SEC Petition Evaluation Report
Petition SEC-00214

Report Rev #:0 Report Submittal Date: September 26, 2013

Subject Expert(s):	Tim Adler
Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00214	83.14	August 22, 2013	Sandia National Laboratories-Livermore

NIOSH-Proposed Class Definition
All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area at Sandia National Laboratories-Livermore in Livermore, California, from October 1, 1957 through December 31, 1994, for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Related Petition Summary Information			
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
N/A	N/A	N/A	N/A

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
N/A	N/A

ORAU Lead Technical Evaluator: Tim Adler	**ORAU Peer Review Completed By:** Daniel Stempfley

Peer Review Completed By:	[Signature on File] *Sam Glover*	9/26/2013 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on File] *J. W. Neton*	9/27/2013 *Date*
SEC Evaluation Approved By:	[Signature on File] *Stuart L. Hinnefeld*	9/27/2013 *Date*

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Evaluation Report Summary: SEC-00214, Sandia National Laboratories-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*.

NIOSH-Proposed Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked in any area at Sandia National Laboratories-Livermore in Livermore, California, from October 1, 1957 through December 31, 1994, 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.

Feasibility of Dose Reconstruction Findings

NIOSH lacks sufficient information, which includes internal and external personnel monitoring data, process data, and radiological source term information, to allow it to estimate with sufficient accuracy the potential internal and external exposures to radionuclides which include but are not limited to uranium, uranium tritides and hydrides, tritium, and thorium, as well as potential exposures from radiological classified activities to which the proposed class may have been subjected. NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Sandia National Laboratories-Livermore workers with sufficient accuracy up through 1989. After 1989 medical X-rays are not applicable because they were performed offsite.

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

- Sources of internal radiation for members of the proposed class included exposures to depleted uranium, tritium, uranium tritides, uranium hydrides, thorium, and highly enriched uranium. Primary sources of potential internal doses to depleted uranium were from machining performed in the Weapons Laboratory Facility Complex. Tritium, uranium tritide, and uranium hydride dose sources were associated with research activities taking place within the Tritium Research Laboratory. Highly enriched uranium and thorium may have been involved in classified activities at other site locations and also resulted in potential internal doses.

- NIOSH has access to records suggesting that tritium and uranium urinalyses were performed for workers within the Tritium Research Laboratory and those machining depleted uranium. NIOSH does not, however, have access to all internal monitoring results nor complete source term and process records, nor can it assess what fraction of the records are available.

- Principal sources of external radiation for members of the proposed class included exposures to highly enriched uranium, uranium hydrides, thorium, Radiography Facility isotope sources, and potentially other radionuclides from classified work.

- NIOSH has access to records suggesting that external monitoring was performed for many site workers. NIOSH does not however, have access to all external monitoring results nor complete source term and process records.

- 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 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-Livermore during the period from October 1, 1957 through December 31, 1994, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

The NIOSH evaluation did not identify any evidence supplied by the petitioners or from other resources that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures, such as nuclear criticality incidents or other events involving similarly high levels of exposures. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of tritium, uranium, and possibly from direct exposure to radioactive materials. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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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 employees who worked at Sandia National Laboratories–Livermore during a specified time. It provides information and analysis 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, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

This evaluation, in which NIOSH provides its findings both on the feasibility of estimating radiation doses of members of this class with sufficient accuracy and on health endangerment, was conducted in accordance with the requirements of EEOICPA and 42 C.F.R. § 83.14.

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 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 proposed class of employees through NIOSH dose reconstructions.[1]

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 the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, 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

[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.

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 final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 NIOSH-Proposed Class Definition and Petition Basis

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-Livermore in Livermore, California, from October 1, 1957 through December 31, 1994, 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. During this period, employees at this facility were involved with nuclear ordnance design and testing, and scientific research.

The evaluation responds to Petition SEC-00214 which was submitted by an EEOICPA claimant whose dose reconstruction could not be completed by NIOSH due to a lack of sufficient dosimetry-related information. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at Sandia National Laboratories-Livermore (abbreviated as SNL-Livermore throughout most portions of this report) from October 1, 1957 through December 31, 1994 and the information available to NIOSH to characterize particular processes and radioactive source materials. Using available sources, NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of radionuclides of concern, and information describing processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

4.1 Operations Description

SNL-Livermore activities were established in Livermore, California in early 1956 to provide direct support for Lawrence Livermore National Laboratory (LLNL) nuclear weapons designs (SNL, 2005). Design support for LLNL was originally provided by a small group of engineers and support staff. Initially, approximately two dozen employees worked with LLNL on LLNL property in abandoned naval air station barracks (Johnson, 1997, pdf p. 90). By the end of 1956, plans were completed to increase Livermore staff to about 1,000 personnel and to invest 5 million dollars in the construction of permanent buildings and support facilities across the street from LLNL. SNL-Livermore employees occupied their first building (Building 911) on the newly developing SNL-Livermore site in October 1957 (Johnson, 1997, pdf p. 90). By 1958, with over 800 employees, SNL-Livermore worked on the

[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.

W38 warhead for Titan I and Atlas missiles (Ullrich, 2003). The SNL-Livermore site presently consists of approximately 70 buildings/facilities on 410 acres and is located just across East Avenue from LLNL in Livermore, California. Although NIOSH does not know the specific number of employees on site for each year being evaluated in this report, various captured Atomic Energy Commission (AEC) Annual Radiation Reports indicate SNL-Livermore's worker population to have ranged from approximately 1,000 to 1,300. Table 4-1 (using employee counts from SNL-Albuquerque's Human Resource Department) shows the number of SNL-Livermore employees beginning in 1980 through 1994.

Table 4-1: SNL-Livermore Employee Population (1980-1994)

Year	No. of Employees		Year	No. of Employees		Year	No. of Employees
1980	1067		1985	1076		1990	1074
1981	1081		1986	1061		1991	1038
1982	1082		1987	1080		1992	1041
1983	1106		1988	1074		1993	1050
1984	1101		1989	1050		1994	1018

SNL-Livermore's primary mission during the time coinciding with the Cold War (1956 to 1989) was to design and test non-nuclear components of nuclear weapons designed by LLNL. SNL-Livermore was to engineer, or "weaponize," the nuclear physics packages designed by LLNL; production of parts and final weapons was accomplished at other weapons complex sites. Support for LLNL also expanded to include effects test analyses and telemetry for LLNL nuclear tests of nuclear weapon designs. In 1959, SNL-Livermore also moved into evaluation of nuclear detonation as part of the Plowshare Program (which ended in the early 1970s) (Ullrich, 2003).

Sandia Corporation, a Lockheed Martin Company, currently operates SNL-Livermore and Sandia National Laboratories-Albuquerque in Albuquerque. From 1956 to 1993, SNL-Livermore was managed and operated by American Telephone and Telegraph. In 1993, the contract was awarded to Martin Marietta Corporation, now known as Lockheed Martin Corporation (DOE, 2003, pdf p. 26).

The Environmental Test Building for the new SNL-Livermore site (completed by the end of 1958) was used for some testing of new designs. During the 1960s, additional support facilities were built, including storage and a maintenance shop. Additional test facilities (the centrifuge and Explosive Test Facility) were also constructed. In 1970, 86 acres were added to the site, providing an additional buffer area.

Although SNL-Livermore has never lost their core mission of nuclear ordnance design and testing, the laboratory moved further into scientific research in the late 1960s, bringing in scientists, mathematicians, and materials specialists to work in applied research. SNL-Livermore's initial move into research on tritium grew out of its familiarity with, and use of, tritium in components. In 1974, the first structure dedicated to tritium research at SNL-Livermore, the Tritium Research Laboratory (TRL), was added to the site, with completion of the basic laboratory building during the summer of 1975 (Garcia & Gorman, 1996, pdf p. 15). The TRL became operational in late 1978.

Ranging further from weapons engineering, SNL-Livermore also pursued combustion research and, during the 1973 to 1974 energy crisis, began conducting some research into alternative energy. The expanded purpose resulted in an increased variety of facilities within the site. In addition to the TRL, a large complex of structures for the Combustion Research Facility was completed in 1980. An additional 24 acres of land was added as a buffer zone on the east side near the Tritium Facility in 1979. In 1986, an additional 228 acres was obtained, allowing an alternative exit route from the facility. Finally, in 1998, SNL-Livermore took part in a small land exchange to create a consistent buffer zone line along the western boundary, in which 2.8 acres were received in exchange for 5.4 acres (ORAUT-TKBS-0053). This brought the site's area down to 410 acres where it remains today.

In support of the various missions identified above, a number of activities were undertaken at SNL-Livermore over the years, some of which involved the handling and release of radioactive materials. A complete list of buildings including known information about present and past uses and the presence of radioactive materials is provided in *Summary Site Profile for Sandia National Laboratories in Livermore, California* (referred to as ORAUT-TKBS-0053 throughout this document). A subset of this building list has been compiled in Table 4-2 below to present the known major process complexes at the SNL-Livermore site that handled radioactivity in some manner over the years, and to show the predominant radiologically-related activities that took place in these complexes.

Although information is available indicating that SNL-Livermore employees were not physically located on SNL-Livermore property until October 1957, details of the early work performed and the first presence of radionuclides on the site are not available to NIOSH (detailed source term and process documentation for the earliest period of the site's development have not been captured). Without such documentation, NIOSH assumes that source terms potentially capable of producing external and internal exposures from October 1957 forward may have been present due to ongoing nuclear weapons design and test support work performed for LLNL.

Table 4-2: SNL-Livermore Major Process Complexes Handling Radioactivity
Table 4-2 spans two pages.

