SEC Petition Evaluation Report
Petition SEC-00208

Report Rev #: 0 Report Submittal Date: November 19, 2012

Subject Expert(s):	Jason Davis
Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00208	83.14	October 25, 2012	Battelle Laboratories – King Avenue

NIOSH-Proposed Class Definition
All Atomic Weapons Employees who worked at the King Avenue facility owned by Battelle Laboratories in Columbus, Ohio, during the period from April 16, 1943 through June 30, 1956, 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
N/A	N/A	N/A	N/A

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

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Peer Review Completed By:	[Signature on File] *Timothy Taulbee*	11/19/2012 *Date*
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Evaluation Report Summary: SEC-00208, Battelle Laboratories – King Avenue

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 Atomic Weapons Employees who worked at the King Avenue facility owned by Battelle Laboratories in Columbus, Ohio, during the period from April 16, 1943 through June 30, 1956, 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

NIOSH lacks sufficient information, which includes biological monitoring data, air monitoring information, and/or process and radiological source term information to allow it to estimate with sufficient accuracy the potential internal exposures to uranium, thorium, their progeny, and mixed fission products to which the proposed class may have been subjected. NIOSH finds that it is not applicable to reconstruct occupational medical dose for Battelle Laboratories - King Avenue workers because medical X-ray procedures were performed at an off-site, non-EEOICPA-covered facility.

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

- Principal sources of internal radiation for members of the proposed class included exposures to uranium and thorium, including the progeny of these radionuclides, used in laboratory-scale and pilot-plant-scale research activities. Potential for internal exposure through inhalation and ingestion of these materials during sample preparation and processing would have been significant if adequate exposure prevention protocols were not in place. Documentation verifying the use of such protocols is not currently available to NIOSH.

- NIOSH has identified limited personnel internal monitoring data for select individuals for the years 1955-1956. The data are not comprehensive and there is no evidence to indicate these data are representative of the most highly-exposed workers at the King Avenue facilities, or to indicate that the available sample results are representative of all workers. Without additional personnel radiation monitoring data representing the period from April 16, 1943 through June 30, 1956, NIOSH has insufficient information to appropriately characterize radioactive material intakes during Battelle Laboratories – King Avenue operations.

- NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored internal exposures for Battelle Laboratories – King Avenue workers during the period of Atomic Weapons Employer operations from April 16, 1943 through June 30, 1956.

- Principal sources of external radiation for members of the proposed class included exposures to uranium and thorium, including the progeny of these radionuclides, used in laboratory-scale and pilot-plant-scale research activities.

- NIOSH has located some documentation on quantities of radiological materials shipped to Battelle Laboratories – King Avenue for processing or testing. Available records indicate that a wide variety of material forms, including uranium ore and metal, and monazite ore were used for research and pilot plant projects at the site. Materials and experimental activities involved uranium and decay chain radionuclides being chemically separated and re-concentrated so that they were often out of the equilibrium state; the degree of disequilibrium is generally unknown to NIOSH. It is unknown if and how this material may have been stored on site.

- NIOSH has located 199 external dosimetry records for the year 1951, as compared to only a single record for 1950. External monitoring records available to NIOSH increase each year after 1951 to 2195 records in 1956 and 3317 records in 1957. NIOSH has determined that it may be feasible to reconstruct monitored external doses during the period from January 1, 1951 through June 30, 1956.

- NIOSH has indications that, in 1949, medical X-ray examinations were performed at an off-site university hospital. NIOSH has determined that it is not applicable to reconstruct occupational medical dose for Battelle Laboratories - King Avenue workers during the period from April 16, 1943 through June 30, 1956 because medical X-ray procedures were performed at an off-site, non-EEOICPA-covered facility.

- 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 Battelle Laboratories – King Avenue during the period from April 16, 1943 through June 30, 1956, 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 radiation exposures through intakes of uranium, thorium, and mixed fission products as well as 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-00208

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: Jason Davis, Oak Ridge Associated Universities. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for employees who worked at a specific facility during a specified time. It provides information and analysis germane to considering a petition for adding a class of employees to the Congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

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

2.0 Introduction

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

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioners and the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary

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

of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 NIOSH-Proposed Class Definition and Petition Basis

The NIOSH-proposed class includes all Atomic Weapons Employees who worked at the King Avenue facility owned by Battelle Laboratories in Columbus, Ohio, during the period from April 16, 1943 through June 30, 1956, 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 this facility were involved in atomic energy research and development (R&D) activities including: processing and machining of enriched, natural, and depleted uranium and thorium for fuel element fabrication and other uses; radiotracer studies; radiochemical analyses; and powder metallurgy studies (Decommissioning Plan, 2003).

The evaluation responds to Petition SEC-00208 which was submitted by an EEOICPA claimant whose dose reconstruction could not be completed by NIOSH due to a lack of sufficient dosimetry-related information. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

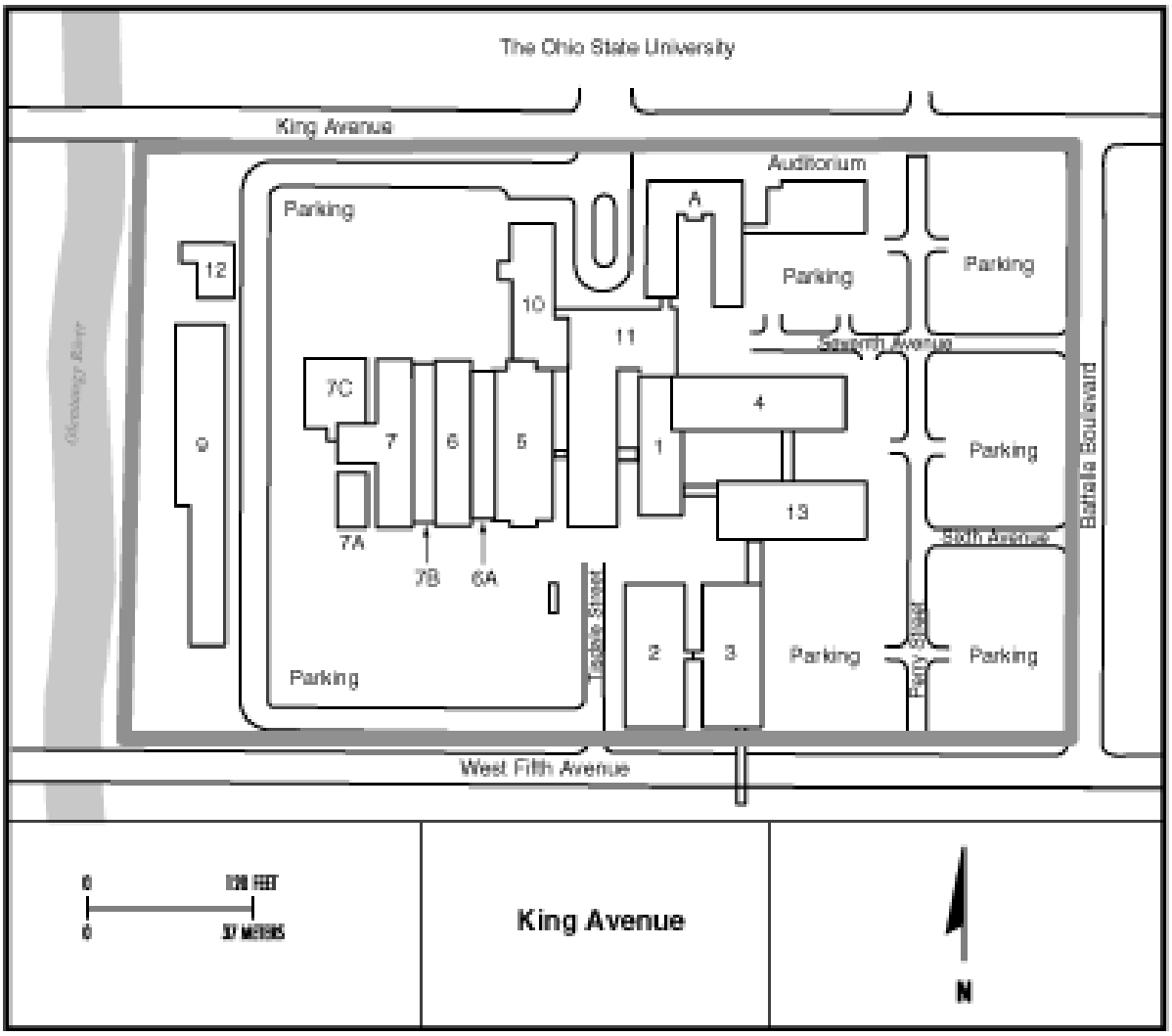
The following subsections summarize the radiological operations at Battelle Laboratories - King Avenue from January 1, 1943 through June 30, 1956 and the information available to NIOSH to characterize particular processes and radioactive source materials. Using available sources, NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of radionuclides of concern, and information describing processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

4.1 Operations Description

Battelle Laboratories - King Avenue is located in Columbus, Ohio. Battelle operated two separate facilities in the Columbus, Ohio area. The King Avenue site consists of nine affected buildings, located within the city of Columbus. The 58.3-acre plot (see Figure 4-1), accommodating 21 buildings, is bordered by King Avenue to the north, Battelle Boulevard and Perry Street to the east, Third Avenue to the south, and the Olentangy River to the west (Environmental Report, 1996). Although Battelle performed research throughout the campus, it used only nine buildings to perform most of its nuclear weapons-related work. NIOSH has been unable to gather enough data to quantify

[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 total number of workers at the site during the period under evaluation. It is known that 110 employees worked under contract W-7405-ENG-92 as of January 31, 1948 (Progress Report, 1948a) and 172 employees worked on the projects under that contract as of January 31, 1949 (Progress Report, 1949).



