

SEC Petition Evaluation Report Petition SEC-00201

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| Subject Expert(s): | Robert Burns |
| Site Expert(s): | NA |

| Petitioner Administrative Summary | | | |
|-----------------------------------|---------------|-------------------------|------------------------|
| Petition Under Evaluation | | | |
| Petition # | Petition Type | Petition A Receipt Date | DOE/AWE Facility Name |
| SEC-00201 | 83.14 | May 3, 2012 | Hanford Engineer Works |

| NIOSH-Proposed Class Definition |
|---|
| All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Hanford Engineer Works in Richland, Washington, from July 1, 1972 through December 31, 1983, 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 |

| 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 |

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| ORAU Lead Technical Evaluator: Robert Burns | ORAU Peer Review Completed By: Michael Kubiak |
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| Peer Review Completed By: | _____ [Signature on File] <i>Sam Glover</i> | _____ 5/31/2012 <i>Date</i> |
| SEC Petition Evaluation Reviewed By: | _____ [Signature on File] <i>J. W. Neton</i> | _____ 6/1/2012 <i>Date</i> |
| SEC Evaluation Approved By: | _____ [Signature on File] <i>Stuart L. Hinnefeld</i> | _____ 6/1/2012 <i>Date</i> |

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Evaluation Report Summary: SEC-00201, Hanford Engineer Works

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

NIOSH-Proposed Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Hanford Engineer Works in Richland, Washington, from July 1, 1972 through December 31, 1983, 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-00201 proposes a class that begins on July 1, 1972 and extends through December 31, 1983. For this current report, NIOSH lacks sufficient information, which includes biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source information, to allow it to estimate with sufficient accuracy the potential internal exposures to purified highly-enriched uranium, U-233, neptunium, or thorium to which the proposed class may have been subjected.

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

- In 2009, HHS designated a class of Hanford employees for inclusion in the SEC for the period October 1, 1943 through June 30, 1972, thus enveloping two previously-enacted classes. NIOSH has continued to evaluate the time period after June 30, 1972 as part of its ongoing dose reconstruction and continued data capture efforts since 2009.
- Principal sources of internal and external radiation for members of the current proposed class included exposures to HEU, U-233, thorium, and neptunium in the 200 Area and 300 Area during activities in support of defense -related research, development of advanced reactor fuels, chemical separations of irradiated nuclear fuels, packaging of product materials, maintenance and waste-handling operations, and facility decontamination and decommissioning efforts.
- Consistent with previous NIOSH determinations associated with the evaluations of SEC-00057 and SEC-00152, 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.

- NIOSH has evaluated the available information and determined that it does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to sufficiently estimate potential internal exposures to HEU, U-233, thorium, or neptunium during the period from July 1, 1972 through December 31, 1983. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to HEU, U-233, thorium, or neptunium and resulting doses for the proposed class of employees during the period from July 1, 1972 through December 31, 1983.
- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Hanford Engineer Works during the period from July 1, 1972 through December 31, 1983, 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 inadequately monitored radionuclides and from direct exposure to radioactive materials. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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SEC Petition Evaluation Report for SEC-00201

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: Bob Burns, NGTS, Inc. 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 current NIOSH-proposed class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Hanford Engineer Works in Richland, Washington, from July 1, 1972 through December 31, 1983, 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, employees at the Hanford facility were involved with defense-related research and development activities, research and development of advanced reactor fuels, chemical separations of irradiated nuclear fuels, packaging of product materials, maintenance and waste-handling activities, and facility decontamination and decommissioning activities.

The evaluation responds to Petition SEC-00201 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 three 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 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 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.

Detailed information associated with the Hanford worker classes added to the SEC in 2007, 2008, and 2009 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); and *SEC Petition Evaluation Report, Petition SEC-00152* (NIOSH, 2009).

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>.

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-00152 in 2009. NIOSH has determined that additional dose reconstruction infeasibilities exist through December 31, 1983 due to work with highly-enriched uranium (HEU), U-233, thorium, and neptunium for which NIOSH has inadequate information to bound dose. Consistent with the determinations of the SEC-00152 evaluation, 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 Engineer Works where these hazards potentially existed during the period from July 1, 1972 through December 31, 1983.

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize radiological operations at the Hanford Engineer Works (hereafter referred to as Hanford) from July 1, 1972 through December 31, 1983 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 breadth and compartmentalized nature of operations at Hanford, which included Pacific Northwest National Laboratory (PNNL) activities, makes it difficult to identify every program or facility where HEU, U-233, thorium, or neptunium might have been used. The information included within this evaluation report is meant only to be a summary of the available information. It is not meant to be a complete description of all operations involving the materials of concern.

4.1 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 Engineer Works, 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.

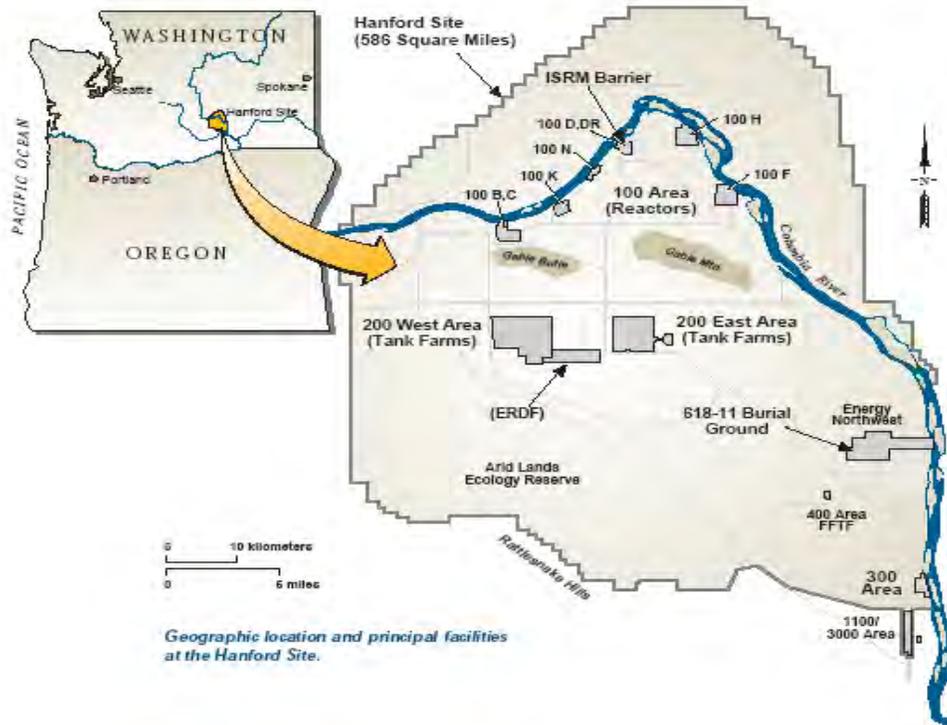


Figure 4-1: Hanford Engineer Works Major Operational Areas

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 Engineer Works 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 | ISO-CHEM 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 |

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

| Dates | Areas | Activities |
|------------------|--------------|--|
| 1968 | 100 | Shutdown of B Reactor |
| 1969 | 100 | Shutdown of C Reactor |
| 1970 | 100 | Shutdown of KW Reactor |
| 1971 | 100 | Shutdown of KE Reactor |
| 1972 | 200 | Shutdown of UO3 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 UO3 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 |

4.1.1 Operations with Highly-Enriched Uranium or U-233 at Hanford

A nuclear material safeguards audit of Pacific Northwest Laboratories (PNL, predecessor to PNNL) performed for FY 1973 showed a total inventory of 7.5E6 grams of enriched uranium held in PNL programs at Hanford (PNL-D-1242). This was government-owned material. There was additional enriched uranium that was privately-owned. It is emphasized that the data provided are for enriched uranium and should not be construed as representing solely HEU. Enriched uranium was held by 14 organizations, including Metallurgy Development and Fuels Design and Development.

