SEC Petition Evaluation Report
Petition SEC-00226

Report Rev #: 0 Report Submittal Date: March 16, 2015

Subject Expert(s):	Michael Kubiak
Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00226	83.14	March 13, 2015	Hanford

NIOSH-Proposed Class Definition

All employees of Department of Energy contractors and subcontractors (excluding employees of the following Hanford prime contractors during the specified time periods: Battelle Memorial Institute, January 1, 1984 through December 31, 1990; Rockwell Hanford Operations, January 1, 1984 through June 28, 1987; Boeing Computer Services Richland, January 1, 1984 through June 28, 1987; UNC Nuclear Industries, January 1, 1984 through June 28, 1987; Westinghouse Hanford Company, January 1, 1984 through December 31, 1990; and Hanford Environmental Health Foundation, January 1, 1984 through December 31, 1990) who worked at the Hanford site in Richland, Washington, during the period from January 1, 1984 through December 31, 1990, 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 included in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00057	83.13	Hanford	Two classes added to the SEC
SEC-00152	83.14	Hanford	One class added to the SEC
SEC-00155	83.13	Hanford	No class added to SEC
SEC-00201	83.14	Hanford Engineer Works	One class added to the SEC

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report for Petition SEC-00057-1	Hanford
SEC Petition Evaluation Report for Petition SEC-00057-2	Hanford
SEC Petition Evaluation Report for Petition SEC-00152	Hanford
SEC Petition Evaluation Report for Petition SEC-00155	Hanford
SEC Petition Evaluation Report for Petition SEC-00201	Hanford Engineer Works

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Peer Review Completed By:	[Signature on File] *Sam Glover*	3/16/2015 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on File] *J. W. Neton*	3/16/2015 *Date*
SEC Evaluation Approved By:	[Signature on File] *Stuart L. Hinnefeld*	3/16/2015 *Date*

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Evaluation Report Summary: SEC-00226, Hanford

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 contractors and subcontractors (excluding employees of the following Hanford prime contractors during the specified time periods: Battelle Memorial Institute, January 1, 1984 through December 31, 1990; Rockwell Hanford Operations, January 1, 1984 through June 28, 1987; Boeing Computer Services Richland, January 1, 1984 through June 28, 1987; UNC Nuclear Industries, January 1, 1984 through June 28, 1987; Westinghouse Hanford Company, January 1, 1984 through December 31, 1990; and Hanford Environmental Health Foundation, January 1, 1984 through December 31, 1990) who worked at the Hanford site in Richland, Washington, during the period from January 1, 1984 through December 31, 1990, 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 included in the Special Exposure Cohort.

Feasibility of Dose Reconstruction Findings

This current evaluation of petition SEC-00226 proposes a class that begins on January 1, 1984 and extends through December 31, 1990. NIOSH lacks sufficient information, which includes radiobioassay monitoring data for construction trades workers, and sufficient workplace monitoring and source term data, to allow it to estimate with sufficient accuracy the potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities, to which the proposed class may have been exposed during the period from January 1, 1984 through December 31, 1990. NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Hanford workers with sufficient accuracy.

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

- Construction trades workers conducted a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages (including work in high-contamination and high-airborne radioactivity areas). Construction trades workers conducted work in facilities such as the 100-N reactor, PUREX fuel reprocessing facilities, research facilities, and plutonium finishing facilities and vaults.

- Principal sources of internal radiation exposure for members of the proposed class included radionuclides such as: isotopes of uranium, thorium and plutonium; neptunium-237; americium-241; tritium; and mixed fission and activation products.

- NIOSH evaluated a group of construction trades workers employed by the prime radiological area construction contractor at Hanford through February 28, 1987. The NIOSH evaluation was based on interviews and Hanford correspondence that provided evidence that the construction trades workers' fundamental type of work, as well as radiological monitoring practices, were substantively different from other Hanford operational workers. NIOSH has determined that this condition continued after February 28, 1987, when Kaiser Engineers Hanford replaced J. A. Jones Construction Services as the site prime construction services contractor.

- The number of construction trades worker radiobioassay analyses being performed increased after February 1987 when Kaiser Engineers Hanford became the site's prime construction services contractor. However, NIOSH has determined that the Kaiser Engineers Hanford bioassay program was not performing the expected numbers of periodic (routine) *in vitro* analyses until into calendar year1990. In 1990 the proportion of periodic *in vitro* bioassays performed for Kaiser Engineers Hanford workers (including subcontractor workers) increased to a level commensurate with that of other radiological facility operators. Data available to NIOSH indicate that by the end of 1990, improvements in the construction services contractor bioassay program allowed the radiological work specific to construction trades workers to be represented in the data used by NIOSH to produce internal dose coworker distributions.

- NIOSH determined that it lacks sufficient information, which includes sufficient radiobioassay monitoring data for construction trades workers, and sufficient workplace monitoring and source term data, that would allow it to estimate with sufficient accuracy the potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities to which the proposed class may have been exposed during the period from January 1, 1984 through December 31, 1990. The DOL and DOE determined that a NIOSH recommendation for a specific class of workers employed by the prime construction trades contractors (and their subcontractors) during this time could not be implemented. Therefore NIOSH, in consultation with DOE and DOL, has developed a recommended class definition that includes all employees of DOE contractors and subcontractors, excepting specifically identified non-construction prime contractors, for whom NIOSH, to date, has not identified a dose reconstruction infeasibility.

- The principal sources of external radiation for members of the proposed class included exposures to beta and photon radiation associated with various enrichments of uranium, activation and fission products, and high-energy betas and photons in the separations and research facilities.

- NIOSH has determined that available external monitoring data may be used in accordance with existing procedures on a case-by-case basis for the purpose of partial dose reconstructions. NIOSH has also determined that adequate reconstruction of medical dose is likely to be feasible by using claimant-favorable assumptions in the technical information bulletin Dose Reconstruction from Occupational Medical X-Ray Procedures (ORAUT-OTIB-0006) and the Hanford site profile documents.

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 with included contractors and subcontractors during the period from January 1, 1984 through December 31, 1990, 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 fuel handling, reactor operations, or fuel reprocessing related radionuclides. 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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SEC Petition Evaluation Report for SEC-00226

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: Michael Kubiak; MJW Technical Services. 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 a specific facility 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 advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary

[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.

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 Department of Energy contractors and subcontractors (excluding employees of the following Hanford prime contractors during the specified time periods: Battelle Memorial Institute, January 1, 1984 through December 31, 1990; Rockwell Hanford Operations, January 1, 1984 through June 28, 1987; Boeing Computer Services Richland, January 1, 1984 through June 28, 1987; UNC Nuclear Industries, January 1, 1984 through June 28, 1987; Westinghouse Hanford Company, January 1, 1984 through December 31, 1990; and Hanford Environmental Health Foundation, January 1, 1984 through December 31, 1990) who worked at the Hanford site in Richland, Washington, during the period from January 1, 1984 through December 31, 1990, 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 included in the Special Exposure Cohort. During this period, construction trades workers conducted a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages (including work in high-contamination and high-airborne radioactivity areas). Construction trades workers conducted work in facilities such as the 100-N reactor, PUREX fuel reprocessing facilities, plutonium finishing facilities and vaults, and research facilities. Consequently the workers were potentially exposed to radionuclides such as: isotopes of uranium, thorium and plutonium; neptunium-237; americium-241; tritium; and mixed fission and activation products.

The evaluation responds to Petition SEC-00226 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).

There are currently four classes of Hanford workers already designated for inclusion in the SEC. Two are associated with two previous NIOSH evaluations of petition SEC-00057 (57-1 and 57-2) under 42 C.F.R. § 83.13. Together, these two classes cover specified site areas and time periods spanning the period October 1, 1943 through December 31, 1968.

A third class, designated in 2009, is associated with the NIOSH evaluation of petition SEC-00152 under 42 C.F.R. § 83.14. This class encompasses all employees at all site areas and spans the period from October 1, 1943 through June 30, 1972, thus superseding the two SEC-00057 classes. This encompassing class came about as a result of NIOSH's ongoing dose reconstruction and continued data capture efforts, which confirmed that additional dose reconstruction infeasibilities exist due to work with inadequately monitored radionuclides such as purified forms of polonium, thorium, and neptunium. NIOSH further determined that there is insufficient access control information and

[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.

worker-movement data to accurately assess whether an energy employee, or class of employees, did, or did not, potentially enter specific Areas of the Hanford site.

A fourth class, designated in 2012, is associated with the NIOSH evaluation of petition SEC-00201 under 42 C.F.R. § 83.14. This class encompasses all site areas and spans the period from July 1, 1972 through December 31, 1983. This class resulted from NIOSH's ongoing dose reconstruction and continued data capture efforts after the implementation of SEC-00152 in 2009. NIOSH determined that additional dose reconstruction infeasibilities existed through December 31, 1983, due to work with highly-enriched uranium (HEU), U-233, thorium, and neptunium, for which NIOSH had inadequate information to bound dose. Consistent with the determinations of the SEC-00152 evaluation, NIOSH determined that there continued 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 of the Hanford site where these hazards potentially existed during the period from July 1, 1972 through December 31, 1983.

Detailed information associated with the Hanford worker classes added to the SEC in 2007, 2008, 2009, and 2012 can be found in the respective NIOSH evaluation reports, *SEC Petition Evaluation Report, Petition SEC-00057-1* (NIOSH, 2007); *SEC Petition Evaluation Report, Petition SEC-00057-2* (NIOSH, 2008); *SEC Petition Evaluation Report, Petition SEC-00152* (NIOSH, 2009); and *SEC Petition Evaluation Report, Petition SEC-00201* (NIOSH, 2012).

The current class proposed in this evaluation report resulted from NIOSH's ongoing dose reconstruction and continued data capture efforts after the implementation of SEC-00201 in 2012. Continued data research efforts included on-site document searches and worker interviews conducted jointly by NIOSH and the Board. NIOSH evaluated a group of construction trades workers employed by the prime radiological area construction contractor at Hanford through February 28, 1987. The NIOSH evaluation was based on interviews and Hanford correspondence (Surveillance, 1984) that provided evidence that the construction trades workers' fundamental type of work, and radiological monitoring practices, were substantively different from other Hanford operational workers.

NIOSH has concluded that the type of work and the exposure potential for this group of construction trades workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the worker monitoring data set. Data available to NIOSH indicate that by the end of 1990, improvements in the construction services contractor bioassay program allowed the radiological work specific to construction trades workers to be represented in the data used by NIOSH to produce the internal dose coworker distributions. NIOSH determined that it lacks sufficient information, which includes sufficient radiobioassay monitoring data for construction trades workers, and sufficient workplace monitoring and source term data, that would allow it to estimate with sufficient accuracy the potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities, to which the proposed class may have been exposed during the period from January 1, 1984 through December 31, 1990.

DOL and DOE determined that a NIOSH recommendation for a specific class of workers employed by the prime construction trades contractors, J. A. Jones Construction Services Company (often referred

to as JA Jones or JAJ throughout this report) or Kaiser Engineers Hanford (often referred to as Kaiser, Kaiser Engineers, or KEH throughout this report), and their contractors and subcontractors, could not be implemented. Therefore NIOSH, in consultation with DOE and DOL, has developed a recommended class definition that includes all employees of DOE contractors and subcontractors, excepting specifically identified non-construction prime contractors, for whom NIOSH, to date, has not identified a dose reconstruction infeasibility.

4.0 Radiological Operations and Contractors Relevant to the Proposed Class

The following subsections summarize the radiological operations and some key contractors at Hanford from January 1, 1984 through December 31, 1990, 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 General Site Operations Description

In 1943, the U.S. Army Corp of Engineers selected an area of approximately 600 square miles in southeastern Washington State for the production of plutonium and other nuclear materials to support weapons production for World War II. This area, now known as the Hanford site, was divided into three major operational areas devoted to plutonium production. The 100 Areas handled production reactor operations; the 200 Areas handled fuel reprocessing, plutonium recovery, and waste management; and the 300 Area handled fuel fabrication and general research and development activities. In the early 1970s, operations began in another area—the 400 Area, about 6 miles northwest of the 300 Area. The facility at this location was an experimental sodium-cooled breeder reactor known as the Fast Flux Test Facility. There were other Hanford Areas, but they had little, if any, involvement with radioactive materials operations. The 600 Area was the general category assigned to facilities that supported multiple operations but were not within the security boundaries of other major areas (including road systems, fire stations, environmental and weather monitoring stations, and Nike missile sites). Figure 4-1 shows the locations of the major Hanford operational areas.

