SEC Petition Evaluation Report
Petition SEC-00229

Report Rev Number:	0
Report Submittal Date:	November 2, 2015
Subject Expert(s):	Chris Miles, Vince King, Jason Davis
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition Number:	SEC-00229
Petition Type:	83.14
Petition A Receipt Date:	October 27, 2015
DOE/AWE Facility Name:	Battelle Laboratories – King Avenue

Petition Class

NIOSH-Proposed Class Definition:	All Atomic Weapons Employees who worked at the facility owned by the Battelle Laboratories at the King Avenue site in Columbus, Ohio, during the period from July 1, 1956 through December 31, 1970, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking Number(s):	SEC-00208
Petition Type:	83.14
DOE/AWE Facility Name:	Battelle Laboratories – King Avenue
Petition Status:	Class added to the SEC for April 16, 1943 through June 30, 1956

Related Evaluation Report Information

Report Title:	SEC Petition Evaluation Report for Petition SEC-00208
DOE/AWE Facility Name:	Battelle Laboratories – King Avenue

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Evaluation Report Summary: SEC-00229, Battelle Laboratories – King Ave.

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*.

Previous Class Evaluated by NIOSH

In its 2012 Evaluation Report for Petition SEC-00208, NIOSH defined a single class of employees for which it could not estimate radiation doses with sufficient accuracy from April 16, 1943 through June 30, 1956. This infeasibility was due primarily to a lack of internal monitoring data for individuals potentially exposed to airborne radioactive materials. NIOSH also concluded in the 2012 evaluation that external dose reconstruction was infeasible for the period April 16, 1943 through December 31, 1950.

NIOSH-Proposed Class to be Added to the SEC

Since issuing the 2012 SEC-00208 Evaluation Report, NIOSH has continued the evaluation of the post-June 30, 1956 period and have concluded that there are insufficient data to estimate thorium intakes from July 1, 1956 through December 31, 1970.

Based on its continued research on thorium operations conducted after its 2012 Evaluation Report, NIOSH has concluded that there are insufficient data available to estimate thorium intakes, including their associated progeny, prior to 1971. NIOSH is therefore proposing to expand the class of employees for which NIOSH recommends inclusion in the SEC.

The 83.14 class presently being recommended for inclusion in the SEC includes: All Atomic Weapons Employees who worked at the facility owned by the Battelle Laboratories at the King Avenue site in Columbus, Ohio, during the period from July 1, 1956 through December 31, 1970, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Feasibility of Dose Reconstruction

In addition to the dose reconstruction infeasibilities identified in the 2012 Evaluation Report, NIOSH now finds it is not feasible to estimate internal exposures with sufficient accuracy for all workers at the site from July 1, 1956 through December 31, 1970. NIOSH has determined that there is insufficient information to estimate internal dose from intakes of thorium, and their associated progeny, from July 1, 1956 through December 31, 1970. NIOSH has determined however, that partial internal dose reconstructions can be performed for workers who were monitored for thorium intakes during this period.

The NIOSH dose reconstruction feasibility findings for this current evaluation are based on the following:

- Principal sources of internal radiation dose for members of the evaluated class included exposures to uranium and thorium and their decay products. The modes of thorium exposure were inhalation and ingestion during the research and processing of thorium metal, ceramics, solutions, and concentrates, or during the subsequent re-suspension of thorium.

- In this current evaluation, NIOSH has determined that there are insufficient data available to bound intakes of thorium and their associated progeny for the period from July 1, 1956 through December 31, 1970. Although the vast majority of thorium work at Battelle Laboratories – King Avenue took place prior to 1957 (nearly 10,000 kg of thorium processed from 1951-1956), sporadic thorium work continued at least through 1969. Based on documented thorium surveys conducted in 1970, it appears that the potential for thorium exposure continued into that year as well.

- A melting operation involving Mg, Li, and Th metals was conducted in June 1963 without notifying the Health and Safety office. Once the operation was identified, Health and Safety staff took action and reported that: (1) no respiratory protection was used the first day of the melts [June 24, 1963]; (2) the melting furnace was hooded, but the pouring operation was not vented; and (3) the men involved said they would report all future use of radioactive metal to the safety office. This latter point indicates that, in the past, workers might or might not have notified the Health and Safety office of radiological work. As a result, the Health and Safety records might or might not be covering all of the thorium work.

- NIOSH has now concluded that there are insufficient internal dosimetry data or air monitoring data available to estimate thorium intakes prior to 1971. Although there are limited air-monitoring data for thorium during the period of 1961 through 1969, the dates of monitoring do not correlate well with other data showing thorium receipts and thorium processing at the laboratories. NIOSH has therefore concluded that these air monitoring data may not be representative of all thorium processing at Battelle Laboratories – King Avenue and/or the available data indicating dates and quantities of thorium processed during the 1960s may be incomplete.

- Based on the lack of internal dose monitoring data or air monitoring data for Battelle Laboratories – King Avenue workers during the period from July 1, 1956 through December 31, 1970, NIOSH has determined that sufficiently accurate internal dose reconstruction for thorium exposures is not feasible. However, NIOSH has identified sufficient information and data to support bounding internal dose estimates for thorium after December 31, 1970 when there appears to have been no operations or work with thorium.

- NIOSH finds that it is feasible to reconstruct occupational medical dose for Battelle Laboratories - King Avenue workers with sufficient accuracy from July 1, 1956 through December 31, 1970.

