1 SNL-L Internal Monitoring Data

The diffraction and fluorescence operations would not be expected to routinely generate any intakes (Boehme, 2007). The potential for internal exposure at SNL-L in Building 913 resulted from work with uranium. Uranium exposures, most likely from depleted uranium, since only depleted uranium was present in the Weapons Laboratory Facility Complex (ORAUT-TKBS-0053, Table 2-1), may have resulted from handling uranium components and samples that were handled during routine X-ray

Diffraction and Fluorescence operations in Building 913-Rooms 113 and 128.[4] Although the exposure potential was very low, it is likely that uranium bioassay were performed because of the presence of uranium in the lab and the radiological program monitoring requirements. However, all internal uranium bioassay results for this class were zero, or non-detects.

A review of the available uranium bioassay data shows uranium data monitoring for the three members that comprise the class, from 1975 to 1984. Total uranium analysis was performed by fluorimetry with a detection limit between 1 ug/l to 12 ug/l (ORAUT-TKBS-0053; Uranium Bioassay Results, 1965-1990).

A review of the records for this facility does not provide any indication of any *in vivo* monitoring, such as lung counting, being performed.

Details regarding the various analyses used and the associated minimum detectable activities are presented in the *Summary Site Profile for Sandia National Laboratories in Livermore, California* (ORAUT-TKBS-0053).

6.2 SNL-L External Monitoring Data

The dosimetry data from SNL-L consist of values for non-penetrating and penetrating dose, with the penetrating portion attributed to photon exposures and the non-penetrating portion attributed to beta and X-ray exposures. The film badge and TLD systems employed at SNL-L resulted in varying detection capabilities for the period and worker class evaluated in this report.

Film badges consisted of four windows: one open and the other three filtered with various densities of lead, cadmium, and aluminum. A review of the dosimetry history at SNL-L (Wright, 1993) indicates that the change from film badges to TLDs occurred in about 1966. However, other documents indicate that the Radiation Detection Company (RDC) was still processing badges for SNL-L as late as 1970 (DeSelm, 1965; ORAUT-TKBS-0053).[5] It is presumed that badges processed by RDC after 1966 still consisted of film-type dosimeters, and it is possible that the switch to TLDs coincided with a switch of dosimetry service providers from RDC to RESL in Idaho Falls, Idaho (Wright, 1993). For the purposes of the SNL-L Site Profile Document and this evaluation, it is reasonable to assume that film dosimeters were used at SNL-L until about 1971. The film badges were capable of discerning between penetrating (photon) and non-penetrating (X-ray, beta) exposures (ORAUT-TKBS-0053, Section 6.4.2).

As reported in Wright (1993), until 1982, SNL-L's TLD technology consisted of a 2-chip badge with only one filter type and could not discriminate between different radiation types or energies (the TLDs consisted of two TLD-100 chips in a plastic holder). However, the actual dosimetry records for this period report doses in penetrating and non-penetrating dose categories, including beta, photon, and neutron radiations. A 1983 dosimetry program memo suggests that non-penetrating dose may have also been assigned as penetrating dose, but the document does not provide any indication of how

[4] Medora, Riasp, HP. Oak Ridge Associated Universities (ORAU). February 2007.

[5] The summary provided in the Draft Sandia National Laboratory-Livermore Site Profile was based on the following primary source documents: SNL-L, 1958-1961; SNL-L, 1961-1962; Campbell, 1962; Rhodes, 1964; Lovell, 1966; and RDC, 1969.

different radiations were assessed (ORAUT-TKBS-0053, Section 6.4.2.1). In 1982, SNL-L switched to a two-element TLD from Eberline that apparently could better discriminate between different radiation types and provide directly measurable indicators of these various dose quantities. In 1984 SNL-L switched to a three-element badge which did a better job of discriminating between the different radiation types and energies. SNL-L continued using the Eberline dosimeter until about 1989 when the site switched to the multi-element Harshaw TLD (ORAUT-TKBS-0053, Section 6.4.2.1).

Badges were exchanged on a monthly basis until mid-to-late 1964 when a quarterly badge exchange policy was instituted for the beta gamma dosimeter; the neutron dosimeter was still exchanged on a monthly frequency (Campbell, 1964). Around 1971, when the switch from film to thermoluminescent dosimeters (TLDs) took place, the beta gamma dosimeter exchange frequency changed to semi-annually. In 1989, when the SNL-A beta gamma dosimeter was used at Livermore, the exchange frequency changed back to quarterly (Hallman, 1989).