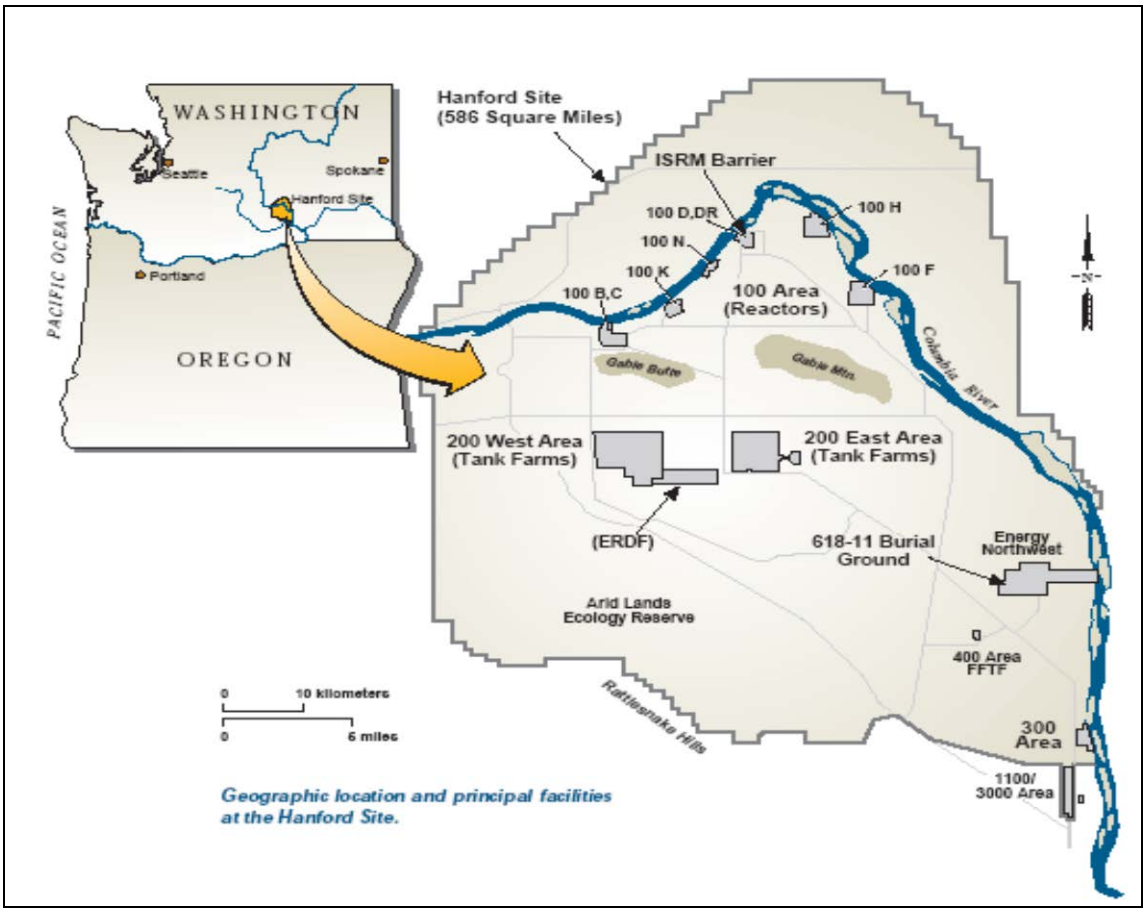

Figure 4-1: Hanford Major Operational Areas

To ensure continuing plutonium production capacity, many major Hanford plutonium production operations were duplicated. In addition, Hanford plutonium production operations were also essentially self-sufficient, containing all necessary support services and facilities. However, both initially and with changing missions, some operations utilized facilities and services located in other Areas. For example, after 1973 most of the radioactive liquid waste from all Hanford operations was transferred to the 200 Areas for processing and storage.

Plutonium production at the Hanford site peaked from 1956 through 1965. During the late 1960s, plutonium needs decreased and many production facilities were shut down. Initial decommissioning of many production-related facilities began in the late 1960s and continued through 1990. In 1988, the final Separations Plant (PUREX) and production operations at the Plutonium Finishing Plant were placed on standby. As production operations decreased, the era of diversification began; Hanford site activities related to peaceful applications of nuclear energy replaced those related to weapons. Table 4-1 summarizes Hanford site development.

Table 4-1: Hanford Development Chronology
(This table spans two pages)

Dates	Areas	Activities
Pre-September 1946	All	Fuel manufacturing (313 and 314), reactors (100-B, 100-D, and 100-F), and separation/finishing (221/224-T, 221/224-B, 221/224-U, and 231-Z) facilities completed and operating; ongoing R&D activities related to reactors, radiation effects, and radiochemistry
August 1, 1946	All	Atomic Energy Act passed
September 1, 1946	All	General Electric Company assumes prime site contractor responsibility from E.I. DuPont de Nemours and Company
January 1, 1947	All	Manhattan Engineer Project replaced by Atomic Energy Commission
1947	All	Cold War Era begins
1947 - 1949	200	Installation of 42 single-shell waste tanks
1949	200	Startup of Rubber Glove (RG) Line in 234-5Z Plutonium Finishing Plant
1949	100	Startup of H Reactor
1950 - 1952	200	Installation of 18 single-shell waste tanks
1950	100	Startup of DR Reactor
1951	200	Startup of 242-T and 242-B evaporators
1952	300	Startup of Physical Constants Test Reactor
1952	200	Startup of REDOX (S-Plant), U-Plant uranium recovery operations, and Remote Mechanical A Line
1952	100	Startup of C Reactor, Experimental Animal Farm, and Aquatic Biology Laboratory
1953 - 1955	200	Installation of 21 single-shell waste tanks
1954	300	Startup of Thermal Test Reactor
1954	100	Startup of KW Reactor
1955	100	Startup of KE Reactor
1956	200	Shutdown of B-Plant and T-Plant; Startup of UO_3 Plant and PUREX (A-Plant)
1958	200	Shutdown of U-Plant
1960	300	Startup of Plutonium Recycle Test Reactor
1963 - 1964	200	Installation of 4 single-shell waste tanks
1964	100	Startup of N-Reactor power generating plant; Shutdown of DR Reactor
1964	200	Startup of Plutonium Reclamation Facility
January 4, 1965	All	Battelle Memorial Institute assumes responsibility for management of Hanford laboratories
November 1, 1965	100/300	Douglas-United Nuclear Inc. assumes responsibility for fuels and reactors
1965	100	Shutdown of H and F Reactors
January 1, 1966	200	ISOCHEM assumes responsibility for chemical processing and plutonium finishing
September 1, 1967	200	Atlantic Richfield Hanford Company assumes responsibility for chemical processing
1967	100	Shutdown of D Reactor
1967	300	Construction completed on High Temperature Lattice Test Reactor
1967	200	Shutdown of S-Plant (REDOX)
1968 - 1988	200	Installation of 28 double-shell waste tanks
1968	100	Shutdown of B Reactor
1969	100	Shutdown of C Reactor

Table 4-1: Hanford Development Chronology
(This table spans two pages)

Dates	Areas	Activities
1970	100	Shutdown of KW Reactor
1971	100	Shutdown of KE Reactor
1972	200	Shutdown of UO_3 Plant
1973 - 1976	200	Startup of evaporator plants 242-S and 242-A
January 19, 1975	All	Energy Research and Development Administration replaces Atomic Energy Commission
July 1, 1977	200	Rockwell Hanford Operations assumes responsibility for reprocessing
October 1, 1977	All	Department of Energy replaces Energy Research and Development Administration
1980	400	Startup of Fast Flux Test Facility
1983	200	Restart of UO_3 Plant
June 29, 1987	All	Westinghouse Hanford Company assumes responsibility for fuel manufacturing, reactor operations, chemical engineering, and waste management
1987	100	Shutdown of N Reactor
1988	200	A-Plant (PUREX) placed on standby
1989	200	Plutonium Finishing Plant placed on standby
1989	All	Cold War Era ends

4.2 Contractor Operations Descriptions

This evaluation deals with an assessment of the radiation monitoring practices of specific site contractor companies during the evaluation period. The type and scope of radiological operations across the Hanford site are not the main subject of this evaluation; rather, the general bioassay monitoring practices put in place by specific site construction contractors, and the internal radiation monitoring program transitions as the site construction contracting scheme changed during the period from January 1, 1984 through December 31, 1990, are the focus of this evaluation. The following subsections describe examples of the radiological operations support provided by the site's prime construction contractors and are not meant to provide a full assessment of all radiological projects on the Hanford site.

4.2.1 J. A. Jones Construction Services Company, 1984 through February 28, 1987

J. A. Jones was the Hanford site prime contractor for construction services from 1953 through February 28, 1987. During this time JAJ construction trades workers conducted a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages (including work in high-contamination and high-airborne radioactivity areas). Examples of radiological projects for which JAJ construction trades workers provided support include:

- 1981, PUREX, millwright work and work in Q, N, and R cells (Rad Survey Cards, 1981);
- 1986, work in Building 231-Z of the 200 Area (Rad Zone Log, 1986);

- 1986, 100N with pencil dosimeter readings indicating up to 250 mR per shift (Gamma and Work Log, Nov-Dec1986; Exposure Log, Jan1986); and

- 1984-1987, All Areas, union hall workers were used for short duration, high exposure activities, allowing 300 mR exposures in a week. Additional personnel were brought in as necessary for reactor refueling, etc. Workers would sometimes receive the weekly dose limit in a matter of a few hours (Personal Communication, 2014g).

4.2.2 Kaiser Engineers Hanford, March 1, 1987 through December 31, 1990

In October 1986, DOE announced the selection of Kaiser Engineers Hanford for negotiation of a contract to perform engineering and construction services in support of DOE programs at the Hanford site. This consolidated contract, effective March 1, 1987, combined engineering and construction services previously provided separately by the KEH and the JAJ companies (DOE, 1986). Phase-in of the contract began December 1, 1986; approximately 1,000 employees were employed by KEH and JAJ at the time (DOE, 1986). KEH was required to retain the vast bulk of the present employees.

Examples of radiological projects for which KEH and JAJ construction trades workers provided support from March 1, 1987 through December 31, 1990 include:

- 1985-1993, work in 300, 400, 200W, 200E, and in 100N during outages with up to 600 mR per day if transitioning from one work week to the next (Personal Communication, 2014m) and

- 1988-1993, work in PUREX, 100N, and 300 Area.

- 1987-1993, All Areas, union hall workers were used for short duration, high exposure activities, allowing 300 mR exposures in a week. Additional personnel were brought in as necessary for reactor refueling, etc. Workers would sometimes receive the weekly dose limit in a matter of a few hours (Personal Communication, 2014g).

4.2.3 Westinghouse Hanford Company Contract Consolidation, June 1987

On June 29, 1987, Westinghouse Hanford Company (WHC) assumed contract responsibilities from United Nuclear Company (UNC) and Rockwell Hanford Operations (RHO), giving WHC responsibility for fuel manufacturing, reactor operations, chemical engineering, and waste management. At this time Boeing Computer Services Company also became a fully integrated subcontractor of WHC. With the consolidation of facility operations under WHC in June 1987, WHC became responsible for the implementation of the internal and external dosimetry programs for facilities previously operated by UNC and RHO. Facilities under WHC control after June 1987 continued to utilize the site's prime construction contractor KEH. KEH maintained control of its own radiological control and dosimetry programs. Dosimetry program implementation for construction contractor employees in the WHC facilities was not turned over to WHC until October 1, 1993, when Kaiser Engineers Hanford became a partially integrated subcontractor to WHC.

4.3 Radiation Exposure Potential from Operations

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (DOL). As such, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report; this report concentrates on the relevant aspects of internal exposures and internal exposure monitoring during the specified time period.

4.3.1 Hanford Internal Dosimetry Program for Site Contractors

The Hanford Internal Dosimetry Program was administered by Battelle Memorial Institute as operators of Pacific Northwest Laboratory (PNL). The internal dosimetry program provided the assessment and documentation of occupational doses to workers from intakes of radionuclides at Hanford for the purpose of determining compliance with applicable internal dose standards. The internal dosimetry program also included the routine bioassay monitoring program specified by site contractors for their workers, provided technical guidance to contractors on internal dosimetry matters, and established the models to be used for evaluation of internal radionuclide depositions (Meeting Minutes, Sep1986, PDF pp. 4-11).

Contractor organizations were responsible for the protection of their workers from internal exposures to radioactivity and for determining the extent of application of the internal dosimetry program. This included the identification of their needs for bioassay monitoring and for determining when potential internal exposures had occurred. The program required that an assessment of an individual's internal exposure (in terms of dose equivalent) be performed whenever there was reason to suspect (based on contractor-driven field monitoring or bioassay data) that an occupationally derived intake or related series of intakes could potentially exceed 100 mrem/year annual effective dose equivalent in any single year (Meeting Minutes, Sep1986, PDF pp. 4-11).

4.3.2 Access Control Systems

During the period under evaluation, the Hanford site had implemented a primary system for controlling and tracking radiological work, and eventually for documenting and controlling worker access to the site radiological areas.

Westinghouse Radiation Area Management System (WRAM)

The WRAM system tracked training and qualifications, radiologically-controlled area activities, and personnel working in radiologically-controlled areas. WRAM was a database shared on a local area network, operated on computer workstations, and contained information such as (WRAM, 1992):

- Names of the employees who have worked, or were presently working, at the location;
- Personnel data such as identification numbers, dosimetry exposure records, training records, and medical data;
- Area access management

  - Radiation Work Permits (RWP)
  - As Low As Reasonably Achievable (ALARA) Reviews
  - Training requirements
  - Dosimetry requirements
  - Mask fit requirements; and

- Personnel exposure information
  - Online exposure records
  - Weekly (7 day) exposure records
  - Exposure measured by dosimeter badges and self-reading pencil dosimeters.

The WRAM system was intended to allow for verification and display of an employee's qualifications for entering a radiologically-controlled area. Dose tracking records, including self-reading dosimeters which were issued and returned, were maintained and applied to specific work locations and RWPs for purposes of ALARA trending (WRAM, 1992).

The WRAM system was implemented sometime after 1987 (Personal Communication, 2014a), and was brought to the 200 Areas from N Reactor. WRAM was used in the late 1980s to start checking worker compliance, but "it wasn't very good at first" (Personal Communication, 2014a). WRAM was a system used only in Westinghouse-controlled facilities into the early 1990s. WRAM was populated from paper and hand written readings and was simply a digitized record of those manual transactions (Personal Communication, 2014c). Construction workers were required to have the same monitoring as prime contractors, but prior to the WRAM implementation it was difficult for the facility health physics staff to check the workers for compliance (Personal Communication, 2014a).

4.3.3 Radiation Exposures Relevant to the Recommended Class

The potential for internal and external radiation doses associated with this evaluation existed when the Hanford prime construction contractors, JAJ and KEH, supplied their construction trades worker forces to conduct a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages in Hanford operational radiological facilities such as those controlled by WHC, Rockwell, United Nuclear, and Battelle. Construction trades workers' duties included work in high-contamination and high-airborne radioactivity areas in facilities such as the 100-N reactor, PUREX fuel reprocessing facilities, research facilities, and plutonium finishing facilities and vaults. As presented in Section 4.2, construction trades worker radiological work locations included fuel fabrication, reactors, separations and waste management, and research locations of the 100, 200, and 300 Areas. The potential radiological exposures for such areas of the Hanford site are presented below (ORAUT-TKBS-0006-2; NIOSH, 2012).

Fuel Fabrication Facility Support

- External exposures at the fuel fabrication facilities were primarily from beta and photon radiation associated with various enrichments of uranium.

- Internal exposures at the fuel fabrication facilities were primarily associated with inhalation of various enrichments of uranium, including recycled uranium.

- Radionuclides of internal dosimetric concern included Th-232, U-235, U-238, Np-237, Pu-238, Pu-239, and Am-241.

Reactor Facility Support

- External exposures at the production reactors were primarily due to the presence of activation and fission products (FPs).

- Internal exposures at the production reactors were primarily due to the inhalation or absorption of activation products and, to a lesser degree, FPs during refueling and maintenance operations.