Area	Building Number(s)	Time Period	Activities	Radionuclides
Weapons Laboratory Facility Complex	910, 912, 913, 914, 916, and 918	1958–1998	Test/repair neutron detectors, machining of depleted uranium (DU), radiography of weapons components, radiography for materials science studies, tritium storage studies, ion beam analysis of materials, Radiflo leak tests	Depleted uranium, tritium, neutron generator, accelerators, sealed sources, amounts of krypton-85
Radiography	923	Unknown–Early 1990s	Radiography using X-rays, gamma rays, neutrons, and beta particles	Cobalt-60, iridium-192, californium-252, X-ray machines
Micro and Nano	941, 942,	Unknown–	Radiography for	In Building 941

Table 4-2: SNL-Livermore Major Process Complexes Handling Radioactivity
Table 4-2 spans two pages.

Area	Building Number(s)	Time Period	Activities	Radionuclides
Technologies Laboratories	and 943	Present	materials science studies	only: X-ray, uranium-238, and beta sources (sealed)
Former Tritium Research Laboratories (Currently the Chemical and Radiological Detection Laboratory)	967, 968, and 969	1974–1996	Tritium research: >0.1 g tritium handled in glovebox, 0.0005–0.1 g in high velocity air hoods	Tritium, depleted uranium (no radionuclides after decommissioning complete in 1996)
Explosives and Environmental Testing Complex	955, 956, 966, 972, 974, 976, 977, 978, 979, 981, and 983	1958–Present	Environmental testing of mock-up weapons and components	Depleted uranium
Storage Facilities	921, 927, 961, and 982	Unknown–Present	Storage and packaging of waste materials	Tritium, depleted uranium, natural thorium, trace plutonium-239 and mixed fission products

Notes: This table is a modified version of Table 2-1from ORAUT-TKBS-0053.

According to SNL-Livermore annual environmental reports dating back to 1983, the laboratory typically handled kilogram amounts of depleted uranium, gram amounts of tritium (when the TRL was operational), and only microcurie quantities of other isotopes (SNL, 1983, pdf p. 3). However, the 1992 Environmental Impact Statement for LLNL and SNL-Livermore noted that 100 Ci iridium-192 and cobalt-60 radiographic isotopes and many other smaller sealed sources with activity ranging from 1 μCi to 500 mCi, were stored in a shielded radiography cell (DOE, 1992; ORAUT-TKBS-0053).

DU is, and has been, largely in the form of alloyed metal components, often encapsulated (ORAUT-TKBS-0053). Wet machining of uranium metal did occur over the years (SOP#1066; ORAUT-TKBS-0053). Powdered depleted uranium sealed in storage containers for tritium-storage studies (as the tritide) has also been present (post-1988) in approximately 1-kg amounts (SOP#757). A classified activity involving powdered uranium hydride in gram amounts was conducted in gloveboxes in buildings 979, 916, and the TRL (Personal Communication, 2006). There were some thorium metal parts used on test systems as well (Personal Communication, 2006).

Classified interviews and data capture work have also revealed that kg quantities of highly enriched uranium were on site during the middle 1960s to the middle 1970s. Additionally, kilogram quantities of thorium were present from the middle 1970s to middle 1980s.

4.2 Radiation Exposure Potential from Operations

The potential for external radiation dose existed at multiple SNL-Livermore locations including the Weapons Laboratory Facility Complex, Radiography, Micro and Nano Technologies Laboratories, the Explosives and Environmental Testing Complex, and the storage facilities. Radionuclide sources potentially involved include highly enriched uranium, uranium hydride, thorium, and other various sources, as identified in Table 4-3 below. Based on the site operations outlined in Section 4.1, beta, photon, and neutron exposures were possible and are estimated and summarized in Table 4-3. Additional classified activities may have also resulted in external dose potential.

Table 4-3: SNL-Livermore Radiation Types, Energies, and Percentages
Table 4-3 spans two pages.

Area	Process Description	Radiation Type	Energy Selection (keV)	Percentage [a]
Weapons Laboratory Facility Complex (Buildings 910, 912, 913, 914, 916, 918) Years: 1958-1998	Test/repair of neutron and X-ray detectors (neutron and X-ray generators)	Photon Neutron	>250 10-100 100-2,000 2,000-20,000	100 5 5 90
	Wet machining of depleted uranium	Beta Photon	>15 30-250 >250	100 50[b] 50[b]
	Radiography for weapons components	Beta Photon	>15 30-250 >250	100 50[b,c] 50[b,c]
	Radiography for materials science studies (X-ray diffraction operations later moved to building 941)	Beta Photon	>15 <30 30-250 >250	100 40 30 30
	Tritium storage studies	Photon	30-250 >250	50[b,d] 50[b,d]
	Ion beam analysis of materials	Photon	30-250 >250	30 70
	Radiflo leak tests	Beta Photon	>15 30-250 >250	100 10 90
Radiography (Building 923) Years: Unknown-Early 1990s	Radiography using X-rays, gamma rays, neutrons, and beta particles (cobalt-60, iridium-192, californium-252)	Beta Photon Neutron	>15 <30 30-250 >250 10-100 100-2,000 2,000-	100 5 45 50 5 70 25

Table 4-3: SNL-Livermore Radiation Types, Energies, and Percentages
Table 4-3 spans two pages.

Area	Process Description	Radiation Type	Energy Selection (keV)	Percentage [a]
			20,000	
Micro and Nano Technologies Laboratories (Buildings 941, 942, and 943) Years: Unknown-Current	Radiography for materials science studies (radiological materials in building 941 only; uranium-238 and sealed beta sources)	Beta Photon	>15 <30 30-250 >250	100 40 30 30
Explosives and Environmental Testing Complex (Buildings 955, 956, 966, 972, 974, 976, 977, 978, 979, 981, 983) Years: 1958–Current	Environmental testing of mock-up weapons and components (DU)	Beta Photon	>15 30-250 >250	100 50 50
Storage Facilities (Buildings 921, 927, 961, 982) Years: Unknown–Current	Storage and packaging waste materials (tritium, natural thorium, trace plutonium-239, and mixed fission products)	Beta Photon	>15 30-250 >250	100 70 30

Notes:
This table is a modified version of Table 6-4from ORAUT-TKBS-0053.
a. Estimated primarily by site personnel.
b. Based on favorable to claimant default assumptions provided for depleted uranium.
c. Assumes radiography primarily associated with weapons mock-ups and depleted uranium.
d. Assumes only external exposures would be associated with depleted uranium beds in tritium storage facility.

Primary sources of internal radiation exposure at the site included tritium research conducted in TRL, limited uranium operations, and depleted uranium machining. Information obtained via classified interviews and data capture indicated that highly enriched uranium and thorium were onsite in significant quantities. Activities involving these sources included classified work, which may also have presented internal exposure potentials.

The TRL was completed in 1978 for the purpose of performing research and development functions for the DOE Office of Defense Programs to support weapons development. At its peak operation, the TRL employed approximately 35 experimenters and support personnel (Garcia & Gorman, 1996, pdf p. 10). TRL operations were generally concerned with the physical and chemical characterization of tritium and its compounds. It was generally handled in the form of a gas, although effluents could be in the form of a gas, liquid, or solid. Additional work included fabrication of tritium compounds for use as engineering components and examining the behavior of hydrogen isotopes and helium in metals to understand transport and structural properties. All operations involving gram quantities of tritium were conducted inside gloveboxes. Other activities using smaller quantities were performed in the "Radioactive Materials Area" which was separated from the rest of the facility by two sets of double doors. The ventilation system for this area was designed to direct airflow from clean areas to areas of increasing contamination potential (Wright, 1981). Mixed solid and liquid tritiated waste was generated; the majority of the waste was in the form of scintillation cocktails, which were shipped

offsite for incineration in Florida (ORAUT-TKBS-0053). Larger (gram quantities) of tritium operations were terminated in 1992. Cleanup and tritium inventory reduction activities were conducted at the TRL from 1992 through 1994. In November 1994, DOE reclassified the TRL as a non-nuclear, low hazard, general-purpose facility. All radioactive source materials were removed by 1996 (Johnson, 1997b, pdf p. 8)

A Uranium Tritide Bed installed at the TRL in 1991 to store tritium as uranium tritide also presented a potential for exposure to uranium powder (SOP#757). In addition, parts contaminated with uranium dioxide dust were received by SNL-Livermore (Lovell, 1982), posing a potential airborne dust hazard. A Safe Operating Procedure (SOP) issued in September 1994 stipulates operating procedures for the bed, indicating it was still in use at that time (SOP, 1994, pdf p. 6).

Uranium alloy machining was performed at the SNL-Livermore facility beginning in approximately 1971 (Adolphson, 1972). Several memos indicate that machining and testing of uranium alloys had previously been performed at the Union Carbide Y-12 plant and elsewhere. However, requirements for SNL-Livermore were such that they needed "between 50 and 100 specimens of various shapes and sizes per month" (Adolphson, 1972), thus requiring initiation of an on-site program. The machining was routinely done via a wet process. In addition to an inhalation exposure potential (relatively low when using a wet process), uranium machining also posed a potential exposure via industrial hazards such as wounds. All such incidents were to be reported to the Medical Department and wound counts made on any puncture wounds; however, no data on wound counts were found in the available records.

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations at the SNL-Livermore site is from 1956 through present. In early 1956, approximately two dozen employees worked with LLNL on LLNL property in abandoned naval air station barracks (Johnson, 1997a, pdf p. 90). By the end of 1956, plans were completed to increase Livermore staff to about 1,000 personnel and to invest 5 million dollars in the construction of permanent buildings and support facilities across the street from LLNL. SNL-Livermore employees occupied their first building (Building 911) on the newly developing SNL-Livermore site in October 1957 (Johnson, 1997a, pdf p. 90).

NIOSH has encountered data retrieval problems while processing individual claims and performing SNL-Livermore data capture work. The data retrieval issues appeared to potentially affect significant portions of the covered time period and impact all types of workers. As such, NIOSH determined that the entire time period through 1994 warranted evaluation. Towards the end of 1994, internal and external monitoring program oversight was being performed by the SNL-Albuquerque site and database use to maintain resultant data was becoming integrated. Because SNL-Livermore employees were located on LLNL property from 1956 until October 1957, any worker exposures incurred during that time would be determined in association with an EEOICPA evaluation for LLNL.