- NIOSH finds that it is feasible to reconstruct external dose for Battelle Laboratories - King Avenue workers with sufficient accuracy after December 31, 1950.

- Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the proposed class, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Battelle Laboratories – King Avenue during the period from July 1, 1956 through December 31, 1970, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

- NIOSH concludes pursuant to 42 C.F.R. § 83.13(c)(1), that there is sufficient 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 for the period at Battelle Laboratories – King Avenue after December 31, 1970.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the proposed class from July 1, 1956 through December 31, 1970.

NIOSH did not identify any evidence supplied by the petitioner or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation. Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under their employment at Battelle Laboratories – King Avenue or in combination with work days within the parameters established for other SEC classes. For the period after December 31, 1970, a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the evaluated class.

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ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Christopher Miles, Quantaflux, LLC. 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 facility owned by the Battelle Laboratories at the King Avenue site in Columbus, Ohio, during the period from July 1, 1956 through December 31, 1970, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort. During this period, employees at this facility were involved 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-00229 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 thorium operations at Battelle Laboratories - King Avenue. The time period addressed in this evaluation is from July 1, 1956 through December 31, 1970. Thorium-related activities prior to July 1, 1956 are also mentioned in this section since those activities could have resulted in legacy materials and residual contamination affecting workers in the later years. 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.

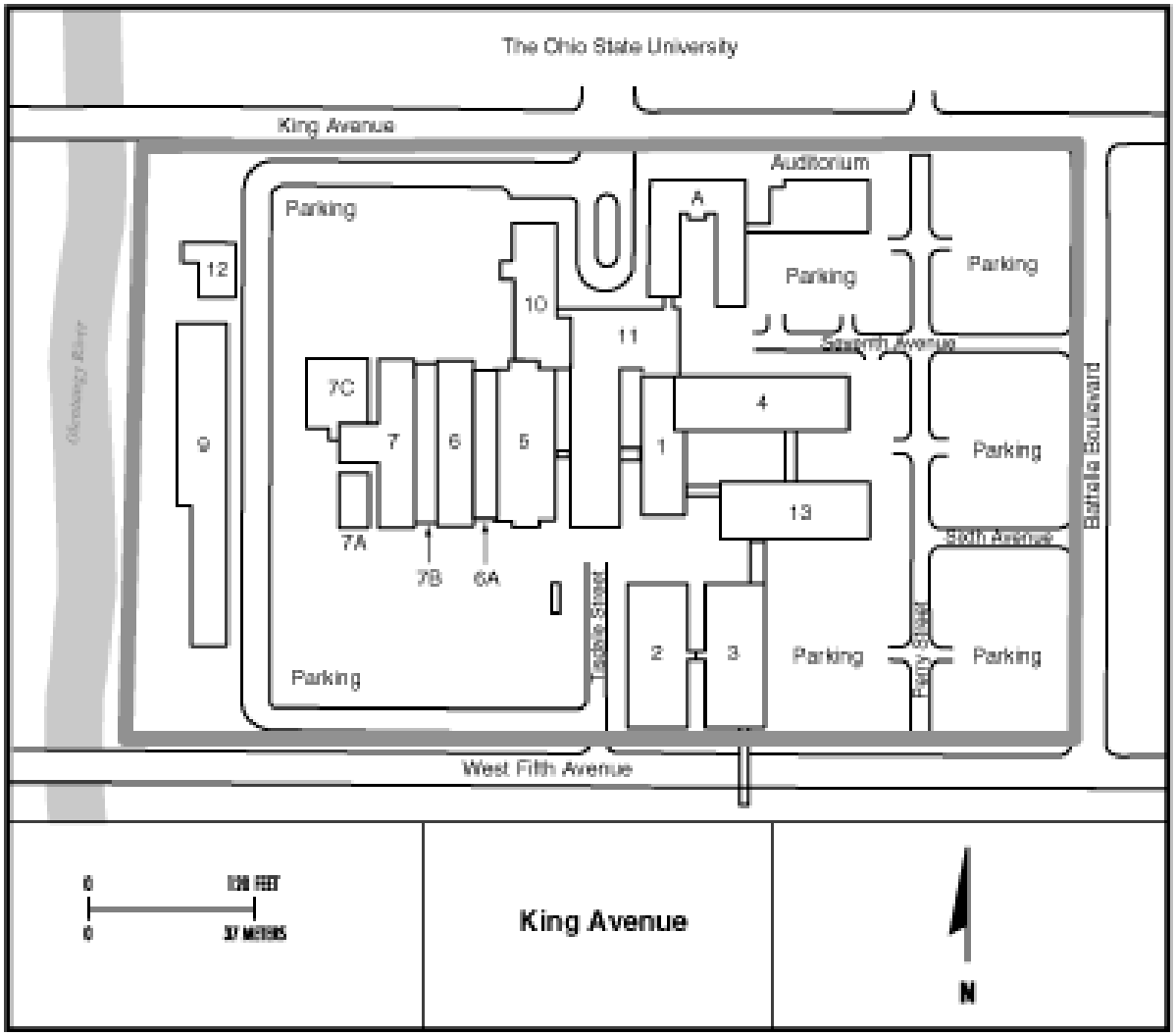
4.1 Operations Description

The following activities were performed at the King Avenue location: processing and machining enriched, natural, and depleted uranium and thorium; fabricating fuel elements; analyzing radiochemicals; and studying power metallurgy (Battelle Facility, 2015).

