SEC Petition Evaluation Report
Petition SEC-00204

Report Rev #:0 Report Submittal Date: November 13, 2012

Subject Expert(s):	Mike Mahathy, Pat McCloskey
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00204	83.13	June 5, 2012	July 24, 2012	Baker Brothers

Petitioner-Requested Class Definition

All employees who worked in any area of Baker Brothers, in Toledo, Ohio, from June 1, 1943 through December 31, 1996.

Class Evaluated by NIOSH

All employees who worked in any area of the Baker Brothers site in Toledo, Ohio, from June 1, 1943 through December 31, 1996.

NIOSH-Proposed Class to be Added to the SEC

All Atomic Weapons Employees who worked at the Baker Brothers site in Toledo, Ohio, during the period from June 1, 1943 through December 31, 1944, 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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Evaluation Report Summary: SEC-00204, Baker Brothers

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*.

Petitioner-Requested Class Definition

Petition SEC-00204 was received on June 5, 2012, and qualified on July 24, 2012. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area of Baker Brothers, in Toledo, Ohio, from June 1, 1943 through December 31, 1996.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class. NIOSH evaluated the following class: All employees who worked in any area of the Baker Brothers site in Toledo, Ohio, from June 1, 1943 through December 31, 1996.

NIOSH-Proposed Class(es) to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employees who worked at the Baker Brothers site in Toledo, Ohio, during the period from June 1, 1943 through December 31, 1944, 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. The time period of the NIOSH-proposed class was reduced from that of the evaluated class (see Section 3.0 below) because NIOSH has data and methods to estimate internal and external doses with sufficient accuracy for the period from January 1, 1945 through December 31, 1996.

Feasibility of Dose Reconstruction

NIOSH finds it is not feasible to estimate internal exposures with sufficient accuracy for all workers at the site from June 1, 1943 through December 31, 1944. NIOSH has confirmed that Baker Brothers workers were exposed to unmonitored releases of uranium metals and dust. NIOSH has not identified personal monitoring data, or sufficient source term data, or sufficient information on radiological controls used during the AWE operations period. Consequently, NIOSH cannot reconstruct internal uranium doses with sufficient accuracy for the period June 1, 1943 through December 31, 1944. With the exception of this class, per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses more precisely than an

estimate of maximum dose. Information available from the site documentation and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the period from January 1, 1945 through December 31, 1996.

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 natural uranium metals. Baker Brothers received uranium rods from MED and machined them into slugs. The modes of exposure were inhalation and ingestion during the processing of these metals.

- NIOSH has found no indication of an internal dose monitoring program at the Baker Brothers site during the AWE operations period. NIOSH has identified air sample results from three different days in 1943 and 1944, but they are insufficient to estimate intakes. NIOSH has insufficient information regarding radiological controls used by Baker Brothers to support the use of existing NIOSH procedures to bound possible internal uranium exposures during AWE operations at Baker Brothers. Based on lack of sufficient data for Baker Brothers workers, sufficiently accurate internal dose reconstruction is not feasible for the AWE operational period from June 1, 1943 through December 31, 1944.

- NIOSH has obtained post-AWE breathing zone air data and remediation period bioassay data. NIOSH has determined that the available data, combined with methods available in existing NIOSH procedures, are adequate to support sufficiently accurate internal dose reconstruction for the Baker Brothers residual radiation and remediation periods from January 1, 1945 through December 31, 1996.

- Principal sources of external radiation for members of the proposed class included exposures to gamma and beta radiation associated with handling and working in proximity to natural uranium metals. The modes of exposure were direct radiation, submersion in potentially-contaminated air, and exposure to contaminated surfaces.

- NIOSH has found no indication of an external dose monitoring program at the Baker Brothers site during the AWE operations period. NIOSH has obtained breathing zone air data, and area monitoring data during the Baker Brothers residual radiation and remediation periods. In addition, NIOSH has obtained worker bioassay data during the site remediation period.

- NIOSH has determined that sufficiently accurate reconstruction of external doses for Baker Brothers workers is feasible for the AWE operational period from June 1, 1943 through December 31, 1944 using existing NIOSH procedures pertaining to the handling of uranium metal. NIOSH has determined that sufficiently accurate reconstruction of external doses is feasible for the residual radiation and remediation periods (January 1, 1945 through December 31, 1996) using available area and personnel monitoring data and the assumptions and approaches presented in existing NIOSH procedures.

- NIOSH has found records to indicate that a medical monitoring program existed from the start of AWE operations. Chest X-rays were scheduled in June 1943 for Robin Hood Hospital in Toledo. Therefore, NIOSH finds that it is not applicable to reconstruct occupational medical dose for Baker Brothers workers because medical X-ray procedures would have been 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 Baker Brothers during the period from June 1, 1943 through December 31, 1944, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

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 June 1, 1943 through December 31, 1944.

NIOSH did not identify any evidence supplied by the petitioners 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 uranium, combined with external exposures to gamma and beta radiation. 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 at least 250 aggregated work days either solely under their employment or in combination with work days within the parameters established for other SEC classes.