Source: Battelle History, 1999

Figure 4-1: Battelle Laboratories – King Avenue Site Map

Battelle Memorial Institute (BMI) began its period of government service in 1942 by performing work for the Office of Scientific Research and Development under contract OEMsr-85 (Radiological Assessment, 1988).

On April 16, 1943, BMI, acting through what is now its Columbus Operations (BCO), entered into Contract Number W-7405-ENG-92 with the Manhattan Engineer District to perform atomic energy research and development (R&D) activities (Decommissioning Plan, 2003). The initial emphasis of Contract W-7405-ENG-92 was the fabrication, rolling, forging, and extrusion of uranium metal (Trip

Report, 1943; Trip Report, 1947a). Small sections of uranium and cold-rolled Ames thorium were tested for thermal conductivity. In addition, thorium samples were annealed and acid-dipped to investigate the possibility of removing oxide scales resulting from heat treatment and fabrication of thorium metals (Tuballoy, 1945). Small amounts of high-purity thorium were prepared at BMI prior to 1951 by the thermal decomposition of crude thorium tetraiodide metal from Ames. In addition, samples of Ames thorium were forged at BMI before being sent to Westinghouse for rolling into metal bars (Thorium Metallurgy, 1951).

BMI conducted an investigation to obtain data on the roll-separating forces to be expected when uranium is rolled under various conditions. The effects of the initial metal structure, the reduction rate, and the heating method on the roll load were determined by rolling round bars and flat strips at temperatures between 250º and 800º C. Cast-uranium bar stock and gamma-extruded uranium rods 1-5/8 inches in diameter by 8 inches in length were used in this process; they were rolled in an open-pass mill originally designed for rolling steel (Uranium Rolling, 1952).

Interest in alloying uranium to improve the corrosion resistance and dimensional stability of fuel elements and slugs prompted a study of the binary systems of uranium with zirconium, chromium, columbium, vanadium, and molybdenum. Data collected as part of this study included the diffusion properties, mechanical properties, and conclusions about the possibility of using the alloys as fuel cladding (Uranium Alloys, 1952). A similar study investigated the possibility of vapor-depositing coatings of chromium, molybdenum, niobium, vanadium, and zirconium onto uranium fuel rods to improve the corrosion resistance over traditional aluminum-clad rods (Uranium Coatings, 1953).

Thorium-uranium alloys were also investigated with the objective of improving corrosion resistance and irradiation stability by means of alloying as well as control of processing variables. Thorium-uranium alloys (formed by the addition of molybdenum, niobium, or zirconium) were specifically investigated; the additions were made with the goal of strengthening the thorium matrix and stabilizing the gamma uranium phase. Studies were conducted of binary thorium-uranium alloys as-cast, hot-rolled, and cold-reduced to determine the variation of structure with fabrication (Progress Report, 1959).

Small-batch studies were conducted to investigate the influence of melting atmosphere during the re-casting of electrolytic thorium powders (Trip Report, 1955). In order to test the creep properties of thorium, material from Ames Billet A-388 was hot-rolled at 1450º F to 1/8-inch by 7-inch slabs. The slabs were pickled to remove oxidation scale and cold-rolled to 0.080-inches thick. The thorium sheet was then surface-ground to 0.060 ± 0.005 inch by removing 0.010 inches from each of the two faces. The test specimens were machined to a 3-inch reduced section with 1-1/4-inch radius (Thorium Creep, 1953).

At the request of the AEC's New York Operations Office, Battelle furnished technical assistance in the rolling operation and in the metallographic examination of the finished bars. Previously-supplied rod had been made by forging Ames billets into square bars and rolling these bars into round rods. The same facilities were not readily available; so, given the urgency of the request, the rods were rolled directly from the billets in the rolling mill normally used to fabricate uranium rods. The rolling was done by the Simonds Saw and Steel Co. at Lockport, New York on August 16, 1951. Thorium rods, 1-7/16 inch in diameter, were rolled from Ames castings and re-melted thorium chips (Thorium Rolling, 1951).

Other activities conducted under this contract included investigations into general thorium metallurgy (Alloys, 1958; Thorium Properties, 1952), and the development of radioactive tracers for industrial process control (Progress Report, 1960).

In September 1946, Contract Number W-38-094-ENG-27 was initiated. The research program was carried out in three stages:

1. During the first stage, an appraisal was made of the possibilities of separating uranium from various sources via beneficiation, pyrometallurgy, electrometallurgy, or hydrometallurgy. This stage lasted approximately five months (Phosphate Studies, 1948, pdf p. 5).

2. From March 1947 to December 1947, work focused on methods for leaching uranium from phosphate rocks and then recovering uranium from the leach solutions.

3. The final stage aimed to extract uranium from phosphate ores, while retaining the phosphate itself as a recoverable product (Phosphate Studies, 1948, pdf p. 5). From October 1, 1949 to May 31, 1950, a limited investigation was undertaken on methods of recovering uranium from North Dakota lignite via acid and carbonate leaching (Uranium Recovery, 1950).

Contract Number AT-30-GEN-202 was implemented in September 1947. Work on this project was an expansion and continuation of work initiated under Contract W-38-094-ENG-27. Whereas the previous contract focused on the recovery of uranium from phosphate ores, this research focused on the ability to recover uranium from Chattanooga shale deposits (Phosphate Studies, 1948, pdf p. 20). The objective of this project was to develop a practical process for recovering uranium from domestic low-grade shales with uranium contents of between 0.005 and 0.009 percent. Batches of up to 20 pounds were processed by roasting and sulfuric acid leaching (Uranium Recovery, 1948). Temperature, particle size, sulfuric acid concentration, pulp density, and leaching time were each varied to determine the optimum process for mineral extraction while attempting to retain the solid kerogen in the shale for later conversion into oil and gasoline (Quarterly Report, 1949). A similar study was conducted under Contract AT(49-1)-641. Work on this project appears to have concluded with the publication of a final report on January 14, 1954 (Uranium Recovery, 1954).

The purpose of Contract AT-30-1-GEN-258 was to improve on the Monticello leach process for ore extraction. The processes used at the time for treating western carnotite ores were developed to give the maximum recovery of vanadium. In order to establish the conditions required for maximum uranium recovery, research was conducted on the roasting and leaching of ore samples. To that end, 5-7 pound batches of carnotite ore were processed while changing one variable in the process at a time to quantify the effects of these subtle changes (Carnotite, 1948). This project was declared complete on June 30, 1949, following which the remaining inventory and equipment was transferred to the projects under Contract W-7405-ENG-92 (Field Trip, 1949).

In October 1947, it was noted that monazite-processing methods available at the time focused on the recovery of rare earth metals and were not satisfactory for the recovery of uranium and thorium from the ore sands. With this in mind, the Atomic Energy Commission (AEC) established a research project under Contract Number AT-30-1-GEN-228 to discover the most suitable method for mineral recovery from monazite (Recovery, 1948). The AEC gave Battelle the assignment of developing a process for the extraction of both uranium and thorium from monazite sands. In addition, Battelle was expected to preserve the rare earth materials from the sands in a form that would be marketable to

other industries (Monazite, 1949). Research on the project commenced in January 1948 with two 50-pound samples of monazite provided by the AEC. The samples were one each of Indian and Brazilian ores. The Indian ore contained 6.56% thoria (ThO_2) and 0.23% U_3O_8; the Brazilian ore contained 3.08% thoria and 0.47 U_3O_8 (Recovery, 1948; Monazite, 1949).

Sands were treated with caustic soda and nitric acid to dissolve the minerals. From this point, experiments were carried out using various organic solvents to remove the metals from solution. Initial studies were conducted using five-pound batches with plans in place to expand the operation to a pilot-scale plant with 100-pound batch-processing capabilities. After the initial steps of handling the dry source materials, the processed material was conducted as a closed-liquid system with little potential for exposure to airborne materials (Trip Report, 1949, pdf p. 4). By July 1, 1950, the laboratory-scale extraction of minerals from monazite was ready for pilot-plant testing (Thorium Development, 1950).

The original contract was modified on August 14, 1951 to allow Battelle to develop their solvent extraction process up through pilot scale. The pilot plant, constructed at the King Avenue facility, had a capacity to produce four pounds of thorium per hour using three 10-stage mixer-settlers for the extraction, scrubbing, and stripping operation (Thorium Status, 1951). The contract was terminated by the AEC on May 31, 1952 and small-scale research for the purpose of closing out the project was conducted until August 31, 1952. Following contract termination, the pilot plant used for the project was dismantled, crated, and shipped to Fernald, Ohio (Termination, 1952).

The nature of the research being performed at Battelle made it mandatory that a remote-handling facility be built. Thus, in 1955, Battelle expanded the existing nuclear facilities by building the first privately-owned nuclear research center in the world. This facility, the Nuclear Sciences Area, located at the north end of the West Jefferson site, included a research reactor, critical assembly facility, hot cells, and later a plutonium laboratory (Decommissioning Plan, 2003).