The 58.3-acre Battelle Laboratories - King Avenue site in Columbus, Ohio accommodated 21 buildings (see Figure 4-1). The site is bordered by King Avenue to the north, Battelle Boulevard and

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

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: Building A, Buildings 1 through 7, and Building 9. During the period of this evaluation (July 1, 1956 through December 31, 1970), thorium operations are believed to have taken place in Buildings A and 1 through 7.



Source: Battelle History, 1999

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

Nearly 10,000 kilograms of thorium were handled and processed in the various buildings at the Battelle Laboratories – King Avenue site prior to July 1, 1956 (Inventory, 1985, PDF pp. 45-127). Legacy materials and residual contamination from those early operations could have resulted in thorium intakes to workers in later years.

Table 4-1 summarizes known thorium operations during the period of this evaluation, July 1, 1956 through December 31, 1970. Although there is some evidence of thorium work in the Building 1 foundry, information is incomplete (see also Section 5.7).

Table 4-1: Thorium Operations at Battelle Labs – King Ave. (1956 – 1984)

Period of Operations	Quantity (grams)	Building	Description of Use
1/1/55 – 3/1/57	1,000	3	Thorium uranium diagrams
1/1/55 – 3/1/57	1,000	6	Thorium uranium diagrams
1/1/56 – 6/1/57	200,000	2	R&D of alloys (U, Th, etc.)
1/1/56 – 6/1/57	200,000	3	R&D of alloys (U, Th, etc.)
1/1/56 – 6/1/57	200,000	4	R&D of alloys (U, Th, etc.)
1/1/56 – 6/1/57	200,000	5	R&D of alloys (U, Th, etc.)
1/1/56 – 6/1/57	200,000	7	R&D of alloys (U, Th, etc.)
1/1/58 – 6/1/58	1,000	3	Macrography (Th, U)
1/1/58 – 12/1/59	25,000	3	Thorium alloy development
9/16/59 – 3/31/61	2,000	5	A study of the corrosion resistance of thorium under atmospheric conditions, and additional accelerated thorium and uranium corrosion exposure.
4/1/62 – 6/30/62	750	3	Experimental coating of 1/8-inch diameter thorium oxide spheres with alumina, zirconia, and zirconium metal and/or zirconium alloy by chemical vapor deposition.
3/1/66 – 6-30/66	1,000	A	Prep of irradiation and calibration samples (Th, U)
3/1/66 – 8/30/66	1,000	3	Prep of irradiation and calibration samples (Th, U)
5/1/68 – 6/30/69	400	3	Hot-hardness of non-stoichiometric ThO_2 and UO_2.
10/1/79 – 11/30/84	10	6	Chemical identification of organic complexants and evaluation of organo-radionuclide interactions.
10/1/79 – 11/30/84	10	7	Chemical identification of organic complexants and evaluation of organo-radionuclide interactions.
4/1/80 – 3/31/81	447	3	Provide high-temperature, controlled-atmosphere, sintering operations of sponsor's thoria specimens and evaluate their density, chemical.

Source: Inventory, 1985

4.2 Radiation Exposure Potential from Operations

The potential for external radiation dose existed in all nine buildings where radioactive materials were handled or stored. During the period of this evaluation (July 1, 1956 through December 31, 1970), thorium operations are believed to have taken place in Buildings A and 1 through 7. Based on the site operations outlined in Section 4.1, sources of exposure included beta, gamma and neutron radiation emitted from uranium, thorium, and a variety of fission and activation products.

The primary sources of internal radiation exposure at the site were uranium, thorium, uranium and thorium progeny, and fission products. The dose reconstruction infeasibility that was identified, and that led to this evaluation, was the inability to estimate potential thorium intakes accurately. Quantities of thorium handled, along with brief description of the associated operations are given in Table 4-1.

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 (Battelle Facility, 2015). Radiological operations for the AEC 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 radiological operations.

4.4 Site Locations Associated with Radiological Operations

During the period of this evaluation (July 1, 1956 through December 31, 1970), thorium operations are known to have taken place in Buildings A and 1 through 7. More details about each building and their operations 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 advanced 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 not found any evidence of thorium operations in this building.

4.5 Job Descriptions Affected by Radiological Operations

Any workers present in buildings where radioactive materials were handled and stored had the potential for radiation exposures. Workers present during radiological operations in Building A and Buildings 1 through 7 had the potential for intakes of thorium. This would include, but not be limited to, researchers, operators, trades workers, maintenance personnel, supervisors, security officers, and fire protection workers.

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 or insufficient, 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 or insufficient, 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 or they are incomplete, 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) 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 Defense Technical Information Center database, the Energy Employees Claimant Assistance Project, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment 1 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 September 2, 2015)

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

Description	Totals
Total number of claims submitted for dose reconstruction	72
Total number of claims submitted for energy employees who worked during the period under evaluation (July 1, 1956 through December 31, 1970).	42
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).	32
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	18*
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	24

* None of the internal dosimetry records were for thorium.

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 received some internal monitoring data from Battelle Laboratories for claimants for the time period under evaluation, although none of these data are specific for thorium.

5.3 Worker Interviews

To obtain additional information, NIOSH interviewed a former site employee. This employee worked at Battelle throughout the 1960s. A telephone interview was conducted with this individual for the purpose of learning more about thorium usage during the interviewee's employment at Battelle-King Ave. The interviewee was asked to describe thorium operations, their locations, forms of thorium used, radiological controls used, protective equipment used, and individual dose monitoring.