- Radionuclides of internal dosimetric concern included metal oxide corrosion products such as Mn-54, Fe-59, Co-58, and Co-60, with Co-60 being the predominant contributor to dose and activity.

Fuel Reprocessing Facility Support

- External exposures at the PUREX and UO_3 reprocessing facilities were primarily from high-energy betas and photons in the separations facilities associated with FPs.

- Internal exposures at the PUREX and reprocessing facilities, primarily associated with contamination incidents, could be due to FPs or plutonium or uranium isotopes.

- Radionuclides of internal dosimetric concern included H-3, Co-60, Sr-90, Ru-103, Ru-106, I-131, Cs-137, Ba/La-140, Ce-141, Ce-144, U-234, U-235, Pu-239, and Am-241, and possible legacy quantities of U-233, Np-237, and Th-232/228.

Plutonium Finishing Facility Support and Area 300 Research Facilities

- External exposures at the plutonium finishing facilities accounted for the majority of personnel external exposures to neutron radiation. Worker external exposure in the vault rooms was due to low-energy photons and neutrons during inspection activities.

- Internal exposures in the finishing plants related primarily to contamination incidents involving americium and plutonium.

- Radionuclides of internal dosimetric concern included U-233, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, and Am-241.

The type of work and the exposure potential relevant for this group of construction trades workers was substantially different than other workers at Hanford; therefore, NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the worker monitoring data set.

4.4 Time Period Associated with Radiological Operations

As stated in Section 3.0, in 2012 HHS designated a class of Hanford employees for inclusion in the SEC for the period from July 1, 1972 through December 31, 1983. Based on its ongoing dose reconstruction and continued data capture efforts since 2012, NIOSH performed an evaluation based on interviews and Hanford correspondence that provided evidence that the construction trades workers' fundamental type of work, and radiological monitoring practices, were substantively different from other Hanford operational workers. NIOSH has concluded that the type of work and the exposure potential for this group of construction trades workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the worker monitoring data set. Data available to NIOSH indicate that by the end of 1990, improvements in the construction services contractor bioassay program allowed the radiological work specific to construction trades workers to be represented in the data used by NIOSH to produce the internal dose coworker distributions. Thus, the time period associated with this NIOSH evaluation, extending from the end of the currently-designated SEC class, is from January 1, 1984 through December 31, 1990.

4.5 Site Locations Associated with Radiological Operations

Consistent with the NIOSH, DOE, and DOL determinations associated with the evaluations of SEC-00152 in 2009 (NIOSH, 2009) and SEC-00201 in 2012 (NIOSH, 2012), NIOSH has determined that the Hanford site-specific and claimant-specific data available for the time period under evaluation continue to be insufficient to allow NIOSH to characterize construction trades worker movements across the radiologically-controlled site facilities, or among the major 100, 200, and 300 Areas, during the period under evaluation (January 1, 1984 through December 31, 1990). As presented in Section 4.3.2 above, deficiencies existed with the WRAM tracking system employed during the time period under evaluation. NIOSH is unable to accurately assess whether individual, or groups of construction trades workers, did or did not potentially enter radiologically-controlled work areas at the Hanford site having the potential for internal radiation dose during the period under evaluation. Therefore, NIOSH cannot define individual worker exposure scenarios based on specific Hanford work locations during the period from January 1, 1984 through December 31, 1990.

4.6 Job Descriptions Affected by Radiological Operations

As stated in Section 4.4 of this report, through the course of ongoing dose reconstruction, NIOSH has determined that the Hanford site-specific and claimant-specific data available for the time period of this evaluation are insufficient to allow NIOSH to characterize construction trades worker movements across the site, or among the 100, 200, and 300 Areas. The data available to NIOSH on a claim-specific level are also often insufficient for NIOSH to limit a worker's potential exposure scenarios based on job titles and/or job assignments. The areas associated with this evaluation include all areas of the Hanford site, and NIOSH is unable to eliminate any specific worker from any of the listed potential exposure scenarios 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 Hanford. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of Hanford documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

In addition to examining its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class, NIOSH and the Board conducted organized site visits in August and December of 2014 in an attempt to gather documents and data relevant to dose monitoring practices for the construction trades workers after the end of the currently-designated SEC class (i.e., after December 31, 1983). NIOSH's SRDB currently contains over 2,795 documents and subdocuments associated with the Hanford site that have been added since the June 2012 evaluation of SEC-00201. Attachment One contains a summary of Hanford data gathering efforts and documents.

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 February 20, 2015)

Table 5-1: No. of Hanford Claims Submitted Under the Dose Reconstruction Rule	
Description	**Totals**
Total number of claims submitted for dose reconstruction	5,384
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1984 through December 31, 1990)	2,175
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (January 1, 1984 through December 31, 1990) (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval)	1,801
Number of claims for which internal dosimetry records were obtained for energy employees who worked during the period under evaluation (January 1, 1984 through December 31, 1990)	1,532
Number of claims for which external dosimetry records were obtained for energy employees who worked during the period under evaluation (January 1, 1984 through December 31, 1990)	2,125

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

5. 3 Worker Interviews

There have been multiple worker interviews (individual and group interviews) with current and former Hanford personnel. 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, 2014a, *Personal Communication with Former Hanford Employee*; Telephone Interview by EEOICPA NIOSH Team; November 4, 2014; SRDB Ref ID: 141150

- Personal Communication, 2014b, *Personal Communications with Former Hanford* Employee; Interviews by EEOICPA NIOSH Team; August 4, 2014, August 7, 2014, and December 11, 2014; SRDB Ref ID: 141002 & 141003

- Personal Communication, 2014c, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 11, 2014; SRDB Ref ID: 141004

- Personal Communication, 2014d, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 9, 2014; SRDB Ref ID: 141005

- Personal Communication, 2014e, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 11, 2014; SRDB Ref ID: 141006

- Personal Communication, 2014f, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 9, 2014; SRDB Ref ID: 141008

- Personal Communication, 2014g, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141009

- Personal Communication, 2014h, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 10, 2014; SRDB Ref ID: 141010

- Personal Communication, 2014i, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141012

- Personal Communication, 2014j, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141013

- Personal Communication, 2014k, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 10, 2014; SRDB Ref ID: 141014

- Personal Communication, 2014l, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 24, 2014; SRDB Ref ID: 141015

- Personal Communication, 2014m, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141016

- Personal Communication, 2014n, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141017

- Personal Communication, 2014o, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 10, 2014; SRDB Ref ID: 141018

5. 4 Internal Personnel Monitoring Data

NIOSH dose reconstructions for unmonitored workers, including construction trades workers, assign unmonitored internal radiation doses per Attachment C – Internal Dosimetry Coworker Data for the Hanford Site of the site Technical Basis Document (TBD) ORAUT-TKBS-0006-5, *Hanford Site – Occupational Internal Dose*. NIOSH evaluated a group of construction trades workers employed by the prime radiological area construction contractor at Hanford through February 28, 1987. The NIOSH evaluation was based on interviews and Hanford correspondence (Surveillance, 1984) that provided evidence that the construction trades workers' fundamental type of work, and radiological monitoring practices, were substantively different from other Hanford operational workers. NIOSH has concluded that the type of work and the exposure potential for this group of construction trades workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the worker monitoring data set. Identification of Battelle Dosimetry observations in a 1984 letter (Surveillance, 1984) introduced uncertainty as to whether the construction trades workers' radiological exposures were adequately represented in the data used by NIOSH to produce the internal dose coworker distributions of ORAUT-TKBS-0006-5.

For investigation into the status of construction trades workers' internal dose monitoring data, NIOSH reviewed an updated version of the Hanford dosimetry database (REX). For the years of concern in this evaluation, the monitoring data for JAJ employees, and for the employees of JAJ contractors and subcontractors, were normally entered into the REX database under a common company identifier code. NIOSH examined the availability of monitoring data for the JAJ company code for the period through February 28, 1987. Beginning March 1, 1987, under a consolidated contract with KEH, the architectural and engineering services contract and the construction services contract previously provided separately by KEH and JAJ, respectively, were combined for consolidated management by KEH (DOE, 1986). NIOSH also examined the availability of REX monitoring data for the KEH company code (including KEH contractors and subcontractors) for the period under evaluation after February 28, 1987. Table 5-2 and Figures 5-1 and 5-2 present the monitoring data for JAJ and KEH (and their contractors) available to NIOSH in the Hanford REX database for the years shown.

Table 5-2: No. of Construction Workers with Available Monitoring Data

	JA Jones Construction and Subcontractors			Kaiser Engineers Hanford and Subcontractors		
Year	***In Vitro***	***In Vivo***	**External**	***In Vitro***	***In Vivo***	**External**
1983	3	178	2,786			132
1984	6	232	2,725			96
1985	7	312	2,954			116
1986	20	386	1,930			1,227
1987*		48	86	4	649	2,238
1988				336	1,017	2,345
1989				281	935	2,242
1990				362	827	2,070
1991				650	1,039	2,306

* Kaiser Engineers Hanford replaced J. A. Jones Construction as the construction services prime contractor on March 1, 1987.

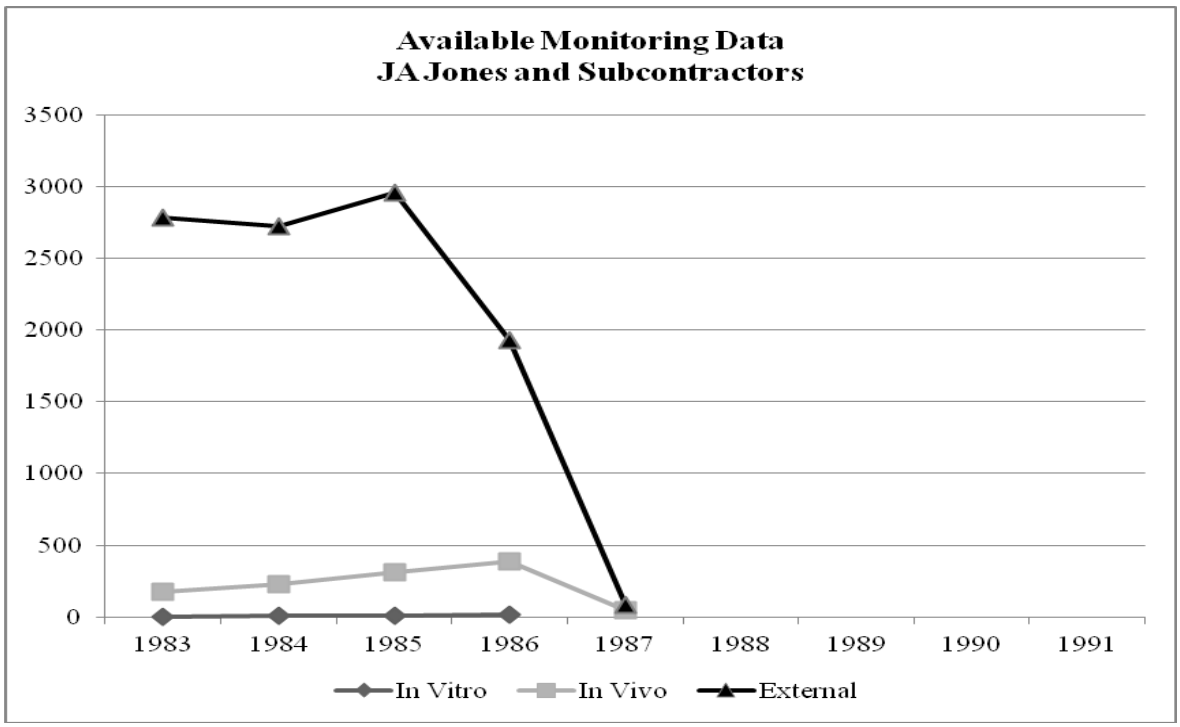

Figure 5-1: Available Monitoring Data – JA Jones and Subcontractors

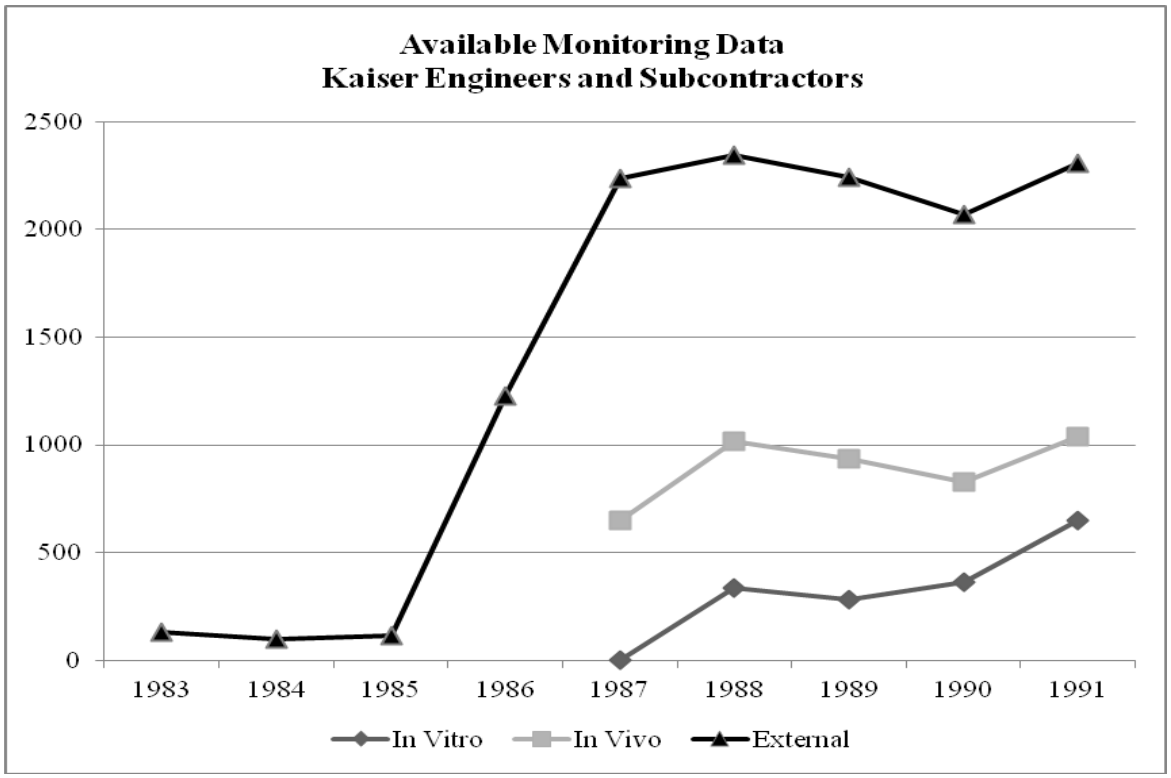

Figure 5-2: Available Monitoring Data – Kaiser Engineers and Subcontractors

Table 5-2 and Figure 5-1 illustrate that the JAJ dosimetry program appears to have been ordering minimal internal bioassay analyses during the period from January 1, 1984 through February 28, 1987, as compared to the 2,700 to 3,000 JAJ workers being monitored for external exposure in 1984 and 1985. The apparent scarcity of JAJ internal radiation monitoring during this period is supported by various documents (Surveillance, 1987) and interviews conducted with past and present Hanford site workers. For example, JAJ radiation protection management documentation (Personal Communication, 2014g) indicates that:

- Many JAJ employees were not involved with bioassay programs; and
- JAJ management was not receptive to bioassay program implementation due to costs (additional $1M per year to conduct bioassay).