For the period from January 1, 1945 through December 31, 1996, 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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SEC Petition Evaluation Report for SEC-00204

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: Mike Mahathy, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any area of the Baker Brothers site in Toledo, Ohio, from June 1, 1943 through December 31, 1996. It provides information and analyses 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. This report also does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

This evaluation was conducted in accordance with the requirements of EEOICPA, 42 C.F.R. pt. 83, and the guidance contained in the Division of Compensation Analysis and Support's (DCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, DCAS-PR-004.[1]

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 (HHS) 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 class of employees through NIOSH dose reconstructions.[2]

42 C.F.R. § 83.13(c)(1) states: *Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose.*

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires

[1] DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).
[2] 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.

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 at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for one or more other SEC classes.

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 petitioner(s) and the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order 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 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 decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[3]

3.0 SEC-00204, Baker Brothers Class Definitions

The following subsections address the evolution of the class definition for SEC-00204, Baker Brothers. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00204 was received on June 5, 2012, and qualified on July 24, 2012. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area of Baker Brothers, in Toledo, Ohio, from June 1, 1943 through December 31, 1996.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Baker Brothers workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00204 for evaluation:

[3] 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.

Petition Basis: Radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored either through personal monitoring or through area monitoring.

In support of this basis, the petitioner made the following statement referring to the Energy Employee: "He was not monitored for uranium and thorium."

Based on its Baker Brothers research and data capture efforts, NIOSH determined that it has access to limited process information, air sampling, radiological surveys, and dosimetry data for Baker Brothers workers during the time period under evaluation. However, NIOSH also determined that air sampling, radiological surveys, and dosimetry records are not complete for all time periods or for uranium. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that both internal and external radiation exposures and radiation doses were not adequately monitored at Baker Brothers, either through personal monitoring or area monitoring. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class. Therefore, NIOSH defined the following class for further evaluation: All employees who worked in any area of the Baker Brothers site in Toledo, Ohio, from June 1, 1943 through December 31, 1996.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employees who worked at the Baker Brothers site in Toledo, Ohio, during the period from June 1, 1943 through December 31, 1944, 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. The time period of the NIOSH-proposed class was reduced from that of the evaluated class because NIOSH has data and methods to estimate internal and external doses with sufficient accuracy for the period from January 1, 1945 through December 31, 1996.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding Baker Brothers. 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 2 contains a summary of Baker Brothers 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.

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document. Although there is not a specific site profile for the Baker Brothers site, as part of NIOSH's evaluation detailed herein, it examined the following TBD for insights into Baker Brothers operations or related topics/operations at other sites:

- *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*; Battelle-TBD-6000, Rev. 01; effective June 17, 2011; SRDB Ref ID: 101251

4.2 Technical Information Bulletins

A Technical Information Bulletin is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following Technical Information Bulletins as part of its evaluation:

- *Estimation of Ingestion Intakes*, OCAS-TIB-009, Rev. 0, NIOSH Office of Compensation Analysis and Support; April 13, 2004; SRDB Ref ID: 22397

- *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*; ORAUT-OTIB-0070, Rev. 01; effective March 5, 2012; SRDB Ref ID: 108851

- *Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*; ORAUT-OTIB-0079, Rev. 00; January 3, 2011; SRDB Ref ID: 89563

4.3 Facility Employees and Experts

To obtain additional site information, NIOSH routinely interviews former site employees. NIOSH attempted to conduct interviews for this evaluation but were not able to locate former workers from the 1943-1944 operational period. As a result, no interviews were conducted of the Baker Brothers site workers who worked during the 1943-1944 operational period.

4.4 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 4-1 summarizes the results of this review. (NOCTS data available as of October 24, 2012)

Table 4-1: No. of Baker Brothers Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	4[a]
Total number of claims submitted for energy employees who worked during the period under evaluation (June 1, 1943 through December 31, 1996)	4
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).	4
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	0

[a] Only two of the four claimants had recorded employment during the AWE operational period at Baker Brothers.

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. NIOSH reviewed dose reconstructions executed for the four existing Baker Brothers claims. Only two of the four claims represent claimants who worked during the AWE operations period. For one of the claims, the dose reconstruction completed in 2007 used data presented in ORAUT-OTIB-0004 which has since been cancelled. It appears the claimant was included in another site's SEC class and no further dose reconstruction has been performed. For the second claim with employment during the AWE operations period, the dose reconstruction used data given in Battelle-TBD-6000 to bound internal and external doses. Dose reconstructions for the two remaining claims with employment during the residual radiation period were based on guidance for external and internal dose assignments given in Battelle-TBD-6000.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. One hundred fifty-six documents in this database were identified as pertaining to Baker Brothers. These documents were evaluated for their relevance to this petition. The documents include historical background on facility operations and medical surveillance as well as limited results of air and surface contamination sampling.

4.6 Documentation and/or Affidavits Provided by Petitioners

In qualifying and evaluating the petition, NIOSH reviewed the following documents submitted by the petitioners:

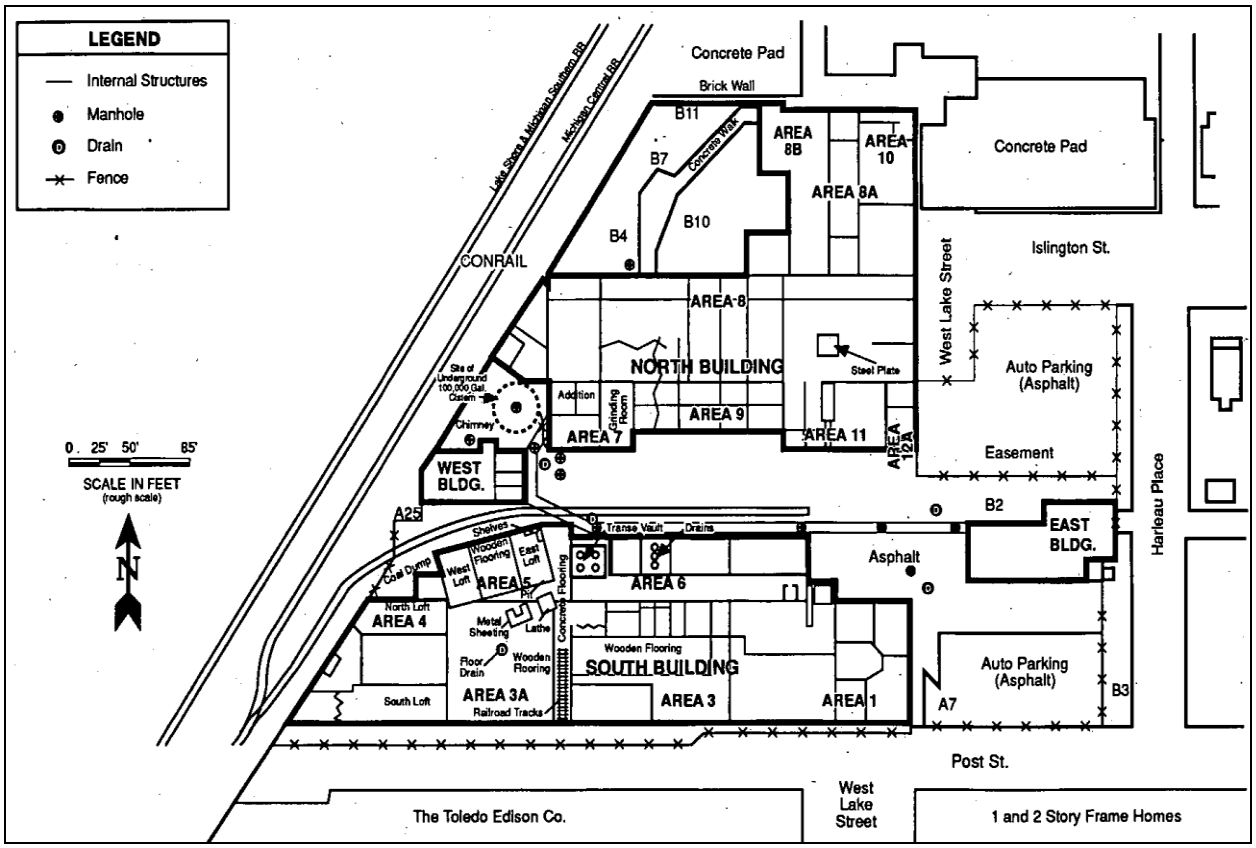
- *Form B - 83.13*; received June 5, 2012; DSA Ref ID: 116870 (Form B, 2012)
- *Petition Authorization Form*; received July 31, 2012; DSA Ref ID: 117401 (Authorization, 2012)
- *Supporting Document-Medical Records*; received June 5, 2012; DSA Ref ID: 116871 (Support 2012a)
- *Supporting Documents-Fact Sheet, Cover Letter, and Engineering Evaluation/Cost Analysis for the Baker Brothers Site*; received June 21, 2012; DSA Ref ID: 117100 (Support, 2012b)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at Baker Brothers from June 1, 1943 through December 31, 1996 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Baker Brothers Plant and Process Descriptions

Baker Brothers was located at 2551-2555 Harleau Place at the intersection with Post Street in Toledo, Ohio, on a 19-acre site (Survey, 1996). Baker Brothers received uranium rods from the Manhattan Engineer District (MED) in 1943 and 1944 and machined them into slugs for use in early MED reactors at Clinton Engineering and Hanford. The Baker Brothers commercial property consisted of several buildings as shown on the 1938 site map in Figure 5-1 (Survey, 1992). For the period under evaluation, approximately thirty-five persons were tasked with the AWE work (Site Visit, Sep1943; Woodward, 1944; Monitoring, 1944). NIOSH does not have information on the total number of workers at the site from 1943 through 1944.



Source: Survey, 1992, pdf p. 27

Figure 5-1: Baker Brothers Site Map Circa 1938

Immediately surrounding the site were commercial businesses to the north and south, residences to the east, and several railroad tracks with residences beyond the tracks to the west. A rail spur also entered the site from the railroad tracks to the west. The exterior ground cover at the site was mostly asphalt or concrete with small patches of grass near the roads. The exception to this was the courtyard area north of Area 8, which was covered by approximately 24 inches of gravel. This gravel was backfilled after contaminated soils and debris were removed and taken to Ottawa Lake, Michigan in November 1991 (Nimmagadda, 1995).

There were four main buildings (known as North, East, South, and West). The interiors of each of the larger buildings (North and South Buildings) were subdivided into various numbered areas, as shown in Figure 5-1. The buildings were erected in the 1920s; they were brick with a saw-tooth roof configuration and concrete floors. The exception was the South Building, which had aluminum siding in Area 1 and wooden floors in Areas 3A, 4, and 5.

- North Building: Located at 2555 Harleau Place; 40,000 ft^2 consisting of Areas 7 through 12A. Uranium work was conducted solely in Area 7 (Site Characterization, 1995). The courtyard behind this building was used to stage uranium metal rods during Manhattan Engineering District (MED) operations, and after 1944, was used for storage of electric motors and transformers.