Until 1988, BCO performed nuclear materials R&D work at these privately-owned facilities for the Manhattan Engineer District and its successor agencies (the AEC, the Energy Research and Development Agency [ERDA], and the Department of Energy [DOE]). BCO also performed commercial nuclear operations and work for other Federal agencies, such as the Department of Defense (U.S. Air Force, U.S. Army, U.S. Navy) and the National Aeronautics and Space Agency Administration (NASA) (Decommissioning Plan, 2003).

4.2 Radiation Exposure Potential from Operations

The potential for external radiation dose existed in the nine buildings described in Section 4.4. Based on the site operations outlined in Section 4.1, sources of exposure included beta, gamma, and neutron radiation emitted from a variety of research and development studies, as well as pilot-plant-scale metallurgical and mineral extraction activities using carnotite ores, pitchblende ore, monazite sands, and oil shales (Phosphate Studies, 1948, pdf p. 33; Field Trip, 1949; Progress Report, 1948b; Phosphate Studies, 1948, pdf p. 20). Creation and encapsulation of Sr-90 and Co-60 sources was also performed in the radiochemistry laboratories (Monitoring Records, 1951-1952a).

The primary sources of internal radiation exposure at the site were uranium, thorium, uranium and thorium progeny, and fission products generated during R&D studies, as well as pilot-plant-scale metallurgical and mineral extraction activities using carnotite ores, pitchblende ore, monazite sands, and oil shales (Phosphate Studies, 1948, pdf p. 33; Field Trip, 1949; Progress Report, 1948b; Phosphate Studies, 1948, pdf p. 20). Creation and encapsulation of Sr-90 and Co-60 sources was performed in the radiochemistry laboratories (Monitoring Records, 1951-1952a). Small quantities (less than 1 curie) of fission products were counted in the gamma-counting laboratory (Procedures Manual, 1962). Quantities of materials handled by Battelle are given in Tables 4-1 and 4-2.

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time period associated with Atomic Weapons Employer (AWE) operations at the Battelle Laboratories – King Avenue site is from 1943-1986 with no specific dates identified (DOE, 2012). Although radiological operations were conducted prior to this date, operations under an AEC contract are known to have commenced on April 16, 1943 (Decommissioning Plan, 2003). NIOSH has not located an indication of a specific operational end date. Lacking definitive information, December 31, 1986 is currently assumed to be the end of covered AWE operations.

NIOSH is currently in the process of continuing data capture activities in support of Site Profile development for both Battelle's King Avenue and West Jefferson sites. As described later in Section 5 of this report, NIOSH's earliest indication to date of a bioassay monitoring program at the King Avenue site is in July 1956. Although data collection is continuing to better define the scope of the Battelle monitoring programs, NIOSH has determined that the remaining data sources are not likely to yield adequate bioassay monitoring data earlier than July 1956 for the King Avenue site. NIOSH is continuing to evaluate the available internal monitoring data beginning in July 1956 and their impact on post-June 1956 dose reconstruction feasibility determinations. Because the continuing data resource assessment affects only post-June 1956, NIOSH has determined that it is appropriate to present in this report its evaluation of the period from April 16, 1943 through June 30, 1956. NIOSH is continuing its data capture and Site Profile development efforts to support sufficiently accurate dose reconstruction for the periods after June 30, 1956.

Table 4-1: Battelle Materials Inventory Data												
Dates	**Uranium (kg)**				**Enriched Uranium (kg)**				**Thorium (kg)**			
	Beginning	**Receipts**	**Removals**	**Ending**	**Beginning**	**Receipts**	**Removals**	**Ending**	**Beginning**	**Receipts**	**Removals**	**Ending**
12/31/46-12/31/47 (a)	253.8	106.121	155.421	204.5	0	0.24083	0.24083	0	29.200	841.500	410.600	460.100
1/1/48-11/30/48 (a)	204.500	1,604.2	318.9	1,360.6	0	4.725	4.725	0	460.1	205.2	577.0	75.7
1/1/50-7/31/50 (b)	1,595	310	101	1,771	0.28	0.98	1.26	0	262	6	0	254
1/1/51-4/30/51 (c)	1,657	346	12	1,967	0.095	0.068	0.089	0.074	252	257	62	440

(a) Source: Inventories, 1947-48
(b) Source: Inventories, 1950
(c) Source: Inventories, 1951

Table 4-2: Battelle Materials Receipts and Shipments					
Approximate Date	**Material**	**Quantity**	**Shipped From**	**Shipped To**	**SRDB Ref ID**
2/11/43	U metal	66.6 lb	Metallurgical Laboratory	Battelle Memorial	82369
2/16/43		77 lb			
2/17/43		128.1 lb			
2/18/43		218 lb			
2/20/43		70.3 lb			
2/24/43		121 lb			
3/2/43		68.4 lb			
3/5/43		158.6 lb			
3/8/43		126.0 lb			
3/8/43		153.0 lb			
3/9/43		205.0 lb			
3/10/43		83.6 lb			
3/12/43		163.6 lb			
3/16/43		350 lb			
3/17/43		262 lb			
3/22/43		152.2 lb			
3/22/43	U metal scrap	182 lb	Battelle Memorial	Metallurgical Laboratory	
3/24/43	U metal	168.7 lb	Metallurgical Laboratory	Battelle Memorial	
3/26/43		173.1 lb			
3/31/43		157.5 lb			
4/1/43		189.9 lb			
4/5/43		147.9 lb			
4/13/43	U metal scrap	224 lb	Battelle Memorial	Metallurgical Laboratory	
5/4/43		182.5 lb			
5/12/43	U metal	177.0 lb	Metallurgical Laboratory	Battelle Memorial	
5/17/43		96.6 lb			
6/18/43		382.7 lb			
11/10/43	Uranium	15.54 lb	Clinton Engineer Works	Battelle Memorial	78304
7/29/44	U metal	158.62	Metallurgical Laboratory	Battelle Memorial	82384
10/31/47	U metal tubes	20 ea.	Unknown	Battelle Memorial	66919
12/22/47	U metal rods	200 lb	Hanford	Battelle Memorial	66923
1/31/48	Monazite Sand	2.7 kg	Mallinckrodt	Battelle Memorial	85873, pdf pp. 3, 19 16858, pdf p. 16
4/9/48	Uranium dicarbide	1,000 g	Battelle Memorial	DOE Schenectady Office	88146
	Uranium monocarbide	500 g			

Table 4-2: Battelle Materials Receipts and Shipments					
Approximate Date	**Material**	**Quantity**	**Shipped From**	**Shipped To**	**SRDB Ref ID**
4/22/48	Th metal bars	909.95 lb	Battelle Memorial	Westinghouse Electric	95617
5/17/48	Th metal	300 lb	Ames	Battelle Memorial	88051
5/25/48	Th scrap	150 kg	Battelle Memorial	Ames	88049
7/20/48	U metal rods	1,000 lb	Hanford	Battelle Memorial	66922
10/--/48	U metal rod	1x 8in. rod	Battelle Memorial	MIT	30748
6/2/49	Th	200 Lb	Ames	Battelle Memorial	95628
10/19/49	Natural U	500 lb	Hanford	Battelle Memorial	66949
8/30/50	Natural U	500 lb	Hanford	Battelle Memorial	66953
6/30/51	Th	1 kg	Battelle Memorial	ORNL	101788
	U	130 g			
	Th	28 kg	ORNL	Battelle Memorial	
8/31/51	Th	52 kg	Battelle Memorial	ORNL	
	U	291 g			
	Th	29 kg	ORNL	Battelle Memorial	
3/19/51	Uranium carbide	10 kg	Battelle Memorial	Air Force Material Command (Oak Ridge)	66956
1/10/52	Th Nitrate	200 lb	Middlesex	Battelle Memorial	86958
02/--/53	Th scrap	470 kg	Battelle Memorial	National Lead of Ohio	31429
10/11/1954	Th oxide	50 lb	National Lead of Ohio	Battelle Memorial	31484

4.4 Site Locations Associated with Radiological Operations

During the 1940s, from 1952 through 1958, and periodically during the 1960s and 1970s, scientists developed encapsulation techniques for highly-enriched uranium (HEU) in the old administration building (Building A). Building 1 contained a foundry and metal fabrication shop in its large open bay, and scientists and engineers also worked there to improve the recovery of uranium from ores and milling byproducts (Traveler's Guide, 2002).

Buildings 2 through 7 and 10 through 13 were not constructed until the mid-1950s (Phosphate Studies, 1948, pdf p. 47). The AEC funded the majority of the research that occurred in Building 2, where technicians electroplated reactor fuel destined for the Hanford Reservation and heat-treated slugs of uranium and thorium alloys. Building 3 housed research in uranium and beryllium. The radiochemistry and metallurgical laboratories were in Building 4. Buildings 5 and 9 contained tall open bays with large machine shops for grinding and shaping uranium, thorium, and beryllium. Analytical chemists worked for the AEC, DOE, and Navy in Buildings 6 and 7 (Traveler's Guide, 2002).

More details about the operations conducted in each building are presented below.