In addition to enriched uranium, the FY 1973 audit showed an inventory of U-233 which was held by five organizations. These included Plutonium Recycle Test Reactor (PRTR) Storage, Plutonium Recycle Critical Facility (PRCF) Nuclear Experiments, and Chemical Technology. The U-233 inventory data do not necessarily reflect separated material. Material that is a constituent of another medium (e.g., irradiated fuel) is also represented.

The nuclear materials safeguards audit of PNL for FY 1974 showed a total enriched uranium inventory of greater than 2.8E6 grams held in 12 organizations. Seven of these held inventories were more than 1 kg. The FY 1974 inventory showed a total of 7,333 grams of U-233 held in four organizations. The large majority of this material (> 7 kg) was held by the Nuclear Experiments group (PNL-D-1241).

Work with HEU at Hanford during the period July 1, 1972 – December 31, 1983 included defense-related metallurgical research activities at the 231-Z facility, located in the 200 West Area. A former DOE accountability officer, who oversaw materials safeguards at Hanford, stated that 231-Z handled "every flavor" of uranium, though not much U-233 (Personal Communication, 2011k). A PNNL Security Officer stated that machining of HEU at 231-Z probably took place until 1975 (Personal Communication, 2011a). A retired metallurgist from Building 231-Z stated that they had "huge" amounts of HEU there (Personal Communication, 2011e). HEU was also used in the Plutonium Finishing Plant (Z Plant) facility (Personal Communication, 2011m).

Work with HEU also took place in the 300 Area. A retired PNNL program manager stated that work with HEU by the reactor physics and chemistry groups in the basement of the 325 Building probably took place as late as the mid-1980s, and there were a number of other 300 Area buildings where HEU might have been used. These included 303-C, 305, 313, 314, 326, 327, and 333 (Personal Communication, 2011m). A current site worker stated that HEU was stored in the 324 Building, but it is unclear over what time period this occurred (Personal Communication, 2011d). A retired fuels development worker said he believed that operations involving blending melts of HEU and low-enriched uranium to create medium-enriched uranium took place in the 306 Building in the post-1972 period (Personal Communication, 2011f).

In May 1974, a Criticality Safety Specification (CSS) was activated for the 306 Building to cover fabrication of approximately 350 aluminum-HEU fuel rods for the Neutron Multiplier Facility. The rods were to contain up to 35 wt% HEU having an enrichment of 93.2%. Each fuel piece was specified as containing 7.43 g of U-235. The same CSS was reactivated in July 1976 to cover additional fabrication work with fuel for the Neutron Multiplier Facility (CSS, 1976).

The two THOREX processing campaigns performed at the PUREX plant in the mid-1960s and in 1970 generated large volumes of thorium nitrate product solution. This material was stored in four 50,000 gallon tanks at the 241-WR Vault facility at the U Plant in the 200 West Area. The thorium nitrate solution contained an accountable quantity of U-233 (Personal Communication, 2011k). Starting in early 1977, this material was loaded into a series of 33 tank car shipments and sent to Fernald for processing into a dry product suitable for long-term storage. Each tank car was expected to contain approximately 130 grams of U-233 (dispersed in approximately 8,900 gallons of solution containing about 11,000 kg of thorium). The first four of the tank cars received at Fernald contained a total of 270.3 grams U-233 (NLO, 1977).

4.1.2 Operations with Neptunium at Hanford

The nuclear materials safeguards audit of PNL performed for FY 1973 showed a total inventory of 165 grams of neptunium held by five organizations. These included the Metallurgy Development, Chemical Technology, and Fuels Design and Development (PNL-D-1242). As with the U-233 inventory data, the neptunium inventory values do not necessarily reflect separated material. Thus, the neptunium held by the Metallurgy Development group (for instance) may have been of a different nature than that held by the Fuels Design and Development group.

The nuclear materials safeguards audit of PNL performed for FY 1974 showed a total inventory of 276 grams of neptunium held by five organizations. The largest amount was held by the Metallurgy Development group. The next two largest inventories were held by the Chemical Technology group

and the Fuels Design and Development group (308 Building) (PNL-D-1241). Buildings 325 and 329 were also mentioned as locations where neptunium was used (Personal Communication, 2011m).

A retired PNNL program manager noted that neptunium was not a scarce commodity at Hanford; it was around and they had it as a matter of routine (Personal Communication, 2011n).

Defense-related metallurgical research at 231-Z included work with alloys containing neptunium metal as a tracer material. The neptunium content of these alloys was low; however, the production methods were such that purified neptunium feed material would seem necessary. A nuclear materials inventory of 231-Z for April 1977 shows neptunium metal and neptunium scrap. However, it is unclear where the materials were physically located (it appears some of the materials in the inventory were located off site) (Inventory, 1977).

The PUREX plant was shut down in September 1972 and did not resume operation until November 1983. In April 1982 (prior to restart), Rockwell Hanford Operations sent a request to DOE to allow it to discard neptunium solution containing approximately 300 grams of neptunium. The solution would contain neptunium that was held up in PUREX systems that would be liberated during enhanced readiness tests (Request, 1982). Side-pocketing of low-concentration neptunium solution from backcycle waste streams in J Cell did not resume until 1985 (Accountability, 1988). Neptunium followed the uranium product stream in the PUREX process and was present in the waste stream from the final uranium cycle. This stream also contained plutonium and fission products. Neptunium would be separated and concentrated from the uranium waste stream until about 2 kg were present. It would then be sent to Tank J2 for storage. As of March 1988, approximately 12.6 kg of neptunium was present in Tank J2 awaiting final disposition (Accountability, 1988). This material was a dilute product, containing significant fission product and actinide contamination. In September 1992, DOE issued a concurrence with Westinghouse Hanford Company's recommendation that the dilute neptunium solution stored in J Cell be sent to the 200 Area tank farms as waste (Concurrence, 1992). The PUREX plant was identified for closure shortly thereafter (in December 1992) (WHC-SD-WM-ER-350).

Prior to the PUREX shutdown in 1972, neptunium (nitrate) solution purified in Q Cell would be stored in glass pencil tanks contained in gloveboxes. The neptunium product was described as being emerald green in color (Personal Communication, 2011k). It would be loaded-out into L-10 containers for shipment to Savannah River Site (SRS). Shipments would be made whenever the pencil tanks got full. A current site worker described a practice where workers loading the purified neptunium solution into product receiver cans would top the containers off by manually ladling-in the solution (Personal Communication, 2011d). A retired accountability officer said he was unaware of this practice (Personal Communication, 2011k). SOP No. 14-28, issued October 10, 1971, describes loadout of purified neptunium solution from the measuring tank in Q Cell into one-gallon polyethylene bottles at approximately three liters per bottle (SOP, 1971).

Examples of shipments of neptunium nitrate solution to SRS in the period under evaluation include a shipment of 54 bottles on October 31, 1972, and a shipment of seven bottles on December 12, 1972. The October 31 shipment totaled 184 kg of solution containing greater than 6 kg of neptunium. The December 12 shipment contained 455 grams of neptunium (ARH-2327 BK1).

Neptunium purification operations (formerly conducted in Q Cell) never resumed after PUREX restarted in 1983. However, there are records of entries being made into Q Cell during the shutdown period to perform activities such as glove box work and leak repairs (Radiation Survey Cards, 1981).