- East Building: Located at 2551 Harleau Place; 8,000 ft^2 consisting of a two-story, unoccupied structure formerly used for offices. During FUSRAP Characterization in 1989, it was only used to store furniture.

- South Building: Located at 1000 Post Street; 45,000 ft^2 consisting of Areas 1, 3, 3A, 4, 5, 6. It was used to support operations during MED work, and afterwards, for offices and electric motor repairs. Areas 3 and 6 were completely refurbished following a fire that occurred after the completion of MED operations.

- West Building: Located adjacent to the Conrail property; l0,000 ft^2 consisting of a two-story, high bay (no second floor). It was previously used as an electric motor shop and is called the Power or Boiler House. During FUSRAP characterization, it was not being used or occupied.

Since the termination of MED operations at Baker Brothers in1944, the site has been divided into two separate properties that support ongoing commercial enterprises. The property is still privately owned and is currently occupied by a motor brokerage and an electrical services company (DOE, 2012).

Plant/Process Description and Chronology

Under jurisdiction of the Army Corps of Engineers in the early 1940s, the MED was established as the lead agency in the development of nuclear energy for defense-related projects. Raw materials containing uranium ores were procured, stored, and processed into various uranium oxides, salts and metals. Fabricators were contracted to form the metal first into rods by rolling or extruding (Survey, 1992) and then they were machined into slugs for the production reactors.

The MED needed to temporarily expand its machining capacity until permanent facilities were installed at Hanford Engineer Works (Authority Review, 1992). Approximately forty shops were contacted to meet a September 1, 1943 deadline for the fabrication of 100 tons of uranium slugs. Of these forty shops, Baker Brothers was found to be capable of handling the work to satisfy the developmental, production, and security requirements. Purchase Order XPG-582 ½ was placed with Baker Brothers on May 29, 1943, for a portion of the total machining required, and the remaining portion was placed with Herring-Hall-Marvin Safe Company (HHM) in Hamilton, Ohio. Baker Brothers started work on this order in June 8, 1943, and it was expected to take 6 to 8 weeks to complete it (Site Visit, Sep1943).

The MED delivered the uranium metal rods under guard to the railroad spur between the North and South Buildings at Baker Brothers. From there the rods were carted into a large roll-up door, through a corridor in the north building to the courtyard for storage until the machinists were ready to process them in Area 7. Finished slugs left Baker Brothers on the same railroad spur, and were to be taken to ALCOA in New Kensington, PA for canning.

The MED slug production was moving toward completion when, in early September 1943, the MED requested machining of an additional thirty tons of rod (which until this time had been held in reserve). The MED included this work in that being performed on Purchase Orders XPG-174 ½ and XPG-582 ½ at HHM and Baker Brothers, respectively.

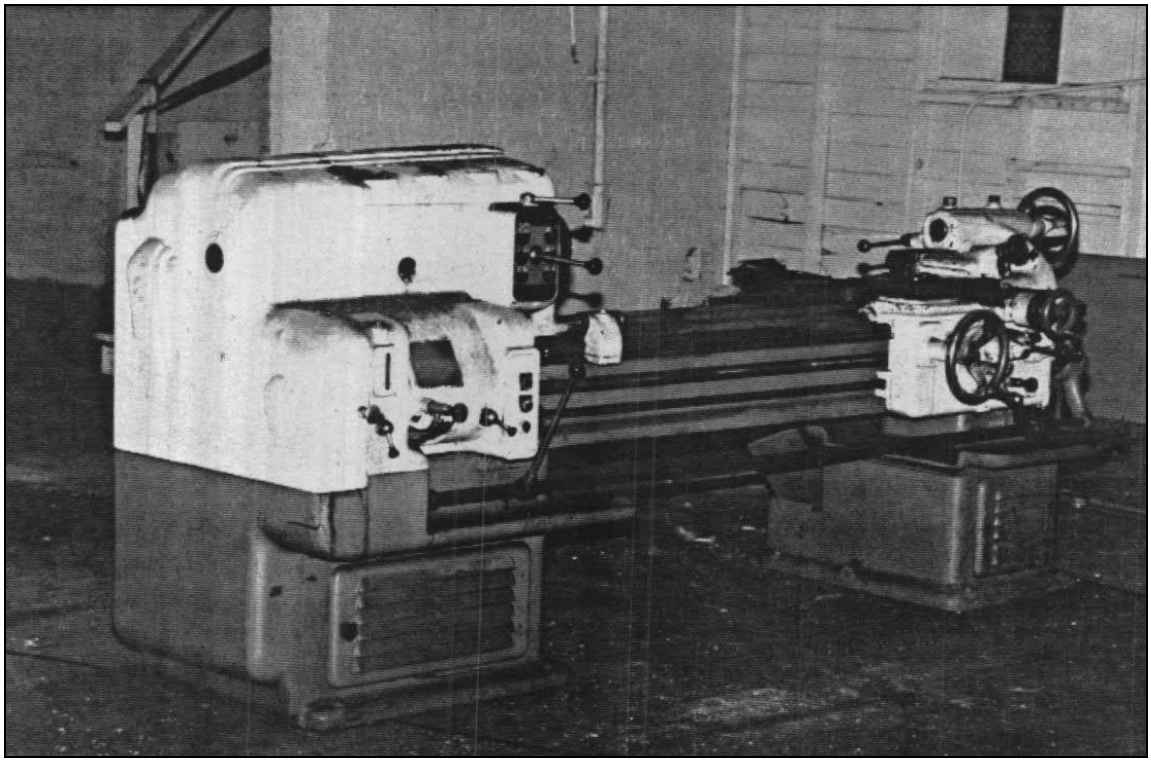
Also in September 1943, the MED requested that Baker Brothers begin refacing and milling grooves into the slugs in order to facilitate their acceptance tests. This groove-milling task (Purchase Order XPG-1795 ½) was expanded to include 15-tons of rejected slugs; it was completed in April 1944.