Table 5-2 and Figure 5-2 indicate that KEH expanded the *in vivo* and *in vitro* bioassay programs upon assuming the JAJ site support and construction responsibilities in March 1987. This is supported by a February 22, 1988, Battelle Internal Dosimetry Program Monthly Report (Monthly, Feb1988) that stated:

> *Kaiser Engineers Hanford Co. has informed PNL that they are establishing a routine bioassay monitoring program for their workers. KEH has estimated that about 100 strontium-90 urinalyses, 400 plutonium urinalyses, 400 chest counts and 900 whole body counts per year will be requested once the program is in full swing. KEH plans to begin the routine monitoring in March but will distribute their requests over the next twelve months.*

However, a subsequent May 23, 1988, Battelle Internal Dosimetry Program Monthly Report (Monthly, May1988) stated:

> *The routine bioassay program for Kaiser Engineering Hanford has had a somewhat inauspicious beginning. Although the program, which commenced in March, included in vivo and urinalysis measurements on several hundred workers, there have yet to be any in vivo measurements performed. Because of funding shortages at KEH, the commencement of routine in vivo measurements will not begin until July at the earliest. Also, during April, KEH scheduled 21 routine urine bioassays for which valid samples were received from only two workers.*

To further investigate the changes in the construction contractor bioassay program implemented when KEH assumed the consolidated construction services contract in March 1987, NIOSH examined the breakdown of the types (i.e., analysis reason codes) of the *in vivo* and *in vitro* bioassays being implemented by KEH for the years 1987 onward. NIOSH compared the relative frequencies of various bioassay reason codes (baseline, periodic, termination, and special). For the comparison during the years under evaluation, NIOSH evaluated the statistics for the KEH construction worker bioassay program against: 1) the entire sample population in the Hanford REX database; and 2) the combined sample population for three major site radiological facility operators. The three facility operators chosen for the comparison were WHC, UNC, and RHO. Table 5-3 presents the relative frequencies of periodic (routine) bioassays found in the Hanford REX database, associated with each calendar year during the period from 1987 through 1991.

Table 5-3: Periodic Bioassays Reported - Percent of Total Annual Bioassays						
	In Vivo			*In Vitro*		
Year	**Kaiser**	**Westinghouse UNC Rockwell**	**All**	**Kaiser**	**Westinghouse UNC Rockwell**	**All**
1987	58.2%	67.6%	68.8%	0.0%	87.0%	85.5%
1988	47.8%	78.3%	73.5%	30.8%	76.4%	71.9%
1989	51.3%	76.3%	71.7%	31.7%	72.2%	68.1%
1990	61.4%	70.0%	68.1%	67.5%	72.6%	73.3%
1991	54.0%	78.9%	74.2%	58.7%	65.9%	66.2%

Regarding *in vivo* analyses, Table 5-3 indicates that KEH was performing a lower proportion of periodic *in vivo* analyses, as compared to the *in vivo* data examined for the WHC/UNC/RHO dataset and the all-monitored-workers dataset. NIOSH's additional examination of the four major *in vivo* reason codes from 1987-1991, indicates that KEH performed a higher percentage of baseline and termination analyses than were found in the data for the chosen radiological facility operators (i.e., WHC/UNC/RHO). This is to be expected due to the high worker turnover rates observed in the construction contractor work-force. This higher proportion of baselines and terminations performed by KEH reduces the proportion of periodic *in vivo* analyses seen in Table 5-3 for KEH. Table 5-3 indicates that the KEH routine *in vivo* program appears to have been already more comprehensive than their routine *in vitro* bioassay program in the years immediately after KEH assumed the consolidated construction services contract in March 1987.

Regarding the *in vitro* analyses, Table 5-3 indicates that the KEH implementation of improvements to the routine *in vitro* bioassay program appears to have lagged. Figure 5-3 presents the Table 5-3 relative frequencies of periodic *in vitro* bioassays found by NIOSH for the period from 1987 through 1991.

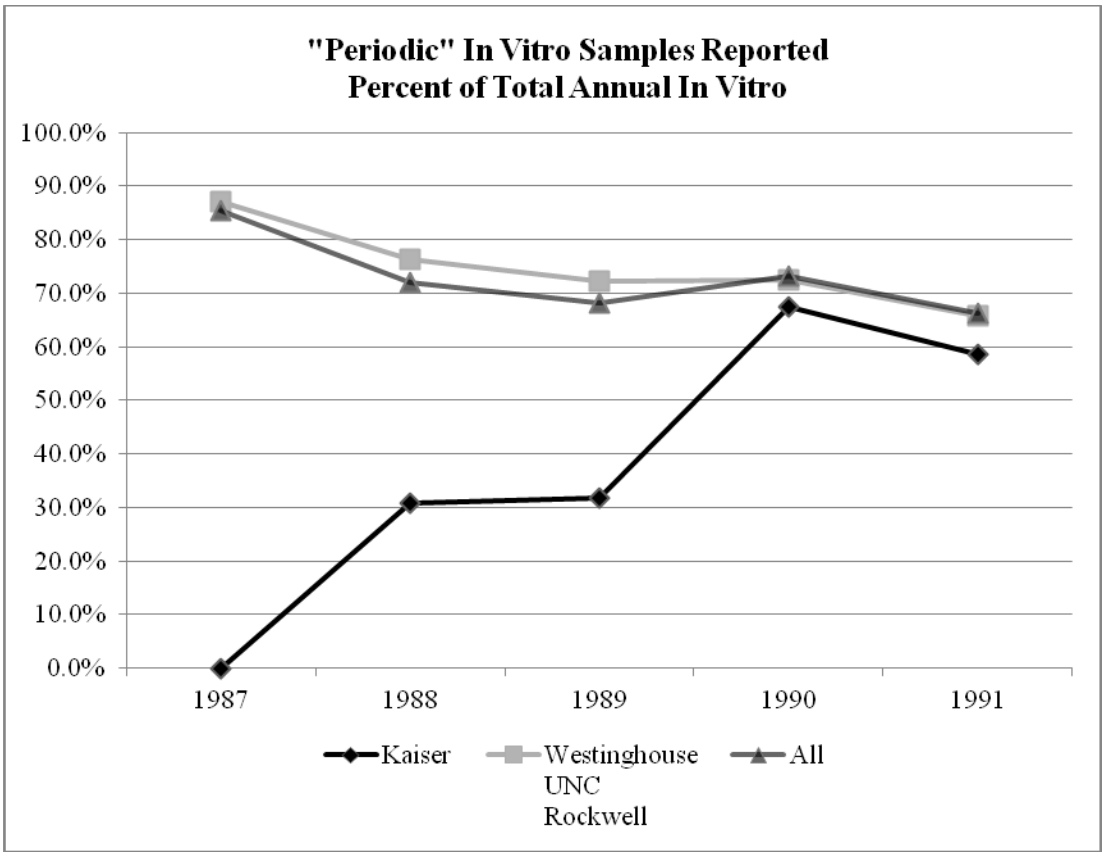

Figure 5-3: "Periodic" *In Vitro* Samples Reported – Percent of Total Annual *In Vitro*

Figure 5-3 indicates that KEH's *in vitro* bioassay program was increasing the number of periodic (routine) *in vitro* analyses performed during the years 1987 through 1990. In 1990 the proportion of periodic *in vitro* bioassays performed for KEH workers (including KEH subcontractor workers) increased to a level commensurate with that of the comparison WHC/UNC/RHO facility operators. These data are consistent with the observations noted above in the May 23, 1988, Battelle Internal Dosimetry Program Monthly Report (Monthly, May1988) indicating that KEH met with some difficulty implementing their planned bioassay program improvements after assuming the consolidated construction services contract in March 1987.

After assuming the consolidated construction services contract in March 1987, KEH construction trades workers continued to conduct a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages (including work in high-contamination and high-airborne radioactivity areas). Construction trades workers conducted work in facilities such as the 100-N reactor, PUREX fuel reprocessing facilities, plutonium finishing facilities and vaults, and research facilities. Consequently, the workers were potentially exposed to radionuclides such as: uranium isotopes, thorium and plutonium, neptunium-237, americium-241, tritium, and mixed fission and activation products. NIOSH examined the available Hanford REX exposure data for indications that the observed KEH bioassay program improvements routinely included appropriate analytes for such radiological work (e.g., bioassay for plutonium intakes). NIOSH examined the frequencies of *in vivo* chest count analyses and *in vitro*

plutonium analyses performed by KEH after assuming the consolidated construction services contract in March 1987. For the comparison, NIOSH again evaluated the statistics for the KEH construction worker bioassay program against: 1) the entire sample population in the site exposure database REX; and 2) the combined sample population for three major site radiological facility operators (WHC, UNC, and RHO). Table 5-4, and Figures 5-4 and 5-5, compare the percentage of dosimetry badged workers that have *in vivo* chest counts and *in vitro* plutonium samples in the Hanford REX exposure database for the years shown.

Table 5-4: Percentage of Dosimetry Badged Workers with Available Plutonium Monitoring Data

	Percentage with *In Vivo* Chest Counts			Percentage with *In Vitro* Plutonium Samples		
Year	**Kaiser and Subcontractors**	**Westinghouse UNC Rockwell**	**All**	**Kaiser and Subcontractors**	**Westinghouse UNC Rockwell**	**All**
1987	0.5%	10.0%	8.3%	0.1%	11.5%	8.7%
1988	9.0%	10.3%	7.3%	12.2%	13.1%	8.8%
1989	12.4%	10.0%	7.6%	11.1%	12.2%	8.3%
1990	18.3%	12.7%	9.2%	15.3%	11.2%	8.0%
1991	25.9%	9.7%	8.4%	25.5%	13.1%	10.1%
1992	18.7%	10.0%	8.4%	16.5%	12.3%	9.0%
1993	16.5%	14.8%	11.1%	12.5%	20.0%	12.8%