Prior to the early 1990s, SNL-Livermore's monitoring program and subsequent records retention were all performed on site. During this period, records were primarily in hard copy form and no centralized records center or database storage was being used. As centralized record storage databases were being

developed at SNL-Albuquerque (approximately 1989 for external data and 1993 for internal data), SNL-Livermore records, records retention, and oversight of the SNL-Livermore monitoring program were being transferred to SNL-Albuquerque. The data transfer process apparently started around 1990 and occurred over several years. This sequence of events and the preliminary analysis of EEOICPA claimant data associated with SNL-Livermore indicate that the storage of both internal and external SNL-Livermore monitoring data, either in reliably retrievable hard-copy form or within the developing databases systems, was likely not well established until the 1993-1994 time period. SNL-Livermore monitoring data sufficiency from 1995 to present is not within the scope of this evaluation but is being assessed in conjunction with an ongoing SNL-Albuquerque database evaluation.

4.4 Site Locations Associated with Radiological Operations

Because SNL-Livermore employees were located on LLNL property from 1956 until October 1957, any worker exposures incurred during that time would be determined in association with an EEOICPA evaluation for LLNL. NIOSH has determined that the site-specific and claimant-specific data available for this evaluation are insufficient to allow NIOSH to characterize worker movements across the SNL-Livermore site between areas containing radiological source material and other areas of the site during the portion of the evaluation period presented in this report (effectively October 1, 1957 through December 31, 1994). NIOSH is unable to accurately assess whether an energy employee, or class of employees, did or did not potentially enter specific areas of the SNL-Livermore site having the potential for radiological exposures during the defined period of time. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations at SNL-Livermore during the period from October 1, 1957 through December 31, 1994.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has determined that the site-specific and claimant-specific data available for SNL-Livermore for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group was not potentially exposed to radioactive material releases or possible subsequent contamination.

NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions.

5.0 Summary of Available Monitoring Data for the Proposed Class

The primary data used for determining internal exposures are derived from personal monitoring data, such as urinalyses, fecal samples, and whole-body counting results. If these are unavailable, the air monitoring data from breathing zone and general area monitoring are used to estimate the potential internal exposure. If personal monitoring and breathing zone area monitoring are unavailable, internal exposures can sometimes be estimated using more general area monitoring, process information, and information characterizing and quantifying the source term.

This same hierarchy is used for determining the external exposures to the cancer site. Personal monitoring data from film badges or thermoluminescent dosimeters (TLDs) are the primary data used

to determine such external exposures. If there are no personal monitoring data, exposure rate surveys, process knowledge, and source term modeling can sometimes be used to reconstruct the potential exposure.

A more detailed discussion of the information required for dose reconstruction can be found in OCAS-IG-001, *External Dose Reconstruction Implementation Guideline,* and OCAS-IG-002, *Internal Dose Reconstruction Implementation Guideline*. These documents are available at: http://www.cdc.gov/niosh/ocas/ocasdose.html.

5.1 Data Capture Efforts and Sources Reviewed

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding SNL-Livermore. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of the available SNL-Livermore 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 in this report. 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.

5.2 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 5-1 summarizes the results of this review. (NOCTS data available as of July 18, 2013)

Table 5-1: No. of SNL-Livermore Claims Submitted Under the Dose Reconstruction Rule	
Description	**Totals**
Total number of claims submitted for dose reconstruction	132
Total number of claims submitted for energy employees who worked during the period under evaluation (October 1, 1957 through December 31, 1994)	123
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).	105
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	25
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	112

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Of the total of 123 claims submitted for employees who worked during the period under evaluation, SNL-Livermore has responded to 120 claims. Of these 120 claims, SNL-Albuquerque has supplied internal monitoring data for 21 claimants (~18%). NIOSH captured internal monitoring data for an additional four claimants. Of the 120 claims receiving SNL-Livermore/DOE responses, SNL-Albuquerque has supplied external monitoring data for 71 claimants (59%). NIOSH captured external monitoring data for an additional 41 claimants.

5.3 Worker Interviews

There have been multiple SNL-Livermore worker interviews (individual and group interviews) with current and former SNL-Livermore personnel. Some of these interviews were performed by NIOSH, while others were interviews performed by organizations for purposes other than supporting this specific evaluation report. These interviews have been considered and referenced throughout this evaluation. Interviews have been conducted via telephone and in person. They were conducted in accordance with site procedures for both classified and unclassified activities and are referenced below:

- Personal Communication, 2006, *Personal Communication with an SNL-Livermore Health Physicist*; In-Person Interview by ORAU Team; April 12, 2006; SRDB Ref ID: 23574

- Personal Communication, 2009a, *Personal Communication with an SNL-Livermore Site Historian*; In-Person Interview by SC&A/Saliant; February 18, 2009; SRDB Ref ID: 119139

- Personal Communication, 2009b, *Personal Communication with an SNL-Livermore Engineer/Management*; In-Person Interview by SC&A/Saliant; June 9, 2009; SRDB Ref ID: 119135

- Personal Communication, 2009c, *Personal Communication with an SNL-Livermore Research Chemist*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119134

- Personal Communication, 2009d, *Personal Communication with an SNL-Livermore Radiation Protection Worker*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119136

- Personal Communication, 2009e, *Personal Communication with an SNL-Livermore Worker Involved in Environmental Monitoring*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119137

- Personal Communication, 2009f, *Personal Communication with an SNL-Livermore Radiation Technician*; In-Person Interview by SC&A/Saliant; June 11, 2009; SRDB Ref ID: 119138

- Personal Communication, 2009g, *Personal Communication with an SNL-Livermore Mechanical Engineer*; Telephone Interview by SC&A/Saliant; June 15, 2009 & June 28, 2009; SRDB Ref ID: 119141

- Personal Communication, 2013a, *Personal Communication with Seven Former SNL-Livermore Employees*; In-Person Interviews by NIOSH; multiple interviews with dates ranging from January 19-24, 2013; SRDB Ref ID: 125770 & 125792

- Personal Communication, 2013b, *Personal Communication with Two SNL-Livermore Workers*; In-Person Interviews by NIOSH; January 22, 2013; SRDB Ref ID: 125756

5.4 Internal Personnel Monitoring Data

This section provides a summary of the types of internal personnel monitoring data known to have been collected (but not necessarily available to NIOSH**)** during the October 1, 1957 through December 31, 1994 evaluation period at SNL-Livermore. The information has been obtained via interviews with SNL-Livermore workers and through document data capture efforts. Monitoring data for the vast majority of this time period exists almost exclusively in hard copy form, in individual worker files, and in generally poorly indexed inactive record storage. As a result, NIOSH is unable to ascertain an accurate number of total internal and external monitoring results for the monitored site workers over the evaluated period. Additional details of problems associated with record storage are detailed in Section 6.0 of this evaluation.

Work with radionuclides that created a potential for internal exposure at SNL-Livermore included depleted uranium machining, tritium research conducted in the TRL, classified operations, and other various research projects over the years (ORAUT-TKBS-0053). Highly enriched uranium and thorium were also known to be onsite and could possibly have been sources of internal exposures. Radiation workers were monitored for internal exposures using urine bioassay.

Based on available monitoring data, the radionuclides of primary concern for internal dosimetry at SNL-Livermore appear to have been tritium and uranium. Tritium exposure occurred primarily in the TRL. The primary detection method for intakes of tritium at SNL-Livermore has been urine bioassay (Potter, unspecified). There is no evidence that urine bioassay samples were analyzed for any radionuclides except tritium and uranium, or that other types of bioassay (i.e., fecal analyses or *in vivo* counting) were employed at SNL-Livermore prior to 1992. However, preliminary examination of SNL-Albuquerque's internal monitoring database indicates that a few monitoring data are available

for thorium and plutonium isotopes, americium, and mixed fission products starting in 1992. Thus far, no internal monitoring data other than urine bioassay samples for uranium and tritium have been provided during the EEOICPA claims process.

The uranium bioassay was performed on individuals involved in machining depleted uranium as well as others involved with handling uranium powders or those defined as "Radiation Workers" in areas where air concentrations potentially exceeded 10% of the air concentration guidelines. Captured documentation indicates that this monitoring requirement and definition was implemented in 1979 (Wright, 1979). Although bioassay monitoring was performed earlier, monitoring program procedural documentation stipulating requirements have not been captured. Additionally, insufficient data availability precludes using co-worker models to fill in data gaps.

5.4.1 Tritium Bioassay

According to a final facility status report for TRL (Garcia & Gorman, 1996), tritium bioassays were performed on a weekly basis for individuals involved in experimental work at the TRL from 1979 through 1995 when the TRL was decommissioned. Individuals working in the Waste Handling Facility may also have participated in the tritium bioassay program, at least during 1991 (Garcia, 1991a; Garcia, 1991b). Bioassays were also required for all personnel inside the TRL when an evacuation alarm occurred (ORAUT-TKBS-0053). Additional samples were required in some cases by Safe Work Permits (SWPs) or at the discretion of health physicists. The *Tritium Research Laboratory Safety Analysis Report* (Wright, 1981) specifies weekly bioassay with samples analyzed by liquid scintillation counting (Wright, 1981, pdf p. 100). Laboratory analyses were performed, in house, by the Health Physics Division. As evidenced by reviewed documentation, doses were calculated and reported on a monthly basis.

A 1993 memo (Wright, 1993) describes the methods by which tritium bioassay data were managed between 1977 and 1993. According to the memo, bioassay results were originally maintained in a VAX text file. The VAX files were transferred into REFLEX, a database management program in 1988. In 1990, the files were sent to SNL-Albuquerque for entry into personnel dosimetry histories. As of 1993, the date of the memo, the bioassay data were collected by SNL-Livermore and a hard copy was sent to SNL-Albuquerque on a monthly or quarterly basis.