Purchase Order XPG-582 ½ work ended in October 1943, after machining 2,107 rods into 41,133 slugs and reclaiming 4,267 other slugs. However, prior to completion, another purchase order (RPG-800 ½) was placed with Baker Brothers for approximately 500 hours of machining work in support of the slug-canning development program for Hanford, and included the reclamation of used experimental slugs for the Grasselli Research Laboratory. Baker Brothers was selected because of its heavier machines and its inherent ability to maintain closer tolerances. Also at the end of 1943, defects in extruded rod had become prevalent at Revere Copper and Brass Inc. and machining tests were to be performed at Baker Brothers to determine the extent of the imperfections. At the start of 1944, with the machining of slugs well under way at Hanford (DuPont, 1945, pdf p. 97), MED's interest in the machining program was primarily the fulfillment of various requests for experimental slugs.

Baker Brothers' machining services were reactivated in May 1944 when Project 1553 (Purchase Order RPG 4014 ½) was opened for a special order from the Explosives Department for the fabrication of 48,000 unbonded slugs for Hanford. The need for these slugs was so critical that work was performed on a 24-hour daily basis in order to expedite delivery.

The original scope of work for this special order was machining slugs to a finished diameter and length. Soon after the work started, Baker Brothers suggested that production could be increased if rough-turned slugs were ground to a finished diameter, as this was the best-known high-production method for close tolerance work. However, Baker Brothers could not obtain a grinder in time to meet the accelerated delivery requirements for the slugs, so MED placed Purchase Order RPG-4291 ½ with the Wm. E. Pratt Manufacturing Co. of Joliet, Illinois, for the centerless grinding of rough-turned slugs. The scope of the Baker Brothers order was then reduced to include only the work preparatory to the grinding operation. Because of this reduction in work scope, Baker Brothers was able to increase its production greatly by using equipment capable of the wider range of tolerances acceptable for rough turning. This increased output was accomplished at increased cost due to the use of additional personnel on overtime shifts, greater consumption of Hydromite (coolant), and various other factors.

According to a Metallurgical Laboratory Health Division correspondence, which was issued following a visit to Baker Brothers on June 21, 1943 (Nickson, 1943), heavy fumes were produced by the four lathes used in machining the rods. Figure 5-2 provides an example of one of the lathes.



Source: DOE, 1992, pdf p. 24

Figure 5-2: Lathe Used for Machining Uranium Rods at Baker Brothers

An electrostatic precipitator was installed after February 4, 1944, and was effective at controlling the fumes as indicated by air sample data described in Section 5.2.1 below.

Machining operations were conducted in the Grinding Room in the North Building. For security purposes, containers of scrap metal and the turnings were stored in the Grinding Room and other areas of the plant for periods of several days to several weeks before shipment. The total amount of uranium machined by Baker Brothers was somewhere between 90 and 300 tons (approximately 1 to 4 train carloads), and there were always DuPont, MED or University of Chicago Metallurgical Laboratory personnel present at the site for these operations (DOE, 1995, pdf p. 23**).** MED work was completed at Baker Brothers on August 15, 1944, and the final shipment of uranium turnings from the site was scheduled for September 8, 1944 (Morse, 1944), but NIOSH has not found confirmation of this shipment. The Baker Brothers facility assets were eventually liquidated and the machinery and equipment were sold at auction. There is no evidence that a radiological survey was performed at the completion of operations in 1944 (Residual Evaluation, unspecified, pdf p. 33).

The DOE conducted radiological surveys in 1981 that detected uranium residues exceeding current federal guidelines (Aerospace, unspecified). From this, the DOE determined that a detailed characterization of the Baker Brothers site was necessary. This characterization was started in 1989 and identified the courtyard north of Area 8 as the most contaminated area (Survey, 1992). In 1991, prior to the completion of characterization by the DOE, the property owner excavated the courtyard and replaced some of the contaminated material with clean fill. The excavated contaminated soils were taken to a private residence in Ottawa Lake, Michigan, for use as fill. In 1992, DOE designated the Baker Brothers site and the Michigan property eligible for remediation under FUSRAP. The Michigan property was remediated in the fall of 1994 (Site Characterization, 1995), and in 1995, DOE completed their characterization of the Baker Brothers Site (Site Characterization, 1995).

The results of this detailed characterization were used by DOE to engineer and perform a remediation of the Baker Brothers site in 1995. In 2001, DOE certified the site's compliance with cleanup standards and released it for unrestricted use.

5.2 Radiological Exposure Sources from Baker Brothers Operations

MED-related activities conducted at Baker Brothers between June 8, 1943 and September 8, 1944, were limited to the use of natural uranium metal. These MED activities were the source of radioactive materials brought to the site, which caused radiological exposures during the entire NIOSH-evaluated period.