From information in a memo dated October 6, 1965 and information available in annual dose summary reports, it can be concluded that until 1970, all personnel at SNL-L were badged (DeSelm, 1965; AEC, Various dates). After 1970, only employees working with or around radiation-generating devices or those that had the potential to exceed a pre-specified threshold were badged (ORAUT-TKBS-0053, Section 6.4.1.1).

Table 6-1, which provides annual dosimetry data for the years 1967 through 1990, was created using data from the Annual Summary reports. The format of these reports changed over time; hence, the available data changed over time. All numbers were derived from the data in the Annual Summary reports.

Table 6-1: Annual Dosimetry Data from 1967-1990

Year	Total Number of Employees Monitored	Dose Range (Rem)	Number in Range	Number Not Monitored	Number with a Dose of Zero
1967	1288	0-1	1286	0	Unknown
		1-2	2		
1968	1253	0-1	1252	0	Unknown
		1-2	1		
1969	1249	0-1	1249	0	Unknown
1970	857	0-1	857	167	Unknown
1971	923	0-1	923	147	Unknown
1972	927	0-1	927	150	Unknown
1973	795	0-1	795	125	Unknown

Table 6-1: Annual Dosimetry Data from 1967-1990					
Year	**Total Number of Employees Monitored**	**Dose Range (Rem)**	**Number in Range**	**Number Not Monitored**	**Number with a Dose of Zero**
1974	1,098	< 0.100	104	Unknown	976
		0.100 – 0.249	13		
		0.250 – 0.490	2		
		0.500 – 0.749	2		
1975	802	< 0.100	150	Unknown	638
		0.100 – 0.249	9		
		0.250 – 0.499	4		
		0.500 – 0.749	0		
		0.750 – 0.999	1		
1976	856	< 0.100	147	Unknown	695
		0.100 – 0.249	10		
		0.250 – 0.499	3		
		0.500 – 0.749	1		
1977	935	< 0.100	202	Unknown	726
		0.1100- 0.249	7		
1978	973	< 0.100	116	Unknown	853
		0.100 – 0.249	2		
		0.250 – 0.499	2		
1979	896	< 0.100	98	Unknown	796
		0.100 - 0.249	2		
1980	888	< 0.100	260	Unknown	624
		0.100 – 0.249	3		
		0.250 – 0. 499	1		
1981	1093	< 0.100	36	Unknown	1053
		0.100 – 0.249	3		
		0.250 – 0.499	1		
1982	946	< 0.100	91	Unknown	851
		0.100 – 0.249	3		
		0.250 – 0.499	0		
		0.500 – 0.749	1		
1983	976	< 0.100	58	Unknown	914
		0.100 – 0.249	3		
		0.250 – 0.499	0		
		0.500 – 0.749	1		
1984	546	< 0.100	37	Unknown	507
		0.100 – 0.249	2		

Table 6-1: Annual Dosimetry Data from 1967-1990					
Year	**Total Number of Employees Monitored**	**Dose Range (Rem)**	**Number in Range**	**Number Not Monitored**	**Number with a Dose of Zero**
1985	506	< 0.100	28	Unknown	476
		0.100 – 0.249	2		
1986	2,606	< 0.100	278	Unknown	2,267
		0.100 – 0.250	31		
		0.250 – 0.500	14		
		0.500 – 0.750	5		
		0.750 - 1	4		
		1 - 2	5		
		2 - 3	2		
1987	557	Unknown	Unknown	Unknown	557
1988	2,787	< 0.100	397	Unknown	2,289
		0.100 – 0.250	62		
		0.250 – 0.500	20		
		0.500 – 0.750	9		
		0.750 - 1	4		
		1 - 2	5		
		2 - 3	1		
1989	3,164	< 0.100	527	Unknown	2,589
		0.100 – 0.250	26		
		0.250 – 0.500	12		
		0.500 – 0.750	5		
		0.750 - 1	1		
		1 - 2	4		
1990	3,128	< 0.100	416	Unknown	2,676
		0.100 – 0.250	18		
		0.250 – 0.500	11		
		0.500 - 0750	1		
		0.750 – 1	3		
		1 - 2	3		

Notes:
SNL-L data for 1986 through 1990 were not available separately from SNL-A data. The totals include data for both SNL-A and SNL-L.