- Building A (Corporate Office Building): A steel, concrete, and brick U-shaped structure completed in 1929 (Battelle Story, 1986). The west wing and north end contain three floors plus basement and attic levels. The east wing contains four floors plus a basement level. Building A contained the main library, a small auditorium, a creep laboratory (for high-temperature deformation testing), a non-destructive testing laboratory including radiography with small radioactive sources, general offices, and document storage. Access to the building was controlled (Battelle History, date unknown). Operations in this building included the encapsulation of highly enriched uranium for advance test reactor fuel elements. (Decommissioning Plan, 2003). The principal operation in Building A was a thorium solvent extraction pilot plant (Resurvey, 1977). Some metallurgical studies of uranium were also carried on in this building (Battelle History, date unknown).

- Building 1 (Foundry): A four-story concrete, steel, and brick structure that is connected to Building 4 on the east and Building 11 on the north. Building 1 contains ore laboratories, miscellaneous laboratories, offices, and a foundry occasionally used for processing natural or depleted uranium or natural thorium (Battelle History, date unknown). Uranium ore processing and ore beneficiation studies were performed in this facility in support of feed material processing centers operated by other AEC contractors. A foundry and melting, cutting, and grinding facilities are located within this building. (Decommissioning Plan, 2003).

- Building 2 (Metalworking Building): Building 2 is a two-story, steel-frame structure with a basement and equipment rooms under the east end of the structure. Building 2 was used for AEC research, including the electroplating of Hanford reactor slugs, heat treatment and fabrication of uranium and thorium alloys, rolling studies, alloy development, and fuel element fabrication. (Decommissioning Plan, 2003).

- Building 3 (Materials Building): A two-story, steel-frame structure with a basement. Laboratories and offices were located on all three floors. This building housed powder metallurgy, melting, metallographic, and ceramics research facilities using enriched, natural, and depleted uranium as well as thorium (Decommissioning Plan, 2003).

- Building 4 (Radiochemistry Laboratory): A two-story, steel-framed structure with a ground-floor basement and a partial sub-basement. Building 4 contained a radiochemistry laboratory and an encapsulation facility for highly-enriched uranium (Decommissioning Plan, 2003). Activities in this building consisted of preparing, handling, and storing radiological specimens for use in radioanalytical, metallurgical, and non-destructive examination, as well as irradiation capsule fabrication operations. At the Radioisotope Laboratory in Building 4, the doors from the corridor into the medium- and high-level laboratories were locked from the outside at all times. Access was otherwise through the locker room, which itself was entered through the office area (Procedures Manual, 1962). These doors were used only for transporting casks and heavy equipment in and out of the laboratory. Permission of the laboratory supervisor was required before the doors could be used.

- Building 5 (Machine Shop): A three-story, steel-frame structure with laboratories and offices located on all three floors. The machine shop produced substantial work for AEC/ERDA/DOE programs. Work in this area involved machining, grinding, and milling operations on depleted, natural, and enriched uranium as well as thorium (Decommissioning Plan, 2003).

- Buildings 6 and 7 (Chemistry Buildings): Analytical chemistry activities in support of the DOE/Navy program took place in these buildings. Work in these areas involved alloy studies, corrosion research, and chemical and instrumental analyses of uranium and thorium samples (Decommissioning Plan, 2003). Building 7 was also used for the packaging of radiological and mixed waste containing licensed byproduct material. At the Gamma (Co-60 irradiation) Facility in Building 6, permission for non-staff members to enter the facility had to be obtained from the facility staff (Procedures Manual, 1962). This facility was kept locked overnight, on holidays, and on weekends to prevent unauthorized personnel from entering.

- Building 9 (Mechanical Engineering Building): Research programs were conducted in here for AEC/ERDA/DOE involving natural and depleted uranium (Decommissioning Plan, 2003).

NIOSH has determined that the site-specific and claimant-specific data available for the time period of this evaluation are insufficient to allow NIOSH to characterize worker movements across the Battelle Laboratories – King Avenue site. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations within the Battelle Laboratories – King Avenue site during the period under evaluation.

4.5 Job Descriptions Affected by Radiological Operations

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

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

5.0 Summary of Available Monitoring Data for the Proposed Class

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

This same hierarchy is used for determining the external exposures to the cancer site. Personal monitoring data from film badges or thermoluminescent dosimeters (TLDs) are the primary data used to determine such external exposures. If there are no personal monitoring data, exposure rate surveys, process knowledge, and source term modeling can sometimes be used to reconstruct the potential exposure.

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

5.1 Data Capture Efforts and Sources Reviewed

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding Battelle Laboratories – King Avenue. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of Battelle Laboratories – King Avenue documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

5.2 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 5-1 summarizes the results of this review. (NOCTS data available as of October 15, 2012)

Table 5-1: No. of Battelle Labs – King Ave. Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	62
Total number of claims submitted for energy employees who worked during the period under evaluation (April 16, 1943 through June 30, 1956).	25
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	19
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	6

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. The dose reconstruction claimant computer-assisted telephone interviews (CATIs) provided some information regarding work locations, hours worked, and hazards encountered. The interviews also identified conditions for which there would have been potential for either internal or external exposures. As noted in Table 5-1, NIOSH has not received internal monitoring data from Battelle Laboratories for any claimants for the time period under evaluation.

5.3 Worker Interviews

NIOSH has reviewed the CATIs conducted for claims filed with NIOSH for energy employees who worked at the Battelle Laboratories – King Avenue site during the period under evaluation. These interviews did not indicate any potential sources for additional monitoring or process data.

Based on the extensive data capture efforts performed to date for the Battelle Laboratories sites in Columbus, Ohio, NIOSH determined that additional worker interviews would neither change the

NIOSH feasibility determination nor allow NIOSH to limit the class to specific locations or work groups. Therefore, no additional interviews were pursued.

5.4 Internal Personnel Monitoring Data

NIOSH has not located any bioassay results for the time period prior to 1955. NIOSH has located a single uranium bioassay result for 1955 (Monitoring Records, 1955-1978) and 68 results for 1956 (Monitoring Records, 1955-1978; Monitoring Records, 1954-1960; Monitoring Records, 1953-1963; Monitoring Records, 1955-1988; Urinalysis Results, 1956). The urinalysis samples appear to have been assayed for uranium by gross alpha counting (Monitoring Records, 1955-1978). In 1956, Battelle began submitting urine samples to the Ohio State University Toxicology Department for uranium analysis. Shortly after, Battelle switched to submitting samples to Nuclear Science and Engineering Corporation of Pittsburgh, Pennsylvania for analysis. At this time, the program required employees to submit urine samples at six-month intervals unless an incident evaluation suggested the need for more frequent sampling. Depending on the work processes, urine samples were analyzed for the presence of uranium or counted for gross beta (Battelle Bioassay, 1957).

NIOSH has found indications of respirator use during BMI operations (Uranium Rolling, 1952); however, NIOSH has not found sufficient information to fully understand the scope of the BMI respiratory protection protocols used during the period under evaluation, or the extent of any organized respiratory protection program in place at the site.

No thorium bioassay records have been located, nor has any other information been identified regarding personnel monitoring for internal radiation exposure for the period April 16, 1943 through June 30, 1956. To date, documentation available to NIOSH does not provide any indication that a routine bioassay monitoring program existed at the Battelle Laboratories during the 1943 through June 1956 time period.

The NOCTS database was reviewed for claimants whose work history included Battelle Laboratories – King Avenue during part or all of the covered period (1943 through 1956). A total of 25 claimants were identified. The files for all 25 claimants were thoroughly reviewed and limited instances of internal monitoring data were found. This is consistent with the above determination that insufficient monitoring existed and that only very limited internal monitoring data are available to NIOSH prior to July 1, 1956.

5.5 External Personnel Monitoring Data

To date, NIOSH has been unable to locate any Battelle programmatic documentation specifying which King Avenue site workers should have been monitored for external radiation exposure and on what frequency monitoring devices should have been exchanged. The earliest date for a film badge that has been found in the available records is February 14, 1951 (Monitoring Records, 1951-1952b). Beginning at that time, NIOSH has access to external monitoring data records that include gamma, beta, and neutron exposures. Badges appear to have been worn thereafter throughout the period of operation. Figure 5-1 shows the growth in the number of personal dosimeters issued starting in 1950. NIOSH has located 199 external dosimetry records for the year 1951, as compared to only a single record for 1950. External monitoring records available to NIOSH increase each year after 1951 to 2195 records in 1956 and 3317 records in 1957.