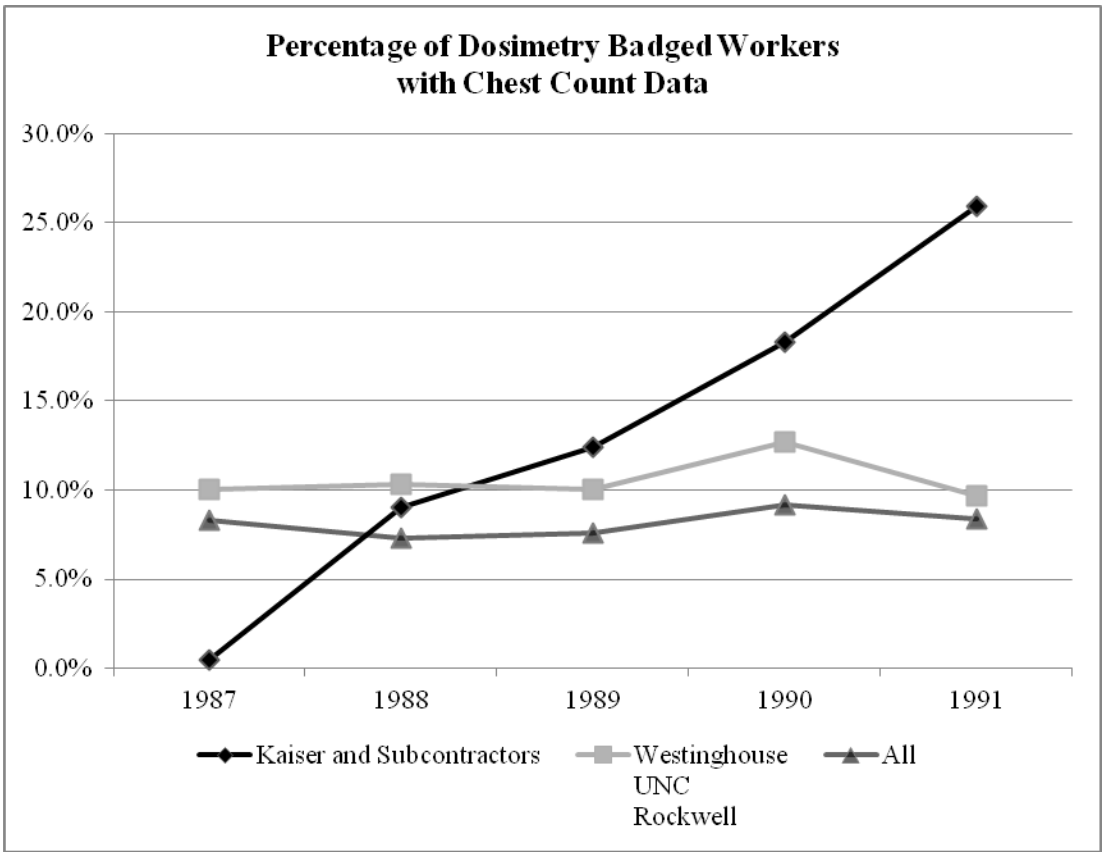

Figure 5-4: Percentage of Dosimetry Badged Workers with Chest Count Data

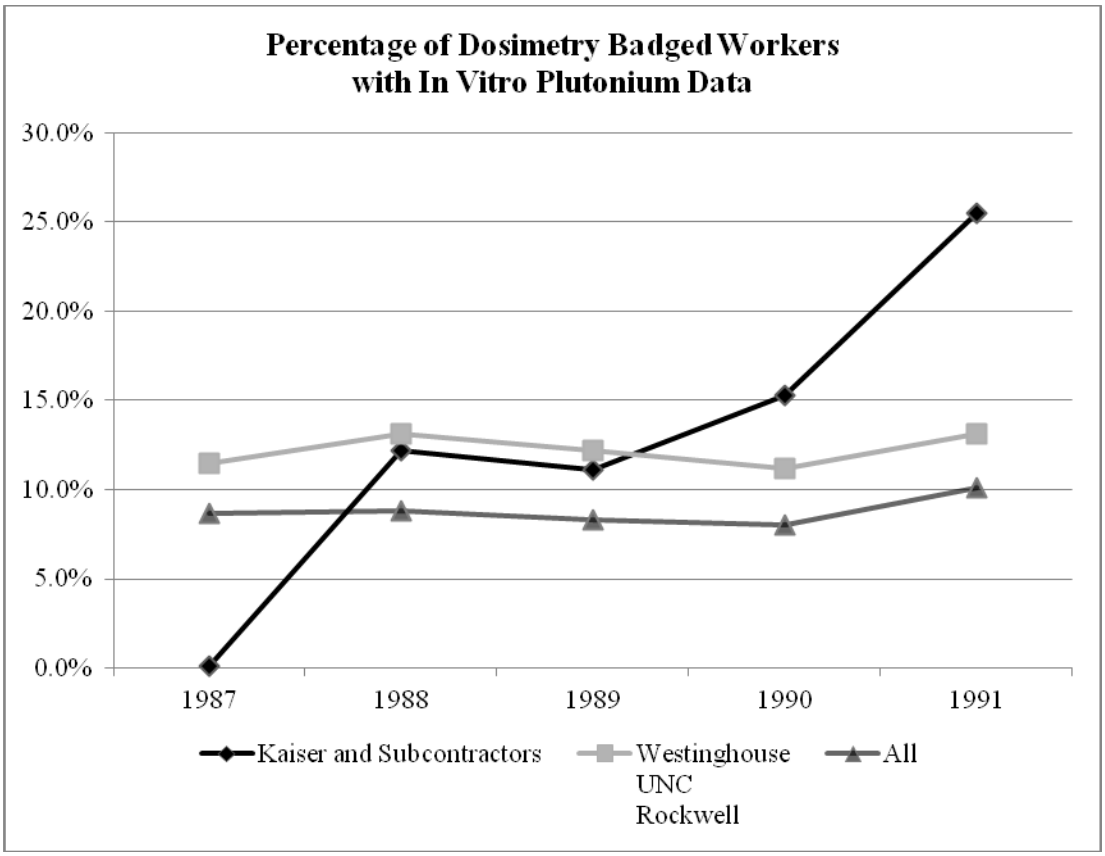

Figure 5-5: Percentage of Dosimetry Badged Workers with *In Vitro* Plutonium Data

Figures 5-4 and 5-5 present the number of workers included in KEH's implementation of chest counting *in vivo* analyses, and plutonium-specific *in vitro* analyses, performed for the years 1987 through 1991. The number of dosimetry badged KEH workers (and subcontractors) included in monitoring programs appropriate for detection of plutonium intakes appears to have increased quickly after KEH assumed the consolidated contract in March 1987.

As stated previously, NIOSH evaluated whether the construction trades workers' radiological exposures were adequately represented in the data used by NIOSH to produce the internal dose coworker distributions in ORAUT-TKBS-0006-5 for the assignment of unmonitored doses. The NIOSH evaluation of available internal personnel monitoring data for JAJ and KEH workers (see Table 5-2) confirms that NIOSH lacks available *in vitro* exposure monitoring data appropriate for the diverse radiologically-significant work performed by JAJ during the years 1984-1987. Although indications are that KEH expanded the *in vivo* and *in vitro* bioassay programs upon assuming the JAJ site support and construction responsibilities in March 1987, Figure 5-3 above indicates that expected numbers of periodic (routine) *in vitro* analyses were not being performed by KEH until into calendar year1990. In 1990 the proportion of periodic *in vitro* bioassays performed for KEH workers (including KEH subcontractor workers) increased to a level commensurate with that of the comparison WHC/UNC/RHO facility operators. NIOSH has concluded that the type of work and the exposure potential for this group of construction trades workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario

until such time that the construction worker exposures are adequately represented in the worker monitoring data set. Data available to NIOSH indicate that by the end of 1990, improvements in the construction services contractor bioassay program allowed the radiological work specific to construction trades workers to be represented in the data used by NIOSH to produce the ORAUT-TKBS-0006-5 internal dose coworker distributions.

5.5 External Personnel Monitoring Data

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to construction trades workers employed by, or subcontracted to, the Hanford site construction services prime contractors, J. A. Jones Construction and Kaiser Engineers Hanford, could not be reconstructed. In light of this internal monitoring-based conclusion, NIOSH did not perform an exhaustive evaluation of external monitoring data for the evaluation period of January 1, 1984 through December 31, 1990. Although this evaluation draws no specific conclusions about the external data and the ability to bound external dose for the class under evaluation, NIOSH has drawn the following general conclusion: available external monitoring data may be used in accordance with existing procedures on a case-by-case basis for the purpose of partial dose reconstructions. This determination is consistent with NIOSH's previous evaluation of SEC-00201 for the preceding period through December 31, 1983 (NIOSH, 2012).

5. 6 Workplace Monitoring Data

As the site construction services prime contractors, J. A. Jones and Kaiser Engineers Hanford were required to deploy their construction trades employees (and the employees of their contractors and subcontractors) to perform a broad range of work activities supporting research, fuel handling, plutonium processing, decontamination and decommissioning, and reactor outages (including work in high-contamination and high-airborne radioactivity areas). Construction trades workers conducted work in facilities such as the 100-N reactor, PUREX fuel reprocessing facilities, plutonium finishing facilities and vaults, and research facilities. Currently, NIOSH does not have access to the associated workplace contamination or air sampling data for each of the areas potentially occupied by the construction trades workers during the period from January 1, 1984 through December 31, 1990.

5. 7 Radiological Source Term Data

As discussed previously relative to workplace monitoring data, the site construction services prime contractors were required to deploy their construction trades employees and the employees of their contractors and subcontractors to an array of radiological work-sites across the Hanford facility. Currently, NIOSH does not have access to the associated source term information or radiological material inventory data for each of the areas potentially occupied by the construction trades worker forces during the period from January 1, 1984 through December 31, 1990.

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 whose 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.

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.

As presented above, current NIOSH dose reconstructions for unmonitored Hanford workers, including construction trades workers, assign unmonitored internal radiation doses per ORAUT-TKBS-0006-5, Attachment C – Internal Dosimetry Coworker Data for the Hanford Site. Identification of the Battelle dosimetry observations in their 1984 letter (Surveillance, 1984) introduced uncertainty as to whether the radiological exposures for construction trades workers working for J. A. Jones were adequately represented in the data used by NIOSH to produce the internal dose coworker distributions in ORAUT-TKBS-0006-5. The JAJ period as the site prime construction services contractor ended on February 28, 1987, after which Kaiser Engineers Hanford assumed the consolidated constructions services contractor role. NIOSH evaluated a group of construction trades workers employed by the prime radiological area construction contractor at Hanford through February 28, 1987. The NIOSH evaluation was based on interviews and Hanford correspondence (Surveillance, 1984) that provided evidence that the construction trades workers' fundamental type of work, and radiological monitoring practices, were substantively different from other Hanford operational workers. NIOSH has concluded that the type of work and the exposure potential for this group of construction trades

workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the worker monitoring data set.

NIOSH's examination of available JAJ internal monitoring data, presented in Section 5.4 of this report, for the period from January 1, 1984 through February 28, 1987, indicates that the JAJ dosimetry program appears to have been ordering minimal internal bioassay analyses during the period from January 1, 1984 through February 28, 1987, as compared to the 2,700 to 3,000 JAJ workers being monitored for external exposure in 1984 and 1985.

The data presented in Table 5-2 of this report indicate that when Kaiser Engineers Hanford took over the consolidated construction services contract in March 1987, additional bioassay monitoring was initiated by KEH beyond that previously performed by JAJ. This is supported by the February 22, 1988, Battelle Internal Dosimetry Program Monthly Report (Monthly, Feb1988) discussing KEH planned program improvements (see Section 5.4 above). However, during this period of forecasted and observed improvements in the number of construction trades worker bioassays performed by KEH, NIOSH continued to see indications that available monitoring data sets may not have yet included monitoring data representative of construction trades workers' potential exposure scenarios, including:

- A Battelle [Redacted per Privacy Act] observed in May 1988 (Monthly, May1988) that "*Because of funding shortages at KEH, the commencement of routine in vivo measurements will not begin until July at the earliest. Also, during April, KEH scheduled 21 routine urine bioassays for which valid samples were received from only two workers.*"

- The implementation of improvements to the routine *in vitro* bioassay program appears to have lagged. Although indications are that KEH expanded the *in vivo* and *in vitro* bioassay programs upon assuming the JAJ site support and construction responsibilities in March 1987, the expected numbers of periodic (routine) *in vitro* analyses were not being performed by KEH in 1987 or 1988. The type of work and the exposure potential for this group of construction trades workers was substantially different than other workers at Hanford, and therefore NIOSH cannot use existing coworker data to establish a bounding scenario until such time that the construction worker exposures are adequately represented in the routine worker monitoring data.

During the years 1987 through 1990, KEH's *in vitro* bioassay program continued increasing the number of periodic (routine) *in vitro* analyses performed. NIOSH finds that in 1990 the proportion of periodic *in vitro* bioassays performed for KEH workers (including KEH subcontractor workers) increased to a level commensurate with that of a chosen comparison group of three radiological facility operating contractors (WHC, UNC, and RHO). Beginning January 1, 1991, NIOSH has determined the personnel monitoring data available in the Hanford REX exposure database contain sufficient routine internal monitoring results for construction trades workers, including *in vivo* monitoring chest count data and *in vitro* plutonium monitoring data, to adequately represent construction trades workers' exposures scenarios.

Development of the Recommended SEC Class Description

NIOSH determined that it lacks sufficient information, which includes sufficient radiobioassay monitoring data for construction trades workers, and sufficient workplace monitoring and source term data, that would allow it to estimate with sufficient accuracy the potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities, to which the proposed class may have been exposed during the period from January 1, 1984 through December 31, 1990. DOL and DOE determined that a NIOSH recommendation for a specific class of workers employed by the prime construction trades contractors (and their subcontractors) during this time could not be implemented. Therefore NIOSH, in consultation with DOE and DOL, has developed a recommended class definition that includes all employees of DOE contractors and subcontractors, excepting specifically identified non-construction prime contractors, for whom NIOSH, to date, has not identified a dose reconstruction infeasibility.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to fuel handling, reactor operations, fuel reprocessing, or research-related radionuclides during the period from January 1, 1984 through December 31, 1990. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from January 1, 1984 through December 31, 1990, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed with included contractors and subcontractors during the period from January 1, 1984 through December 31, 1990, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to construction trades workers employed by, or subcontracted to, the Hanford site construction services contractors, J. A. Jones Construction Services Company and Kaiser Engineers Hanford**,** and their contractors and subcontractors, could not be reconstructed for a dose reconstruction referred to NIOSH by DOL. As noted above, HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report.

Although this evaluation draws no specific conclusions about the external data and the ability to bound external dose for the class under evaluation, NIOSH has drawn the following general conclusion: available external monitoring data may be used in accordance with existing procedures on a case-by-case basis for the purpose of partial dose reconstructions. This determination is consistent with

NIOSH's previous evaluation of SEC-00201 for the period through December 31, 1983 **(**NIOSH, 2012).

Consistent with previous NIOSH determinations associated with the evaluations of SEC-00057, SEC-00152, and SEC-00201, NIOSH has determined that adequate reconstruction of medical dose is likely to be feasible by using claimant-favorable assumptions in the technical information bulletin *Dose Reconstruction from Occupational Medical X-Ray Procedures* (ORAUT-OTIB-0006) and the Hanford site profile documents.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for all workers for the period from January 1, 1984 through December 31, 1990, 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). Therefore, dose reconstructions for individuals employed with included contractors and subcontractors during the period from January 1, 1984 through December 31, 1990, 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

In 2012, HHS designated a class of Hanford employees for inclusion in the SEC for the period from July 1, 1972 through December 31, 1983. Based on its ongoing dose reconstruction and continued data capture efforts since 2012, NIOSH evaluated a group of construction trades workers employed by the prime radiological area construction contractor at Hanford through February 28, 1987. The NIOSH evaluation was based on interviews and Hanford correspondence that provided evidence that the construction trades workers' fundamental type of work, as well as radiological monitoring practices, were substantively different from other Hanford operational workers. NIOSH has determined that this condition continued during the period from January 1, 1984 through December 31, 1990. NIOSH therefore recommends that the class include the time period from January 1, 1984 through December 31, 1990.

Consistent with the previous Hanford site SEC evaluations, 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 of the Hanford site, thus having the potential for exposure to fuel handling, reactor operations, fuel reprocessing, or research-related radionuclides during the period under evaluation. NIOSH recommends that the class definition include all buildings and all areas of the Hanford site during the specified time period.

As described in Section 6.1, NIOSH, in consultation with DOE and DOL, has developed a recommended class definition that includes all employees of DOE contractors and subcontractors, excepting specifically identified non-construction prime contractors. NIOSH has determined that the data available are insufficient for NIOSH to limit a worker's potential exposure scenarios based on job titles and/or job assignments during the specified time period. NIOSH therefore recommends that the class include all employees of DOE contractors and subcontractors, excluding specific non-construction prime contractors, regardless of job titles or job/work descriptions during the proposed time period.

7.0 Summary of Feasibility Findings for Petition SEC-00226

This report evaluates the feasibility for completing dose reconstructions for employees at Hanford from January 1, 1984 through December 31, 1990. NIOSH determined that members of this class may have received radiation exposures from fuel handling, reactor operations, fuel reprocessing, or research-related radionuclides. NIOSH lacks sufficient information, which includes radiobioassay monitoring data for construction trades workers, and sufficient workplace monitoring and source term data, that would allow it to estimate with sufficient accuracy the potential internal doses from radionuclides associated with fuel handling, reactor operations, fuel reprocessing, or research activities, 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.

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 with included contractors and subcontractors during the period from January 1, 1984 through December 31, 1990, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Table 7-1 summarizes the results of the feasibility findings associated with the NIOSH evaluation of SEC-00226 at Hanford for each exposure source during the time period from January 1, 1984 through December 31, 1990.