Data used in this table were compiled from Annual Radiation Exposure Reports (AEC, Various dates; **Pacific Northwest Laboratory, 1982).**

SNL-L used external dosimetry that was provided by various organizations; since there were a number of dosimetry suppliers, the external dosimetry data are reported in various different formats. The listing of the different dosimeters used and associated information can be found in Table 6-1 of the *Summary Site Profile for the Sandia National Laboratories in Livermore, California* (ORAUT-TKBS-0053).

For the time period from 1967 through 1972, a report titled *Dosimetry Positive Exposure Listing* shows only positive exposures (SNL, Various dates). None of the class members employed at that time is listed in this report. In another report, titled *SNL Livermore External Dosimetry Records-Prior to 1973,* also covering the time period prior to 1973, there is a note stating, *After July 1, 1965 only positive exposures were posted to the Exposure Records Cards per P K Lowell*. This report has dosimetry data for one class member covered by this evaluation report (Author unknown, Various dates). Based on this review, it appears that only one class member had a positive dose prior to 1973.[6]

The time period from 1973 through 1987 includes data for the entire class for each monitored period (SNLL, 1987a; SNLL, 1987b). The external dosimetry data for 1988 are in a separate report titled *Dosimetry 1988* and data for the entire class are listed in this report (Author unknown, 1988). As part of the NIOSH dosimetry data request for Sandia Livermore personnel, SNL-A provided post-1988 data. The pre-1988 data were collected by the Site Profile authors during a data capture visit to Sandia Livermore.

Details regarding the various dosimeter types and the associated minimum detectable dose are presented in the *Summary Site Profile for the Sandia National Laboratories in Livermore, California* (ORAUT-TKBS-0053).

6.3 SNL-L Air Sampling Data

To date, NIOSH has not located any airborne monitoring data for uranium for Building 913-Rooms 113 and 128 of SNL-L. SNL-L Bioassay Program requirements stated that in order to determine the need for bioassay sampling, air sampling had to be performed in areas where uranium machining occurred (Wright, 1979a). Because only sample analysis occurred in Rooms 113 and 128 (not sample preparation or material machining) it can be concluded that air samples were collected in Building 913, but not necessarily in Room 113 or Room 128. NIOSH does not expect that such monitoring would have been performed in these rooms. Because bioassay monitoring data is available for the proposed class members (the preferred data for reconstructing internal dose), further research for available air sampling data has not been performed as part of this evaluation.

7.0 Feasibility of Dose Reconstruction for the Proposed Class

The feasibility determination for the proposed class of employees covered by this evaluation 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 was feasible to conduct dose reconstructions.

[6] Medora, Riasp, HP. Oak Ridge Associated Universities (ORAU). February 2007.

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 (discussed in Section 9.0 of this report). If these dose reconstructions are not determinative, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.6. This approach is discussed in OCAS'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-00059 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of SNL-L Data

Examination of the internal and external monitoring data available for SNL-L employees indicates that data are of sufficient quality and quantity to satisfactorily represent the range of exposures associated with this class. As discussed in detail in the SNL-L Site Profile, the monitoring approaches and analytical techniques used to assess worker exposures were commensurate with the state-of -the-art methods used at other DOE/AEC facilities at that time.

7.1.1 Internal Data Review

Reliability of the internal monitoring data for the class defined in this report was checked by reviewing the bioassay analysis results for the various bioassay samples collected. Since the data being reviewed are the direct results of the individual analysis and not results obtained from a database, a comparison between the data and a database is not needed. From 1974 through 1985, all uranium bioassay results for the three members of the class evaluated in this report are zero or non-detect values, which is commensurate with the type of work that these individuals performed and the materials they handled. The available uranium bioassay data covers the time period from 1965 through 1990.

7.1.2 External Data Review

Information obtained during data captures was used to supplement the data obtained from the Department of Energy. The only data available for external monitoring is tabulated data (data tables that were created electronically or manually). During the early years (pre-1977), only positive external exposures were recorded. NIOSH is still attempting to locate the individual dosimeter data, if it exists. Data from 1977 through 1988 is available as a tabulation of the individual dosimeter data. Beginning in 1989, SNL-A provided external dosimetry to SNL-L, thus, post-1989 data is available.