- Personal Communication, 2013, *Personal Communication with a Health Physics Staff Member*; Telephone Interview by ORAU Team and NIOSH; September 5, 2013; SRDB Ref ID: 127708

5.4 Internal Personnel Monitoring Data

NIOSH has located 68 bioassay results for 1956 (Monitoring Records, 1953-1963; Monitoring Records, 1954-1960; Monitoring Records, 1955-1978; 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).

A health physics request for thorium bioassay was submitted for [number redacted] individuals on February 27, 1981. This is the first instance of such a request that NIOSH has located (Memo for Bioassay Service, 1981).

The NOCTS database was reviewed for claimants whose work history included Battelle Laboratories – King Avenue during part or all of the covered period (July 1, 1956 through December 31, 1970). A total of 42 claimants were identified. The files for all 42 claimants were thoroughly reviewed and internal monitoring data were found for 18 of those claimants. None of the internal monitoring data were specific for thorium.

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, 1951-1952). 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. External monitoring records available to NIOSH increase each year after 1951 to 2195 records in 1956, and 3317 records in 1957. From 1957 through 1970, there is an abundance of available external monitoring data for workers at Battelle, King Avenue site.

The NOCTS database was reviewed for claimants whose work history included Battelle Laboratories – King Avenue during part or all of the evaluation period (July 1, 1956 through December 31, 1970). A total of 42 claimants were identified. The files for these 42 claimants were thoroughly reviewed and external monitoring data were found for 24 of those claimants.

5.6 Workplace Monitoring Data

A thorough review of all data available to NIOSH resulted in the identification of several examples of thorium-specific workplace monitoring after June 30, 1956. These examples are summarized below in chronological order.

- A breathing zone air sample was taken on March 7, 1957 during a thorium-rolling operation in the basement of Building 3. The measured concentration was 9×10^{-11} microcuries per milliliter of air. Operators wore respirators during this operation (Thorium Result, 1957, PDF p. 2).

- In a survey report dated July 23, 1957 (which included multiple buildings), widespread uranium and thorium contamination was reported (Respirator Memo, 1957, PDF p. 7). This survey consisted of about 600 smears, 64 air samples, and probing of all the areas for unknown sources of radiation and fixed alpha and beta-gamma contamination. The following statement was included in a footnote to the report:

- *About every lab surveyed contained U or Th samples in some form. These were stored on or in desks where food is eaten. Little care is taken to prevent ingestion. No care is taken to prevent material from entering the sewers.*

- A spill occurred when pressure built up in a flask containing thorium nitrate. The spill covered most of the floor in Room 3013. This incident is described in a memorandum dated March 15, 1960 (Thorium Spill, 1960, PDF p. 2). The spill resulted in personnel contamination and decontamination activities are described. There is no mention of bioassay or other dose assessment. NIOSH followed up on this incident and requested bioassay records for the individual involved in the personal contamination incident. Based on the site's response, NIOSH has no indication that follow-up bioassay results are available for this personal contamination incident.

- In July 1961, air samples were taken in the machine shop grinding room (Bldg. 5) during the grinding of arc melt buttons composed of 90% natural thorium. The sampler ran for 141 minutes. The reported air concentration was 2×10^{-10} microcuries per milliliter. During this grinding operation, the worker wore a half-face respirator containing an AEC-approved high-efficiency particulate filter. No internal absorption was anticipated. The report noted that the worker would be requested to submit a specimen (Air Survey Reports, Jul1961, PDF p. 52). NIOSH followed up on this incident and requested bioassay records for the individual involved in the operation who was to receive a bioassay sample request. Based on the site's response, NIOSH has no indication that a follow-up bioassay sample was obtained from this individual even though it was requested by the Health and Safety office.

- In August 1961, another air sample was taken in the machine shop grinding room (Bldg. 5) while grinding an alloy containing 85% thorium. The sampler ran for 60 minutes. A note on the sample form stated: "No significant air contamination was detected in air." When the grinding operation was completed, the grinder was cleaned (Air Survey Report, Aug1961, PDF p. 54).

- On October 11, 1961, an external radiation survey report from Building 5 (including the grinding room) was documented (Radiation Survey Report, Oct1961, PDF p. 48). Thorium was identified as being one of the suspected contaminants. The only reading above background (2 mR/hr) was

taken in the vicinity of a control rod. Although the distance from the control rod is not specified, the measurement appears to have been taken from very close proximity.

- A smear survey report from November 29, 1961 from the Building 5 grinding room indicates thorium as being a suspected contaminant. The health physicist noted that all smears were below permissible levels (Smear Survey Report, Nov1961, PDF p. 46).

- A survey report following clean-up of a spill in Building 5 involving thorium, dated February 14, 1963, showed a reading of 0.2 mR/hr at contact. Smears of the area did not show any removable contamination. The spill had been cleaned up with a sponge and the primary spill area (shelf) had just been painted prior to taking the smears, in order to fix the contamination in place (Thorium Survey Report, 1963, PDF p. 115).

- A smear survey in Building 1 in the south non-ferrous furnace area was conducted on June 25, 1963 following an unmonitored thorium melt operation (Smear Survey Report, 1963, PDF p. 51).