The TRL Health Physics Quarterly Summaries from 1988 through 1995 confirm that urine specimens were collected on a weekly basis and tritium concentrations were determined by liquid scintillation counting. Initially, absorbed doses were calculated for all individuals whose urine bioassay results indicated that they might have received a dose greater than 10 mrem per calendar quarter based on the fact that 10 mrem was the reported sensitivity of the TLDs used for external dosimetry. From 1991 through 1992, absorbed doses were calculated for individuals whose bioassay results indicated a dose greater than 2 mrem per calendar quarter (ORAUT-TKBS-0053). From 1993 through 1995, absorbed doses were calculated for individuals whose bioassay results indicated a dose greater than 1 mrem per calendar month (ORAUT-TKBS-0053).

5.4.2 Uranium Bioassay

Uranium bioassays were required for SNL-Livermore workers involved in depleted uranium machining and other operations where airborne uranium might have been encountered. The urine

bioassay criteria for depleted uranium were described in 1979 correspondence (Wright, 1979). Documentation of earlier monitoring requirements have not been captured. The criteria for minimum routine (semi-annual) uranium bioassay (from 1979 forward at least) were as follows:

- When air sampling results show concentrations at or greater than 10% of the concentration guide of 1E-10 µCi/cm^3.
- For routine handling of uranium hydrides, solutions of uranium compounds, and uranium powders (>4 times per quarter).
- Machining of uranium.
- During any operation that the Hazards Control Division deemed hazardous, or requires air sampling in a SOP or SWP.

Non-routine bioassays were performed in the following situations:

- Cut or lesion during handling or machining of uranium.
- An individual in close proximity or exposed to a uranium metal fire.
- Skin contact with a solution of uranium.

DU alloy machining was performed under SOP 1066 (SOP#1066). The SOP required that all machining operations be performed wet, reducing the risk of fire and generation of airborne dust. The SNL SOP #1066 required semi-annual urine bioassay for uranium but noted that "more frequent urine samples are usually collected" (SOP#1066, pdf p. 4).

5.5 External Personnel Monitoring Data

Historical documentation related to radiological protection programs at SNL-Livermore indicates that external dosimetry monitoring for workers and visitors has been performed throughout the site's history. As was the case with internal monitoring data as noted above in the internal monitoring data section, little of the external monitoring data applicable to the time period being evaluated are stored electronically; instead, monitoring data are stored in individual worker files or poorly-indexed inactive storage. Efficient retrieval of records for compiling total available measurements and results by NIOSH has not been feasible.

From 1956 to 1959, LLNL performed external film dosimetry monitoring services for SNL-Livermore (ORAUT-TKBS-0053). After that, a commercial vendor called Radiation Detection Company (RDC) provided film dosimetry services until the early 1970s (Hanzel, 1960, pdf p. 5; Monitoring Results, 1961-1962; Campbell et al., 1962; Various, 1964; Lovell, 1966; Monitoring Results, 1969). In 1962, there was a brief transfer of contracted film processing services from RDC to a similar provider called Tracerlab (Campbell et al., 1962; ORAUT-TKBS-0053), but Tracerlab was quickly dropped due to poor performance and the contract with RDC was re-established. From about 1972 to 1988, SNL-Livermore external dosimetry was outsourced to the DOE Radiological and Environmental Sciences Laboratory (RESL) in Idaho Falls, ID (Wright, 1993; Wallace, 1988). In 1989, dosimetry services for

SNL-Livermore were transferred to SNL headquarters in Albuquerque, New Mexico. In 1991, the dosimetry processing laboratory at SNL-Albuquerque became DOE Laboratory Accreditation Program (DOELAP)-accredited (Loesch, 1991) as part of the overall plan to provide centralized, unified, and permanent dosimetry services for SNL-Livermore and other Sandia sites (Stanley, 1991; Ward, 1994; ORAUT-TKBS-0053).

Documents from early in SNL-Livermore's history indicate a policy of maintaining permanent dosimetry records (ORAUT-TKBS-0053). Between 1956 and 1959, most SNL-Livermore employees, contractors and visitors were required to wear dosimeter badges (Hanzel, 1960; ORAUT-TKBS-0053). Though LLNL was performing dosimetry services for SNL-Livermore during this time, records management was implemented manually by on-site personnel. Records management continued to be administered by SNL-Livermore (Division 8242-2) for the subsequent period in which RDC provided dosimetry services (1959 to about 1971). By 1965, discussions among SNL-Albuquerque management were taking place with respect to the need to badge all on-site personnel versus badging only personnel with access to "exclusion zones" (areas where radiation fields were present). Eventually, the policy of badging all personnel was abandoned in favor of badging only individuals with potential to exceed certain exposure limits, which appears to have occurred in 1970, according to summarized annual reports of external exposures (Monitoring Results, 1958-1978; ORAUT-TKBS-0053). In 1989, oversight of the external dosimetry program at SNL-Livermore was transferred to SNL-Albuquerque and has since been directed and managed by SNL-Albuquerque's Personnel Dosimetry Department 7715, with on-site oversight and implementation conducted by SNL-Livermore's Personnel Dosimetry Department 8541 (Ward, 1994).

5.6 Workplace Monitoring Data

Though captured documents indicate that some workplace monitoring (air sampling, surveys, smears, etc.) was performed over the years, to date, almost no results applicable to the 1957 through 1994 period have been located. A few survey summaries have been captured as well as some 1994 general area air monitoring results for the TRL. NIOSH has recently obtained permission to view an index that may allow for retrieval of at least some historical workplace monitoring data. However, it is not anticipated that the availability of these data will negate the infeasibility of performing dose reconstruction due to insufficient access to personal monitoring data and source term information. Findings from a 1990 DOE Tiger Team assessment noted improperly calibrated portable and fixed air sampling units, no flow calibration procedures, and no flow calibration data availability (DOE, 1990, pdf p. 286).

5.7 Radiological Source Term Data

The limited source term information available to NIOSH that is relevant to this evaluation was presented in Section 4.1. NIOSH has performed seven data capture visits to SNL-Livermore. Over 1,000 records have been captured. Multiple interviews have also been performed (see Section 5.3). Nevertheless, NIOSH lacks sufficiently detailed source term information on unclassified and classified activities that would allow it to confidently estimate all potential exposures that may have occurred. Potential exposure locations include at the Weapons Laboratory Facility Complex, Radiography, Micro and Nano Technologies Laboratories, the Explosives and Environmental Testing Complex, the TRL, and the storage facilities. Radionuclides include tritium, depleted uranium, highly

enriched uranium, uranium tritide, uranium hydride, various isotope sources utilized within the Radiography Facility, and thorium. Classified activities may have also presented additional potential exposure sources.

6.0 Feasibility of Dose Reconstruction for the Proposed Class

42 C.F.R. § 83.14(b) states that HHS will consider a NIOSH determination that there was insufficient information to complete a dose reconstruction, as indicated in this present case, to be sufficient, without further consideration, to conclude that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy.

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already determined that a dose reconstruction cannot be completed for an employee at the DOE or AWE facility. This determination by NIOSH provides the basis for the petition by the affected claimant. Per § 83.14(a), the NIOSH-proposed class defines those employees who, based on completed research, are similarly affected and for whom, as a class, dose reconstruction is similarly not feasible.

In accordance with § 83.14(a), NIOSH may establish a second class of co-workers at the facility for whom NIOSH believes that dose reconstruction is similarly infeasible, but for whom additional research and analysis is required. If so identified, NIOSH would address this second class in a separate SEC evaluation rather than delay consideration of the claim currently under evaluation (see Section 10). This would allow NIOSH, the Board, and HHS to complete, without delay, their consideration of the class that includes a claimant for whom NIOSH has already determined a dose reconstruction cannot be completed, and the only possible remedy under EEOICPA is the addition of a class of employees to the SEC.

This section of the report summarizes research findings by which NIOSH determined that it lacked sufficient information to complete the relevant dose reconstruction and on which basis it has defined the class of employees for which dose reconstruction is not feasible. NIOSH's determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions.

Section 6.0 describes what is known about pre-1994 monitoring data and source term information availability. Historical data storage practices, and the handling and disposition of data transferred from SNL-Livermore to SNL-Albuquerque have both adversely impacted current data availability making dose reconstruction infeasible. Comparisons of claimant monitoring data supplied by SNL-Albuquerque/DOE (now located in the NOCTS database) to data captured by NIOSH have been made. Discrepancies in data availability noted during these comparisons further highlight the frequent inconsistency between data originally collected, and that which can reliably and efficiently be retrieved from current data storage locations during claims processing. It is noteworthy that similar discrepancies stemming from data retention and availability were observed during the SNL-Albuquerque site SEC-00188 evaluation (NIOSH, 2012). Those discrepancies resulted in inclusion of a class into the SEC for all workers at that site up through 1994. As mentioned previously, the early 1990s time period also saw SNL-Albuquerque assuming responsibility for the SNL-Livermore monitoring program direction and record retention.

Details for internal and external monitoring data comparisons (NOCTS versus site-supplied) will be discussed in their respective subsections below (6.1 and 6.2). To avoid repetition however, descriptions of the historical events simultaneously affecting both internal and external data availability and sufficiency are presented in this section.

According to interviews performed with site records personnel, the SNL-Livermore records storage during the 1957 through 1994 period was generally decentralized (ORAUT-TKBS-0053). Many different operations and areas of the site maintained their own records until 1993-1994 when an onsite Environmental, Safety and Health Records center was established. Efforts were made to consolidate records within the center, and also to transfer collected monitoring records to SNL-Albuquerque during the early 1990s time frame. This was because SNL-Albuquerque was to take over the administration and record maintenance functions for SNL-Livermore's occupational radiological monitoring program. The completeness of both the consolidation and transfer of records to SNL-Albuquerque is uncertain for several reasons. One reason is that periodically records were moved to long term storage in the Iron Mountain storage facility in Irvine, California, prior to the initiation of record transfers to the SNL-Albuquerque site. It has been learned through interviews that transferred record descriptions were generally insufficient to support required targeted identification and retrieval of monitoring records from Iron Mountain. Likewise, transferred record descriptions are insufficient to determine the total numbers and precise types of records moved to the facility. Personnel and area monitoring (and possible source term) records sent to the Iron Mountain repository have not been transferred back to the SNL-Albuquerque site.