7.2 Internal Radiation Doses at SNL-L

The primary source of internal radiation dose for members of the proposed class was from uranium exposures (most likely from depleted uranium) that may have resulted from handling uranium components and samples in the X-ray Diffraction and Fluorescence Laboratories (Buildings 913-Room 113 and 128) (ORAUT-TKBS-0053). According to the petition's supporting documentation (Petition Form B, 2006) provided by a member of the proposed class, employees may have been exposed to radioactive materials while preparing samples for analysis. By contrast, an interview with another member of the proposed class conflicts with the first and indicates that radioactive samples were not prepared in the lab (Boehme, 2007). The fact that the three members of the proposed class were internally monitored for uranium (see 7.2.1, below) indicates that they were likely involved with activities deemed by management to involve the potential for internal exposures (Wright, 1979a). In any case, it can be concluded that the potential for internal dose for the proposed class was very low for the following reasons:

- The *Contamination Assessment and Building Decontamination Report* which details the initial characterization efforts for Building 913 classifies Rooms 113, 113A, and 113B as "unaffected." This classification means either: 1) there is no history of radioactive materials being used or stored in the area, or 2) sufficient information exists to form the basis for an assumption that the radiological conditions are benign (IT Corporation, 2001).

- The "unaffected" classification was supported by radiological measurements collected in connection with the final status surveys for this area (IT Corporation, 2001).

- The lack of positive urinalysis data for the members of this proposed class (see Section 7.2.1, below) suggests that internal exposures to radioactive materials were not occurring at measurable levels (Uranium Bioassay Results, 1965-1990).[7]

7.2.1 Process-Related Internal Doses at SNL-L

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

7.2.1.1 Urinalysis Information and Available Data

The primary radionuclide of concern for Building 913 was uranium, most likely depleted uranium (ORAUT-TKBS-0053, Section 5.2). Uranium urinalysis records are available for SNL-L employees for the period 1967 to 1990 (Uranium Bioassay Results, 1965-1990). These records indicate that all members of the proposed class were monitored for internal uranium exposures during the time period relevant to the petition (December 1, 1967 through December 31, 1990). As previously discussed, it is expected that this monitoring was performed because of the potential for uranium exposures (most likely from depleted uranium) that may have resulted from handling uranium components and samples in the laboratories included in the proposed class definition (Wright, 1979b). Missed dose (associated

[7] Mantooth, Dan, CHP. Dade Moeller & Associates. February 2007. This conclusion was based on the non-detect values provided in *Uranium Bioassay Results*, 1965-1990.

with zero or less than detectable results) can be estimated using the Minimum Detectable Activity (MDA) information provided in the SNL-L Site Profile (ORAUT-TKBS-0053, Table 5-8).

7.2.1.2 Airborne Levels

No measured concentration or action level data were available for Building 913-Rooms 113 and 128 of the Sandia National Laboratory-Livermore. Only three people worked in the X-ray and Diffraction Laboratory during the period identified in the petition (Nichols, 2007) and since the three members of the proposed class were involved in the urinalysis program, airborne exposures to uranium would have been detected and reported accordingly. Missed exposure can be estimated using the urinalysis MDA information presented in the SNL-L Site Profile (ORAUT-TKBS-0053, Table 5-8). Thus, further evaluation of internal exposures based on air sampling is not necessary.

7.2.1.3 Application of Co-Worker Data for Internal Dose Reconstruction

Co-worker data are not needed for the class of employees evaluated in this report since the internal doses of the class were monitored and missed doses (doses below the minimum level of detection) can be estimated.

7.2.2 Ambient Environmental Internal Radiation Doses at SNL-L

Further evaluation regarding the ambient internal radiation dose is not necessary because internal ambient dose is accounted for in the monitored internal exposures. For those employees that were not monitored, methods provided in the SNL-L Site Profile can be used to bound the internal exposures.