- An air sample was taken in Building 1 on June 25, 1963, during the second day of a thorium melt operation. The reported air concentration was 5×10^{-12} microcuries per milliliter (Air Survey Report, 1963, PDF p. 64). A Maximum Permissible Concentration (MPC) of 3×10^{-11} microcuries per milliliter is noted on the report. The following notes were also included on the report:

  - *Safety Office was not notified of this "melt" using Mg, Li, and Th metals. First aid alerted the S.O.*
  - *No respiratory equipment was used the first day of the melts, 6/24/63.*
  - *The melting furnace hooded. The pouring operation was not vented.*
  - *The men involved said that they would report all future use of radioactive material.*

- A routine air sample in Building 5 during a press operation was collected on June 16, 1964 and analyzed for thorium. An air concentration of 4×10^{-12} microcuries per milliliter was reported. A remark included on the report by the survey stated: "This work performed in an open area without benefit of exhausting system." There were no follow-up bioassay results found in the Battelle records for the two individuals who performed the work (Survey Report, 1964, PDF p. 187).

- Several smear surveys for thorium are documented from Building 3 during the 1964-1965 time period. A set of smear survey reports are available, consisting of 169 pages (Contamination Surveys, 1964-1965). Included in that set of survey reports is a memorandum from the Safety Office, dated October 14, 1964 (Handwritten Memo, 1964, PDF p. 133), which states the following:

  Resmears taken of all locations, showing above permissible alpha or beta-gamma activity on the routine monthly smear survey for September (taken 9/30/64), showed no alpha or beta-gamma contamination present with the exceptions of floor smear location #25 in the 1st floor bay area, and hood smear location #4 in Room 3203. I suggest that the floor smear location #25 be smeared weekly in order to keep closer control on possible spread of contamination from this area. The hood in Room 3203 is higher in alpha activity than should be tolerated for a room in which eating areas are involved. I suggest here that the hood should be cleaned and resmears taken until the d/m/cm^2 is 0.2 or below.

- Smear survey reports for thorium from Building 5 are also available during the 1964-1966 time period (Smear Survey Reports, 1964-66, PDF pp. 157-237).

- An air sample for thorium was taken in the foundry north area of Building 1 on May 13, 1966. The reported concentration was 4.2×10^{-13} microcuries per milliliter (Air Survey Report, 1966, PDF p. 195).

- A smear survey was conducted in the north end anvil area of Building 1 on May 24, 1966. This survey was done following crushing operation (Smear Survey Report, May1966, PDF p. 139).

- An air sample for thorium was taken in the foundry north area of Building 1, May 8, 1968, during baking of a thoria-lined furnace. The reported concentration was 5.56×10^{-15} microcuries per milliliter (Air Survey Report, 1968, PDF p. 216).

- On March 21, 1969, an air sample was taken during a thorium melt operation in the north foundry area of Building 1. The reported air concentration was 2.89×10^{-14} microcuries per milliliter (Air Survey Report, Mar1969, PDF p. 66).

- Multiple smear surveys for suspected thorium contamination were performed in Building 1 during the time period from March 21, 1969 through July 23, 1969. High levels of removable contamination were reported on several smears (Smear Survey Reports, Mar1969, PDF pp. 217-222).

- A smear survey for thorium was performed after cleanup of a grinder on April 28, 1970 in Building 5 (Smear Survey Report, 1970, PDF p. 447).

- An external radiation survey was conducted in the Building 1 north foundry area on August 25, 1970. The reported readings were <0.05 mR/hr (Radiation Survey Report, 1970, PDF p. 227). Measurement distances relative to potentially contaminated items are not specified in the report.

- During the time period from April 28, 1977 through June 8, 1977, air samples were collected from several buildings at Battelle – King Avenue. The purpose of this air sampling campaign was to determine the background airborne radioactivity in various areas, including radon and thoron concentrations. After allowing the samples to decay for a few days, the airborne alpha concentrations (of presumable thorium) from areas suspected of having thorium contamination ranged from 6.4×10^{-14} microcuries per milliliter to 1.4×10^{-12} microcuries per milliliter (Air Sampling Log, Apr-Jun1977, PDF pp. 11-22).

5.7 Radiological Source Term Data

Nearly 10,000 kg of thorium were handled and processed in the various buildings at the Battelle Laboratories – King Avenue site prior to July 1, 1956 (SRDB 122079, PDF pp. 45-127). Legacy materials and residual contamination from those early operations could have resulted in thorium intakes to workers in later years. The quantities of thorium presented in Table 4-1 of this evaluation report are based on a computer query of radioactive material usage at Battelle performed on October 17, 1986. The resulting table included project numbers, start and end dates for each project (beginning January 1, 1951), the client name, a brief description of the work scope, a description of radioactive materials involved, and their gram quantities.

Table 4-1 includes entries involving thorium after June 30, 1956. However, Table 4-1 does not include entries for thorium operations in Building 1, even though there is substantial anecdotal evidence that thorium operations did indeed take place there. For example, surveys and/or air samples for thorium were taken in Building 1 in 1963, 1966, 1968, 1969, and 1970. These are discussed in Section 5.6. In addition, Table 4-1 indicates that thorium operations in Building 5 ended on March 31, 1961 even though there is clear evidence that thorium operations persisted in Building 5 well beyond 1961. There are multiple examples of thorium operations described in Section 5.6 that took place throughout the 1960s and in 1970, including thorium melting and grinding. For these reasons, NIOSH has concluded that the inventories presented in Table 4-1 are incomplete.

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 thorium exposures, as described below.