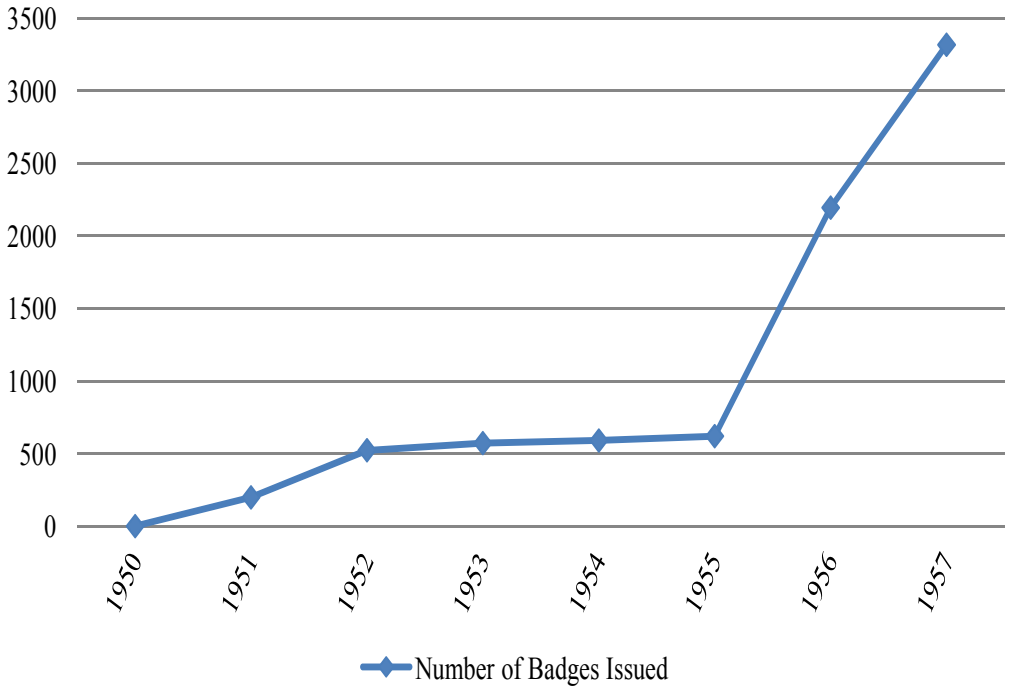


Figure 5-1: No. of Film Badges Issued Per Year at Battelle Laboratories – King Ave.

The NOCTS database was reviewed for claimants whose work history included Battelle Laboratories – King Avenue during part or all of the evaluation period (1943 through 1956). A total of 25 claimants were identified. The files for these 25 claimants were thoroughly reviewed and limited external monitoring data were found. This is consistent with the above determination that insufficient monitoring existed and that only very limited external monitoring data are available to NIOSH until after 1950.

5.6 Workplace Monitoring Data

NIOSH has been unable to locate any information indicating that a routine workplace monitoring program was in place at Battelle Laboratories – King Avenue during the period under evaluation. A report from an AEC visit on July 24, 1946 remarked that the Battelle Laboratories – King Avenue site possessed no radiation survey equipment and was in no way equipped to work with highly-radioactive materials (Trip Report, 1946). As of an AEC visit on December 15, 1947, Battelle had not yet acquired any survey instrumentation. A representative from the Technical Section of the AEC provided recommendations for which types of equipment would be suitable and performed a survey of a single lab and uranium/thorium locker store room. Survey measurements yielding 11 data points were taken with a beta-gamma survey meter and with an alpha ionization chamber survey meter. The highest readings were on the order of tens of mr/hr, indicating an observable exposure potential (Trip Report, 1947b).

On June 8, 1951, Rooms 422, 423, and 424 (all in Building 4) were monitored for radioactivity using a beta-gamma survey meter and by taking contamination smears. A total of 77 smears and 21 gamma-beta measurements were taken in the three buildings. Several of the smear tests from each room exceeded the 150 counts per minute (cpm) tolerance limit in place at that time (Survey, 1951).

Documentation suggests that air sampling equipment was provided to Battelle by the AEC Health and Safety Division in 1949, along with direction to conduct air sampling whenever thorium extraction procedures were active (Trip Report, 1949, pdf p. 4). However, NIOSH has been unable to locate any indication that a routine air sampling program was in place. NIOSH found a single breathing-zone air sample result taken on March 7, 1957 during the rolling of thorium in Building 3 with a result of $9x10^{-11}$ μCi/ml (Thorium Result, 1957).

A set of 48 air samples and nine dust samples have been located for the year 1950. The dust samples were taken from a single room in Building 1 area in which pitchblende ore was being processed. These samples were analyzed by scintillation counting, with the highest result of 13 cpm being observed in samples taken during dry-grinding of the ore (Analysis Results, 1950, pdf p. 112). Some air samples were acquired in Building 3, but the sampling locations for the majority of the samples were not recorded. Specific tasks being undertaken at the time of sampling are noted on the sampling log sheets. Four of the 48 samples were analyzed via scintillation counting and the remaining 44 were analyzed by fluorimetry, with the highest result of 11 cpm being observed during wet-sawing of metal samples (Analysis Results, 1950, pdf pp. 113-118).

5.7 Radiological Source Term Data

Minimal information has been located on quantities of uranium or thorium maintained on site, but it is inferred from research reports that a wide variety of forms of uranium-bearing materials (uranium ore and metal, pitchblende, and uranium dioxide) and thorium were used for research and pilot plant projects. Materials and experimental activities involved uranium, thorium, and decay chain radionuclides being chemically separated and re-concentrated so that they were often out of the equilibrium state; the degree of disequilibrium is generally unknown to NIOSH.

A total of 150 samples made up of cast-uranium bars and gamma-extruded uranium rods with dimensions of 1-5/8 inches in diameter by 8 inches in length were used in support of the rolling studies performed under Contract W-7405-ENG-92 (Uranium Rolling, 1952). Quantities of materials handled by Battelle during other processes are provided in Tables 4-1 and 4-2.

The above materials and forms were sources of potential exposure at the site. It is clear from the available research reports that Battelle Laboratories – King Avenue worked with uranium and thorium; however, the documentation does not provide sufficient information on specific radionuclides, quantities, or forms of the source materials used at any given time during the period under evaluation. NIOSH is unable to make reasonable assumptions about source terms, concentrations, or radiological equilibrium conditions at the Battelle Laboratories – King Avenue facility.

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 discussed in Section 5.4, NIOSH has identified limited urinalysis results analyzed for uranium during the operating period, but has not found documentation that describes the sampling or analysis protocols used with that set of bioassay data. The earliest urinalysis mentioned in records found by NIOSH regards samples submitted in 1955 and 1956; these samples were assayed only for uranium and the results were given in milligrams. It is unclear who performed these initial urine analyses (Urinalysis Results, 1958; Urinalysis Results, 1959). NIOSH has found no indication that workers were monitored for intakes of thorium during the period under evaluation.

It is not known on what general basis workers were selected for bioassay. Based on the dosimetry records available to NIOSH, claimant statements, and Battelle site documents, it appears that King Avenue workers in at least the following categories were included in the urinalysis program:

- Workers in the Building 4 Radioisotope Laboratory complex, and in the radiotracer laboratories in Buildings A and 1. Office personnel in Buildings A, 1, and 4 appear to have been included in the urinalysis program.

- Workers in areas of Buildings 2, 3, and 5 where uranium and other radioactive materials were handled

- Workers in Building 6 laboratories (except the Gamma Laboratory), but possibly only for specific projects

These limited internal personnel monitoring data are for select individuals, and there is no evidence to indicate these data are representative of the most highly-exposed workers at the King Avenue facility; nor is there a way to verify that the available sample results are representative of all workers.

As mentioned in Section 5.6, NIOSH has not located any information documenting or describing a regular workplace monitoring program. Documentation suggests that air sampling equipment was provided to Battelle by the AEC Health and Safety Division along with direction to conduct air sampling whenever thorium extraction procedures were active (Trip Report, 1949, pdf p. 4). However, NIOSH has been unable to locate any indication of compliance with these recommendations.

NIOSH has located some documentation as to quantities of radiological materials shipped to Battelle Laboratories for processing or testing, as detailed in Section 4.2. It is clear from reports that Battelle Laboratories worked with uranium and thorium. As mentioned in Section 5.7, it is inferred from research reports that various forms of uranium-bearing materials were used in the site's research.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to uranium, thorium, and their progeny during a period of AWE operations from April 16, 1943 through June 30, 1956. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to uranium, thorium, and their progeny and resulting doses for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from April 16, 1943 through June 30, 1956, 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 Battelle Laboratories – King Avenue during the period from April 16, 1943 through June 30, 1956, 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 uranium, thorium, and their progeny could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (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.

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

As indicated in Section 5.5, NIOSH has not located any indication of external personnel exposure monitoring for the period from April 16, 1943 through February 13, 1951. No records of any program for personnel monitoring, or data that would be associated with such a program, have been located for the period beginning with the start of AWE operations through February 13, 1951. NIOSH has located 199 external dosimetry records for the year 1951 (beginning on February 14), as compared to only a single record for 1950. External monitoring records available to NIOSH increase each year after 1951 to 2195 records in 1956 and 3317 records in 1957. NIOSH has determined that it may be feasible to reconstruct monitored external doses during the period from February 14, 1951 through June 30, 1956.

As stated in Section 5.6, NIOSH has not located any information documenting or describing a routine workplace monitoring program. No records of any routine monitoring or area survey program have been located for the period under evaluation.

As stated in Section 5.7, NIOSH has located some documentation on quantities of radiological materials shipped to Battelle Laboratories for processing or testing. It is clear from reports that Battelle Laboratories worked with uranium and thorium and that various forms of uranium-bearing materials were used in the site's research. It is unknown if and how this material may have been stored on site.

The earliest date for a film badge that has been found in the available records is February 14, 1951. Beginning at that time, NIOSH has access to external monitoring data records that include gamma, beta, and neutron exposures, but NIOSH cannot verify that the available data are complete for the period under evaluation, or that the appropriate workers were indeed monitored. Badges appear to have been worn thereafter throughout the period of operation.