7.2.3 Internal Dose Reconstruction

Operations conducted in SNL-L Building 913-Room 113 included analyses of simulated weapon's parts and materials using X-ray diffraction, X-ray crystallography, and X-ray fluoroscopy (Petition Form B, 2006; IT Corporation, 2001). The normal complement of employees during the period specified consisted of two individuals: an engineer and a technician (Petition Form B, 2006). The primary ROC for this location was uranium exposures that could have occurred during normal handling of the samples to be examined. No incidents resulting in the release of airborne radioactivity have resulted from the operations at these laboratory locations within this facility (ORAUT-TKBS-0053, Section 2.4.1).

During the period applicable to the petition, the personnel involved in the operations conducted in SNL-L Building 913-Room 113 were monitored for uranium exposure by urinalysis (Uranium Bioassay Results, 1965-1990). The SNL-L Site Profile (ORAUT-TKBS-0053) provides a sound technical basis for estimating missed dose and the dose from ambient environmental radionuclides, if applicable.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

Based on the data/information sources discussed above, NIOSH concludes that the occupational internal dose can be estimated with sufficient accuracy for all members of the proposed class.[8]

[8] Mantooth, Dan, CHP. Dade Moeller & Associates. February 2007.

7.3 External Radiation Doses at SNL-L

The principal sources of external radiation doses for members of the proposed class included exposures to low energy X-rays, beta particles, and gamma rays. The radiation sources contributing to these exposures were (Petition Form B, 2006; ORAUT-TKBS-0053):

- Operations involving the use of X-ray generating devices, i.e., X-ray diffraction, X-ray fluoroscopy, etc.
- Exposures to beta and gamma radiation.
- Periodic X-ray examinations.

7.3.1 Process-Related External Radiation Doses at SNL-L

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

7.3.1.1 Radiation Exposure Environment

Operations conducted in SNL-L Building 913-Room 113 included analyzing simulated weapons components and materials and using X-ray diffraction, X-ray crystallography, and X-ray fluoroscopy (Petition Form B, 2006; IT Corporation, 2001). Typically, two employees at a time would be involved in these operations during the period specified: an engineer and a technician (Petition Form B, 2006).

Radiation from the examination of parts and components using the X-ray diffraction and fluoroscopy machines would have been a potential source of radiation exposure. In addition, there were two reported incidents (one in 1978 and one in 1979) in which different technicians were exposed to the primary X-ray beam due to improper operation of the units and/or failure of the shutter interlock mechanism. The main difference between the 1979 and 1978 incident was the failure of a safety interlock versus the removal of a piece of the equipment (a shutter). The 1979 incident resulted in more dose than the 1978 incident because the removal of the shutter disabled a safety function and shielding. The removal of the safety equipment and shielding resulted in the potential for a more significant radiation exposure than the 1978 incident that involved a safety interlock failure. A dose reconstruction was performed for the X-ray technician involved in the 1979 incident (Lovell, 1980) and data from the reconstructed 1979 incident can be used to bound the exposures resulting from the 1978 incident (Lovell, 1980).

Some of the components/materials being examined may have been comprised of uranium (most likely depleted uranium) which would have been a source of both beta and gamma exposure (ORAUT-TKBS-0053; IT Corporation, 2001).

7.3.1.2 Beta and Photon Characterization

Radiation from beta and gamma sources would have resulted in energies characteristic of uranium (most likely depleted uranium) and its decay products. For the purposes of evaluating beta radiation

exposures, maximum beta energies are assumed to be associated with uranium-238 and its decay products (assigned with an energy >15 keV for the purpose of individual dose reconstructions) (ORAUT-TKBS-0053, Section 6.5.3).

The X-ray generating devices used for operations in Room 113 typically operated at 40 keV and 20 mA and employed copper, iron, tungsten, and cobalt targets (Petition Form B, 2006). Some operations (i.e., beam alignment) may have used lower voltages and currents (Lovell, 1980). For the purpose of evaluating photon exposures and reconstructing dose for the class evaluated in the report, a distribution of photon energies (to account for exposures to radioactive materials and to the photons associated with the operation of the X-ray diffraction and fluorescence equipment) would be applied in the <30 keV, 30-250 keV, and >250 keV ranges (ORAUT-TKBS-0053, Section 6.5.3).