The following subsections provide an overview of the internal and external exposure sources for the Baker Brothers class under evaluation.

5.2.1 Internal Radiological Exposure Sources from Baker Brothers Operations

The primary potential source of internally deposited radioactivity resulting from Baker Brothers operations was inhalation and ingestion of natural uranium. Uranium was present at Baker Brothers as a solid metal, and U-238 was the principal radionuclide of concern (Survey, 1992).

Natural uranium refers to uranium consisting of approximately 99.3% U-238, 0.7% U-235, and a very small residual amount of U-234, by weight. In terms of radioactivity, natural uranium contains approximately equal percentages of U-238 (48.6%) and U-234 (49.2%). These radionuclides emit alpha particles with primary emission energies of 4.20 MeV and 4.15 MeV (U-238), and 4.77 MeV and 4.72 MeV (U-234) (Rad Handbook, 1970). The radioactivity contribution from U-235 is much smaller (approximately 2.2%) relative to U-238 or U-234. U-235 emits alpha particles with energies of 4.40 MeV and 4.37 MeV.

NIOSH was able to find seven uranium air sample results taken on two occasions during MED Operations, as presented in Table 5-1 (Monitoring, 1944; Nickson, 1943).

Table 5-1: Uranium Air Sample Data during MED Operations		
Sample Location	**Sample Date**	**Sample Result (μg/m$^{3)}$**
Near Lathe #2	June 21, 1943	50
Near Lathe #3	June 21, 1943	240
Near Lathe #4	June 21, 1943	84
General Area	February 4, 1944	100
	May 5, 1944	21
Edge of Operating Lathe	February 4, 1944	300
	May 5, 1944	61

5.2.2 External Radiological Exposure Sources from Baker Brothers Operations

Based on information and documentation available to NIOSH, the potential for external radiation doses from uranium and uranium decay products existed at Baker Brothers. The uranium was solely derived from naturally-occurring metals, and thus exhibited a natural isotopic abundance. The following subsections provide an overview of the external exposure sources.

Natural uranium emits both beta particles (electrons) and photons (gamma and X-rays), as shown in Table 5-2. The two primordial components of natural uranium are U-238 and U-235, but some of their decay products grow into equilibrium fast enough to contribute to worker exposures during metal processing. The radioactive material that the MED brought to Baker Brothers during their operations there in 1943 and 1944 continued to be the source of radiological exposures at the site until it was remediated in 1996.

5.2.2.1 Photon

Uranium metal was handled by Baker Brothers employees between June 8, 1943 and September 8, 1944 during MED operations. External exposures to photon radiation would have resulted from the immediate daughter radionuclides in the uranium decay chain. The uranium progeny that result in the most significant photon exposures include Th-234 and Pa-234m (Rad Handbook, 1970). Note that these isotopes have relatively short half-lives and can be assumed to be in equilibrium with the parent U-238. Because of their short half-lives, the exposure potential from these isotopes would follow the parent and will not be considered separately in this document.

U-235 emits alpha particles and gamma photons in about 70% of its transitions, but occurs at 0.720% abundance in natural uranium.

The majority of the photons from natural uranium metals are in the 30-250 keV energy range (Battelle-TBD-6000). However, solid uranium objects provide considerable shielding of the lower-energy photons and "harden" the spectrum, causing the majority of photons emitted from a solid uranium object (e.g., a slug or rod) to have energies greater than 250 keV. While it is recognized that solid uranium sources will have a hardened photon spectrum, exposure to a thin layer of uranium on a surface will result in a larger fraction of exposure to lower-energy photons (Battelle-TBD-6000). Table 5-2 lists the beta and photon emissions of the radionuclides of major external exposure concern. Exposure to these emissions was possible for the period under evaluation during metal-handling and from submersion in contaminated air. Therefore, for the purposes of this evaluation, deep-dose estimates from the uranium sources at Baker Brothers are evenly distributed between photons with E=30-250 keV and photons with E= >250 keV.

Table 5-2: Beta and Photon Emissions of Primary Interest
(This table spans two pages)

Radionuclide	Beta Energy MeV, max. (probability per decay)	Photon Energy MeV (probability per decay)
Uranium-238	None	0.013 (8.8%)
Thorium-234	0.10 (19%)	0.063 (3.5%)
	0.193 (79%)	0.093 (4%)
Protactinium-234m	2.28 (99%)	0.766 (0.2%)
		1.00 (0.6%)
Uranium-235	None	0.144 (11%)
		0.163 (5%)
		0.186 (54%)
		0.205 (5%)
Thorium-231	0.205 (15%)	
	0.287 (49%)	0.026 (15%)
	0.304 (35%)	0.084 (6.5%)
Uranium-234	None	0.053 (0.1%)
Thorium-230	None	0.0667 (0.37%)
		0.142 (0.07%)
		0.144 (0.045%)
Radium-226	None	0.186 (3.28%)
Radon-222	None	0.510 (0.078%)
Polonium-218	0.33 (0.02%)	0.837 (0.0011%)
Lead-214	0.67 (48%)	0.2419 (7.5%)
	0.73 (42.5%)	0.295 (19.2%)
	1.03 (6.3 %)	0.352 (37.1%)
Astatine-218	None	0.786 (1.1%)
		0.053 (6.6%)
Bismuth-214	1.42 (8.3%)	0.609 (46.1%)
	1.505 (17.6%)	1.12 (15.0%)
	1.54 (17.9%)	1.765 (15.9%)
	3.27 (17.7%)	2.204 (5.0%)
Polonium-214	None	0.7997 (0.010%)
Thalium-210	1.32 (25%)	0.2918 (79.1%)
	1.87 (56%)	0.7997 (99%)
	2.34 (29%)	0.860 (6.9%)
		1.110 (6.9%)
		1.21 (17%)