4.1.3 Operations with Thorium at Hanford

Two THOREX processing campaigns were conducted at the PUREX plant prior to the SEC period. The most recent of these was completed in 1970. Following sampling, batches of thorium nitrate product solution from THOREX processing were pumped to a 2,800 gallon tanker trailer staged at the 203-A trailer loading facility and hauled to storage tanks at either the 241-WR Vault or the 204-S railcar unloading facility (ARH-2127). The 241-WR Vault facility was a concrete vault 128 feet long and 66 feet wide. It was located just northeast of the U Plant canyon (Building 221-U) in the 200 West Area. The facility contained nine 50,000 gallon storage tanks, four of which were used to hold thorium nitrate product solution (Vault, 2010). The 204-S facility was part of the REDOX complex, also in 200 West Area.

As of 1976, it was recognized that the thorium nitrate storage tanks at the 241-WR Vault were showing signs of deterioration, prompting the need for an alternate management path for the thorium nitrate solution. A process was selected whereby the solution would be shipped to the Pilot Plant at Fernald to be converted into a dry thoria gel suitable for long-term storage. In January 1977, a total of 33 tank car shipments were planned over a two-year period at a rate of about two shipments per month. Fourteen shipments were scheduled in 1977, 18 in 1978, and a final shipment in 1979. The 33 shipments were to total 222,760 gallons of solution containing 349.9 metric tons of thorium. The shipments began in March 1977. Each tank car contained an average of 8,900 gallons of $\text{Th}(\text{NO}_3)_4$ solution containing about 11 metric tons (11,000 kg) of thorium (Thorium Shipping, 1976; FEMP History, 1997; NLO, 1977; Authorization, 1977).

There is a procedure dated November 13, 1978 addressing general clean-up of the 241-WR Vault cells and flushing of the four tanks that held the thorium nitrate solution (Vault Cleanup, 1978). There is another procedure dated October 4, 1978 for flushing the thorium nitrate tanks at the 204-S facility, where the product solution was transferred into railcars for shipment to Fernald (Flushing, 1978).

Other examples of post-1972 thorium-handling operations at Hanford noted in historical accountability data include a tank car shipment of thorium nitrate to Fernald on May 25, 1973 that contained 10.3 kg of thorium, and a shipment of $\text{PuO}_2\text{-UO}_2\text{-ThO}_2$ scrap to LANL on August 8, 1974 (Shipping, 1973; ARH-2327 BK1). Seven drums containing a total of 533 kg of thorium oxide were shipped from Hanford to Fernald in September 1980 (Shipping, 1980).

Work with thorium in the 300 Area during the period under evaluation included reactor fuels research involving thorium oxide powders (thoria). In August 1978, construction began on the Thorium Oxide Fuel Development Laboratory (TOFDL) in Building 306-W. The TOFDL was completed in mid-1979, but reactor fuel research with thorium oxide powders was already going on in 306-W and in the 325 Building (PNL-2549; PNL-2973). Also, there was a criticality safety specification issued on October 22, 1971 for "machining, handling, and storage of enriched uranium or thorium up to 5 wt% U-235" at the 306 Building (CSS, 1971).

A memo titled "Excess Thorium Oxide" dated April 13, 1977 states that PNL has approximately 609 kg of thorium oxide contained in 17 drums at 209 East (the Critical Mass Laboratory). PNL requested that the material be reserved for possible use in a potential alternate fuel cycle study (Excess, 1977). A memo dated May 25, 1979 mentions that an initial shipment of U-233/thorium fuel rods was expected at the 209-E Building (Critical Mass Laboratory) in August 1979 (Rods, 1979).

4.2 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.

The potential for internal and external HEU, U-233, thorium, and neptunium radiation doses associated with this evaluation existed at the 200 and 300 Areas. Based on the site operations outlined in Section 4.1 and its subsections, sources of internal exposure relevant to this SEC evaluation included inhalation, and possible ingestion, of HEU, U-233, thorium, and neptunium during hands-on and remote activities in support of weapons-related research, development of advanced reactor fuels, chemical separations of irradiated nuclear fuels, packaging of product materials, maintenance and waste-handling operations, and facility decontamination and decommissioning efforts. Examples of such internal exposures are:

Potential HEU Exposures

- *200 Area:* As presented in Section 4.1.1, HEU was used in defense-related research activities performed in the 231-Z facility in the 200 West Area until those operations ceased in FY 1977. However, a precise date when the potential for HEU intakes no longer existed cannot be established given subsequent facility clean-up activities and the fact that much of the equipment used in defense-related research activities remained in place throughout the period under evaluation (to the end of 1983).
- *300 Area:* As presented in Section 4.1.1, multiple reactor fuel research and fabrication projects involving HEU took place in the 300 Area during Hanford's operational history. Precise start and end dates for projects involving HEU in the 300 Area are not known, but chest count data for U-235 are seen for 300 Area workers through 1983.

Potential Neptunium Exposures

- *200 Area:* As presented in Section 4.1.2, neptunium was used in defense-related research activities performed in the 231-Z facility in the 200 West Area until those operations ceased in FY 1977. However, a precise date when the potential for neptunium intakes no longer existed cannot be established given subsequent facility clean-up activities and the fact that much of the equipment used in defense-related research activities remained in place throughout the SEC evaluation period.

Potential Thorium Exposures

- *200 Area:* As presented in Section 4.1.3, a substantial quantity of thorium nitrate solution was stored in the 241-WR Vault and 204-S facilities and shipped to Fernald. These shipments continued through 1978. Procedures for vault clean-up and tank-flushing operations imply that these activities were performed post-1978 after the transfer project was complete. An earlier tank car shipment of thorium nitrate to Fernald took place in May 1973, and seven drums containing 533 kg of thorium oxide were shipped to Fernald in September 1980. Work with thorium oxide fuels at the Critical Mass Laboratory (Building 209-E) in the mid-to-late 1970s is also indicated. The Hanford Radiological Exposure database shows sporadic chest counts for Th-232 for workers in both the 200 East and 200 West Areas in 1983, implying the potential for thorium intakes in the 200 Area throughout the period under evaluation (to the end of 1983).
- *300 Area:* As presented in Section 4.1.3, research and development work with thorium reactor fuels is known to have occurred in the 306-W and 325 Buildings. This work predates the Thorium Oxide Fuel Development Facility that began operating in mid-1979. A 1971 criticality safety specification for 306 Building suggests work of this nature was taking place as of July 1972.

4.3 Time Period Associated with Radiological Operations

As stated in Section 3.0, in 2009 HHS designated a class of Hanford employees for inclusion in the SEC for the period from October 1, 1943 through June 30, 1972, thus enveloping two previously-enacted classes. Based on its ongoing dose reconstruction and continued data capture efforts since 2009, NIOSH determined that work with HEU, U-233, thorium, and neptunium continued beyond June 30, 1972, and that only mass-based uranium bioassay data are available until late 1983. These conditions complicated the NIOSH assessment of potential HEU, U-233, neptunium, and thorium exposures for the Hanford site. NIOSH determined that data conditions and dose reconstruction methodologies for the HEU, U-233, neptunium and thorium operations discussed in Section 4 of this report warranted continued evaluation after the end of the currently-designated SEC class (June 30, 1972). Thus, the time period associated with this NIOSH evaluation is from July 1, 1972 through December 31, 1983.

4.4 Site Locations Associated with Radiological Operations

Consistent with the NIOSH, DOE, and DOL determinations associated with the evaluation of SEC-00152 in 2009 (NIOSH, 2009), 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 worker movements between the 200 and 300 Areas and other areas of the Hanford Engineer Works during the period under evaluation (July 1, 1972 through December 31, 1983). NIOSH is unable to accurately assess whether an energy employee, or class of employees, did or did not potentially enter specific Areas of the Hanford site having the potential for HEU, U-233, neptunium, and thorium exposures during defined periods of time; therefore, NIOSH cannot define individual worker exposure scenarios based on Hanford Engineer Works Areas or specific work locations during the period from July 1, 1972 through December 31, 1983.