NIOSH has not found any bioassay data for thorium for the time period under evaluation (July 1, 1956 through December 31, 1970). The earliest available thorium bioassay data were submitted for two individuals on February 27, 1981 (Memo for Bioassay Service, 1981).

Principal sources of internal radiation dose for members of the evaluated class included exposures to uranium and thorium and their decay products. The modes of thorium exposure were inhalation and ingestion during the research and processing of thorium metal, ceramics, solutions and concentrates, or during the subsequent re-suspension of thorium. In this current evaluation report, NIOSH has determined that there are insufficient data available to bound intakes of thorium and thorium progeny for the period from July 1, 1956 through December 31, 1970. Although the vast majority of thorium work at Battelle Laboratories – King Avenue took place prior to 1957 (nearly 10,000 kg of thorium processed from 1951-1956), sporadic thorium work continued at least through 1969. Based on documented thorium surveys conducted in 1970, it appears that the potential for thorium exposure continued into that year as well. NIOSH has not identified any data suggesting the potential for significant thorium exposures after 1970.

A thorium-melting operation was conducted in June 1963 without the knowledge of the Health and Safety office. Once the operation was identified, Health and Safety staff took action and reported the following:

- The safety office was not notified of the melting operation using Mg, Li, and Th metals.
- No respiratory protection was used the first day of the melts (June 24, 1963).
- The melting furnace was hooded, but the pouring operation was not vented.
- The men involved said that they would report all future use of radioactive metal to the safety office.

The latter point indicates that, in the past, workers might or might not have notified the Health and Safety office of radiological work. As a result, the Health and Safety records might or might not be covering all of the thorium work.

NIOSH has concluded that there are insufficient internal dosimetry data or air monitoring data available to estimate thorium intakes prior to 1971. Although there are limited air-monitoring data for thorium during the period of 1961 through 1969, the dates of monitoring do not correlate well with other data showing thorium receipts and thorium processing at the laboratories. NIOSH has therefore concluded that these air monitoring data may not be representative of all thorium processing at Battelle Laboratories – King Avenue and/or the available data indicating dates and quantities of thorium processed during the 1960s may be incomplete.

The most recent thorium operation prior to 1969 appears to have involved only 400 grams of thorium. However, there is considerable uncertainty as to the magnitude of this operation. The operation appears to have been completed by June 30, 1969. The most recent air monitoring data for thorium was from March 21, 1969. The most recent smear survey for thorium was performed on April 28, 1970, with all measurements "less than 100 dpm/100 cm^2." The most recent radiation survey for thorium was conducted on August 25, 1970. NIOSH has not identified any data to suggest that there existed the potential for significant thorium exposures after 1970.

Based on the lack of internal dose monitoring data or air monitoring data for Battelle Laboratories – King Avenue workers during the period from July 1, 1956 through December 31, 1970, NIOSH has determined that sufficiently accurate internal dose reconstruction for thorium exposures is not feasible. However, NIOSH has identified sufficient information and data to support bounding internal dose estimates for thorium after December 31, 1970 when there appears to have been no operations or work with thorium.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to isotopes of thorium and their progeny prior to January 1, 1971. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to thorium and thorium progeny for the class of employees covered by this evaluation.

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures to thorium and its 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.

The information given in the *Site Profile for Battelle Memorial Institute, King Avenue and West Jefferson Sites, Columbus, Ohio* is sufficient to allow bounding of radiation dose associated with occupationally-related X-ray examinations received by members of the class under evaluation. The examination protocols and equipment used during the relevant time period are documented sufficiently to allow assessments of organ dose that may be considered bounding (ORAUT-TKBS-0058). Therefore, NIOSH concludes that it is feasible to reconstruct occupational medical dose for Battelle workers with sufficient accuracy.

In the previous SEC-00208 evaluation report, NIOSH found that it is feasible to reconstruct external dose for Battelle Laboratories - King Avenue workers with sufficient accuracy after December 31, 1950 (NIOSH, 2012). This conclusion remains unchanged as a result of this present evaluation.

6.3 Class Parameters Associated with Infeasibility

In the previous SEC-00208 evaluation report, NIOSH defined a class of workers at the Battelle – King Ave. facility for whom dose reconstruction is infeasible (NIOSH, 2012); the time period for that previously-defined class is from April 16, 1943 through June 30, 1956. Infeasibilities in reconstructing thorium intakes prior to July 1, 1956 were addressed in that previous SEC class definition. The start date for this current evaluation and class definition is therefore July 1, 1956.

As described in Section 6.1, NIOSH has not identified any data to suggest that there existed the potential for significant thorium exposures after 1970. An end-date of December 31, 1970 is therefore being proposed for this SEC class. NIOSH recommends that the class definition include the period from July 1, 1956 through December 31, 1970.

Documentation available to NIOSH does not indicate any definite access controls or controlled 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. Thus, NIOSH recommends that the class definition include all areas of the Battelle Laboratories – King Ave. site during the specified time period.