Table 7-1: Summary of Feasibility Findings for SEC-00226 January 1, 1984 through December 31, 1990			
Source of Exposure	**Reconstruction Feasible (January 1, 1984 through June 28, 1987)**	**Reconstruction Feasible (June 29, 1987 through December 31, 1990)**	**Reconstruction Not Feasible (January 1, 1984 through December 31, 1990)**
Internal	Employees of: - Department of Energy - Battelle Memorial Institute - Westinghouse Hanford Company - Hanford Environmental Health Foundation - Rockwell Hanford Operations - Boeing Computer Services Richland - UNC Nuclear Industries	Employees of: - Department of Energy - Battelle Memorial Institute - Westinghouse Hanford Company - Hanford Environmental Health Foundation	**ALL OTHER** employees of the Department of Energy contractors and subcontractors
	Reconstruction Feasible (January 1, 1984 through June 28, 1987)	**Reconstruction Feasible (June 29, 1987 through December 31, 1990)**	**Partial Reconstruction Feasible [1]**
External	Employees of: - Department of Energy - Battelle Memorial Institute - Westinghouse Hanford Company - Hanford Environmental Health Foundation - Rockwell Hanford Operations - Boeing Computer Services Richland - UNC Nuclear Industries	Employees of: - Department of Energy - Battelle Memorial Institute - Westinghouse Hanford Company - Hanford Environmental Health Foundation	**ALL OTHER** employees of the Department of Energy contractors and subcontractors
- Gamma	X	X	X[1]
- Beta	X	X	X[1]
- Neutron	X	X	X[1]
- Occupational Medical X-ray	X[2]	X[2]	X[2]

[1] NIOSH has determined that available external monitoring data may be used in accordance with existing procedures, on a case-by-case basis for the purpose of partial dose reconstructions.

[2] NIOSH has determined that adequate reconstruction of medical dose is likely to be feasible by using claimant-favorable assumptions in the technical information bulletin *Dose Reconstruction from Occupational Medical X-Ray Procedures* (ORAUT-OTIB-0006) and the Hanford site profile documents.

8.0 Evaluation of Health Endangerment for Petition SEC-00226

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-00226

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of Department of Energy contractors and subcontractors (excluding employees of the following Hanford prime contractors during the specified time periods: Battelle Memorial Institute, January 1, 1984 through December 31, 1990; Rockwell Hanford Operations, January 1, 1984 through June 28, 1987; Boeing Computer Services Richland, January 1, 1984 through June 28, 1987; UNC Nuclear Industries, January 1, 1984 through June 28, 1987; Westinghouse Hanford Company, January 1, 1984 through December 31, 1990; and Hanford Environmental Health Foundation, January 1, 1984 through December 31, 1990) who worked at the Hanford site in Richland, Washington, during the period from January 1, 1984 through December 31, 1990, 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 included 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 Hanford for whom dose reconstruction may not be feasible.

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

DOE, 1986, *Kaiser Engineers, Inc. Selected as New Hanford Engineering/Construction Contractor*, DOE News Release; Department of Energy (DOE); October 16, 1986; SRDB Ref ID: 140515

Exposure Log, Jan1986, *Exposure Timesheet for Area 100N*; J. A. Jones Construction Services Company; January 10, 1986; SRDB Ref ID: 140505

Gamma and Work Log, Nov-Dec1986, *Gamma Pencil and Work Time Register for November-December 1986*; J. A. Jones Construction Services Company; various entries from November-December 1986; SRDB Ref ID: 140504

Meeting Minutes, Sep1986, *Minutes for Hanford Personnel Dosimetry Advisory Committee Meeting on September 4, 1986 and Hanford Internal Dosimetry Program (July 1986) Attachment*; M. J. Sula; September 12, 1986; SRDB Ref ID: 135319

Monthly, Feb1988, *Monthly Report – February 1988*, correspondence to Jim Houston; Monte Sula; February 22, 1988; SRDB Ref ID: 140682

Monthly, May1988, *Monthly Report – May 1988*, correspondence to Jim Houston; Monte Sula; May 23, 1988; SRDB Ref ID: 140688

NIOSH, 2007, *SEC Petition Evaluation Report for Petition SEC-00057-1, Hanford Engineer Works*; National Institute for Occupational Safety and Health (NIOSH); May 15, 2007; SRDB Ref ID: 72279

NIOSH, 2008, *SEC Petition Evaluation Report for Petition SEC-00057-2, Hanford Engineer Works*, Rev. 01; National Institute for Occupational Safety and Health (NIOSH); March 26, 2008; SRDB Ref ID: 72305

NIOSH, 2009, *SEC Petition Evaluation Report for Petition SEC-00152, Hanford*; National Institute for Occupational Safety and Health (NIOSH); September 28, 2009; SRDB Ref ID: 106105

NIOSH, 2012, *SEC Petition Evaluation Report for Petition SEC-00201, Hanford Engineer Works*; National Institute for Occupational Safety and Health (NIOSH); May 31, 2012; SRDB Ref ID: 141094

ORAUT-TKBS-0006-2, *Hanford Site – Site Description*, Rev. 02; ORAU Team Dose Reconstruction Project for NIOSH; Effective Date February 22, 2010; SRDB Ref ID: 79424

ORAUT-TKBS-0006-5, *Hanford Site – Occupational Internal Dose*, Rev. 05; ORAU Team Dose Reconstruction Project for NIOSH; Effective Date November 5, 2012; SRDB Ref ID: 120177

Personal Communication, 2014a, *Personal Communication with Former Hanford Employee*; Telephone Interview by EEOICPA NIOSH Team; November 4, 2014; SRDB Ref ID: 141150

Personal Communication, 2014c, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; December 11, 2014; SRDB Ref ID: 141004

Personal Communication, 2014g, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141009

Personal Communication, 2014m, *Personal Communication with Former Hanford Employee*; Interview by EEOICPA NIOSH Team; September 25, 2014; SRDB Ref ID: 141016

Rad Survey Cards, 1981, *Radiation Survey Cards for Hanford PUREX Facility*, cards for 1981; Hanford; various dates in 1981; SRDB Ref ID: 109604

Rad Zone Log, 1986, *Radiation Zone Entry Log for Area 200 W, Location 231-Z*; J. A. Jones Construction Services Company; various entries throughout July 1986; SRDB Ref ID: 140615

Surveillance, 1984, *Routine Internal Dosimetry Surveillance Program*, correspondence to David Foust; Monte J. Sula; July 27, 1984; SRDB Ref ID: 82643, PDF pp. 6-7

WRAM, 1992, *Examine Current System, Survey of the Existing System*, chapter regarding the WRAM Database; October 23, 1992; SRDB Ref ID: 140524

Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
Primary Site/Company Name: Hanford DOE, 1942-present Alternate Site Names: Hanford Engineer Works (HEW) Physical Size of the Site: The full Hanford site is approximately 586 square miles. SEC00155 involves all workers at the Plutonium Finishing Plant complex, which is in the 200 Area (approximately 60 square miles and encompasses more than 60 buildings). Site Population: The entire Hanford workforce in September 1990 was nearly 9,000.	Air sample data, ALARA program, americium and neptunium recovery processes, internal dosimetry program reports and procedures, chest X-ray requirements, concentration of NP-237 relative to PU-239, departmental reports, particle size determination, dose data from Hanford DuPont personnel applicable to the Mancuso Study, diethylenetriamene pentaacetate (DTPA) treatment data, environmental data, highly enriched fuel program, history of Hanford exposure limits, hot particle data, internal exposure sources at Hanford, neutron and gamma field surveys, neutron badge data, process descriptions, radiation incidents, radiation protection standards, radioactive shipment records, reactor power levels, retrospective evaluation of data submitted by US Testing, review of US Testing annual quality report, safety analysis reports, special work permits, stack gas particulates report, US Testing records, US Testing audits, feed stock records, neptunium shipment reports, a 1988 document stating that Kaiser was establishing a routine bioassay monitoring program for their workers, a 1988 document stating that because of funding, Kaiser had been unable to conduct any in vivo measurements, trip reports, the 10/2014 updated REX database, U-233 and thorium nitrate specifications, stack gases studies, incident reports, polonium production, catalogs of buildings and facilities, plutonium assessments, Health Instrument Division periodic reports, 100 Area technical activities reports, Radiological Sciences Department periodic reports, Radiation Protection Department periodic reports, radiation monitoring periodic reports, fuel and target failure data, tank inventories, radionuclide releases, slug rupture data, hazards reviews, personnel exposure reductions, "N" Reactor videotapes, material transfers, recovery of neptunium, promethium and facility photographs, engineering drawings, US Testing documents, radiological surveys, and material codes. Personnel interviews with former and current site workers have been conducted. **NOTE:** Awaiting release of three PNNL boxes, document relating to REX history and chain-of custody information, summary of the interaction and periods of WRAM, ACES, Sentinel, and other radiological tracking/access systems, copies of any contracting documents and transition plans for the	OPEN	4,970

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	1987 and 1993 Westinghouse contract expansions, list of “contractor” finding aids, validation of the flow chart, list of ‘contracting officers’ names for the 1993 Westinghouse expansion, and an Excel spreadsheet of contractor box listings.		
State Contacted: NA	Contacting the state was not considered necessary since Hanford is an active DOE site and cooperates with relevant data collection.	09/03/2009	0
Albany Research Center (ARC)	DOE remediation efforts at ARC, an environmental report, operating procedures for the Project Owl vacuum melting laboratory, the metallography of thorium, and separation of U-233.	03/20/2013	6
Ames Laboratory	Industrial Medicine on the Plutonium Project 1977 and histories of Ames Laboratory.	07/25/2006	3
Argonne National Laboratory - East	Evaluations of intake and deposition based on bioassay data, meetings on proposed high temperature oxide pile, and plutonium scrap processing.	04/04/2008	7
Battelle Memorial Institute	Procurement of thorium for U-233 separation studies, material inventories, a soil sample analysis, a 1962 isotope procurement application, and personnel monitoring record of a former Hanford employee.	08/18/2014	5
Brookhaven National Laboratory	Compilation of ambient air monitoring parameters at DOE facilities and accelerator radiation exposures in 1974.	10/23/2011	2
Cincinnati Public Library	Radiation safety in the Manhattan Project, Manhattan Project and Atomic Energy Commission histories, and a paper on the decommissioning of the Ames reactor.	02/10/2011	5
Claimant Provided	Environmental monitoring data, study of uranium losses, in vivo cross comparison studies, how plutonium specimen disintegrates under pressure, behavior of Chinese weapons tests fallout, a bioassay blind audit program, a tank vapor assessment, and information on reducing the concentration of radioisotopes in effluent water.	10/30/2014	16
Curtiss-Wright	Plutonium Fuel Development Laboratory special procedure, packaging archive waste containers for shipment, shipping records and orders, and methods of separating U-233 from thorium.	04/26/2009	11
Dade Moeller	Investigation of personal monitoring film, accidental irradiated fuel discharge from N Reactor, radiation exposures of Hanford workers dying from cancer and other causes, Hanford historical production history of all reactors, separations at the Purex Plant, and departmental descriptions and organizational charts.	08/11/2008	35
Department of Labor / Paragon	Vitrification of Niagara Falls Storage Site residues, progress reports, shipment of thorium oxide slugs, tabulation of Sylvania's outstanding	01/23/2012	33

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	orders, disposition of 763 reject Hanford slugs, complex-wide mixed waste, and an environmental impact statement.		
DOE Albuquerque Operations Office	Hazard level classification and the final environmental impact statement for continued operation of Pantex and associated storage of nuclear weapons components.	04/15/2010	2
DOE Carlsbad Field Office	Threshold helium generation reaction rate measurements in FFTF and SP-100/SP-2 irradiation test.	08/12/2010	6
DOE Environmental Management Business Center (EMCBC) - Denver	The 1989 DOE Performance Indicator Pilot Program.	08/15/2013	1
DOE Germantown	Calculations and poisonous effects of various materials, communications between AEC and Westinghouse, procedures and policies, oxide fuel materials, feasibility of Hanford to provide U-233, fission distribution in uranium oxide pellets, forecast for discharge of thorium, Hanford codes, irradiation of thorium, Manhattan District history books, monthly material accountability, NYOO uranium operations flow chart, organizational charts, radiation exposures, thorium as pile flattening material, trip reports, U-233 production, waste recovery centrifuge test, radiation surveys, and the matrix of Hanford Reporting Information Symbols (RIS).	08/26/2014	73
DOE Legacy Management - Grand Junction Office	Mixed waste oil by Hanford, C and D materials produced at Hanford, contract documents, plutonium in soil, production reports, elimination of feed production at Linde and Electro Metallurgical, enriched uranium account report, extrusion of uranium for Hanford, history of refinery operations and site material accountability, Manhattan District history, metal requirements for X-10, monthly progress reports, waste characterization data and management of radioactive tank waste, rolled uranium and fabrication yields, scrap material from Chapman Valve, shipment of rods, spent nuclear fuel project 324 and 327 Buildings material classifications, Tonawanda progress reports, slug production report for AEC including canning, coating, and treating, billet requirement schedule, plutonium concentrations in soil, off-site waste disposal, and thorium shipment information.	08/30/2011	186
DOE Legacy Management - Morgantown	Accomplishments of the National Lead Company of Ohio in operating the AEC facilities at Fernald, bibliography of epidemiological papers, control technology for radioactive emissions, environmental survey, preliminary summary report of the defense production facilities, health and mortality study, monthly reports, plutonium content information, quality assurance report, activities of the Center for Epidemiologic Research, recycled	12/01/2011	152