4.5 Job Descriptions Affected by Radiological Operations

As stated in Section 4.4, and consistent with the findings associated with the evaluation of SEC-00152, NIOSH has determined that the Hanford site-specific and claimant-specific data available for the period under evaluation continue to be insufficient to allow NIOSH to characterize worker movements across the site, or between 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. NIOSH is unable to eliminate any specific worker from potential HEU, U-233, neptunium, and thorium 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

In addition to examining its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class, NIOSH identified and reviewed numerous data sources to locate information relevant to determining the feasibility of dose reconstruction for the class of employees proposed for this petition. This included determining the availability of information on personnel monitoring, workplace monitoring, and radiological source term data.

NIOSH data capture efforts for the Hanford Engineer Works focused on site and DOE databases, DOE Office of Scientific and Technical Information (OSTI), DOE OpenNet, NRC Agencywide Document Access and Management (ADAMS), and worker interviews. NIOSH conducted three organized site visits in 2010, six in 2011, and one in 2012 in an attempt to gather documents and data relevant to dose reconstruction of Hanford claims. NIOSH's SRDB currently contains over 32,000 documents and subdocuments associated with the Hanford site. Attachment 1 contains a summary of Hanford data gathering efforts and documents.

5.2 Worker Interviews

To obtain additional first-hand information, NIOSH conducted in-person interviews with 19 current or former Hanford Engineer Works employees.

- Personal Communication, 2011a, *Personal Communication with PNNL Security Officer*, In-person communication by ORAU Team; February 1, 2011; SRDB Ref ID: 112041
- Personal Communication, 2011b, *Personal Communication with Retired 231-Z Worker*, In-person communication by ORAU Team; February 2, 2011; SRDB Ref ID: 112043
- Personal Communication, 2011c, *Personal Communication with Retired PNNL Security Officer*, In-person communication by ORAU Team; February 2, 2011; SRDB Ref ID: 112056
- Personal Communication, 2011d, *Personal Communication with Current Hanford Worker*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112039
- Personal Communication, 2011e, *Personal Communication with Retired Building 231-Z Metallurgist*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112045
- Personal Communication, 2011f, *Personal Communication with Retired Nuclear Fuels Development Worker*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112052
- Personal Communication, 2011g, *Personal Communication with Retired Instruments & Controls Specialist*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112050
- Personal Communication, 2011h, *Personal Communication with Retired Critical Mass Laboratory Manager*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112049
- Personal Communication, 2011i, *Personal Communication with Hanford Documentation Staff Member*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112040
- Personal Communication, 2011j, *Personal Communication with Retired PUREX Worker*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112057
- Personal Communication, 2011k, *Personal Communication with Retired Materials Accountability Officer*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112051
- Personal Communication, 2011l, *Personal Communication with PNNL Security Officer*, Follow-up in-person communication by ORAU Team; September 13, 2011; SRDB Ref ID: 112042
- Personal Communication, 2011m, *Personal Communication with Retired PNNL Program Manager*, In-person communication by ORAU Team; September 14, 2011; SRDB Ref ID: 112055

- Personal Communication, 2011n, *Personal Communication with Retired PNNL Program Manager*, Follow-up in-person communication by ORAU Team; November 8, 2011; SRDB Ref ID: 112054
- Personal Communication, 2012a, *Personal Communication with Retired Building 231-Z Metallurgist*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112044
- Personal Communication, 2012b, *Personal Communication with Retired Critical Mass Laboratory Manager*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112048
- Personal Communication, 2012c, *Personal Communication with Retired PNNL Program Manager*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112053
- Personal Communication, 2012d, *Personal Communication with Retired Chemical Separations Worker*, In-person communication by ORAU Team; January 25, 2012; SRDB Ref ID: 112046
- Personal Communication, 2012e, *Personal Communication with Retired Chemical Separations Worker*, In-person communication by ORAU Team; January 25, 2012; SRDB Ref ID: 112047

5.3 Internal Personnel Monitoring Data

This section describes internal personnel monitoring data contained in the Hanford Radiological Exposure (REX) database.

5.3.1 Internal Personnel Monitoring Data for HEU or U-233

Prior to October 1983, the only method available for *in vitro* bioassay of uranium for Hanford workers was a mass-based (fluorometric) method. These analyses determined uranium concentrations on an elemental basis and could not differentiate between different uranium isotopes. *In vitro* bioassay data for uranium are available in the REX database for all years of the period under evaluation, but the data are not isotope-specific and are not associated with specific areas of the plant or otherwise characterized in a manner that would allow differentiation between natural or slightly-enriched uranium and HEU/U-233.

Table 5-1 summarizes the number of *in vitro* bioassay results for uranium in the REX database for the period July 1, 1972 through December 31, 1983. Nearly all of the results are for total (elemental) uranium, which is consistent with the fact that the uranium bioassay program was designed to monitor individuals who worked with natural or slightly-enriched uranium. None of the uranium *in vitro* results for 1983 are indicated as being radiometric (i.e., isotope-specific) analyses. Radiometric results for uranium are shown in REX for 1984 forward. There are also 19 radiometric results reported for samples collected in 1978, 1 for 1979, and 14 for 1982. The distinction between elemental (fluorometric) and radiometric analyses is made based on the units code associated with each result. Results with mass-based units were considered elemental analyses and those with

activity-based units were considered radiometric. There are anomalous entries in the REX database, such as those showing an isotopic analyte but a mass-based result, so defining the analysis type based on the unit code should be considered tentative.

| Table 5-1: <i>In Vitro</i> Data for Uranium in the REX Database | |
|--|--|
| Year | No. of <i>In Vitro</i> Results for U in REX |
| 1972* | 77 |
| 1973 | 65 |
| 1974 | 190 |
| 1975 | 265 |
| 1976 | 116 |
| 1977 | 169 |
| 1978 | 320 |
| 1979 | 267 |
| 1980 | 261 |
| 1981 | 348 |
| 1982 | 303 |
| 1983 | 185 |

*Beginning July 1, 1972

The REX database contains *in vivo* monitoring data (primarily chest counts) for U-235 for all years of the period under evaluation. Table 5-2 summarizes the *in vivo* bioassay data for uranium in the REX database for the period July 1, 1972 through December 31, 1983. Though they are reported as U-235, nearly all of these counts are from individuals who worked with natural or slightly-enriched uranium. For most years all of the uranium *in vivo* counts were chest counts. Other types of *in vivo* counts are seen for some years, as shown in the table. The *in vivo* count data given in Table 5-2 do not include wound counts. The REX database shows eight wound counts for uranium during the evaluation period: two in 1981, two in 1982, and four in 1983.

| Table 5-2: <i>In Vivo</i> Data for Uranium in the REX Database | | | |
|---|---|----------------------------|------------------------------|
| Year | Total No. of <i>In Vivo</i> Results for U in REX | No. of Chest Counts | No. of Other Counts |
| 1972* | 88 | 88 | 0 |
| 1973 | 137 | 137 | 0 |
| 1974 | 1409 | 1409 | 0 |
| 1975 | 4 | 4 | 0 |
| 1976 | 774 | 774 | 0 |
| 1977 | 876 | 873 | 3 (2 whole body, 1 skeletal) |
| 1978 | 1353 | 1353 | 0 |
| 1979 | 1556 | 1552 | 4 (1 abdominal, 3 hand) |
| 1980 | 1618 | 1616 | 2 (whole body) |
| 1981 | 1668 | 1668 | 0 |
| 1982 | 1501 | 1501 | 0 |
| 1983 | 1412 | 1411 | 1 (whole body) |

* Beginning July 1, 1972

5.3.2 Internal Personnel Monitoring Data for Thorium

There are only 11 *in vitro* bioassay (urinalysis) results for elemental thorium or Th-232 in the REX database in the July 1972 through December 1983 period. There is one record in 1979, seven in 1980, and three in 1981 (the years reflect the sample collection dates).