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. Furthermore, available site- and claimant-specific data are insufficient to allow NIOSH 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-00229

This report evaluates the feasibility for completing dose reconstructions for employees at Battelle Laboratories – King Ave. from July 1, 1956 through December 31, 1970. NIOSH determined that members of this class may have received radiation exposures from uranium and 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 thorium exposures during the period from July 1, 1956 through December 31, 1970, 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 internal radiation doses for the proposed class, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Battelle Laboratories – King Avenue during the period from July 1, 1956 through December 31, 1970, 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-00229

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 and thorium and their progeny. 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-00229

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 facility owned by the Battelle Laboratories at the King Avenue site in Columbus, Ohio, during the period from July 1, 1956 through December 31, 1970, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

10.0 Evaluation of Second Similar Class

In accordance with § 83.14(a), NIOSH may establish another class of co-workers at the facility, similar to the classes defined in Section 9.0 of this report and the class defined in Petition Evaluation Report SEC-00208 (NIOSH, 2012), for whom NIOSH believes that dose reconstruction may not be feasible, and for whom additional research and analyses are required. At this time, NIOSH has not identified another similar class of employees at Battelle Laboratories – King Avenue for whom dose reconstruction may not be feasible.

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Termination, 1952, *Proposed Termination of Thorium Project*; letter from B. D. Thomas (acting Director, Battelle) to S. N. Brown (AEC); May 23, 1952; SRDB Ref ID: 95767, PDF pp. 2-4

Thorium Minutes, 1951, *Minutes of Thorium Research Meeting;* description of processes for scaling up operation; Division of Research; April 2, 1951; SRBD Ref ID: 86961, PDF p. 5

Thorium Request, 1949, *Request for Thorium Metal;* Battelle Memorial Institute; June 2, 1949; SRDB Ref ID: 95628, PDF p. 2

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, PDF p. 2

Thorium Scrap, 1953, *Thorium Scrap;* shipment memo to National Lead Co.; Battelle Memorial Institute; February 3, 1953; SRDB Ref ID: 31429, PDF p. 2

Thorium Spill, 1960, *$Th(NO_3)_4$ Spill*, memo regarding a thorium spill with sample results from Tom Norris; Battelle Memorial Institute; March 15, 1960; SRDB Ref ID: 96036

Thorium Survey Report, 1963, *Survey Report of Th. Spill Rm. 5201 Charley Peterson;* Battelle Memorial Institute; February 14, 1963; SRDB Ref ID: 135629, PDF p. 115

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, 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

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 Ave.

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, analysis 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, X-ray survey, historical radiological surveys, radiological release and sample data, radiological characterization plans, sealed source check records, source custodian directories, inspection reports, and laboratory reports.	08/18/2014	873
State Contacted: Ohio Department of Health (614-644-2727)	Environmental reports.	02/02/2012	2
Albany Research Center	Uranium and thorium metallurgical studies.	03/21/2013	8
Ames Laboratory	History of the Ames Project and thorium shipment records.	07/27/2006	2
Argonne National Laboratory - East	Work performed for the Metallurgical Laboratory, thorium in urine and feces samples, and the national plan for off-normal testing of advanced fuels.	06/16/2015	5
Claimant Provided	A Battelle paper on plutonium transport and dose to man at the Nevada Test Site.	05/19/2008	1
Curtiss-Wright	Operations report and shipment records.	05/24/2009	2
Department of Labor / Paragon	Radiological survey plan for property declared excess, the former Lake Ontario Ordnance Works.	12/30/2008	7
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 beryllium, DOE procedures to respond to records requests and EEOICPA claims, and trip reports.	03/07/2011	14

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
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	63
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	159
DOE Legacy Management - Morgantown	Decontamination and decommissioning report, dosimetry files, material accountability, uranium rod rolling studies, a survey of processing methods for the production of thorium metal from monazite sand and thorium nitrate, and individual employee bioassay records.	02/13/2015	13
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Thorium production, bioassay information, incineration of radioactive solid wastes report, major thorium campaigns, material inventory, production, radiological incidents, radiological procedures, radiological surveys, radiological work planning, the X-ray screening program, Health Physics support of decontamination and decommissioning activities, and a trip report.	05/13/2010	72
DOE Oak Ridge Operations, Records Holding Task Group	Battelle report on thorium separation, special nuclear material ledger, trip report, production report, material accountability reports, and a shipment security survey.	06/27/2012	20
DOE 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	7

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
DOE 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-megawatt operation of the Battelle Research Reactor, progress report, survey of irradiation facilities, sampling and testing procedures for special products, trip report, and early fuel development technical reports.	08/18/2014	66
Federal Records Center (FRC) - Dayton, OH	The results of Battelle's participation in Oak Ridge National Laboratory's 1969 nuclear accident dosimeter inter-comparison test.	03/20/2006	1
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, uranium rolling data, and a weekly activities report.	03/20/2013	16
Idaho National Laboratory (INL)	INL operational and safety periodic reports referring to Battelle, material transfer records, incident summary, Health Physics log sheets, and an aircraft nuclear propulsion project report.	01/08/2015	108
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, high purity metals, sputtering and ion plating, and uranium alloy metallurgy.	04/01/2013	18
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
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford Laboratories operation monthly activities reports referring to Battelle, Hanford's experience with thorium, and proposals for in-reactor metallurgical experiments.	02/20/2013	27
Internet - DOE Legacy Management Considered Sites	AEC research and development report, a 1993 interim mixed waste report, and West Valley site history.	11/19/2014	3