Indexing of records received from SNL-Livermore during the early 1990s was also generally insufficient. Once received, an unknown number of these transferred records were subsequently moved into SNL-Albuquerque's inactive (long term) record storage without sufficient re-labeling so as to allow efficient, targeted retrieval. It appears that frequently the records were moved directly to long-term storage without making copies for personal files or entering into the databases being developed at the time. At some point, electronic entry of some of the transferred, hard-copy SNL-Livermore monitoring data was performed by students. However, these records are not considered official records by the site because the work was never quality checked.

An official listing of all historical dose records collected at SNL-Livermore is not available. As such, it is not currently possible to know how many SNL-Livermore monitoring records were originally generated during the 1957-1994 period, or how many of these records are now stored in either of the inactive record storage areas used by the two sites (without suitable, detailed indexing of the records for efficient retrieval). It is expected that the record storage problems described above affect other types of documents such as process, source term, and work place monitoring information.

6.1 Feasibility of Estimating Internal Exposures

NIOSH has evaluated the available personnel and workplace monitoring data and source term information and has determined that there are insufficient data for estimating internal exposures, as described below.

NIOSH has obtained relatively few internal monitoring data for the evaluated period. The total quantity of internal monitoring data potentially available from SNL-Albuquerque is likely low, due to

the relatively low internal exposure potential for many of the activities onsite. Bioassay data for the evaluated period have been provided in response to EEOICPA claimant data requests, and also found in NIOSH-obtained documents through various data capture processes. In addition to internet and onsite searches, NIOSH included records selected from inactive storage (long term) during data capture efforts.

A comparison of internal monitoring data obtained by NIOSH during its own data capture efforts to data supplied by SNL-Albuquerque for the EEOICPA claimant data requests has been performed. The results highlight the ongoing retrieval issues associated with data collected and stored prior to the first electronic storage systems being put in place. Of the 123 NOCTS claims filed with employment within the 1957 through 1994 period, at least 25 were monitored for internal doses based on data supplied by the site and/or obtained by NIOSH via data capture efforts. It is likely that more employees were monitored; however, no additional data have been captured or provided to date. Of these 25 monitored workers, NIOSH captured internal monitoring data for 4 workers (16%) for which the site supplied no internal monitoring data in EEOICPA claims responses. In addition to the four workers for whom the site supplied no internal monitoring data, NIOSH also captured reports for many of the other 25 workers that contained results not supplied by the site (different years). Numbers of individual internal monitoring reports (containing unique data) that were captured by NIOSH, but not supplied by SNL-Livermore during the EEOICPA claim dose reconstruction process are summarized by decade in Table 6-1.

Table 6-1: No. of Internal Monitoring Reports Captured by NIOSH and Not Supplied by SNL-Livermore

Decade	1950s	1960s	1970s	1980s	1990s
No. of Data Reports	2	2	8	18	3

The results highlight internal monitoring data availability and retrievability problems associated with the data collected from the beginning of the evaluated period up into the early 1990s, at a minimum. Two of the three 1990s monitoring reports captured by NIOSH (and not supplied by the site during claims processing) were from 1994. Capturing these documents highlights the unreliability of internal monitoring data storage and its subsequent availability for reconstructing internal doses up through 1994.

Historically decentralized record keeping practices, improper indexing of records placed in long term storage, and a lack of electronic record storage has also prevented NIOSH's ability to determine with confidence, that sufficient information associating job titles and/or job assignments with specific radiological operations or conditions are available. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions. In addition, due to index descriptions that are insufficient for efficient retrieval, it is not known to what extent documents describing processes, source terms, and workplace monitoring may have been either lost or transferred to inactive storage locations. At a minimum, it is known that among other radionuclides listed in Table 4-2, potential onsite radiation sources contributing to internal dose included depleted uranium, tritium, and uranium tritides and hydrides. Highly enriched uranium and thorium are also known to have been onsite in significant quantities per classified data capture work and may have also been dose sources.

In an attempt to obtain necessary process, source term, and work place monitoring details, NIOSH has performed seven data capture visits to the SNL-Livermore site and captured and reviewed over 1,000 records. Multiple interviews have also been performed (see Section 5.3). NIOSH has nevertheless determined it does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to tritium, highly enriched uranium, depleted uranium, uranium tritides and hydrides, thorium, and classified activities during the period of DOE operations. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to, tritium, highly enriched uranium, depleted uranium, uranium tritides and hydrides, thorium, and classified activities and resulting doses for the class of employees covered by this evaluation.

6.2 Feasibility of Estimating External Exposures

NIOSH has evaluated the available personnel and workplace monitoring data and source term information and has determined that there are data insufficiencies for estimating external exposures, as described below. Data insufficiencies described would be expected to affect all external monitoring data including beta, gamma, and neutron monitoring data.

External monitoring data for the evaluated period have been returned during EEOICPA claimant data requests, and also found in NIOSH-obtained documents through various data capture processes. In addition to internet and onsite searches, NIOSH included records selected from inactive storage (long term storage) during data capture efforts.

A comparison of external monitoring data obtained by NIOSH during its own data capture efforts to data supplied by SNL-A for the EEOICPA claimant data requests has been performed. The results highlight the ongoing retrieval issues associated with data collected by SNL-Livermore and data/documentation storage issues described in Section 6.0. Of the 123 SNL-Livermore worker EEOICPA claims filed with employment within the 1957-1994 period, at least 112 of those employees were monitored for external exposures based on data supplied by the site and/or obtained by NIOSH via data capture efforts. It is possible that more employees were monitored; however, to date, no additional data have been discovered or provided. Of these 112 workers monitored, NIOSH captured external monitoring data for 41 workers (~36 %) for which the site supplied no external monitoring data in EEOICPA claims responses. The number of individual external monitoring reports (containing unique data) that were captured by NIOSH, but not supplied by SNL-Livermore during the EEOICPA claim dose reconstruction process are summarized by decade in Table 6-2.

Table 6-2: No. of External Monitoring Reports Captured by NIOSH and Not Supplied by SNL-Livermore

Decade	1950s	1960s	1970s	1980s	1990s
No. of Data Reports	11	66	62	25	12

The results highlight external monitoring data availability problems associated with the beginning of the evaluated period up into the early 1990s at a minimum. Three of the twelve 1990s monitoring

reports captured by NIOSH (and not supplied by the site during claims processing) were from 1992. Capturing these documents highlights the unreliability of external monitoring data storage and its subsequent availability for reconstructing internal doses up through 1992 at least. Uncertainty currently surrounds process and source term information, and internal data availability information up to 1994 due to the data transfer and storage processes described in Sections 6.0 and 6.1 above. As such, NIOSH is unable to conclusively demonstrate that external monitoring data availability for 1993 and 1994 is sufficient to reconstruct doses incurred in those years for all workers.

As was the case for internal record availability, historically decentralized record keeping practices, improper indexing of records placed in long term storage, and a lack of electronic record storage has also prevented NIOSH's ability to determine with confidence that sufficient information associating job titles and/or job assignments with specific radiological operations or conditions are available. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions. In addition, with index descriptions that are insufficient for efficient retrieval, it is not known to what extent documents describing processes, source terms, and work place monitoring may have been either lost or transferred to inactive storage locations. At a minimum, it is known that among other radionuclides listed in Table 4-2, potential onsite radiation sources contributing to external exposure included highly enriched uranium, uranium hydrides, the Radiography Facility isotope sources, and thorium. Classified work likely also presented potential sources for exposure during the 1957-1994 period.

In an attempt to obtain necessary process, source term, and work place monitoring details, NIOSH has performed seven data capture visits to SNL-Livermore and captured and reviewed over 1,000 records. Multiple interviews have also been performed (see Section 5.3). NIOSH has nevertheless determined that it does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential external exposures to beta, gamma, and neutron radiation from highly enriched uranium, uranium hydrides, Radiography Facility isotope sources, thorium, and classified work during the period of DOE operations. Consequently, NIOSH finds that it is not feasible to estimate with sufficient accuracy beta, gamma, and neutron external exposures resulting from highly enriched uranium, uranium hydrides, Radiography Facility isotope sources, thorium, classified work, and resulting doses for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses for the period from October 1, 1957 through December 31, 1994, NIOSH intends to use any external 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-Livermore during the period from October 1, 1957 through December 31, 1994, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.3 Class Parameters Associated with Infeasibility

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations at the SNL-Livermore site is from 1956 through present. NIOSH has encountered monitoring data retrieval problems while processing individual claims and performing SNL-Livermore data capture work. The data retrieval issues appeared to potentially affect significant portions of the covered time period and impact all types of workers. As such, NIOSH determined that the entire operational time

period through 1994 warranted evaluation. Towards the end of 1994 internal and external monitoring program oversight was being performed by the SNL-Albuquerque site and database use to maintain resultant data was becoming integrated with their system. SNL-Livermore monitoring data sufficiency from 1995 to present is not within the scope of this evaluation.

NIOSH therefore recommends that the class include the period from October 1, 1957 through December 31, 1994. Because SNL-Livermore employees were located on LLNL property from 1956 until October 1957, any worker exposures incurred during that time would be determined in association with an EEOICPA evaluation for LLNL.

NIOSH has determined that there continues to be insufficient access control information and worker movement data to accurately assess whether an energy employee, or class of employees, did or did not potentially enter specific areas containing radiological source material and other areas of the site during the portion of the evaluation period presented in this report (October 1, 1957 through December 31, 1994). NIOSH recommends that the class definition include all buildings and all areas during the specified time period.