The REX database contains 16 *in vivo* bioassay results for Th-232 during the period under evaluation: one in 1972, one in 1973, two in 1977, seven in 1979, and five in 1983. The four counts from 1972 through 1977 were whole body counts. All of the others were chest counts.

5.3.3 Internal Personnel Monitoring Data for Neptunium

The REX database contains four *in vitro* monitoring results for Np-237 for the July 1972 through December 1983 period. All four are baseline urinalysis samples collected on September 6, 1972.

The only *in vivo* analysis result for Np-237 in the REX database during the period under evaluation is a wound count performed on April 24, 1981.

5.3.4 Summary of Evaluation-Specific Internal Personnel Monitoring Data

In Vivo Analyses

There are chest count data for uranium (reported as U-235) in the REX database for all years under evaluation. However, the lack of worker location information and the NIOSH determination that the majority of Hanford workers who were monitored for uranium labored with natural or slightly-enriched uranium precludes using the uranium chest count data for assigning intakes of HEU.

The REX database contains 16 *in vivo* bioassay results for Th-232 during the period under evaluation. Four of these are for whole body counts performed in 1972, 1973, and 1977. The remaining results are for chest counts performed in 1979 and 1983.

The only *in vivo* analysis result for Np-237 in the REX database during the period under evaluation is a wound count performed on April 24, 1981.

In Vitro Analyses

In vitro bioassay data for uranium are available in the REX database for all years of the period under evaluation; however, the data are not isotope-specific and are not associated with specific areas of the plant or otherwise characterized in a manner that would allow differentiation between natural or slightly-enriched uranium and HEU/U-233. Radiometric results for uranium are routinely shown in REX beginning in 1984, thus allowing for the assessment of intakes of enriched uranium for such samples.

There are only 11 *in vitro* bioassay (urinalysis) results for elemental thorium or Th-232 in the REX database for the time period under evaluation. There are no *in vitro* results for thorium prior to 1979 or after 1981.

The only *in vitro* analysis results for neptunium in the REX database for the period under evaluation are for four baseline urine samples collected on September 6, 1972.

5.4 External Personnel Monitoring Data

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to purified HEU, U-233, thorium, and neptunium could not be reconstructed. In light of this conclusion, NIOSH did not perform an exhaustive evaluation of external monitoring data for the evaluation period of July 1, 1972 through December 31, 1983. 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-00152 for the period through June 30, 1972 (NIOSH, 2009).

5.5 Workplace Monitoring Data

NIOSH has found no workplace monitoring records specific to HEU, U-233, thorium, or neptunium from the period under evaluation that could be used to bound the dose. There are numerous memos that indicate that a workplace air monitoring program was in place in the 300 Area and at 231-Z as of the mid-1970s, but little information generated by this program is available for evaluation. Both routine and incident-driven air sampling data are seen, but the documentation is intermittent and is not sufficient to allow the assigning or bounding of radionuclide intakes during the evaluation period. Most of the available data are gross alpha concentrations. No radionuclide specific air sampling data were observed for HEU, U-233, thorium, or neptunium. However, there is mention of an air sampling system for the thorium facility in 306 Building in 1979 (Monthly Report, 1979). Limited radiation survey data are also seen in miscellaneous memos, but NIOSH has determined that this information is insufficient for estimating or bounding intakes.

5.6 Radiological Source Term Data

The source term information available to NIOSH that is relevant to this evaluation was presented in Section 4.1. NIOSH lacks sufficient source term information that would allow it to estimate all potential HEU, U-233, thorium, or neptunium exposures to which the proposed class may have been exposed.

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 in Section 5.3, NIOSH has no indication that the Hanford Engineer Works implemented routine or special bioassay programs sufficient to detect intakes of purified HEU, U-233, thorium, or neptunium until the end of the period under evaluation. NIOSH determined that work areas were not associated with bioassay analysis records until 1982, and that only mass-based uranium bioassay data are available until late 1983.

Prior to October 1983, the only method available for *in vitro* bioassay of uranium for Hanford workers was a mass-based (fluorometric) method. These analyses determined uranium concentrations on an elemental basis, could not differentiate between different uranium isotopes, and were therefore inadequate for NIOSH assessment of potential exposures to HEU and U-233. The bioassay data available to NIOSH in the Hanford REX database begin to indicate the use of radiometric (i.e., isotope-specific) analyses for uranium in October 1983. NIOSH has determined that by the end of 1983, available Hanford isotopic uranium analysis records are sufficient for the differentiation of HEU and U-233 exposures from exposures to natural or slightly-enriched uranium.

In the absence of adequate *in vitro* or *in vivo* bioassay, NIOSH also lacks sufficient workplace monitoring or source term data (as presented in Sections 5.5 and 5.6) to estimate potential internal exposures to HEU, U-233, neptunium, and thorium in the 200 and 300 Areas of the Hanford Engineer Works.

With the initiation of radiometric uranium *in vitro* bioassay analysis in October 1983, and allowing the last months of 1983 for the site's full implementation, NIOSH has determined that the internal monitoring data in the Hanford REX database is adequate to support sufficiently accurate dose

reconstruction for HEU and U-233 beginning January 1, 1984. Furthermore, NIOSH believes that maturation of Hanford work practices and programs as well as the nature of work performed after 1983 were such that dose from potential intakes of thorium or neptunium can be bounded with sufficient accuracy.

NIOSH has evaluated the available information and determined that it does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to sufficiently estimate potential internal exposures to HEU, U-233, thorium, or neptunium during the period from July 1, 1972 through December 31, 1983. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to HEU, U-233, thorium, or neptunium and resulting doses for the proposed class of employees under evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from July 1, 1972 through December 31 1983, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at the Hanford Engineer Works during the period from July 1, 1972 through December 31, 1983, 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 purified HEU, U-233, thorium, and neptunium 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-00152 for the period through June 30, 1972 (NIOSH, 2009).

Consistent with previous NIOSH determinations associated with the evaluations of SEC-00057 and SEC-00152, 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 July 1, 1972 through December 31, 1983, NIOSH intends to use any external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at the Hanford Engineer Works during the period from July 1, 1972 through December 31,

1983, 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

As stated in Section 3.0, in 2009 HHS designated a class of Hanford Engineer Works employees associated with SEC-00152 for inclusion in the SEC for the period October 1, 1943 through June 30, 1972, thus enveloping two previously-enacted classes. Through the course of ongoing dose reconstruction and continued data capture efforts after the implementation of SEC-00152, NIOSH has determined that, due to work with inadequately-monitored radionuclides such as purified forms of HEU, U-233, thorium, and neptunium in the 200 and 300 Areas of the Hanford site, additional dose reconstruction infeasibilities exist through December 31, 1983. By 1983, Hanford had fully implemented isotopic analysis for uranium bioassay. Also prior to 1983, Hanford began populating the location fields in the REX database, allowing NIOSH to confirm that the available bioassay results for HEU, U-233, neptunium, or thorium are associated with the work areas of the likely highest-exposed individuals. NIOSH therefore recommends that the class include the period from July 1, 1972 (the end of the previous designated SEC period) through December 31, 1983.

Consistent with the determinations of the SEC-00152 evaluation, 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 Engineer Works having the potential for HEU, U-233, neptunium, and thorium exposures during the period from July 1, 1972 through December 31, 1983. Consistent with the NIOSH, DOE, and DOL determinations associated with the 2009 evaluation of SEC-00152 (NIOSH, 2009), NIOSH recommends that the class definition include all buildings and all Areas of the Hanford Engineer Works during the proposed time period.

Consistent with the determinations of the SEC-00152 evaluation, NIOSH has determined that the data available to NIOSH on a claim-specific level continue to be insufficient for NIOSH to limit a worker's potential exposure scenarios based on job titles and/or job assignments during the period from July 1, 1972 through December 31, 1983. NIOSH therefore recommends that the class include all workers, regardless of job titles or job/work descriptions during the proposed time period.