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	uranium reports, Fernald shipment reports, an update of quantity in storage for radioactive mixed wastes, material transfer reports, and Grand Junction Facilities dosimetry reports with some Hanford data.		
DOE Legacy Management - MoundView	Personnel at risk in plutonium-238 operations, re-irradiation of radium, effluent information system/onsite discharge information system, evaluation of high assay Pu-238 oxide for use in fabrication of plasma-fired microspheres, external radiation levels, development and use of actinium, Hanford wastes, production machining of uranium, incineration of radioactive solid wastes, Battelle occupational exposure history, production reports, radiological incidents, shipping documents, standard operating procedures, thorium accountability documents, U-233 as a contaminant in thorium nitrate solution, monthly progress reports, summary of production orders, assessment of the health and mortality studies of federal nuclear workers, U-233 concentration in thorium residues at Fernald, and quality assurance activities.	01/17/2011	143
DOE Legacy Management - MoundView / Albany Research Center	A 1958 symposium on uranium industry occupational health experience and practices.	09/30/2003	1
DOE Legacy Management - Westminster Office	The 2003 MED/AEC/DOE external dosimetry technical basis document, status of stable metal tritides at Mound, and lung counter inter-comparison studies.	02/04/2013	6
DOE Oak Ridge Operations Office	Paducah hazardous waste disposal, internal dosimetry, industrial hygiene documents which refer to Hanford, storage and disposition of U-233, and the recovery of Np-237 from Hanford recycled uranium.	07/09/2012	12
DOE Oak Ridge Operations, Records Holding Task Group	Film badge and exposure correspondence, material requirements and transfers, Np-237 recovery, thorium shipments, feed materials production reports, uranium production statistics, and NIOSH researcher notes.	06/25/2013	90
DOE Oak Ridge Public Reading Room	Nationwide accountability of source and fissionable materials.	04/08/2011	1
DOE Office of Scientific and Technical Information (OSTI)	Ionium, uranium-232, and thorium-228 properties, applications, and availability, survey of irradiation facilities, meeting on collection and measurement of radioactive air contaminants, preliminary hazards report for a reactor experiment at CANEL, a proposed Purex Separations Plant study, trip report, Mallinckrodt reports on Hanford feed material and cross-checking of samples, zirconium cladding information, breeder fuel development, progress reports, laboratory surfaces decontamination, film badge modifications, UO2 pellet fabrication, Np-237 processing, isotope inventories, and a request for six irradiated Hanford slugs.	08/21/2014	64
East Tennessee Technology Center (ETTP) Records Center	The history and description of Hanford recycled uranium at the DOE	05/05/2014	1

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	Gaseous Diffusion Plants.		
Environmental Measurements Laboratory (EML)	Hanford Uranium Bioassay Program and reference to the 1962 criticality incident.	01/21/2011	2
Federal Records Center (FRC) - Chicago	A working group meeting on radioactive waste management.	09/27/2006	1
Federal Records Center (FRC) - Denver	Radiation exposure reports, beryllium usage and incidents, a review of criticality accidents, a plutonium worker health study, multi-site radiological protection and dosimetry inventories, and the identification of mixed waste streams.	01/25/2012	8
Federal Records Center (FRC) - Kansas City / Bannister	Task proposals for ANL fuel cycle and waste management field work.	08/15/2008	1
Federal Records Center (FRC) - San Bruno	Air sampling equipment and procedures at reactor sites throughout the United States, Lawrence Berkeley National Laboratory work authorizations and surveys, operations documents, and logbooks of isotopes received.	08/02/2012	17
General Atomics	Nuclear material shipping and receiving reports, and Health Physics and Medical Department reports.	01/09/2006	2
General Electric Vallecitos	TLD and film badge technical information.	05/18/2007	2
Hagley Museum and Library	Activity of DPW-100 slugs, bioassay manual, canning enriched slugs and Li-Al alloy slugs, continuous incineration of plutonium-bearing scrap, fission product activity, fuel element failures, gamma activity of tritium slugs, monthly reports, slug failures, plutonium button fabrication, plutonium coupling - neutron monitoring, plutonium waste recovery, postum production, radiation readings, reactor shielding, continuous monitor for I-131 in stack gases, thorium program, trip reports, U-237 in UNH processing, uranium isotope analyses, comparison of Chalk River and Hanford slugs, Hanford history, monthly reports, radiographic inspection, reactor operation following slug failures, report of meeting Battelle Memorial Institute, aid of new fuel elements, status of P-10 program, and waste management tank design.	10/01/2010	110
Hanford / SC&A	Incident reports, technical section reports, routine fecal sampling, thyroid monitoring review, whole body counting, a waste encapsulation report, the redox ruthenium problem, a 1948 review of the stack discharge particulate problem, and a September 1946 monthly report.	01/20/2009	13
Health Physics Society	Bioassay criteria for environmental restoration workers.	03/22/2007	1
Idaho National Laboratory (INL)	A review of Hanford fuel processing at INL, INL reports referencing Hanford, US reactors operating histories, a Rocky Flats incident involving Hanford feed material, and shipping and receiving records.	11/18/2014	30
Indiana Department of Homeland Security	US Army Corps of Engineers presentation documenting work done at	07/05/2012	1

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	Joslyn Steel for Hanford.		
Interlibrary Loan	Thorium production technology, a criticality short course, environmental levels of radioactivity at AEC installations, Seaborg's journals, and the proceedings of the 1993 incineration conference.	08/22/2012	16
Internet - Defense Technical Information Center (DTIC)	Annual reports to Congress, DOE internal dosimetry standard, mixed oxide and breeder reactor reports, low-level waste reports, a global fissile material report, a toxicological profile for plutonium, and the US Navy's manual of radiological safety.	10/04/2013	24
Internet - DOE	An analysis of airborne radioactivity release fractions and the DOE Guide of Good Practices for Occupational Radiation Protection in Plutonium Facilities.	12/04/2008	2
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	05/12/2010	0
Internet - DOE Environmental Management	Linking Legacies, Chapter 3 - Wastes.	10/28/2007	1
Internet - DOE Legacy Management Considered Sites	Decontamination and decommissioning of the Westinghouse Nuclear Fuel Facility at Cheswick, PA, a Ventron remedial action certification docket, mixed waste inventory report, and 1951 Tonawanda Area progress reports.	04/24/2012	6
Internet - DOE OpenNet	Absorption and translocation by plants of radioactive elements from "jangle" soil, human radiation experiments information, air pathway report, Columbia River pathway dosimetry report, fission product iodine during early Hanford operations, hematological effects on heavily irradiated Japanese fishermen, history of the Inhalation Toxicology Research Institute, Manhattan District history book, monthly activities, products, operations and progress reports, Newell Stannard interview, Bikini fall of 1978, plutonium release estimates, radiation dose estimates from Hanford radioactive material releases to the air and the Columbia River, radiological incidents, a thyroid disease study, purchase order, trip reports to Joslyn Steel, Pu-238 shipments, the assay of Fe-55 and Fe-59 in biological samples, and status reports.	11/11/2014	100
Internet - DOE OpenNet / Hanford	C.C. Gamertsfelder interview.	11/26/2007	1
Internet - DOE OpenNet / NIOSH	A 1960 annual report to Congress.	01/11/2008	1
Internet - DOE OSTI	Thorium metallurgy and ORIGEN reports.	05/30/2007	3
Internet - DOE OSTI / SC&A	A summary of radiation accidents and incidents, 1945-1955.	02/21/2007	1
Internet - DOE OSTI Energy Citations	Pinellas Plant feasibility study, radioactive waste shipments to Hanford, characterization of UO-2 and Pu-O2 powders, process description for the retrieval of earth-covered transuranic waste containers, decontamination	08/01/2013	75

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	and decommissioning information, wrap module 1 sampling and analysis plan, monthly activity reports, beta treatment of uranium, production of medical radioisotopes, technical progress reports, radioactive waste processing, chemical processing reports, and fuel fabrication and irradiation.		
Internet - DOE OSTI Information Bridge	Risk of transporting plutonium oxide and liquid plutonium nitrate, early reactor waste, contaminated sites within the DOE Complex, environmental management report, external dosimetry technical basis information, americium recovery and purification, monthly reports, hazard analyses, human radiation experiments, plutonium safety evaluation report, hazards evaluation for enriched uranium-thoria, processing E-metal in the 200 Areas, production tests, protective measures for personnel manual, radiation control standards and procedures, radiation survey report, reprocessing uranium - molybdenum alloy fuels, 300 Area history, low-level waste vitrification melter, iodine-131 releases, an ionium for radioisotope preparation status report, buried waste integrated demonstration program DOE complex buried waste characterization assessment, hazardous waste shipment data collection from DOE sites, incineration of DOE offsite mixed waste at the INEEL, inter-calibration of counting laboratories, N-Reactor monthly reports, shipment of TRU waste from West Jefferson, Ohio, spent fuel background report, summary of the environmental dose models, surface radiological investigations, tritiated wastewater treatment and disposal evaluation, fuel reports, reactor research reports, a stockpile management report, a safety analysis report, thoria development activities, fissile materials control and disposition, preparation of neptunium peroxide, Chemical Processing Department reports, and a tank content estimate.	11/30/2013	383
Internet - DOE OSTI Information Bridge / Hanford	A fuel element technical manual and a report of a plutonium oxide storage container rupture.	10/22/2009	2
Internet - DOE OSTI Information Bridge / SC&A	324 building closure waste assessment and closure plan, heat source processing, and a waste classification sampling plan.	03/15/2012	5
Internet - DOE OSTI SciTech Connect	The Hanford Bioassay Program, incident reports, the 1996 radiological protection support services report, high-level waste reports, tank remediation reports, fire prevention for sodium coolant and spent nuclear fuel, and decontamination and decommissioning reports.	11/04/2014	30
Internet - Energy Employees Claimant Assistance Project (EECAP)	Incident reports, environmental contamination assessments, and a summary report on high-level waste repository concepts.	03/31/2014	16

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
Internet - Global Security	Weapons of Mass Destruction Website: Polonium.	09/14/2009	1
Internet - Google	Radiological surveys, B Reactor museum association history of 100-B/C reactor operations, separation of the uranium isotopes by gaseous diffusion, General Atomics hot cell facility decontamination, monthly reports, health-physics, instrumentation, and radiation protection, history of the department of nuclear science and engineering, nuclear weapons data-book, Project Trinity information, FUSRAP reports, site operating report, annual site environmental report, US nuclear weapons research, development, testing, and production, long-term management of nuclear materials, annual report on waste generation and minimization, environmental restoration and management, Manhattan Engineer District history, low-level radioactive wastes, practices and problems in disposal of radioactive wastes into the ground, subsurface behavior of plutonium and americium, summary of contaminated sites and initial cleanup work, mission transition reports, a timeline of the Manhattan Project, general environmental reports, storage of Rocky Flats material, technology trends of DOE sites, DOE occupational radiation exposure reports, air cleaning conference proceedings, separation of plutonium and neptunium, and building histories.	12/22/2014	351
Internet - Google / SC&A	The dry cask storage project and planning for hot cell closure.	03/28/2011	2
Internet - Hanford	The 300 Area history, Ra-226 waste tank inventory, building radiological characterizations, facility status change forms, and the characterization and disposal plan for tank farm long-length equipment.	06/05/2013	12
Internet - Hanford Declassified Document Retrieval System (DDRS)	Alpha hand monitoring, americium recovery, radiological surveys, attenuation of a neutron and gamma ray beam, calibrated neutron sources and area monitoring chambers, power levels versus Po-210 production, dosimetry and spectrometry of fast neutrons by radio-activation, dosimetry in the Hanford gamma irradiation facilities, double moderator neutron dosimeter, iodine release, sensitivities of reactor neutron flux monitors at B Reactor, measurements produced neptunium, integrated thermal neutron exposure, determination of the radon content of water, neptunium recovery, neutron dosimetry and irradiation of solids, neutron flux monitor detector, power and exposure levels of Hanford reactors, notes on dosimetry problems, production statistics of N Reactor operations, radiation exposure data, radiological incidents, safety analysis report, slow and fast neutrons, scintillation count-rate and dose-rate meter, monthly and weekly reports, thorium U-233 separation, trip reports to Joslyn Steel, production of high exposure plutonium for ZPPR, shipments to Rocky Flats, and tritium	08/16/2013	2,077

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	exposures.		
Internet - Hanford Declassified Document Retrieval System (DDRS) / SC&A	1948 100 and 300 Areas reports and a 1957 Irradiation Processing Department report.	11/01/2007	2
Internet - Health Physics Journal	An airborne radioiodine dispersion study and I-129 in rabbit thyroids near the Idaho National Laboratory. NOTE: A further review of this source is planned.	OPEN	2
Internet - Journal of Occupational and Environmental Health	No relevant data identified.	07/20/2010	0
Internet - Los Alamos National Laboratory (LANL)	The radiochemistry of the elements.	07/10/2013	1
Internet - Massachusetts Department of Environmental Protection	A report which mentions Ventron shipments to and from Hanford.	04/19-2012	1
Internet - National Academies Press (NAP)	DOE weapons complex management of health, safety, and environmental issues, characterization and treatment of radioactive wastes, analysis of cancer risks of populations near nuclear facilities, management and disposition of excess plutonium, and a National Research Council report on the cleanup technology roadmap.	08/19/2013	5
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	05/12/2010	0
Internet - National Technical Information Service (NTIS)	Feasibility studies of the correlation of lifetime health and mortality of AEC and AEC contractor personnel.	08/21/2006	2
Internet - NIOSH	Residual radioactive and beryllium contamination reports and SEC Petition Evaluation reports.	03/22/2013	6
Internet - NRC Agencywide Document Access and Management (ADAMS)	NRC's decommissioning procedures and criteria, environmental statement on the use of recycled plutonium in mixed oxide fuel in light water cooled reactors, a survey of waste solidification process technologies, an evaluation of potential recycling scrap metals from nuclear facilities, waste tank remediation reports, waste disposal reports, environmental impact statements, basalt waste isolation reports, I-129 in groundwater reports, storage and disposition of weapons-grade material, storage and leaching from spent fuel, improving confinement ventilation systems, special form capsule testing, audit reports, quality assurance for waste repositories, waste retrieval criteria, and weld inspections of Pu sealed sources.	03/28/2013	289
Internet - Oak Ridge National Laboratory (ORNL)	ORNL Laboratory and Metallurgy, Operations, Chemical Technology, and Radioisotope Distribution Division periodic reports referencing Hanford and solvent stability in nuclear fuel processing.	04/08/2013	156
Internet - USACE/FUSRAP	No relevant data identified.	05/12/2010	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	05/12/2010	0