7.3.1.3 History of Whole Body External Monitoring

Although some film dosimetry may still have been in use in 1971(Nichols, 2005*)*,after about 1968, whole-body external monitoring dosimeters worn by SNL-L personnel consisted of two-element DuPont Type 554 beta/photon film that included a special nuclear track emulsion, type-A film. From 1968 to the present, most dosimeters consisted of multichip TLDs. During the covered period applicable to this petition, whole-body external monitoring was performed primarily with a 2-chip TLD that provided a nearly tissue-equivalent deep dose response, but did not permit adequate deep and shallow radiation discrimination (Wright, 1993).

7.3.1.4 Dosimetry Records

External dosimetry records are available for the covered period applicable to this petition. The data are arranged by employee social security number and provide penetrating and non-penetrating radiation dose information from which gamma, beta, and neutron doses are inferred.

A dose reconstruction was performed for an X-ray technician who was involved in an incident involving the removal of a shutter in an X-ray Diffractometer (Lovell, 1980); these data can be used to estimate the dose for the petitioner from a previous and similar incident involving the same equipment (Nichols, 2007). The main difference between the 1978 and 1979 incident involves the failure of a safety interlock (in 1978) versus the removal of a piece of the equipment (a shutter), which allowed a full intensity beam without shielding. The 1979 exposure was much more severe (considering that actual instrument safety equipment and shielding were removed) with the potential for more significant radiation exposures as compared to the 1978 exposure (Lovell, 1980; Nichols, 2005).

7.3.1.5 Application of Co-Worker Data for External Dose Reconstruction

A co-worker study has not been completed for employees at SNL-L and would not be applicable to the members of the proposed cohort since their external doses were monitored and/or can be estimated on the basis of their individual records and other information discussed in this evaluation.[9]

[9] Mantooth, Dan, CHP. Dade Moeller & Associates. February 2007.

7.3.2 Ambient Environmental External Radiation Doses at SNL-L

An evaluation of the ambient external radiation dose is not necessary because this dose is accounted for in the process-related external dose evaluation. For those employees that were not monitored, methods provided in the SNL-L Site Profile can be used to assess the external exposure (ORAUT-TKBS-0053).[10]

7.3.3 SNL-L Occupational X-Ray Examinations

A review of claimant files shows that from 1965 through the 1980s, a single posterior-anterior (PA) chest exam was performed at hire, annually, and possibly upon termination. The files also show that anterior posterior (AP) and lateral (LAT) lumbar spine X-rays were also performed at hire as late as 1971. As specified in ORAUT-TKBS-0053, Section 3.1 assumes that medical X-rays were performed until 1989.

7.3.4 External Dose Reconstruction

As of February 1, 2007, one EEOICPA claim from the SNL-L workers had been submitted to NIOSH; dose reconstruction has not been completed for this claim. This claim covers the entire range of operations at the SNL-L and includes external monitoring data.

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

- Photon and Beta Dose
- Unmonitored Individuals Working in Production Areas
- Medical X-ray

7.3.4.1 Photon and Beta Dose

Routine photon exposures would have resulted from using the X-ray Diffraction and Fluoroscopy machines to analyze parts, components, and samples.

As previously mentioned, the dosimetry data consist of values for non-penetrating and penetrating dose, with the non-penetrating portion assumed to result from beta and X-ray exposures. The film badge and TLD systems employed at SNL-L resulted in varying detection capabilities for the time period evaluated in this report.

Because the film badges used at SNL-L were capable of discerning between penetrating (photon) and non-penetrating (X-ray, beta) exposures, the data provided for that time period are sufficient for the purpose of reconstructing the pre-1968 external dose for the class of workers evaluated in this report.[11]

[10] The summary provided in the Draft Sandia National Laboratory-Livermore Site Profile was based on the following primary source documents: ORAUT-TKBS-0006-06 and ORAUT-TKBS-0048.

[11] Stempfley, Dan, Sr. Health Physicist. Dade Moeller & Associates. February 2007.

The two-element dosimeter used from 1966 through 1982 consisted of two TLD-100 chips in a plastic holder with some level of filtration; this did not permit adequate shallow and deep dose discrimination. The TLDs were processed by RESL Idaho (Wright, 1993; ORAUT-TKBS-0053).[12] The TLD-100, without any significant filtration, over responds slightly below 30 keV. The TLD holder provided some filtration such that the TLD response would be nearly linear down to the energies encountered in the X-ray diffraction and fluoroscopy lab (ICRU, 1992). For the purpose of establishing a bounding dose scenario for reconstructing dose for the worker class evaluated in this report, NIOSH could assign the entire recorded amount as penetrating dose (ORAUT-TKBS-0053) and also assign it as non-penetrating, which would result in claimant-favorable dose estimations.