NIOSH has determined that the site-specific and claimant-specific data available for SNL-Livermore for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group was not potentially exposed to radioactive material releases or possible subsequent contamination. NIOSH has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions. Without such information, NIOSH is unable to define potential radiation exposure conditions based on worker job descriptions. NIOSH therefore recommends that the class include all workers, regardless of job titles or job/work descriptions during the proposed time period.

7.0 Summary of Feasibility Findings for Petition SEC-00214

This report evaluates the feasibility for completing dose reconstructions for employees at SNL-Livermore from October 1, 1957 through December 31, 1994. NIOSH determined that members of this class may have received radiation exposures from tritium, depleted uranium, highly enriched uranium, uranium tritides and hydrides, and thorium. NIOSH lacks sufficient information, which includes biological monitoring data, sufficient process, and radiological source information, that would allow it to estimate the potential internal and external exposures to which the proposed class may have been exposed.

NIOSH has documented herein that it cannot complete the dose reconstructions related to this petition. The basis of this finding demonstrates that NIOSH does not have access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate.

NIOSH finds that it is likely feasible to reconstruct occupational medical dose for SNL-Livermore workers with sufficient accuracy up through 1989. After 1989 medical X-rays are not applicable because they were performed offsite.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at SNL-Livermore during the period from October 1, 1957 through December 31, 1994, 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-00214

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. § 83.14(b) and § 83.13(c)(3). Pursuant to these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulations require 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 has determined that members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of radionuclides and from direct exposure to radioactive materials. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00214

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This 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-Livermore in Livermore, California, from October 1, 1957 through December 31, 1994, 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.

10.0 Evaluation of Second Similar Class

In accordance with § 83.14(a), NIOSH may establish a second class of co-workers at the facility, similar to the class defined in Section 9.0, for whom NIOSH believes that dose reconstruction may not be feasible, and for whom additional research and analyses is required. If a second class is identified, it would require additional research and analyses. Such a class would be addressed in a separate SEC evaluation rather than delay consideration of the current claim. At this time, NIOSH has not identified a second similar class of employees at SNL-Livermore for whom dose reconstruction may not be feasible.

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11.0 References

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

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

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

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

Adolphson, 1972, *Machining Test Specimens in Uranium Alloys*, correspondence to J. F. Bryson; D. R. Adolphson; April 7, 1972; SRDB Ref ID: 23662

Campbell et al., 1962, *Dosimetry Program Information*; collection of three correspondence; R. O. Campbell, Robert Crow, and Eugene Tochilin; June 1962 (7^{th}, 18^{th}, 19^{th}); SRDB Ref ID: 23724

DOE, 1990, *Tiger Team Assessment of the Sandia National laboratories Livermore, California*, DOE/EH-0141; Department of Energy (DOE); August 1990; SRDB Ref ID: 23554

DOE, 1992, *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, Volume II of V, Appendices A-D*, DOE/EIS-0157; Department of Energy (DOE); August 1992; SRDB Ref ID: 15935

DOE, 2003, *Final Site-Wide Environmental Assessment of the Sandia National Laboratories/California, DOE/EA-1422*; Department of Energy (DOE); January 2003; SRDB Ref ID: 28165

Garcia, 1991a, *Bioassay Program Requirements*, correspondence to K. K. Babcock; T. B. Garcia; April 3, 1991; SRDB Ref ID: 23664, pdf p. 3

Garcia, 1991b, *Radioactive/Mixed Waste Operations at Buildings 961 & 968*, correspondence to D. A. Wright; T. B. Garcia; May 24, 1991; SRDB Ref ID: 23664, pdf pp. 4-5

Garcia & Gorman, 1996, *Radiological Characterization and Final Facility Status Report Tritium Research Laboratory*, SAND96-8004. UC-407; T. B. Garcia and T. P. Gorman; Printed August 1996; SRDB Ref ID: 22982

Hanzel, 1960, *Review and Evaluation of Present Film Badge Radiation Monitoring Program, Sandia Corporation, Livermore Laboratory*, correspondence to G. L. Rhodes; Robert L. Hanzel; July 8, 1960; SRDB Ref ID: 23727 pdf pp. 5-9

Johnson, 1997a, *Sandia National Laboratories, A History of Exceptional Service in the National Interest*; Leland Johnson; printed in 1997; SRDB Ref ID: 84961

Johnson, 1997b, *Tritium Research Laboratory Cleanup and Transition Project Final Report*, SAND97-8009; A. J. Johnson; printed February 1997; SRDB Ref ID: 23424

Loesch, 1991, Laboratory *Accreditation of Sandia National Laboratories*, correspondence to Gene Runkle; Robert M. Loesch, Department of Energy; October 30, 1991; SRDB Ref ID: 19079

Lovell, 1966, *Summary of Film Badges Cost for Fiscal Year 1966*, correspondence to G. L. Rhodes; P. K. Lovell; September 13, 1966; SRDB Ref ID: 23678, pdf pp. 2-3

Lovell, 1982, *Handling D-38 Contaminated B-83 Parts at SNLL*, correspondence; P. K. Lovell; February 19, 1982; SRDB Ref ID: 24806

Monitoring Results, 1958-1978, *Summaries of Whole-Body Radiation Exposures to Ionizing Radiation for Various Dates from 1958 through 1978*; Sandia Laboratories; 1958-1978; SRDB Ref ID: 32731

Monitoring Results, 1961-1962, *External Dosimetry Data for Various Dates from 1961 through 1962*; 1961-1962; SRDB Ref ID: 23720

Monitoring Results, 1969, *Dosimetry Reports for Various Dates from June-December 1969*; Vendor is Radiation Detection Company; 1969; SRDB Ref ID: 32296 & 23729

NIOSH, 2012, *SEC Petition Evaluation Report for Petition SEC-00188, Sandia National Laboratories-Albuquerque*; National Institute for Occupational Safety and Health (NIOSH); February 21, 2012; SRDB Ref ID: 115521

ORAUT-TKBS-0053, *Summary Site Profile for Sandia National Laboratories in Livermore, California*, Rev. 00; ORAU Team Dose Reconstruction Project for NIOSH; Cincinnati, Ohio; May 1, 2007; SRDB Ref ID: 31467

Personal Communication, 2006, *Personal Communication with an SNL-Livermore Health Physicist*; In-Person Interview by ORAU Team; April 12, 2006; SRDB Ref ID: 23574

Personal Communication, 2009a, *Personal Communication with an SNL-Livermore Site Historian*; In-Person Interview by SC&A/Saliant; February 18, 2009; SRDB Ref ID: 119139

Personal Communication, 2009b, *Personal Communication with an SNL-Livermore Engineer/Management*; In-Person Interview by SC&A/Saliant; June 9, 2009; SRDB Ref ID: 119135

Personal Communication, 2009c, *Personal Communication with an SNL-Livermore Research Chemist*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119134

Personal Communication, 2009d, *Personal Communication with an SNL-Livermore Radiation Protection Worker*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119136

Personal Communication, 2009e, *Personal Communication with an SNL-Livermore Worker Involved in Environmental Monitoring*; In-Person Interview by SC&A/Saliant; June 10, 2009; SRDB Ref ID: 119137

Personal Communication, 2009f, *Personal Communication with an SNL-Livermore Radiation Technician*; In-Person Interview by SC&A/Saliant; June 11, 2009; SRDB Ref ID: 119138

Personal Communication, 2009g, *Personal Communication with an SNL-Livermore Mechanical Engineer*; Telephone Interview by SC&A/Saliant; June 15, 2009 & June 28, 2009; SRDB Ref ID: 119141

Personal Communication, 2013a, *Personal Communication with Seven Former SNL-Livermore Employees*; In-Person Interviews by NIOSH; multiple interviews with dates ranging from January 19-24, 2013; SRDB Ref ID: 125770 & 125792

Personal Communication, 2013b, *Personal Communication with Two SNL-Livermore Workers*; In-Person Interviews by NIOSH; January 22, 2013; SRDB Ref ID: 125756

Potter, unspecified, *Technical Basis Document for Internal Dosimetry at Sandia National Laboratories, Rev. 3, Radiation Protection Internal Dosimetry (RPID) Program*; prepared by C. A. Potter; unspecified date; SRDB Ref ID: 23582

SNL, 1983, *Sandia National Laboratories Livermore Environmental Summary for Calendar Year 1983*; SNL-Livermore; no publication date provided; SRDB Ref ID: 23130

SNL, 2005, *Site Environmental Report for 2004 for Sandia National Laboratories, California*, SAND 2005-2628; B. L. Larsen, Sandia National Laboratories; printed June 2005; SRDB Ref ID: 22925

SOP#757, *Safe Operating Procedure No. 757, Tritium Research Laboratory Uranium Tritide Bed*; dated/revised February 26, 1991; SRDB Ref ID: 23774

SOP#1066, *Sandia National Laboratories-Livermore SOP No. 1066, Machining Depleted Uranium Metal*, Rev. C; dated October 1, 1989; SRDB Ref ID: 23733

SOP, 1994, *ES&H Activity-Specific Standard Operating Procedure for Tritium Research Laboratory Uranium Tritide Bed*, SP472820 Issue B; September 1994; SRDB Ref ID: 71581

Stanley, 1991, *Basis for Wearing Only One Dosimeter*, correspondence to N. R. Ortiz with select pages of a DOE Handbook regarding the accreditation program for personnel dosimetry systems; A. L. Stanley; April 22, 1991; SRDB Ref ID: 18275

Ullrich, 2003, *Cold War Context Statement, Sandia National Laboratories, California Site*, SAND2003-0112; Rebecca A. Ullrich, Sandia National Laboratories; printed January 2003; SRDB Ref ID: 22926