7.0 Summary of Feasibility Findings for Petition SEC-00201

This report evaluates the feasibility for completing dose reconstructions for employees at the Hanford Engineer Works from July 1, 1972 through December 31, 1983. NIOSH determined that members of this class may have received inadequately monitored internal radiation exposures from purified HEU, U-233, thorium, and neptunium. NIOSH lacks sufficient information, which includes biological monitoring data, sufficient air monitoring information, or sufficient process and radiological source information that would allow it to estimate the potential internal exposures to which the proposed class may have been exposed.

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

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at the Hanford Engineer Works during the period from July 1, 1972 through December 31, 1983, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00201

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-00201

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Hanford Engineer Works in Richland, Washington, from July 1, 1972 through December 31, 1983, 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 are 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 the Hanford Engineer Works 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

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ARH-2127, *PUREX Process Operation and Performance, 1970 Thoria Campaign*, R. L. Walser, R. R. Jackson, Atlantic Richfield Hanford Company; March 1977; SRDB Ref ID: 64807

ARH-2327 BK1, *Historical Data for 741 Shipments*, J. G. Murphy, Atlantic Richfield Hanford Company, Richland, Washington; January 3, 1972; SRDB Ref ID: 112058

Authorization, 1977, *Authorization to Ship SS Materials*, National Lead Company of Ohio; January 24, 1977; SRDB Ref ID: 43586

Concurrence, 1992, *Disposition of Np-237 Nitrate Solution Stored in the PUREX Plant*, memo to J. R. Hunter from C. G. Halsted (U.S. Department of Energy); September 9, 1992; SRDB Ref ID: 100961

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CSS, 1976, *Reactivation of Criticality Safety Specification 306-1.17, Rev. 0, 5/17/74*, reactivation of CSS titled: Fabrication of Fuel Rods for the Neutron Multiplier Facility; Battelle Pacific Northwest Laboratories; July 20, 1976; SRDB Ref ID: 100850

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Flushing, 1978, *Flushing Thorium Nitrate Storage Tanks at the 204-S Facility*, RHO, PUREX Plant; October 4, 1978; SRDB Ref ID: 106487

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NIOSH, 2007, *SEC Petition Evaluation Report for Petition SEC-00057-1, Hanford*; 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*; 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

ORAUT-OTIB-0006, *Dose Reconstruction from Occupational Medical X-Ray Procedures*, Rev. 4, Oak Ridge Associated Universities; June 20, 2011; SRDB Ref ID: 98147

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Personal Communication, 2011b, *Personal Communication with Retired 231-Z Worker*, In-person communication by ORAU Team; February 2, 2011; SRDB Ref ID: 112043

Personal Communication, 2011c, *Personal Communication with Retired PNNL Security Officer*, In-person communication by ORAU Team; February 2, 2011; SRDB Ref ID: 112056

Personal Communication, 2011d, *Personal Communication with Current Hanford Worker*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112039

Personal Communication, 2011e, *Personal Communication with Retired Building 231-Z Metallurgist*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112045

Personal Communication, 2011f, *Personal Communication with Retired Nuclear Fuels Development Worker*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112052

Personal Communication, 2011g, *Personal Communication with Retired Instruments & Controls Specialist*, In-person communication by ORAU Team; June 14, 2011; SRDB Ref ID: 112050

Personal Communication, 2011h, *Personal Communication with Retired Critical Mass Laboratory Manager*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112049

Personal Communication, 2011i, *Personal Communication with Hanford Documentation Staff Member*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112040

Personal Communication, 2011j, *Personal Communication with Retired PUREX Worker*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112057

Personal Communication, 2011k, *Personal Communication with Retired Materials Accountability Officer*, In-person communication by ORAU Team; June 15, 2011; SRDB Ref ID: 112051

Personal Communication, 2011l, *Personal Communication with PNNL Security Officer*, Follow-up in-person communication by ORAU Team; September 13, 2011; SRDB Ref ID: 112042

Personal Communication, 2011m, *Personal Communication with Retired PNNL Program Manager*, In-person communication by ORAU Team; September 14, 2011; SRDB Ref ID: 112055

Personal Communication, 2011n, *Personal Communication with Retired PNNL Program Manager*, Follow-up in-person communication by ORAU Team; November 8, 2011; SRDB Ref ID: 112054

Personal Communication, 2012a, *Personal Communication with Retired Building 231-Z Metallurgist*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112044

Personal Communication, 2012b, *Personal Communication with Retired Critical Mass Laboratory Manager*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112048

Personal Communication, 2012c, *Personal Communication with Retired PNNL Program Manager*, Follow-up in-person communication by ORAU Team; January 24, 2012; SRDB Ref ID: 112053

Personal Communication, 2012d, *Personal Communication with Retired Chemical Separations Worker*, In-person communication by ORAU Team; January 25, 2012; SRDB Ref ID: 112046

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PNL-2973, *Thoria Development Activities Annual Report – Fiscal Year 1978*, Battelle Pacific Northwest Laboratory; February 1979; SRDB Ref ID: 112066

PNL-D-1241, *Nuclear Materials Safeguards Appraisal Survey 55 of Battelle, Pacific Northwest Laboratory*, U.S. Atomic Energy Commission, Richland Operations Office, Richland, Washington; March 4, 1975 (for FY 1974); SRDB Ref ID: 112059

PNL-D-1242, *Survey 51 – A Review of the Nuclear Materials Safeguards Practices, Procedures, and Information System (NMIS)*, U.S. Atomic Energy Commission; January 25, 1974; SRDB Ref ID: 112060

Radiation Survey Cards, 1981, *Radiation Survey Cards for Hanford PUREX Facility*, cards for March 1-11, 1981, including cards for Q cell; Hanford; various dates in March 1981; SRDB Ref ID: 109604, pdf pp. 13-14 and 17-19

Request, 1982, *Request to Discard Neptunium Solution – Project Number HE-022101U – Request Number RR-179*, letter to G. J. Miskho (U.S. Department of Energy – Richland) from M. P. Larson (Rockwell Hanford Operations); April 6, 1982; SRDB Ref ID: 100501

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Shipping, 1980, *Nuclear Material Transaction Report*, documents related to shipping thorium oxide from Battelle-Richland to National Lead Co. of Ohio; September 17, 1980; SRDB Ref ID: 43554

SOP, 1971, *PUREX Plant: Neptunium Purification Product Handling - Product Loadout to Bottles*, SOP No. 14-28; Atlantic Richfield Hanford Company; October 10, 1971; SRDB Ref ID: 105830

Thorium Shipping, 1976, *Storable Thorium Product*, National Lead Company of Ohio; December 10, 1976; SRDB Ref ID: 28877

NLO, 1977, *U-233 as a Contaminant in Hanford Thorium Nitrate Solution*, letter to H. D. Fletcher (U.S. Energy Research and Development Administration – Oak Ridge) from S. F. Audia (National Lead Company of Ohio); May 19, 1977; SRDB Ref ID: 43563

Vault, 2010, *Waste Information Data System General Summary Report: 241-WR Vault*, GE-HAPO; June 4, 2010; SRDB Ref ID: 99781

Vault Cleanup, 1978, *WR Vault Cleanup and Tank Flush*, Standard Operating Procedure PO-700-160; RHO; November 13, 1978; SRDB Ref ID: 106490

WHC-SD-WM-ER-350, *Historical Tank Content for the Southeast Quadrant of the Hanford 200 Areas*, Rev. 0; Westinghouse Hanford Company; June 1995; SRDB Ref ID: 112067