At many AWE facilities, physical examinations were required as a condition of employment, sometimes including medical screening X-rays. Per 42 C.F.R. pt. 81, NIOSH includes in its dose reconstructions external doses received from medical X-rays if they were a condition of employment and performed at the AWE site in question or at another covered facility. Medical X-rays administered off site at a non-covered facility are not included in dose reconstructions (ORAUT-OTIB-0079).

An Army Corps of Engineers memo from September 1943 suggested that physical and laboratory examinations of the workers on the project did not seem necessary due to the limited exposure potential (Trip Report, 1943). Prior to a site visit on June 3, 1949 by a clinical medical advisor to the AEC, Battelle had no preventative medical program for radiation workers. At that time, direction was given to initiate a preventative medical program that paralleled the Laboratory's beryllium screening program. This directed program consisted of a pre-placement physical examination that included a blood count, urinalysis, and chest X-ray. Also required were urinalyses and complete blood counts every six months. An annual and termination examination would include urinalysis and blood counts as well as a repeat chest X-ray. It was specified in the documentation that the X-ray and biological specimens were to be taken at the nearby University Hospital (Trip Report, 1949, pdf p. 3). NIOSH finds that it is not applicable to reconstruct occupational medical dose for Battelle Laboratories - King Avenue workers because medical X-ray procedures were performed at an off-site, non-EEOICPA-covered facility.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential external exposures to uranium, thorium, and their progeny during a period of AWE operations from April 16, 1943 through February 13, 1951. Consequently, NIOSH finds that it is not feasible to estimate with sufficient accuracy external exposures to uranium, thorium, and their progeny and resulting doses for a portion of the class of employees covered by this evaluation. NIOSH has determined that it may be feasible to reconstruct monitored external doses during the period from February 14, 1951 through June 30, 1956.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses for the period from April 16, 1943 through February 13, 1951, 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 Battelle Laboratories – King Avenue during the period from April 16, 1943 through February 13, 1951, 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 presented in Section 4.3, operations under an AEC contract at the King Avenue site are known to have commenced on April 16, 1943 (Decommissioning Plan, 2003). NIOSH is in the process of continuing data capture activities in support of Site Profile development for both Battelle's King Avenue and West Jefferson sites; but NIOSH has determined that the remaining data sources are not likely to yield adequate internal monitoring data earlier than July 1956 for the King Avenue site. NIOSH is continuing to evaluate the available internal monitoring data beginning in July 1956 and their impact on post-June 1956 dose reconstruction feasibility determinations. NIOSH therefore recommends that the class definition include the period from April 16, 1943 through June 30, 1956.

As stated in Section 4.4, documentation available to NIOSH does not indicate any definite boundaries between radiological and non-radiological areas at Battelle Laboratories for the period under evaluation. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations. NIOSH recommends that the class definition include all areas of the Battelle Laboratories – King Avenue site during the specified time period.

As stated in Section 4.5, it is not possible to determine that any specific work group was not potentially exposed to radioactive material releases or possible subsequent contamination. Given the lack of information regarding job descriptions or associations between job titles and/or job assignments with specific radiological conditions, NIOSH recommends that the class include all Atomic Weapons Employees at the site.

7.0 Summary of Feasibility Findings for Petition SEC-00208

This report evaluates the feasibility for completing dose reconstructions for employees at Battelle Laboratories – King Avenue from April 16, 1943 through June 30, 1956. NIOSH determined that members of this class may have received radiation exposures from uranium, thorium, and their progeny. 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 during the period from April 16, 1943 through June 30, 1956 which the proposed class may have incurred.

NIOSH has documented herein that it cannot complete the dose reconstruction 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 Battelle Laboratories – King Avenue during the period from April 16, 1943 through June 30, 1956, 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-00208

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 uranium, thorium, and their progeny, 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-00208

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all Atomic Weapons Employees who worked at the King Avenue facility owned by Battelle Laboratories in Columbus, Ohio, during the period from April 16, 1943 through June 30, 1956, 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. Because a second class is identified, it requires additional research and analyses. Such a class will 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 Battelle Laboratories – King Avenue, for whom dose reconstruction may not be feasible.

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11.0 References

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

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

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

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

Alloys, 1958, *Constitution of Uranium and Thorium Alloys*, F. A. Rough and A. A. Bauer; Battelle Memorial Institute; June 2, 1958; SRDB Ref ID: 101308

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Inventories, 1950, *Source and Fissionable Materials Inventory and Material Balance Reports*, Battelle Memorial Institute; various dates in 1950; SRDB Ref ID: 95616

Inventories, 1951, *Source and Fissionable Materials Inventory and Material Balance Reports*, Battelle Memorial Institute; various dates in 1951; SRDB Ref ID: 95611

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Monitoring Records, 1951-1952a, *Personnel Monitoring Records for [Name redacted]*, Battelle Memorial Institute; various dates from 1951 to 1952; SRDB Ref ID: 108608

Monitoring Records, 1951-1952b, *Personnel Monitoring Records for [Name redacted]*, Battelle Memorial Institute; various dates from 1951 to 1952; SRDB Ref ID: 108616

Monitoring Records, 1953-1963, *Personnel Monitoring Records for [Name redacted]*, Lab results read by Battelle Memorial Institute; various dates from 1953 to 1963; SRDB Ref ID: 108575

Monitoring Records, 1954-1960, *Personnel Monitoring Records for [Name redacted]*, Lab results read by Nuclear Science and Engineering Corporation for Battelle Memorial Institute personnel; various dates from 1954 to 1960; SRDB Ref ID: 108582

Monitoring Records, 1955-1978, *Personnel Monitoring Records for [Name redacted]*, Current Occupational Radiation Exposure sheets with results read by R. S. Landauer Jr. & Co. for Battelle Memorial Institute personnel; various dates from 1955 to 1978; SRDB Ref ID: 108466

Monitoring Records, 1955-1988, *Personnel Monitoring Records for [Name redacted]*, Lab results; Battelle Memorial Institute; various dates from 1955 to 1988; SRDB Ref ID: 108485

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Progress Report, 1959, *Progress Relating to Civilian Applications During March, 1959*; R. W. Dayton and C. R. Tipton; Battelle Memorial Institute; April 1, 1959; SRDB Ref ID: 26180

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Radiological Assessment, 1988, *Cursory Radiological Assessment, Battelle Columbus Laboratory Decommissioning and Decontamination Project*, Radiological Survey Group, Argonne National Laboratory; ANL-ESH-TS-88-102; October 1988; SRDB Ref ID: 25760

Recovery, 1948, *Topical Report: Contract No. AT 30-1-Gen-228: Recovery of Thorium and Uranium from Monazite Sands*, A. E. Bearse, et al; Battelle Memorial Institute; August 13, 1948; SRDB Ref ID: 96004

Resurvey, 1977, *Radiological Resurvey of BCD Facilities Involved with Manhattan Engineering District Projects*, Battelle Columbus Division, Battelle Memorial Institute; August 8, 1977; SRDB Ref ID: 66974

Survey, 1951, *Health Physics Survey of Rooms 422, 423, and 424*; memorandum to A. E. Bearse from R. L. Belcher; Battelle Memorial Institute; June 8, 1951; SRDB Ref ID: 95529

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Thorium Metallurgy, 1951, *Interim Report on Metallurgy of Thorium and Thorium Alloys*, Oak Ridge National Laboratory; December 7, 1951; SRDB Ref ID: 27338

Thorium Result, 1957, *Thorium Air Contamination*, memorandum to B. E. White from C. L. Salander; Battelle Memorial Institute; March 14, 1957; SRDB Ref ID: 96030

Thorium Rolling, 1951, *The Rolling of Thorium Rod*, H. A. Saller, et al; Battelle Memorial Institute; December 19, 1951; SRDB Ref ID: 95994

Thorium Properties, 1952, *Mechanical and Metallurgical Properties of Thorium*, A. D. Schwope, et al; Battelle Memorial Institute; November 18, 1952; SRDB Ref ID: 95997

Thorium Status, 1951, *Status of Thorium Semi-Works Plant Project*, memo from W. E. Kelley (AEC NYOO) to R. W. Cook (Director of Production, Washington); November [illegible], 1951; SRDB Ref ID: 10903, pdf p. 38

Thorium Technology, 1951, *The Technology of Thorium*, L. L. Marsh and J. R. Keeler; BMI-76; Battelle Memorial Institute; July 18, 1951; SRDB Ref ID: 79559

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Trip Report, 1943, *Report on Visit to Battelle Memorial Institute – 9 September 43*, memorandum to Dr. S. L Warren (Manhattan District – Rochester) from Capt. J. L. Ferry (U.S. Army Corps of Engineers); September 11, 1943; SRDB Ref ID: 10761

Trip Report, 1946, *Report on Visit to Battelle Memorial Institute, Columbus, Ohio, 24 July 1946*, memorandum to Col. W. D. Fleming (Chief, Medical Division) from W. R. Clarkson (Medical Corps, Army Service Forces, United States Engineer Office); August 2, 1946; SRDB Ref ID: 104525

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Trip Report, 1947b, *Trip Report of Radiation Survey at Battelle Memorial Institute, Columbus Ohio*, memorandum to A. D. Dahl (AEC Instrument Branch) from R. L. Morgan (AEC Technical Section); December 15, 1947; SRDB Ref ID: 8611