After SNL-L began to use the 2- and 3-element Eberline TLD, it was possible to discern between penetrating (photon) and non-penetrating (X-ray, beta) exposures. Therefore, the data provided for that time period are sufficient for the purpose of reconstructing the post-1982 external dose for the class of workers evaluated in this report.[13]

7.3.4.2 Incidents

There were two incidents (one in 1978 and another in 1979) involving a mechanical failure of a safety interlock and the bypassing of a shutter in an X-ray Diffractometer. A dose reconstruction and report is available for the 1979 incident (Lovell, 1980). In the 1978 incident, the safety interlocks failed while calibrating a refractometer. As a result, the operator received an accidental elevated exposure of ionizing radiation to his extremities (i.e., fingers on the right hand and right arm, and to a lesser extent his upper body and trunk) (Petition Form B, 2006; Wright, 2007). In the 1978 incident, the beam was confined by a collimator. In the 1979 incident, the shutter was removed, which allowed a full intensity beam without any shielding or collimation to reach the operator. A reenactment of the 1979 incident showed that at the closest exposure point, the beam size was 13 centimeters in diameter and the exposure time ranged from 15 to 20 seconds. Since both incidents occurred with the same equipment, operating under similar conditions, NIOSH has determined that the dose estimate for the 1979 incident can be used as a bounding external exposure scenario (because of the lack of shielding in that case and the 1979 incident having a much higher exposure potential) to permit estimating dose for the 1978 event.[14]

7.3.4.3 Medical X-ray

The typical X-rays taken during the annual physical included a single PA chest exam; this procedure was in place until some time in the 1980s (ORAUT-TKBS-0053, Section 3.1). For the purpose of this document, it is assumed that this practice continued until 1989.

[12] The summary provided in the Draft Sandia National Laboratory-Livermore Site Profile was based on the following primary source documents: Wallace, 1988 and Ormond, 1986.

[13] Mantooth, Dan, CHP. Dade Moeller & Associates. February 2007.

[14] Medora, Riasp, HP. Oak Ridge Associated Universities (ORAU). February 2007.

7.3.5 External Dose Reconstruction Feasibility Conclusion

Based on reviews and analysis of the available data and the SNL-L Site Profile, NIOSH concluded that the SNL-L external monitoring data are sufficient to estimate the maximum external radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred by any member of the class. Therefore, external radiation dose can be estimated with sufficient accuracy for the class evaluated in this report.

7.4 Evaluation of Petition Basis for SEC-00059

The following subsections evaluate the assertions made on behalf of petition SEC-00059 for SNL-L.

7.4.1 Evaluation of Major Topics Detailed in Petition SEC-00059

The following major topics were detailed in petition SEC-00059. Italicized statements are from the petition; the comments that follow are from NIOSH.

7.4.1.1 Two Specific Incidents: 1978 and 1979 Incidents

SEC-00059: *The basis for proposing that one or more unmonitored, unrecorded, or inadequately monitored exposure incidents occurred can be exemplified by citing two incidents that occurred during the 23 years that this laboratory was operated.*

The petitioner referred to two incidents: one in 1978 and one in 1979. Both incidents occurred on the same Norelco Diffraction X-ray Generator and were due to equipment failure or work being performed in violation of procedures and not in accordance with standard industry practices. The petitioner has provided evidence of a potential unmonitored exposure with no personal or area monitoring data for the first exposure incident.

Information contained in the incident report for the second incident (Lovell, 1980) and information obtained from interviews with former employees (Nichols, 2007) indicates that the second incident was more severe, of longer duration, and resulted in a larger exposure than the first incident. NIOSH has determined that the data contained in the 1979 incident report can be used to establish a bounding external exposure scenario (because of the lack of shielding in that case) that will permit estimating external dose for the 1978 event.