Attachment 1: Data Capture Synopsis

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|--|--|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| <p><u>Primary Site/Company Name:</u> Hanford Engineer Works (HEW) DOE, 1942-present</p> <p><u>Alternate Site Names:</u> Hanford</p> <p><u>Physical Size of the Site:</u> The full Hanford site is approximately 586 square miles. SEC00155 involves all workers at the Plutonium Finishing Plant complex, which is in Area 200 (approximately 60 square miles and encompasses more than 60 buildings).</p> <p><u>Site Population:</u> The entire Hanford workforce in September 1990 was nearly 9,000.</p> | <p>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, diethylenetriamine 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, N Reactor training videos, fuel processing videos, neptunium shipment reports, and trip reports. Personnel interviews with former and current site workers have been conducted. Awaiting information identifying the material balance areas that were under PNNL control, logbooks or lab notebooks created by the PNNL Criticality Laboratory, a search of all available systems for the Handwritten Accountability System for 231-Z, access to the 360 degree photo gallery of the 231-Z building, and a listing of accident/incident reports prepared by PNNL.</p> | OPEN | 5,232 |
| State Contacted: NA | NOTE: Contacting the state was not considered necessary since Hanford is an active DOE site and cooperates with relevant data collection. | 09/03/2009 | 0 |
| Battelle Memorial Institute | Procurement of thorium for U-233 separation studies, material inventories, and personnel monitoring record of a former Hanford employee. | 02/01/2012 | 3 |
| Cincinnati Public Library (Interlibrary Loan) | Radiation safety in the Manhattan Project and environmental levels of radioactivity at AEC installations. | 07/02/2010 | 13 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| Claimant Provided | Environmental monitoring data, study of uranium losses, in vivo cross comparison studies, how plutonium specimen disintegrates under pressure, and information on reducing the concentration of radioisotopes in effluent water. | 08/18/2010 | 10 |
| 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, departmental descriptions and organizational charts. | 08/11/2008 | 36 |
| Department of Energy (DOE) | The guide for good radiological practices at plutonium facilities. | 05/27/2011 | 1 |
| Department of Labor / Paragon | Vitrification of Niagara Falls Storage Site residues, progress reports, shipment of thorium oxide slugs, tabulation of Sylvania's outstanding orders, disposition of 763 reject Hanford slugs, complex-wide mixed waste, and an environmental impact statement. | 01/23/2012 | 28 |
| DOE Albuquerque Operations Office | Hazard level classification. | 04/15/2010 | 1 |
| DOE Ames Laboratory | Industrial Medicine on the Plutonium Project 1977. | 07/25/2006 | 1 |
| DOE 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 |
| DOE Brookhaven National Laboratory | Compilation of ambient air monitoring parameters at DOE facilities. | 10/23/2011 | 2 |
| DOE Carlsbad, NM | Threshold helium generation reaction rate measurements in FFTF and SP-100/SP-2 irradiation test. | 08/12/2010 | 6 |
| DOE Environmental Measurements Laboratory (EML) | Hanford Uranium Bioassay Program and reference to the 1962 criticality incident. | 01/21/2011 | 2 |
| 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, and radiation surveys. | 05/01/2009 | 70 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| DOE Hanford / SC&A | Incident reports, technical section reports, and a waste encapsulation report. | 09/22/2008 | 4 |
| 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 | 172 |
| 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 uranium reports, Fernald shipment reports, an update of quantity in storage for radioactive mixed wastes, material transfer reports, and GJOO dosimetry reports with some Hanford data. | 12/01/2011 | 151 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database) | 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 | 105 |
| DOE 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 | 22 |
| DOE Nevada Test Site | Photographs of workers in protective clothing. | 04/26/2005 | 2 |
| DOE Oak Ridge Institute for Science and Education (ORISE) | Chelation DTPA data for DOE Employees - REAC. | 08/06/2009 | 94 |
| DOE Oak Ridge National Laboratory (ORNL) | Safe handling of unprocessed metal, DuPont employee roster, Mancuso Study data, and spills of Hanford material at ORNL. | 09/13/2011 | 33 |
| DOE Oak Ridge Operations Office | Paducah hazardous waste disposal, internal dosimetry, and industrial hygiene documents which refer to Hanford. | 12/22/2011 | 3 |
| DOE Oak Ridge Operations, Records Holding Task Group | Film badge and exposure correspondence, material requirements and transfers, Np-237 recovery, and NIOSH researcher notes. | 04/08/2011 | 19 |
| DOE Oak Ridge Public Reading Room | Nationwide accountability of source and fissionable materials. | 04/08/2011 | 1 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|--|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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, and UO2 pellet fabrication. | 03/26/2012 | 28 |
| DOE 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 |
| DOE Paducah Gaseous Diffusion Plant | Radioactivity analysis reports, air samples, trace element analysis, ash results, power results, and sample data unspecified. | 09/18/2006 | 5 |
| DOE Rocky Flats Environmental Technology Site (RFETS) | External dosimetry technology technical basis document. | 05/17/2006 | 2 |
| DOE Sandia National Laboratories, Livermore | Various employee exposure reports. | 03/28/2007 | 1 |
| DOE Savannah River Site | Irradiation of thorium slugs, use of pocket dosimeters, progress reports, 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, and an ORAU Team researcher's notes. | 03/19/2012 | 61 |
| DOE Waste Isolation Pilot Plant | Battelle West Jefferson transuranic waste shipments to Hanford. | 11/05/2010 | 5 |
| DOE 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 |
| 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. | 06/15/2010 | 5 |
| 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. | 01/10/2006 | 1 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| General Atomics | Nuclear material shipping and receiving reports, health physics reports, 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 | 108 |
| Health Physics Society | Bioassay criteria for environmental restoration workers. | 03/22/2007 | 1 |
| Internet - Defense Technical Information Center (DTIC) | Annual reports to Congress, DOE internal dosimetry standard, mixed oxide and breeder reactor reports, and a toxicological profile for plutonium. NOTE: Documents were added by Site Association Review. | 01/09/2012 | 14 |
| Internet - DOE | An analysis of airborne radioactivity release fractions. | 12/04/2008 | 1 |
| 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 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|--|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| Internet - DOE 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, and tritium exposures. NOTE: Documents were identified by previous research or Site Association Review. | 05/05/2011 | 1,456 |
| Internet - DOE Legacy Management Considered Sites | Decontamination and decommissioning of the Westinghouse Nuclear Fuel Facility at Cheswick, PA and progress reports. NOTE: Documents were identified by previous research or Site Association Review. | 05/12/2010 | 4 |
| Internet - DOE Oak Ridge National Laboratory | ORNL operations and technical reports which refer to Hanford. | 03/15/2012 | 61 |
| 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, and status reports. NOTE: Documents were identified by previous research or Site Association Review. | 03/30/2012 | 85 |
| Internet - DOE OpenNet / Hanford | C.C. Gamertsfelder interview. | 11/26/2007 | 1 |
| Internet - DOE OSTI | Thorium metallurgy and ORIGEN reports. | 05/30/2007 | 3 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|--|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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 and decommissioning information, wrap module 1 sampling and analysis plan, monthly activity reports, beta treatment of uranium, fuel fabrication and irradiation. NOTE: Documents were identified by previous research or Site Association Review. | 04/03/2012 | 31 |
| 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, intercalibration 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, and a tank content estimate. NOTE: Documents were identified by previous research or Site Association Review. | 04/20/2012 | 271 |
| 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 - Global Security | Weapons of Mass Destruction Website: Polonium. | 09/14/2009 | 1 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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, and building histories. NOTE: Documents were identified by previous research or Site Association Review. | 04/15/2012 | 217 |
| Internet - Google/ SC&A | The dry cask storage project and planning for hot cell closure. | 03/28/2011 | 2 |
| Internet - Health Physics Journal | An airborne radioiodine dispersion study. NOTE: Document was identified by Site Association Review. | 12/06/2011 | 1 |
| Internet - Journal of Occupational and Environmental Health | No relevant data identified. | 07/20/2010 | 0 |
| Internet - National Academies Press (NAP) | Tank waste retrieval, processing, and on-site disposal at three DOE sites and complex-wide improving waste characterization and treatment. | 07/11/2010 | 2 |
| Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office | No relevant data identified. | 05/12/2010 | 0 |
| Internet - NIOSH | A beryllium report and SEC Petition Evaluation reports. | 01/09/2012 | 3 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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. NOTE: Documents were identified by previous research or Site Association Review. | 03/25/2012 | 194 |
| Internet - SC&A / DOE Hanford Declassified Document Retrieval System (DDRS) | Monthly reports, radiation monitoring manual, and a radiological incident investigation. | 11/05/2008 | 6 |
| 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 |
| 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, and a feasibility study for the St. Louis site. | 10/03/2008 | 4 |
| Mound Museum | Plutonium shipments and control, 1949 liquid waste disposal and biological research. | 07/25/2008 | 3 |
| 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 | 39 |
| 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, thorium requirements, fission product distribution, test rolling, and trip reports. | 08/19/2010 | 38 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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 |
| New York State Department of Environmental Conservation | Nickel plating of uranium slugs at Sylvania for Hanford. | 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, and USTUR active registrants living and deceased. | 04/26/2011 | 89 |
| NIOSH (SC&A) | DOE Ohio Field Office recycled uranium report, personnel interview, highly enriched uranium working group reports, and generation and uranium information. | 02/16/2006 | 6 |
| Nuclear Regulatory Commission (NRC) Non-Publicly Available Records Collection | Documents related to the construction of the military compact reactor. | 09/22/2011 | 1 |
| 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, and the transfer of irradiated TRIGA fuel elements to Hanford. | 03/28/2012 | 43 |
| Nuclear Regulatory Commission (NRC) Public Document Room / Internet - NRC ADAMS | Comparison of Hanford environmental models. | | 1 |
| 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 the 1984 atmospheric sciences report. | 06/14/2011 | 52 |
| Oak Ridge Public Library | Construction for Atomic Bomb production facilities. | 05/12/2011 | 6 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|--|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| 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, documented communication, 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. | 03/08/2102 | 131 |
| Richland, WA Federal Building | Documented communications with process knowledge experts, weapons development reports, nuclear materials safeguards. All are sensitive documents. | 04/18/2012 | 34 |
| 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, summary of recorded external radiation doses for Hanford Workers 1944-1989, and a personnel interview. | 08/05/2011 | 56 |
| SC&A / DOE Hanford | Monthly reports, control of ground contamination, personnel interview, 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, stack gas decontamination - separations plant and stack gas decontamination, and a review of tritium control symposium. | 08/05/2011 | 31 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|---|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| SC&A / DOE 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, kilogram quantities of UO ₂ -233 for the light water breeder reactor demonstration program, and xenon calculations. | 06/24/2010 | 98 |
| SC&A / NARA - Atlanta | Health and safety report and UO ₃ specifications. | 03/17/2004 | 2 |
| SC&A / NIOSH | Recycled uranium generation and flow and plutonium storage vulnerabilities. | 02/16/2006 | 2 |
| Santa Susana Field Laboratory | History of Nuclear Materials Development Facility. | 12/18/2007 | 1 |
| Science Applications International Corporation (SAIC) | Radiation exposures by AEC Operating Office and summaries of whole body radiation exposures. | 09/02/2004 | 8 |
| 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 remelting of Hanford uranium scrap at Mallinckrodt. | 11/01/2008 | 12 |
| 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, and Hanford airborne particle releases in 1947 and 1948. | 10/10/2011 | 14 |
| 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 | 573 |
| Unknown / DOE Hanford | Fifth semiannual report of the AEC. | 03/09/2004 | 1 |