Trip Report, 1949, *Report on Visit to Battelle Memorial Institute*, memorandum to File from I. R. Tabershaw, M.D., Clinical Advisor; June 10, 1949; SRDB Ref ID: 8953, pdf p. 3

Trip Report, 1955, *Trip Report: Battelle Memorial Institute, February 7-8, 1955*; memorandum to file from R. R. Herries; E. I. du Pont de Nemours & Co., Explosives Dept., Atomic Energy Division; February 15, 1955; SRDB Ref ID: 40264

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Uranium Alloys, 1952, *Alloys of Uranium with Zirconium, Chromium, Columbian Vanadium, and Molybdenum*, H. A. Saller and F. A. Rough; BMI-752; Battelle Memorial Institute; June 19, 1952; SRDB Ref ID: 120445

Uranium Cladding, 1954, *The Roll Cladding of Uranium with Aluminum*; H. A. Saller S. J. Paprocki, J. F. Delaney; BMI-934; Battelle Memorial Institute; August 3, 1954; SRDB Ref ID: 120448

Uranium Coatings, 1953, *Protection of Uranium: Vapor-Deposited Coatings*, I. E. Campbell, E. M. Sherwood, C. F. Powell, R. P. Jones; BMI-887; Battelle Memorial Institute; November 24, 1953; SRDB Ref ID: 26262

Uranium Recovery, 1948, *Recovery of Uranium from Shales*, A. A. Bearse, et al; Battelle Memorial Institute; BMI-JDS-141; Sept 15, 1948; SRDB Ref ID: 119482

Uranium Recovery, 1950, *Recovery of Uranium from North Dakota Lignites*, R. A. Ewing, et al; Battelle Memorial Institute; BMI-237; July 31, 1950; SRDB Ref ID: 119481

Uranium Recovery, 1954, *The Recovery of Uranium from Chattanooga Shales*, R. Q. Wilson, et al; BMI-274; January 14, 1954; SRDB Ref ID: 119470

Uranium Rolling, 1952, *The Rolling of Uranium*, H. A. Saller, J. R. Keeler, R. J. Donley; BMI-800; Battelle Memorial Institute; December 30, 1952; SRDB Ref ID: 120446

Urinalysis Results, 1956, *Uranium Urinalysis Results for [Names Redacted]*, samples read by Clayton S. Smith, Ph.D., M.D., Consulting Chemist and Toxicologist; various dates in 1956; SRDB Ref ID: 95541

Urinalysis Results, 1958, *Uranium Urinalysis Results for [Names Redacted]*, samples read by Nuclear Science and Engineering Corporation; June 26, 1958; SRDB Ref ID: 34412

Urinalysis Results, 1959, *Uranium Urinalysis Results for [Names Redacted]*, samples read by Nuclear Science and Engineering Corporation; September 14, 1959; SRDB Ref ID: 34415

Attachment 1: Data Capture Synopsis

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site / Company Name: Battelle Laboratories - King Avenue AWE 1943-1986; BE 1943-1961; DOE 1986-2000 (remediation); Residual Radiation 2001 - March 1, 2011 Alternate Site Names: Battelle Columbus Laboratories (BCL) Battelle Memorial Institute (BMI) Physical Size of the Site: King Avenue site comprises approximately 6 acres. Site Population: Historical documents list the population at 7,000 to 10,000 employees.	Air sample analyses, analyses reports on uranium, area and film badge reports, radiological procedures, building identification, environmental monitoring reports, in-vivo count data, license application renewal, list of individuals on uranium bioassay, monthly reports, personnel subject to chronic neutron exposure, procedures and operations for the processing of special nuclear materials, quarterly environmental TLD results, radiation surveys, radiological incidents, shipment documentation, source and fissionable materials inventory, thorium operations and x-ray survey. Additional documents (Research papers from 1949-1983, Project files from the Radiation Safety Office, Environmental reports 1970-present) were identified by the site and negotiations are underway to allow for a site visit to review and capture relevant data.	OPEN	607
State Contacted: Ohio Department of Health	Environmental report.	02/02/2012	2
Argonne National Laboratory - East	Work performed for the Metallurgical Laboratory and thorium in urine and feces samples.	04/24/2012	2
Curtiss-Wright	Operations report and shipment records.	05/24/2009	2
Department of Labor / Paragon	Radiological survey plan for property declared excess.	12/30/2008	2
DOE Environmental Management Consolidated Business Center	List of National Lead of Ohio subcontractors.	07/05/2011	1
DOE Germantown	FUSRAP consideration, preliminary investigation, site history and description reports, studies and hazards of phosphate, and a trip report.	06/18/2008	9
DOE Legacy Management	Access control of visitors, neutron surveillance for buildings JN-1, 2, and 4, assumptions associated with data input for CINDY calculations, decommissioning project internal dosimetry technical basis document, radiation safety manual, bioassay program procedures, special nuclear materials license 34-6854-5 and SNM-7 amendments, counting and sample preparation, external dosimetry program, film badge records, and plutonium procedures manual.	07/30/2008	65

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
DOE Legacy Management - Grand Junction Office	Actinide screen data for radionuclides contained in strippable paint, quality assurance, analysis of sludge from decontamination process, area progress report, characterization of the JN-1 hot cell waste drums, classification of nuclear materials in the 327 building, contract numbers and identifying symbols, decontamination work plan information, radiological condition of the plutonium laboratory, historical information, SNM data, shipment information, material balance reports, monthly reports, pre-characterization of King Avenue, radiological incidents, and trip reports.	08/26/2011	152
DOE Legacy Management - Morgantown	Decontamination and decommissioning report, dosimetry files, material accountability, and a survey of processing methods for the production of thorium metal from monazite sand and thorium nitrate.	12/01/2011	11
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Thorium production, bioassays information, incineration of radioactive solid wastes report, major thorium campaigns, material inventory, production, radiological incidents, radiological procedures, radiological surveys, radiological work planning, and a trip report.	05/13/2012	65
Federal Records Center (FRC) - San Bruno	Summaries of fuels and materials development programs, environmental sampling plan, quarterly reports, and studies of metabolism.	08/03/2012	6
Hagley Museum and Library	Trip report, index to reactor fuel data sheets, and new fuel element development information.	10/28/2010	9
Hanford	Internal dosimetry programs for tritium exposure - minimum requirements, semiannual report of the Atomic Energy Commission, Hanford experience with thorium, Hanford Laboratories operation monthly activities report, monthly accountability report, accounting control of source and fissionable materials, and a weekly activities report.	07/28/2011	12
Interlibrary Loan	Mechanical testing hot cell, decontamination of plutonium facility, neutron radiography of nuclear fuels, and thorium production.	11/03/2006	12
Internet - Defense Technical Information Center (DTIC)	Machining, grinding, and handling magnesium-thorium alloys, evaluation of thorium and uranium compounds as thermal breeder fuels, proposed final environmental statement, effect of nuclear radiation on electronic components, and uranium alloy metallurgy.	05/22/2012	9
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	09/29/2011	0
Internet - DOE Environmental Management	Linking Legacies: Wastes.	10/28/2007	1

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford Laboratories operation monthly activities report.	10/17/2008	16
Internet - DOE Legacy Management Considered Sites	Summary Report 1954 - 1959 AEC Research and Development Report.	10/04/2007	1
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	09/06/2011	0
Internet - DOE Oak Ridge National Laboratory	Aircraft Nuclear Propulsion Project quarterly progress report, investigation of ThF4-fused salt solutions for homogeneous breeder reactors, Metallurgy Division semiannual progress report, Operations Division monthly report, physics of solids institute quarterly progress report, and solvent extraction recovery of uranium from metal waste.	03/09/2012	19
Internet - DOE OpenNet	Monthly status and progress report.	12/26/2007	5
Internet - DOE OSTI	Fuels for research and test reactors, hazards summary report, and an interim report on metallurgy of thorium.	03/19/2008	3
Internet - DOE OSTI Energy Citations	Post irradiation examination and evaluation of a fuel assembly, progress report on metallurgy of tuballoy, overview of U.S. decommissioning experience, progress report, and irradiation qualification testing of SNAP 10A components.	03/05/2012	49
Internet - DOE OSTI Information Bridge	Annual report of waste generation, characterization of transuranium-contaminated solid wastes residues, constitution of uranium and thorium alloys, decommissioning of hot cells, grain refinement of uranium by alloying, heat source component development program quarterly report, irradiation of snap system actuator and position sensor assemblies in a vacuum-nuclear environment, irradiation of snap system electrical devices in a high-temperature vacuum environment, list of radioisotope customers with summary of radioisotope shipments, readiness assessment for the shipment of TRU waste, safety evaluation report for the termination of special nuclear materials license SNM-0007, decommissioning management plan, site environmental report, stabilizing effects of oxide additions to uranium oxide, summary of the environmental dose models used at DOE nuclear sites, survey of refractory uranium compounds, and a trip report.	10/10/2012	86