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	09/06/2011	0
Internet - DOE OpenNet	Monthly status and progress reports, a bibliography of lithium hydride reports, and Mound plutonium shipments.	11/06/2014	8
Internet - DOE OpenNet / NIOSH	The 1960 Atomic Energy Commission Annual Report to Congress.	01/11/2008	1
Internet - DOE OSTI	A hazards summary report for the reflector-control critical-assembly experiments and an interim report on metallurgy of thorium.	11/02/2006	2
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, waste disposal reports, analysis of the phoenix fuel experiments, chemical processing of Pu-238, properties of reactor fuels, civilian applications progress reports, and irradiation qualification testing of SNAP 10A components.	06/13/2013	62
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.	02/20/2013	101
Internet - DOE OSTI SciTech Connect	System requirements for the decontamination, decommissioning, and dismantlement of shielded cells.	11/26/2014	1
Internet - Energy Employees Claimant Assistance Project (EECAP)	Development and testing of reactor fuels, testing of irradiated stainless steel, liquid metal fast breeder reactor studies, uranium alloy metallurgy, fuel canning studies, nuclear waste repository studies including deep salt repositories, and transportation of spent fuel.	11/22/2012	54

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.	10/27/2014	158
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 - Los Alamos National Laboratory (LANL)	The Radiochemistry of the Elements.	07/10/2013	1
Internet - National Academies Press (NAP)	No relevant data identified.	09/06/2011	0
Internet - NIOSH	The 2004, 2006, and 2008 issues of the report on residual radioactive and beryllium contamination at atomic weapons employer facilities and beryllium vendor facilities, and the Petition Evaluation Report SEC-00208, Battelle Laboratories - King Avenue.	10/16/2014	4
Internet - NRC Agency wide 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, an examination of spent fuel rods, waste repository research, and a work plan for the JN-1 spent fuel pool.	12/11/2014	30
Internet - Oak Ridge National Laboratory Library	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, ORNL status and progress reports referring to Battelle, and solvent extraction recovery of uranium from metal waste.	04/01/2013	58
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
Kansas City Plant	1973-1981 annual environmental summary reports.	12/04/2012	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Los Alamos National Laboratory (LANL)	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, separation of polonium from bismuth, bismuth canning and casting, Mound Division of Reactor Development summaries, and a Mound Laboratory notebook index.	02/01/2012	8
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, medical examinations, 1950 memos regarding when film badge service should be started, and shipment information.	09/10/2013	31
National Archives and Records Administration (NARA) - Atlanta / SC&A	1987 results of Battelle film badges assigned at Pinellas.	04/13/2004	1
National Archives and Records Administration (NARA) - College Park	Material balance, reports on thorium project, ORAU Team related personal notes, program on refining of thorium, request for thorium metal, return of thorium scrap to Ames, Iowa, monthly status and progress reports, rolling operations, a request for normal uranium, and thorium fabrication.	03/13/2014	69
National Archives and Records Administration (NARA) - Kansas City	Information on facility decontamination history.	03/30/2005	1
National Archives and Records Administration (NARA) - Seattle	A1966 radioactive material shipment record.	12/18/2014	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 reports, effects of neutron radiation, effects of rolling on the crystallography and metallography of uranium, semiannual reports to Congress, annual reports to Congress, the technology of thorium, and a trip report.	08/27/2014	35
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

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
New York State Archives	Information on contracts, a survey of and exposure reports at Lake Ontario Ordnance Works, and 1952 progress reports.	03/24/2012	6
Nuclear Regulatory Commission Non-Public Holdings	Environmental reports, license SNM-7 amendments and correspondence, 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, radiological status, monthly report, and a weekly activities report.	12/16/2014	29
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 (ORNL)	Report on the direct micro determination of uranium using a modified fluorophotometer, The Battelle Story, studies on large-batch melting of uranium, isotopic power materials development progress reports, fuel element radiation specimens reports, source and special nuclear material accountability reports, and the Amchitka radiobiological program final report.	03/20/2014	54
ORAU	Building verification surveys.	10/05/2012	9
ORAU Team	Radiological incidents, air survey report, radiological practices, bioassay results, medical X-ray dose, Landauer minimum detectable activity, operations with uranium, documented communications, and a report on iridium-238 PUO-2 compatibility.	09/12/2014	39
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, inventory and manufacturing statements, 1991 dosimetry weekly highlights, [Name redacted] pre-1991 publications, and AEC activities.	04/07/2011	16
SAIC	Personnel radiation exposure summaries.	09/02/2004	7
Savannah River Site	Thorium canning and de-canning program, dosimetry visitor cards, metallurgy section monthly report, monthly progress report, trip report, radiation survey log sheets, and thorium and U-233 inventory data.	03/19/2012	22
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

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Unknown	Air sample data, radiation exposure report, environmental reports, investigations regarding former thorium sites, monthly status and progress reports, special irradiation program, FUSRAP elimination reports, Battelle site operations and facility descriptions, and recycled uranium receipts and shipments.	02/04/2011	45
West Valley	Shipping Pu containers to Hanford.	11/24/2006	1
TOTAL	N/A	N/A	**2,468**

Table A1-2: Internet Databases Searched for Battelle Laboratories – King Ave.

NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Battelle – King Avenue Rev 01 (83.14) 09-11-15"

Database/Source	Keywords / Phrases	Hits	Selected
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://reading-room.labworks.org/Catalog/Search.aspx 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 http://www.nv.doe.gov/main/search.aspx 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

Database/Source	Keywords / Phrases	Hits	Selected
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://journals.lww.com/joem/pages/default.aspx COMPLETED 09/29/2011	See Note above	0	0
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/Missions/HTRW/FUSRAP.aspx 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: Interlibrary Loans Document Requested for Battelle Laboratories – King Ave.

Document Number	Document Title	Requested Date	Received Date
No documents ordered.	N/A	N/A	N/A