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
Iowa State University Library	An interview about Ames Laboratory work which mentions Hanford.	09/18/2013	1
Kansas City Plant	Annual environmental summary reports and a 1951 Hanford trip report.	10/10/2013	2
Los Alamos National Laboratory (LANL)	Isotopic content and specific activity of pile-produced plutonium, radioactive waste disposal and related issues, monitoring of certain personnel for internal plutonium contamination, human studies, radiological incidents, radiological releases, and quantities and characteristics of the contact handled low-level mixed waste streams for the DOE Complex.	12/13/2007	27
Lovelace Respiratory Research Institute (LRRI)	Annual reports including Hanford data.	05/22/2007	5
Massachusetts Department of Public Health	Waste disposal practices and shipments from Nuclear Metals to Hanford.	04/12/2012	1
Metals and Controls Corporation, Attleboro, MA	Documentation that Metals and Controls supplied fuel to Hanford.	08/24/2004	1
Missouri Department of Natural Resources	Individual interviews, history of the St. Louis Uranium Processing Plant, a plutonium working group report on plutonium storage, and a feasibility study for the St. Louis site.	10/03/2008	5
Mound Museum	Plutonium shipments and control, bismuth shipments, periodic Mound reports referencing Hanford, plutonium shipments, 1949 liquid waste disposal, polonium research, and biological research.	02/01/2012	27
National Archives and Records Administration (NARA) - Atlanta	Annual reports, review of the existing reactor confinement program at Hanford, assay of uranium by-product materials, contamination of express cars (Hanford shipment), Dragon Project irradiations, human chromosome aberrations, investigative report on X-ray overexposure, list of commission and contractor personnel by professional category, Madison Square area monthly accountability reports, employee monitoring, monthly progress reports, report on health and safety aspects of recycle material, DOE indoor radon study, summary of work done at Berkeley, fission of uranium-235 or plutonium-239, and product specifications.	05/14/2010	43
National Archives and Records Administration (NARA) - Atlanta / SC&A	Pu-238 Be neutron source information.	06/10/2004	1
National Archives and Records Administration (NARA) - College Park	Handling of radioactive waste materials, shipment of Sr-90 and Cs-137, criticality accident analysis, actions related to tank leak, US Transuranium Registry summary report, personal notes, Hanford thorium requirements, fission product distribution, test rolling, thorium special irradiations, thorium hot extrusion work, material accountability reports, and trip reports.	03/11/2014	59
National Archives and Records Administration (NARA) - Kansas City	Historical FUSRAP site information including a DuPont contract at Hanford and the history of the UMETCO Minerals Company, which	03/29/2005	2

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	shipped ingots to Hanford.		
Nevada Test Site (NTS)	The final NTS environmental impact statement including off-site locations and photographs of Hanford workers in protective clothing.	04/26/2005	5
New York State Archives	Process development minutes from 1952-1954, 1952-1953, a Tonawanda sub-office report showing the shipments to Hanford of Simonds Saw & Steel billets, an analysis of the criticality potential of Hanford metal stored at the Lake Ontario Ordnance Works, and feed materials excerpts from the Manhattan District History Book VII.	03/21/2012	7
New York State Department of Environmental Conservation	Nickel plating of uranium slugs at Sylvania for Hanford and an evaluation of the powder metallurgy project.	02/25/2008	2
NIOSH	Analysis of ignition testing on K-west basin fuel, storage of highly enriched uranium, DOE Ohio sites recycled uranium project report, effects of rolling on the crystallography and metallography of uranium, excretion of Pu-239 in a patient with a plutonium contaminated injury, generation and flow of recycled uranium, highly enriched uranium working group report, list of classified documents, production and recovery of U-233 from thorium, reactor production tests, standardization of gold and indium foils and the absolute neutron flux determination, technical activities, research and development reports, testing prediction capabilities of an I-131 terrestrial transport model, worker outreach meeting documents, USTUR active registrants living and deceased SEC Petition 00155 support documentation, worker outreach meeting minutes, the changes to the Hanford and PNNL site descriptions, and process knowledge expert notes on the fecal plutonium bioassay program.	07/17/2014	133
NIOSH / SC&A	DOE Ohio Field Office recycled uranium report and highly enriched uranium working group reports.	02/16/2006	6
Nuclear Information and Records Management Association (NIRMA)	A discussion of the FBI's Rocky Flats raid which mentions Hanford as a source of Rocky Flats plutonium.	03/04/2013	1
Nuclear Metals, Inc.	Index cards documenting reports to Hanford and the feasibility report for fuel rod production for Hanford.	05/24/2012	2
Nuclear Regulatory Commission (NRC) Non-Publicly Available Records Collection	Documents related to the construction of the Military Compact Reactor, a license for the export of U-235 to Norway, and the evaluation of the secondary HTS transient natural circulation test.	06/04/2012	3
Nuclear Regulatory Commission (NRC) Public Document Room	Trip and inspection reports, operating licenses, basalt waste storage units reports, reviews of license applications, audits of waste disposal plans, environmental release assessments, progress reports on radionuclide	09/13/2012	60

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	solubility, and the transfer of irradiated TRIGA fuel elements to Hanford.		
Nuclear Regulatory Commission (NRC) Public Document Room / Internet - NRC ADAMS	Comparison of Hanford environmental models.	08/31/2011	1
Nuclear Regulatory Commission Region 1	Documentation of Hanford's assistance in evaluating a uranium uptake at Nuclear Metals, Inc.	03/29/2013	1
Oak Ridge Institute for Science and Education (ORISE)	Chelation DTPA data for DOE employees - REAC.	08/06/2009	94
Oak Ridge Library for Dose Reconstruction	ORNL and K-25 operational, RALA, and waste disposal reports which refer to Hanford, 200 Area stack contamination, evaluation of Hanford soil contamination, release of radioiodine during metal dissolution, and a 1984 atmospheric sciences report.	06/14/2011	62
Oak Ridge National Laboratory (ORNL)	Safe handling of unprocessed metal, DuPont employee roster, Mancuso Study data, spills of Hanford material at ORNL, ORNL periodic reports referencing Hanford, a 1947 shielding symposium, the 1944 gamma irradiation tolerance dose, and a 1948 exposure estimate for insoluble particulates lodged in the lungs.	09/13/2011	118
Oak Ridge Public Library	Construction for Atomic Bomb production facilities.	11/18/2010	1
Ohio Department of Health	Plans for a scaled down aircraft engine test at Hanford and environmental restoration plans.	11/03/2008	2
ORAU Library	Excerpts from the Nuclear Weapons Databook Volume III.	10/12/2006	1
ORAU Team	Basis for thoron concentration and doses for thoria processing, bounding estimate of neutron dose based on measured photon dose around single pass reactors at Hanford, correspondence on the Mallinckrodt badge program, dosimetry data, human radiation exposures related to nuclear weapons industries, annual reports, ORAU Team generated spreadsheets, radiation dose estimates and hazard evaluation for inhaled airborne radionuclides, Savannah River Site thorium processing timeline, study of atmospheric contamination in the Melt Plant, technical basis documents, workplace measurements of neutron and photon doses, documented correspondence related to US Testing, trip reports, an SEC Petition Evaluation Report, and documented communications.	09/30/2014	162
Pacific Northwest National Laboratories (PNNL)	Hanford environmental surveillance, ORAU Team Project spreadsheets, radiation protection procedures, whole body counter activities, measurement and evaluation of internal exposure, in vivo bioassay methods and sensitivities, preparation of project proposal for new rolling mill, and fixed time estimation of counting rates with background corrections.	04/26/2011	15
Paducah Gaseous Diffusion Plant	Radioactivity analysis reports, air samples, trace element analysis, ash	09/18/2006	5

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	results, power results, and sample data unspecified.		
Richland, WA Federal Building	Documented communications with process knowledge experts, weapons development reports, and nuclear materials safeguards. All are sensitive documents.	04/18/2012	34
Rocky Flats	A lung counter inter-comparison study.	10/30/2013	1
Rocky Flats Environmental Technology Site (RFETS)	An assessment of the flammability of defense transuranic waste.	5/17/2006	1
S. Cohen & Associates (SC&A)	Mortality study, review of low-level waste management ES&H vulnerabilities, highly enriched uranium report, recycled uranium mass balance project, bioassay at Hanford, description of Hanford personnel dosimeter program from 1944-1989, laboratory measurement error in dose estimates, progress reports, radioactive contamination environs report, combination neutron dosimeter in plutonium environments, retrospective assessment of personnel neutron dosimetry, incident investigations, summary of recorded external radiation doses for Hanford Workers 1944-1989, ICPP monthly reports, and a personnel interview.	08/05/2011	136
SC&A / Hanford	Monthly reports, control of ground contamination, KW Reactor incident report, radiation incident investigation, removal of ruptured slugs, examination of selected ruptures, divisions reports, interview with petitioners/former and current Hanford workers, reactor effluent water disposal, ruptured slugs, and stack gas decontamination - separations plant.	06/24/2010	21
SC&A / Idaho National Laboratory	Slug shipments to Idaho Chemical Processing Plant (ICPP), summary of stack gas discharge, iodine calculations for Radioactive Barium-Lanthanum (RALA) production, RALA program and problems, RALA project specification letter, shipments to the ICPP, and ICPP production reports.	06/24/2010	43
SC&A / Internet - DOE Hanford DDRS	Hanford monthly reports.	11/05/2008	6
SC&A / Internet - DOE OpenNet	The first 50 years of plutonium production in the United States.	10/28/2014	1
SC&A / Internet - Google	The Savannah River Site 50th anniversary publication.	04/22/2008	1
SC&A / NARA - Atlanta	Health and safety report on recycle material and UO3 specifications.	03/17/2004	2
SC&A / NIOSH	Recycled uranium generation and flow.	08/14/2003	1
SC&A / Pinellas	A 1993 waste generation and minimization progress report.	06/24/2010	1
SC&A / Stanford Linear Accelerator Center (SLAC)	Investigations of environmental contamination at Hanford.	06/13/2011	4
Sandia National Laboratories, California	Various employee exposure reports.	03/28/2007	1
Sandia National Laboratories, New Mexico	Radiation exposure cards including a Hanford exposure.	02/17/2012	1
Sandia National Laboratories, New Mexico / SC&A	Radioactive material shipping survey for a shipment to Hanford.	09/15/2010	1
Santa Susana Field Laboratory	History of Nuclear Materials Development Facility.	12/18/2007	1
Savannah River Site	Irradiation of thorium slugs, use of pocket dosimeters, progress reports,	03/19/2012	70

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	thorium irradiation program, exposure to gamma radiation, thorium slug failures, production summary 100 and 200 Areas, dosimetry visitors cards, polonium production, Health Physics procedures, exposure data for Hanford test badges, Hanford film badges exposed in the plutonium facility at the Savannah River Site, Savannah River Site lab notebook, a Health Physics methods logbook, monthly status reports which refer to Hanford, thorium and U-233 reports, monitoring of tritium, and an ORAU Team researcher's notes.		
Science Applications International Corporation (SAIC)	Radiation exposures by AEC Operating Office and summaries of whole body radiation exposures.	09/02/2004	8
Senator John Heinz History Center	Westinghouse histories and uranium production.	12/20/2007	5
Southern Illinois University, Edwardsville, IL	Mallinckrodt uranium information, disposal of radioactive wastes in the metropolitan St. Louis area, metal billets for Hanford, inspection of uranium casting facilities, shipments of uranium hexafluoride to Hanford, and re-melting of Hanford uranium scrap at Mallinckrodt.	11/01/2008	12
Stanford Linear Accelerator Center (SLAC) / SC&A	The 1996 SLAC Dosimetry Technical Basis Document.	4/11/2006	1
University of Colorado Norlin Library	Background measurements of alpha particle emitters at Rocky Flats where the radiochemistry was performed by Hanford.	08/20/2003	1
University of Rochester Miner Library	Quarterly review report.	10/14/2008	1
University of Tennessee Library	Inhalation program, case studies of uranium and thorium uptakes, Hanford whole body donors to the Uranium and Transuranium Registry, internal dosimetry research, and Hanford airborne particle releases in 1947 and 1948.	10/10/2011	15
Unknown	Nuclear track emulsions and analysis of urine for very low-level plutonium, bioassay procedures, calculation of neutron flux and exposure, film badge comparison, decontamination and decommissioning, detection limits, bioassay data, environmental reports, estimation of plutonium lung burden by urine analysis, external dosimetry manual, fast neutron dose, gamma dose measurement with film badges, external dosimetry program, monthly reports, site history, medical X-ray exposure study, neutron exposures, waste tank inventories, radiation protection aspects of work with promethium-147, radioactive contamination reports and investigations, radionuclide releases, nuclear track dosimeters exposed to plutonium sources, shipping documents, site maps, stack release data, Tiger Team assessment, Mancuso study progress report number 9, and whole body counter activities.	04/14/2011	588

Table A1-1: Summary of Holdings in the SRDB for Hanford			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
US Army Corps of Engineers (USACE)	A document list for Joslyn Steel including letters and memoranda to Hanford.	07/31/2012	1
US Environmental Protection Agency (EPA)	Report of a damaged low-level waste shipment which was transported through the Hanford site to the US Ecology burial site.	02/14/2014	1
Washington University Libraries - St. Louis	A 1953 report on fast neutron monitoring of personnel.	04/27/2007	1
Waste Isolation Pilot Plant	Battelle - West Jefferson transuranic waste shipments to Hanford.	11/05/2010	5
West Valley Demonstration Project	Shipping of Pu product to Hanford, waste processing description, and references to Hanford's internal dose assignment protocol.	01/17/2010	4
Y-12	A history of the Hanford site included in the Oak Ridge historical evaluation.	2/21/2008	1
Total			**11,417**

Table A1-2: Database Searches for Hanford			
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 “Copy of Hanford Rev 06, (83 13) 02-12-15 (2).”			
DOE CEDR http://cedr.lbl.gov/ COMPLETED 05/12/2010	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 05/12/2010	See Note above	168	2
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 05/12/2010	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 05/14/2010	See Note above	23	1
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 05/12/2010	See Note above	288	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp	See Note above	528	2

Table A1-2: Database Searches for Hanford			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
COMPLETED 05/11/2010			
DOE OSTI SciTech Connect http://www.osti.gov/scitech COMPLETED 04/14/2014	See Note above	1	1
Energy Employees Claimant Assistance Project (EECAP) http://www.eecap.org COMPLETED 03/28/2014	See Note above	23	13
Google http://www.google.com COMPLETED 05/11/2010	See Note above	2,261,772	40
HP Journal http://journals.lww.com/health-physics/pages/default.aspx	See Note above	OPEN	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 07/20/2010	See Note above	1	0
National Academies Press http://www.nap.edu/ COMPLETED 07/11/2010	See Note above	36	2
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 05/12/2010	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 06/14/2011	See Note above	8,511	376
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 05/12/2010	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 05/12/2010	See Note above	0	0