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - Google	Annual report of waste generation and pollution prevention progress, site history, special nuclear materials license SNM-7, decommissioning plan, DOE occupational radiation exposure, environmental report for termination of the NRC license, final status survey report, hot-hardness survey of the zirconium-uranium system, measuring and reporting of effluents fuel processing and fabrication facilities, NRC inspection report, possession of materials in excess of license limits, radiological impact caused by emissions of radionuclides into air, remote handled transuranic waste inventory, site descriptions, residual radioactivity evaluations for individual facilities, site environmental report, trip report, use of wire saw for radiological decontamination and decommissioning, waste characterization inspection report, and waste transportation.	03/29/2012	143
Internet - Health Physics Journal	No relevant data identified.	09/29/2011	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant data identified.	09/29/2011	0
Internet - National Academies Press (NAP)	No relevant data identified.	09/06/2011	0
Internet - NIOSH	Report on residual radioactive and beryllium contamination at atomic weapons employer facilities and beryllium vendor facilities.	01/25/2007	1
Internet - NRC Agencywide Document Access and Management (ADAMS)	Columbus closure project characterization and final status survey report, environmental restoration wastes, license requirements measuring and reporting of effluents fuel processing and fabrication facilities, safety evaluation for license amendment 37 to special nuclear materials license SNM-00007, status of decommissioning program, groundwater sampling, and a work plan spent fuel pool.	06/18/2012	22
Internet - USACE/FUSRAP	No relevant data identified.	09/06/2011	0
Internet - US Transuranium and Uranium Registries	No relevant data identified.	09/06/2011	0
Landauer Client (site) List	Battelle items identified on listing.	OPEN	NA
Los Alamos National Laboratory	Accelerator health physics characterization report of DOE laboratories.	02/28/2012	1
Mesa State College	Tritium and its effects in the environment.	11/18/2010	1
Mound Museum	Plutonium shipments.	02/01/2012	2
National Archives and Records Administration (NARA) - Atlanta	Contract negotiation information, estimated expenditure for thorium production and research, rolling thorium hazards, request for deuterium oxide, progress report of the Special Materials Division, report on research and development, trip report, and shipment information.	05/13/2010	24

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
National Archives and Records Administration (NARA) - College Park	Material balance, report on thorium project, ORAU Team related personal notes, program on refining of thorium, request for thorium metal, return of thorium scrap to Ames, Iowa, and thorium fabrication.	08/19/2010	22
National Archives and Records Administration (NARA) - Kansas City	Information on facility decontamination history.	03/30/2005	1
National Institute for Occupational Safety and Health (NIOSH)	AEC uranium fire experience, fast-neutron and gamma spectrum and dose in beryllium oxide, General Electric Company - rolling mill report, neutron-flux measurements in a flat plate fuel element, quarterly progress report, effects of neutron radiation, effects of rolling on the crystallography and metallography of uranium, and a trip report.	12/12/2011	22
National Technical Information Service (NTIS)	Assemblies for thermal and fast flux irradiation of fuels, decontamination of plutonium facility, environmental report, hazards summary report, measuring the release of short-lived fission gases during capsule irradiations, operation and experimental use of the Battelle Research Reactor, operation and maintenance of an in-pile gas-cooled loop at the Battelle Research Reactor, and radiography using californium-252 neutron sources.	07/17/2006	13
Nevada Test Site Records Center	Material License SNM-7.	07/15/2009	1
New York State Archive	Information on contracts.	03/24/2012	1
Nuclear Regulatory Commission Non-Public Holdings	Environmental report, License SNM-7 amendment, radiographic operations at King Avenue Laboratories, radiation protection program, and transport of low level rad waste material.	09/22/2011	6
Nuclear Regulatory Commission Public Document Room	License SNM-7 information, site environmental report, material balance report, physical security plan, airborne release, decommissioning project, material balance report, and radiological status.	09/13/2012	25
Oak Ridge Library for Dose Reconstruction	Radioactive solid waste storage and disposal, operations division monthly report, and consolidated UF6 release studies.	04/27/2011	3
Oak Ridge National Laboratory	Report on the direct micro determination of uranium using a modified fluorophotometer, The Battelle Story, studies on large-batch melting of uranium, and the Amchitka radiobiological program final report.	05/24/2012	7
Oak Ridge Operations, Records Holding Task Group	Battelle report on thorium separation, special nuclear material ledger, trip report, production report, and a shipment security survey.	04/05/2011	14
Oak Ridge Reading Room	Report on thorium project, preliminary investigation of thorium sludge samples, rolling of thorium metal, and a monthly material accountability report.	04/08/2011	8

Table A1-1: Data capture Synopsis for Battelle Laboratories – King Avenue			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Office of Scientific and Technical Information (OSTI)	Air monitoring program information, aerial radiological survey, data on zirconium-uranium alloys, techniques for rolling uranium metal, report on personnel neutron-dosimetry systems, hazards summary report for 2-mega watt operation of the Battelle Research Reactor, progress report, survey of irradiation facilities, sampling and testing procedures for special products, trip report, and technical reports.	03/26/2012	21
ORAU	Building verification surveys.	10/05/2012	9
ORAU Team	Radiological incident, air survey report, radiological practices, bioassay results, medical X-ray dose, Landauer Minimum Detectable Activity, operations with uranium, and a report on iridium-238 PUO-2 compatibility.	12/03/2010	38
ORAU Vault	Individual dosimetry data.	11/16/2005	68
Pantex	Dosimeter badging.	05/15/2008	1
S. Cohen & Associates (SC&A)	Materials Testing Reactor progress report and inventory and manufacturing statements.	06/24/2010	13
SAIC	Personnel exposure summary.	09/02/2004	6
Savannah River Site	Thorium canning and de-canning program, dosimetry visitors' cards, metallurgy section monthly report, monthly progress report, trip report, radiation survey log sheets, and thorium and U-233 inventory data.	03/19/2012	23
Southern Illinois University	Nuclear fuels and materials development and a transcript of the fifty-sixth meeting of the ABRWH board.	10/29/2008	2
United Nuclear Corporation (Westinghouse), Hematite, MO	Shipping and production documentation.	04/06/2009	1
Unknown	Air sample data, radiation exposure report, environmental report, investigations regarding former thorium sites, monthly status and progress reports, special irradiation program, and recycled uranium receipts and shipments.	04/14/2011	30
West Valley	Shipping Pu containers to Hanford.	11/24/2006	1
TOTAL			**1676**

Table A1-2: Databases Searched for Battelle Laboratories – King Avenue			
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 "Battelle – King Avenue Rev 00 (83.14), 10-29-12"			
Defense Technical Information Center (DTIC) https://www.dtic.mil/ COMPLETED 09/29/2011	See Note above	8,316	7
DOE CEDR https://www.orau.gov/cedr COMPLETED 09/29/2011	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 09/06/2011	See Note above	0	0
DOE Legacy Management Considered Sites http://www.lm.doe.gov/considered_Sites/ COMPLETED 09/06/2011	See Note above	11	1
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 09/06/2011	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 09/06/2011	See Note above	26	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 09/06/2011	See Note above	643	1
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 09/06/2011	See Note above	659	5
Google http://www.google.com COMPLETED 09/06/2011	See Note above	180,906	58
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 09/29/2011	See Note above	41	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 09/29/2011	See Note above	0	0

Table A1-2: Databases Searched for Battelle Laboratories – King Avenue			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
National Academies Press http://www.nap.edu/ COMPLETED 09/06/2011	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 09/06/2011	See Note above	171	5
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 09/06/2011	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 09/06/2011	See Note above	0	0

Table A1-3: DTIC Documents Requested for Battelle Laboratories – King Avenue			
Document Number	**Document Title**	**Requested Date**	**Received Date**
NA	Nuclear Radiation Effects Projects	09/29/2011	
NA Ref ID: 109946	Machining, Grinding, and Handling Magnesium-Thorium Alloys	09/29/2011	12/16/2011
BMI-1568 Ref ID: 102252	Evaluation of Thorium and Thorium-Uranium Compounds as Thermal Breeder Fuels	09/29/2011	10/10/2011
BMI-1300 Ref ID: 101308	Constitution of Uranium and Thorium Alloys	09/29/2011	10/10/2011
NA Ref ID: 102253	The Effect of Nuclear Radiation on Electronic Components	09/29/2011	10/10/2011

Table A1-4: OSTI Documents Requested for Battelle Laboratories – King Avenue			
Document Number	**Document Title**	**Requested Date**	**Received Date**
ORISE-97-1468	Verification survey of Building KA-1, Battelle Memorial Institute, Columbus, Ohio. Final report	11/22/2011	
06-1137	Independent Verification Survey Summary and Results for the Columbus Closure Project, West Jefferson North Site, Revision 1, West Jefferson, Ohio	11/22/2011	
04-1601	Verification Survey of Building JN-2 Battelle/Columbus Operation/West Jefferson Site	11/22/2011	
BMI-274 Ref ID: 119470	The Recovery of Uranium from Chattanooga Shales. Final Report for November 15, 1952 to January 14, 1954	10/01/2012	10/05/2012
BMI-720 Ref ID: 95995	A Study of Thorium-Base Alloys	11/22/2011	11/29/2011
BMI-JDS-227 Ref ID: 05852	Recovery of Thorium and Uranium from Monazite Sands. Progress Report for the Month of February 1950	11/22/2011	11/29/2011
BMI-JDS-169(Sect. I): Ref ID: 95813	Recovery of Thorium and Uranium from Monazite Sands. Section I of Quarterly Report for November 15, 1948 to February 15, 1949	11/22/2011	11/29/2011