Table 5-2: Beta and Photon Emissions of Primary Interest
(This table spans two pages)

Radionuclide	Beta Energy MeV, max. (probability per decay)	Photon Energy MeV (probability per decay)
		1.310 (21%)
		1.410 (4.9%)
		2.010 (6.9%)
Lead-210	0.016 (80%)	0.0465 (4%)
	0.063 (20%)	
Bismuth-210	1.161 (~100%)	None
Polonium-210	None	0.802 (0.0011%)
Thalium-206	1.571 (100%)	0.803 (0.0055%)

Source: Rad Handbook, 1998; a more complete list of uranium progeny can be found in this referenced document.

5.2.2.2 Beta

Beta particle radiation was the dominant source of external radiation exposure associated with uranium-machining activities at Baker Brothers, primarily from U-238 decay products. For example, nearly the entire beta radiation field from depleted uranium comes from the daughter radionuclide Pa-234m, and to a lesser extent from Th-234. The surface beta dose-rate from a uranium slab is approximately 233 mrad per hour.

Beta doses to the skin, extremities, and (sometimes) the lens of the eye can be limiting in facilities that process uranium. Potentially significant skin exposure from uranium occurs primarily from the Pa-234m betas at tissue depths of 4 mg/cm^2 and greater. At 2.29-MeV (E_{max}), beta particles from Pa-234m are the most energetic contributors to the beta exposure.

Table 5-2 shows the principal beta emitters and their energies for the uranium present at Baker Brothers. As indicated, there are a significant number of high-energy betas representing a shallow-dose concern for workers. Workers who handled the uranium metal at Baker would have received these shallow doses. For example, slug quality-assurance inspections involved bare-hand contact with the uranium for six hours per day, as reported in an August 23, 1943 (Site Visit, Aug1943). The primary exposure areas would have been the hands and forearms, the neck and face, and other areas of the body that were not covered.

According to May 1944 correspondence, the most outstanding hazard at Baker Brothers was too much metal handling by the operators and inspectors, as well as hand-filing and carrying the metal bare-handed (Monitoring, 1944).

5.2.2.3 Neutron

Neutron exposures were not evaluated for Baker Brothers because they are negligible for natural-uranium metal-handling facilities (Battelle-TBD-6000).

5.2.3 Incidents

NIOSH did not identify any documented accidents at Baker Brothers that resulted in exceptionally high personnel exposure levels (such as a criticality event). However, the pyrophoric nature of the uranium metal, especially the turnings and fines, led to recurring fires in the early days of the process.

The pyrophoric character of the metal when reduced to grindings and its tendency to react with water were the major difficulties encountered during MED work at Baker Brothers. So hazardous were the conditions that it was necessary to incinerate all grindings in order to accumulate and safely ship the scrap generated from the operation. The uranium chips would spontaneously ignite in the lathe pans and scrap metal containers, so the cooling/lubrication system on each of the four lathes had to be upgraded to allow greater volumes of coolant/lubricant to flow over the turning operation (DuPont, 1945).

A Metallurgical Laboratory letter dated June 29, 1943 describes a fire that consumed 100 pounds of uranium scrap (Nickson, 1943). The Baker Brothers plant manager said the workers were apprehensive about the possible toxic effects. A short talk was given to the workers about what might occur, and what is extremely unlikely to occur in hopes the men would take "a more rational attitude toward the material" (Nickson, 1943).

A letter dated August 27, 1943 states "there were a number of accidental fires, of which at least three were spontaneous. Fires of quantities ranging from several pounds to several hundred pounds have been experienced" (Daniels, 1943).

6.0 Summary of Available Monitoring Data for the Class Evaluated by NIOSH

The following subsections provide an overview of the state of the available internal and external monitoring data for the Baker Brothers class under evaluation.

6.1 Available Baker Brothers Internal Monitoring Data

NIOSH has obtained very limited air monitoring results for monitoring performed in the AWE operations period; one set from 1943 and two sets from 1944. Those data are provided in copies of MED documents (Nickson, 1943; Monitoring, 1944) captured at the Atlanta Federal Records Center (see Table 5-1). The air monitoring samples were collected near the end of the Baker Brothers operation. The final set of samples was collected after lathe ventilation was added after February 4, 1944 (Monitoring, 1944).

NIOSH has obtained results of several contamination surveys conducted during the residual radiation period at the Baker Brothers site and plans to use those data to bound doses from uranium exposures potentially received during that period. These data include:

- Walk-through contamination survey of the Baker Brothers buildings performed by Argonne National Laboratory in 1981. Only two areas were identified as exceeding DOE limits for public release in use at that time (Aerospace, unknown date).