Various, 1964, *Miscellaneous Dosimetry Details*; collection of ten correspondence; by various authors including R. O. Campbell, N. Holdon, P. K. Lovell, J. McNinn, R. Powell, C. L. Rhodes, and Eugene Tochilin; various dates from March through December 1964; SRDB Ref ID: 23689

Wallace, 1988, *Current Status of 1985 Headquarters Nuclear Facilities Appraisal (Ref. Audit E431)*, correspondence to W. V. Ormond with attached 1985 HQ appraisal of SNL-L; S. A. Wallace; September 9, 1988; SRDB Ref ID: 23585

Ward, 1994, *Sandia National Laboratories External Dosimetry Program*, Procedure No.PRDP-00-01; revised by D. C. Ward; effective date March 3, 1994; SRDB Ref ID: 19237

Wright, 1979, *Sandia Livermore's Bioassay Program from Depleted Uranium*, correspondence; Donn A. Wright; May 14, 1979; SRDB Ref ID: 24813

Wright, 1981, *Tritium Research Laboratory Safety Analysis Report*, SAND81-8234; D. A. Wright; printed August 1981; SRDB Ref ID: 22994

Wright, 1993, *History of Radiation Dosimetry at SNL-Livermore as Remembered by D. A. Wright*, correspondence to Lydia Perez; Donn Wright; June 1, 1993; SRDB Ref ID: 24811

Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for SNL-Livermore			
Data Capture Information	**Data Capture Description**	**Completed**	**No. Uploaded into SRDB**
Primary Site / Company Name: Sandia National Laboratories - California (SNL/CA); DOE 1956-present Contractors: Lockheed Martin (1995-present); Martin Marietta (1993-1995); AT&T (1956-1993) Physical Size of the Site: 423 acres Site Population: Currently 900 staff and 250 contractors, post-doctoral fellows, and student interns. There were 1,077 personnel on site in 1972.	Tritium Research Laboratory Health Physics reports, liquid scintillation counter procedures, external dosimetry procedures, ALARA plan, a facial hair procedure for respiratory protection, tritium bioassay results, uranium bioassay results, dosimetry program evaluations, external dosimetry results, machining depleted uranium metal, contamination surveys, neutron generator procedures and doses, handling contaminated components, a history of site radiation dosimetry, x-ray safety, safe operating procedures, procedures for tritium use outside the Tritium Research Laboratory, instrument calibrations, records transfer reports, environmental summaries, operating procedures for radiation sources, building survey reports, interview notes, tritium procedures, and x-ray procedures.	04/29/2013	338
State Contacted: NA	NOTE: Contacting the state was not considered necessary since SNL/ CA is an active DOE site and cooperated with relevant data collection.	07/22/2013	0
Brookhaven National Laboratory	A table showing external exposure totals at sites with accelerators.	11/14/2008	1
Cincinnati Public Library	The "Atoms for Peace" report and a discussion of possible combustion hazards in the 3013 plutonium waste container from radiolytic gas generation.	05/02/2012	2
Colorado State University	Site environmental reports, 1998 site aerial radiological survey, 1997 reclassification of the Tritium Research Laboratory, and a Tiger Team assessment.	04/10/2007	13
Department of Labor / Paragon	Chemical preparation procedures, periodic evaluation of respirator use requirements, site wide air emissions inventory and air emissions permits, and safe operating procedures.	02/25/2013	16
DOE Albuquerque Operations Office	A 1996 final environmental impact statement for operation of the Pantex Plant.	04/14/2010	1
DOE Germantown	DOE records search procedures and the 1965 AEC missions policy for design laboratories and production plants.	08/08/2012	3
DOE Laboratory Accreditation Program (DOELAP)	1988 DOE Laboratory Accreditation Program (DOELAP) applications for Albuquerque Operations Office facilities.	06/11/2009	1
DOE Legacy Management - Grand Junction Office	A reference to Sandia soil sample results.	09/03/2009	1

Table A1-1: Summary of Holdings in the SRDB for SNL-Livermore			
Data Capture Information	**Data Capture Description**	**Completed**	**No. Uploaded into SRDB**
DOE Legacy Management - Morgantown	A log book of incoming memos, a 1988 assessment of DOE environmental, safety, and health needs, and a log of material transfers.	01/27/2011	3
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	A report on incineration of solid wastes, the DOE effluent information system summaries for 1982 and 1984, the 1984 unusual occurrence summary, radionuclide air emissions for 1985, the DOE precious metals report for 1987, and press releases regarding the temporary suspension of waste shipments to commercial burial grounds.	04/23/2008	12
DOE Oak Ridge Operations Office	Audit criteria for industrial hygiene programs.	11/18/2011	1
DOE Office of Scientific and Technical Information (OSTI)	DOE facilities site maps, a report on nickel coatings on thorium and uranium metal, and an annual report of waste generation and pollution prevention progress.	02/22/2013	3
Donn Wright	Energy spectra for various Sandia National Laboratories, California activities and locations.	10/04/2006	1
Federal Records Center (FRC) - Denver	The Photodosimetry Evaluation Book Volume IV.	06/15/2010	1
Federal Records Center (FRC) - San Bruno	Health Physics quarterly reports, corrective action plan for tritium facilities, a report on high dosimeter readings at Lawrence Berkeley National Laboratory (LBNL), and participation by Sandia personnel in a LBNL safety review.	08/02/2012	6
Hanford	A 1943-1970 AEC radiation experience summary, a lab notebook, the EPA's background information on radionuclide air emissions, a nuclear materials transaction report, and the 1996 distribution of updated site profiles.	01/02/2013	5
Idaho National Laboratory (INL)	The report on the fourth topical meeting on tritium technology. SNL/CA provided a list of tritium incidents at the site.	04/04/2012	1
Interlibrary Loan	A survey of mixed-waste HEPA filters and the proceedings of the 1993 Incineration Conference.	05/29/2012	2
Internet	The 2004 report on residual beryllium contamination at DOE facilities.	06/07/2005	1
Internet - Defense Technical Information Center (DTIC)	A 1974 uranium alloy metallurgy report, a 1979 conference on alternative energy sources, and the 2010 global fissile material report.	01/09/2012	3
Internet - DOE	The 1998 DOE Standard, Guide of Good Practices for Occupational Radiological Protection in Plutonium Facilities.	05/11/2007	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	07/26/2013	0
Internet - DOE Environmental Management	Chapter 3 of "Linking Legacies".	10/28/2007	1
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant documents identified.	03/30/2012	0

Table A1-1: Summary of Holdings in the SRDB for SNL-Livermore			
Data Capture Information	**Data Capture Description**	**Completed**	**No. Uploaded into SRDB**
Internet - DOE Legacy Management Considered Sites	A 1993 DOE report on mixed wastes.	04/24/2012	1
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	03/30/2012	0
Internet - DOE OpenNet	Summaries of Mound purchase orders which include SNL/CA, Appendix B of "Linking Legacies", and metabolic studies.	04/24/2012	15
Internet - DOE OSTI	Reports on the cleanup of the Tritium Research Laboratory and an annual report of radioactive waste shipments to and from Nevada Test Site.	05/10/2006	2
Internet - DOE OSTI Energy Citations	2006 and 2007 shipments to and from the Nevada Test Site, pollution prevention and control reports, a Lawrence Berkeley National Laboratory institutional plan referencing joint ventures with SNL/CA, and Lawrence Livermore National Laboratory tritium release and environmental reports.	01/26/2013	13
Internet - DOE OSTI Information Bridge	DOE low-level waste reports, pollution prevention and control reports, 1998 shipments to and from Nevada Test Site, U.S. spent fuel and waste inventories reports, DOE air emissions reports, a Tritium Research Laboratory report, Savannah River Site reports on tritium technology research conducted with SNL/CA, and a 2010 former worker medical screening annual report.	01/26/2013	43
Internet - Environmental Protection Agency	No relevant documents identified.	07/23/2013	0
Internet - Google	SNL/CA environmental reports, LLNL environmental reports which mention SNL/CA, reports to Congress, workforce restructuring reports, DOE occupational exposure reports, the 2007 SNL/CA Administrative Record index, radioactive waste and waste transportation reports, and LLNL newsletters which mention SNL/CA.	04/04/2013	137
Internet - Health Physics Journal	An algorithm for TLD fade and the application of an ICRP clarification to the tritium metabolic model.	07/22/2013	2
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	07/22/2013	0
Internet - Lawrence Berkeley National Laboratory (LBNL)	LBNL environmental reports which mention SNL/CA.	10/18/2006	4
Internet - Lawrence Livermore National Laboratory (LLNL)	LLNL's 1999 monitoring plan which mentions SNL/CA.	02/07/2007	1
Internet - National Academies Press (NAP)	No relevant documents identified.	03/30/2012	0
Internet - NIOSH	2006 and 2008 DOE reports on residual radioactive and beryllium contamination in the DOE Complex.	08/31/2011	2
Internet - NRC Agencywide Document Access	The 1991 and 1992 integrated radioactive waste inventory reports, storage	03/28/2013	11