| Table A1-1: Data Capture Synopsis for Hanford Engineer Works | | | |
|---|--|-----------------------|-------------------------|
| Data Capture Information | General Description of Documents Captured | Date Completed | Uploaded To SRDB |
| Washington University Libraries - St. Louis | Fast neutron monitoring of personnel. | 04/27/2007 | 1 |
| TOTAL | | | 9,886 |

| Table A1-2: Databases Searched for Hanford Engineer Works | | | |
|--|---------------------------|-------------|-----------------|
| Database/Source | Keywords / Phrases | Hits | Selected |
| NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Hanford Rev 05 (83 13) 04-23-12" | | | |
| 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 COMPLETED 05/11/2010 | See Note above | 528 | 2 |
| Google http://www.google.com COMPLETED 05/11/2010 | See Note above | 2,261,772 | 40 |

| Table A1-2: Databases Searched for Hanford Engineer Works | | | |
|---|---------------------------|-------------|-----------------|
| Database/Source | Keywords / Phrases | Hits | Selected |
| HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 07/20/2010 | See Note above | 0 | 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 05/12/2010 | See Note above | 15 | 0 |
| 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 |

| Table A1-3: OSTI Documents Requested for Hanford Engineer Works | | | |
|--|---|-----------------------|----------------------|
| Document Number | Document Title | Requested Date | Received Date |
| PNL-2080-10 | AFCT/TFCT/ISFS Program. Technical Progress Report for the Period April 1, 1978--June 30, 1978 | 11/22/2011 | |
| BNWL-2080-8 | AFCT/TFCT/ISFS Program. Technical Progress Report for the Period January 1, 1978--March 31, 1978 | 11/22/2011 | |
| BNWL-2080-7 | AFCT/TFCT/ISFS Program. Technical Progress Report for the Period October 1, 1977--December 31, 1977 | 11/22/2011 | |
| PNL-2080-17 | AFCT/TFCT/ISFS Program. Technical Progress Report, July 1, 1978-September 30, 1978 | 11/22/2011 | |

| Table A1-3: OSTI Documents Requested for Hanford Engineer Works | | | |
|--|--|-----------------------|----------------------|
| Document Number | Document Title | Requested Date | Received Date |
| PNL-2080-11 | Criticality Research in Support of Chemical Reprocessing in the Thorium Fuel Cycle Technology Program: Basic Process Description | 11/22/2011 | |
| HW-65518 | A Study of the Feasibility for the Large Scale Recovery of Ionium (Thorium-230) From the Uranium Ore Milling Industry in the United States | 11/22/2011 | |
| HEDL-TC-1550-Vol 2-Bk 1 | Alternative Fuel Cycle Evaluation Program. Volume II, Book 1. Fuel Cycle Characterization Study. Summary | 11/22/2011 | |
| HEDL-TC-1550-Vol 2-Bk 10 | Alternative Fuel Cycle Evaluation Program. Volume II, Book 10. Reprocessing of Uranium-Thorium Fuels | 11/22/2011 | |
| HEDL-TME-73-84 | Performance Tests of Metal Oxide Insulated Coaxial Cables for Reactor Instrumentation Application | 11/22/2011 | |
| DOE/RL-95-55 Ref ID: 110605 | Hanford Site Background: Evaluation of Existing Soil Radionuclide Data | 11/22/2011 | 03/26/2012 |
| PNL-4305 Ref ID: 111017 | Pellet-Fabrication Development Using Thermally Denitrated UO ₂ Powder | 11/22/2011 | 03/26/2012 |
| ARH-1508-Del Ref ID: 68428 | 200 Areas Operation Monthly Report, August 1970 | 11/22/2011 | 11/29/2011 |
| ARH-61-Del Ref ID: 68542 | 200 Areas Operation Monthly Report, November 1967 | 11/22/2011 | 11/29/2011 |
| HW-81964 OSTI ID: 4020618 Ref ID: 59951 | Beta-Gamma Dose Rates From U232 in U233 Dated 1964 | 01/05/2009 | 02/24/2009 |