7.4.1.2 Dosimeter Placement

SEC-00059: *These exposures are based on unmonitored, unrecorded, and inadequately monitored exposures. For security purposes, employees were required to wear their dosimeters behind their security badge which effectively blocked a significant amount of the radiation that was being emitted about the room and was exposing those working in the vicinity.*

Based on a review of the Sandia National Laboratory-Livermore program documentation available in the SRDB, NIOSH has determined that the dosimeter was part of the security badge and may have detected exposure in the same manner as a stand-alone dosimeter. During the early years of operation, the dosimeter may have been worn behind the ID picture badge (Nichols, 2005). However, because

dosimetry data and program information are available, it is possible to determine the appropriate correction factors that will ensure claimant favorability in dose reconstruction (applicable to the exposure scenarios that existed at Sandia National Laboratory-Livermore for the proposed time period in this submission).

7.4.1.3 Dosimetry Data Unavailable

SEC-00059: *The dosimetry data and related information for the above mentioned ionizing radiation exposures are unavailable for estimating my radiation dose.*

In the submission, individual exposure records were included as an example of "missing exposure records." The individual was employed from October 1971 through November 1997, but only had exposure records for the years 1989 through 1994. However, a NIOSH investigation revealed that exposure data for the years prior to 1989 were included under the listing of "Legacy" and may be available on microfiche records.

NIOSH has located the personnel monitoring data for the years prior to 1989 and collected the data applicable to the evaluation of the proposed class in this report; these include data for the time period when the incident with the X-ray diffraction unit occurred. With the availability of this data, NIOSH asserts that it has access to a complete set of bioassay and external dosimetry data for the members of the proposed class evaluated in this report. Based on the review and evaluation of the available data, NIOSH has determined that it has access to sufficient information to estimate the internal and external dose for members of the proposed class, for the time period through 1990, with sufficient accuracy (as discussed in this report). At this time, NIOSH has not identified any period at SNL-L with insufficient personnel monitoring data that would prevent estimating doses with sufficient accuracy. Therefore, NIOSH has restricted the evaluation to the proposed class defined in the SEC petition, SEC00059.

7.5 Summary of Feasibility Findings for Petition SEC-00059

This report evaluates the feasibility for completing dose reconstructions for employees at SNL-L from December 1, 1967 through December 31, 1990. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the proposed class of employees.

Table 7-1 summarizes the results of the feasibility findings at SNL-L for each exposure source during the time period December 1, 1967 through December 31, 1990.

Table 7-1: Summary of Feasibility Findings for SEC-00059
December 1, 1967 through December 31, 1990

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal[1]	**X**	
Uranium	X	
External	**X**	

Table 7-1: Summary of Feasibility Findings for SEC-00059 December 1, 1967 through December 31, 1990		
Source of Exposure	**Reconstruction Feasible**	**Reconstruction Not Feasible**
- Gamma	X	
- Beta	X	
- Photon	X	
- X-ray	X	
- Occupational Medical x-ray	X	

[1] **Internal includes evaluation of urinalysis (*in vitro*) data.**

As of January 31, 2007, one claim has been submitted to NIOSH for an individual who worked at SNL-L. A dose reconstruction has not been completed for this individual.

8.0 Evaluation of Health Endangerment for Petition SEC-00059

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.

Our evaluation determined that it is feasible to estimate radiation dose for members of the proposed class with sufficient accuracy based on the sum of information available from available resources. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is not required.

9.0 NIOSH-Proposed Class for Petition SEC-00059

Based on its research, NIOSH modified the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all X-ray technologists and materials scientists who worked at Sandia National Laboratories in the X-ray Diffraction and Fluorescence Laboratory, Building 913-Room 113 and Building 913-Room 128, from December 1, 1967 through December 31, 1990. The petitioner-requested class was modified by removing Building 941-Room 128 from the proposed class definition (Section 9.0) because X-ray Diffraction activities in Building 941 occurred after 1992, which is outside of the time period covered by the petition.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded to them herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Data Base (SRDB), for information relevant to SEC-00059. Further, 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 that it would be feasible to reconstruct the dose for the class proposed in this petition.

10.0 References

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

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

42 C.F.R. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 28, 2004; SRDB Ref ID: 22001

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

ORAUT-OTIB-0006, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures,* Rev. 03, PC-1; December 21, 2005; SRDB Ref ID: 20220

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