Table A1-1: Summary of Holdings in the SRDB for SNL-Livermore			
Data Capture Information	**Data Capture Description**	**Completed**	**No. Uploaded into SRDB**
and Management (ADAMS)	and disposition of weapons-usable materials reports, and design criteria for natural hazards reports.		
Internet - Sandia National Laboratories - California (SNL/CA)	Site environmental reports and the 2003 Cold War Context Statement.	03/26/2006	6
Internet - USACE/FUSRAP	No relevant documents identified.	03/30/2012	0
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	03/30/2012	0
Kansas City Plant	External dosimetry reports and 1998 testimony before Congress.	12/04/2012	5
Lawrence Berkeley National Laboratory (LBNL)	Livermore employee start and termination dates.	05/23/2007	1
Lawrence Livermore National Laboratory (LLNL)	LLNL environmental monitoring reports, tritium release reports, SNL/CA employee exposures at LLNL and the Nevada Test Site, and a 1977 LLNL and SNL/CA aerial survey.	10/20/2009	49
Los Alamos National Laboratory (LANL)	A 1987 environmental report and the DOE characterization report of Health Physics at accelerator facilities.	02/28/2012	2
Missouri Department of Natural Resources	1994 plutonium working group reports.	10/01/2008	2
Mound Museum	Mound research progress reports and a Mound newsletter.	02/01/2012	9
National Archives and Records Administration (NARA) - Atlanta	The DOE indoor radon study and Contolatron/Zetatron contamination issues.	08/12/2004	2
National Archives and Records Administration (NARA) - College Park	Notes taken by NIOSH researchers during a classified material review at the College Park NARA.	07/26/2010	2
National Institute for Occupational Safety and Health (NIOSH)	Worker outreach meeting minutes and Sandia records documentation.	08/27/2012	16
Nevada Test Site (NTS)	The 2003 Final Environmental Statement for NTS and other Nevada locations.	10/01/2003	1
Nuclear Regulatory Commission Public Document Room	The 1972 renewal application for License SNM-145.	11/22/2006	1
Nuclear Regulatory Commission Public Legacy Library	No relevant documents identified.	10/04/2012	0
Oak Ridge National Laboratory (ORNL)	A 1969 Isotopes Development Center newsletter.	01/14/2013	1
ORAU Team	A documented communication, a trip report, DOE annual reports of employee exposures, and the summary site profile and its classification review.	01/05/2012	8
Pantex	Surface contamination procedures for component reservoirs and radon studies.	10/27/2004	2
S. Cohen & Associates (SC&A)	Documented communications, tritium studies and release data, airborne	06/24/2010	64

Table A1-1: Summary of Holdings in the SRDB for SNL-Livermore			
Data Capture Information	**Data Capture Description**	**Completed**	**No. Uploaded into SRDB**
	radioactivity studies and data, a plutonium vulnerability report, DOELAP assessments, Operation Grommet radiological safety reports, worker monitoring lists, a 1994 incident data sheet, neutron studies, and internal dosimetry reports.		
SC&A / DOL/Paragon	The 1994 Tritium Research Laboratory tritium quantity analysis.	02/18/2009	1
SC&A / INL	A DOE environmental survey report on defense production facilities.	06/24/2010	1
SC&A / Pinellas Plant	The 1993 annual report on waste generation and minimization.	06/24/2010	1
SC&A / SNL/CA	Environmental Safety and Health quarterly reports, radiological safety assessments, dosimetry blind audits, urinalysis data, occurrence reports, Management Assurance Department reports, environmental dosimetry results, and air emissions monitoring and reports.	03/31/2009	49
SAIC	Radiation exposure summaries.	09/02/2004	5
Sandia National Laboratories - New Mexico	Ross Aviation shipment surveys, a comprehensive list of Sandia organizations with titles and dates, incident reports, internal dosimetry procedures, bioassay results, characterization of neutron fields, urinalysis results, tritium bioassay records, non-routine dosimeter evaluations, external dosimetry studies and procedures, and a Tiger Team environmental assessment.	01/01/2011	93
Sandia National Laboratories - New Mexico / SC&A	A 1986 compliance survey of Radiological Area 4.	09/15/2010	1
Tri Valley Cares	Final 1992 environmental impact statement with environmental impact report.	03/14/2005	1
University of Colorado Norlin Library	Environmental reports, the final environmental impact statement for SNL/CA and LLNL, radiological characterization of the Tritium Research Laboratory, and the waste characterization form the cleanup of the Tritium Research Laboratory.	06/07/2007	16
University of Colorado Norlin Library / Sandia National Laboratories - California	Site environmental report.	04/18/2006	1
Unknown	Historical reports, beryllium reports, the EEOICPA facility list, a database on thorium facility decommissioning, accident analysis for waste management activities, and a significant building project report.	10/12/2005	13
Unknown / SC&A	Pantex Plant dosimetry records.	08/19/2003	1
Total			**1,002**

Table A1-2: Internet Database Searches for SNL-Livermore			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Sandia CA (83 14)08-19-13."			
Defense Technical Information Center (DTIC) https://www.dtic.mil/ COMPLETED 04/24/2012	See Note above	1,200	5
DOE CEDR https://www.orau.gov/cedr COMPLETED 07/26/2013	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 03/30/2012	See Note above	0	0
DOE Legacy Management Considered Sites http://www.lm.doe.gov/considered_Sites/ COMPLETED 03/30/2012	See Note above	10	2
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 03/30/2012	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 03/30/2012	See Note above	49	3
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 03/29/2012	See Note above	2,105	15
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 03/28/2012	See Note above	877	1
EPA, National Service Center for Environmental Publication http://nlquery.epa.gov/epasearch/epasearch?querytext=%22Sandia+National+Laboratories%2C+Livermore%22&typeofsearch=epa&sort=term_relevancy&results_per_page=10&doctype=all&originalquerytext=%22sandia+national+laboratories%2C+livermore%22&areaname=&faq=yes&filterclause=%28inurl%3A%22www2.epa.gov%2Faboutepa%22%29&sessionid=23F90F4D1B752AF8277B9184661112AF&referer=http%	See Note above	360	0

Table A1-2: Internet Database Searches for SNL-Livermore			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
3A%2F%2Fwww.epa.gov%2Fncepihom%2F&prevtype=epa&result_template=epafiles_default.xsl&areasidebar=search_sidebar&areapagehead=epafiles_pagehead&areapagefoot=epafiles_pagefoot&stylesheet=&po= COMPLETED 07/23/2013			
Google http://www.google.com COMPLETED 04/22/2012	See Note above	112,870	62
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 07/22/2013	See Note above	136	3
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 07/22/2013	See Note above	0	0
National Academies Press http://www.nap.edu/ COMPLETED 03/30/2012	See Note above	1,755	0
NRC ADAMS Public Legacy Library http://adams.nrc.gov/wba/ COMPLETED 10/04/2012	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 10/17/2011	See Note above	3,495	11
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 03/30/2012	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 03/30/2012	See Note above	0	0

Table A1-3: Interlibrary Loan Documents Requested for SNL-Livermore			
Document Number	**Document Title**	**Requested Date**	**Received Date**
CONF-950601 REF ID: 114575	The 99Mo Production Program at Sandia National Labs, June 1995, Transactions of the American Nuclear Society, Annual Meeting of the American Nuclear Society, Vol. 72:141-142	05/01/2012	05/02/2012
NA REF ID: 114585	Possible Combustion Hazards in 3013 Plutonium Waste Container, 11/14/1999-11/18/1999, Transactions of the American Nuclear Society, Vol. 81:87-88, American Nuclear Society 1999 Winter Meeting	05/01/2012	05/02/2012
CONF-971125 REF ID:114597	Production of Fission and Activation Product Isotopes at Sandia National Laboratories, November 16-20, 1997, Transactions of the American Nuclear Society, Vol. 77:521-522, 1997 American Nuclear Society Winter Meeting	05/01/2012	05/02/2012
CONF-971125 REF ID: 114598	Waste Processing to Support 99Mo Production at Sandia National Laboratories, November 16-20, 1997, Transactions of the American Nuclear Society, Vol. 77:556-557, 1997 American Nuclear Society Winter Meeting	05/01/2012	05/02/2012
CONF-860610 REF ID: 114577	Improved Shielding Calculations for the Particle Beam Fusion Accelerator II, Transactions of the American Nuclear Society, June 15, 1986, Vol. 52:143-144	05/01/2012	05/02/2012
NA REF ID: 114582	Photoneutron Production Using Bremsstrahlung from the 14-TW HERMES III Electron Accelerator, July 1993, Nuclear Science and Engineering, Vol. 114(3):190-213	05/01/2012	05/02/2012
CONF-890723 REF ID: 114580	Neutron Effects in High-Power GaAs Laser Diodes, July 25-29, 1989, IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers), Vol. 36(6):2076-2082, Annual Conference on Nuclear and Space Radiation Effects	05/01/2012	05/02/2012
NA REF ID: 114599	A Survey of Mixed-Waste HEPA Filters in the DOE Complex, Feb 28, 2002, Waste Management 2002 Symposium, 14 pages	05/01/2012	05/03/2012
NA REF ID: 115622	133Cs NMR Study of Cesium on the Surfaces of Kaolinite and Illite, November 1996, Geochimica et Cosmochimica Acta, Vol. 60(21):4059-4074	05/01/2012	05/09/2012
NA REF ID: 115625	Using the Tritium Plasma Experiment to Evaluate ITER PFC Safety, June 1993, Journal of Fusion Energy, Vol. 12(1-2):115-119	05/01/2012	05/09/2012
CONF-910920 REF ID: 115624	Simple System for Measuring Tritium Ad/absorption Using a 2. pi. Counter and Thermal Desorption Spectrometer, September 29-October 4, 1991, Fusion Technology, Vol. 21(2):812-817	05/01/2012	05/15/2012
NA REF ID: 115623	Low Level Radioactive Waste Transportation Safety History, September 1997, Radwaste Magazine, Vol. 4(5):22-25	05/01/2012	05/25/2012
NA REF ID: 115535	Thermal Treatment of Radioactive, Hazardous Chemical, Mixed, Energetic, Chemical Weapon, and Medical Wastes : 1993 Incineration Conference : Proceedings of the 1993 Incineration Conference, Knoxville, Tennessee, U.S.A., May 3-7, 1993	05/16/2012	05/29/2012

Table A1-4: OSTI Documents Requested for SNL-Livermore			
Document Number	**Document Title**	**Requested Date**	**Received Date**
SAND2005-0430C	Metal hydride center of excellence & Sandia recent accomplishments	07/23/2010	NA - OSTI doesn't have document
SAND2005-2377C	Overview of DOE metal hydride center of excellence (MHCoE)	07/23/2010	NA - OSTI doesn't have document