- The document, *Radiological Survey of the Former Baker Brothers, Inc. Site, 2551-2555 Harleau Place, Toledo, Ohio,* performed by Oak Ridge National Laboratory (ORNL) and dated March 1992. This report details ORNL's outdoor and indoor radiological surveys conducted in 1989 (Survey, 1992). Contamination survey results from the 1989 survey are provided in Table 6-1, and show four general outdoor areas and one indoor area with contamination that exceeds guideline values from the U.S. DOE Order 5400.5 (April 1990). Gamma radiation surveys performed indoors were below guideline values. NIOSH has identified air-monitoring data in this same document. The air sampling was performed during the 1989 survey (Survey, 1992, pdf p. 24). The results, from breathing zone sampling, were reported as less than the minimum detectable activity (MDA) of U-238. The available documentation states the MDA was 3% of the guideline value of 1E-13 µCi/ml.

Table 6-1: Results from 1989 ORNL Surveys at Baker Brothers
(This table spans two pages)

Location	Alpha (dpm/100cm^2)		Beta (mrad/hr)	Beta (dpm/100cm^2)
	Total	Removable	Total	Removable
South Building Second Floor Indoors	18	0	0.01	
	27	3	0.03	
	36		0.02	
	9	6	0.02	
	36		0.03	16
	9		0.03	
	27		0.03	
	9		0.02	32
	9		0.02	
	36		0.02	
	1900	3	2.25	16
	5400	6	0.03	
		15	7	
			0.02	98
		3	0.03	49
		3	0.03	
		3	0.03	
			0.03	98
		1600	5	2900
East Building	45		0.04	
North Building	18		0.02	
South Building First Floor Indoors	36		0.02	
	9		0.01	
			0.02	98
	27		0.02	
	36		0.02	16
	18	9	0.02	
	18		0.03	33

Table 6-1: Results from 1989 ORNL Surveys at Baker Brothers
(This table spans two pages)

Location	Alpha (dpm/100cm^2)		Beta (mrad/hr)	Beta (dpm/100cm^2)
	Total	Removable	Total	Removable
	36		0.03	
	27		0.03	82
	18	3	0.04	
	9		0.02	16
	36		0.03	213
	9		0.03	197
	18		0.04	16
	18		0.03	
	27	3	0.02	16
			0.02	128
		6	0.02	48
	9		0.03	
	9		0.02	
North Building First Floor Indoors	18		0.02	
	9		0.02	16
	72		0.02	112
	18		0.02	112
	54		0.04	
	27	3	0.02	
East Building First Floor Indoors North Building First Floor Indoors	9	3	0.03	82
	9		0.02	
	18		0.03	
	27	3	0.03	16
			0.02	112
			0.02	64
			0.03	94
		3	0.02	
	36		0.02	16
South Building Roof	171		0.04	64
	9		0.03	
	36		0.03	
	36		0.03	
	261		0.05	
	135		0.03	
	36		0.02	48
	27		0.02	33
	9		0.02	

Source: Survey, 1992
Blank cells mean no data.

- The document, *Characterization Results for the Former Baker Brothers Site, Toledo, Ohio, Bechtel, August 2, 1995*, reports on a radiological and non-radiological characterization performed by Bechtel for DOE in 1995; it contains results of outdoor and indoor radiological sampling (Site Characterization, 1995). The document was captured at the Kansas Federal Records Center. The following types of surveys were performed: beta-gamma floor monitoring of all accessible floors, beta-gamma and alpha hand surveys of floors, walls, ceiling areas, and roofs). This 1995 characterization effort was intended to supplement the 1989 data obtained by ORNL (Survey, 1992), and it did not identify any additional contaminated outdoor areas except for a section of roof on the South Building. This 1995 characterization supplement did identify additional contaminated indoor areas and those survey results only are provided in Table 6-2 as a comparison (< or >) to DOE Order 5400.5 guideline values.

Table 6-2: Results from 1995 Bechtel Surveys at Baker Brothers

Location	Total ($dpm/100cm^2$)	Removable ($dpm/100cm^2$)
North Building Indoors	Several areas identified where survey results exceed an average value of 5,000 and/or a maximum of 15,000	Several areas identified where survey results exceed 1,000
South Building Indoors		

Source: Site Characterization, 1995
Blank cells mean no data.

- The document, *Baker Brothers – Transmittal of Final Engineering Evaluation/Cost Analysis with Responsiveness Summary for the Baker Brothers Site, Toledo, Ohio, SAIC, June 23, 1995*, is an SAIC transmittal and technical report. It contains a presentation of the data presented in the ORNL report discussed above (Survey, 1992) along with additional core sample data obtained by ORNL in 1991 (DOE, 1995). The document was captured at the Kansas Federal Records Center.

- The document, *Post-Remedial Action Report for the Former Baker Brothers Site*, is a Bechtel National issued in February, 1997, providing details and data obtained during the DOE remediation performed in 1995 (DOE, 1997). The document contains summarized data of surveys performed during the clean-up along with post-remedial exposure-rate measurements and discussions of controls used during the clean-up and the disposition of waste materials.

- NIOSH has identified general area air monitoring data collected within the remediation areas (DOE, 1997). The measured U-238 concentrations ranged from 0.00071 pCi/l to 0.00077 pCi/l, which were less than one-half of the derived concentration guide for U-238 (0.002 pCi/l) given in DOE Order 5400.5. Using the maximum reported value, ORAUT derived an air concentration of 0.77 pCi/m^3 (0.00077 pCi/l x 1E+3 l/m^3).

- The document, *Verification of the Former Baker Brothers, Inc. Site, Toledo, Ohio*, issued by Oak Ridge Institute for Science and Education (ORISE) in December 1996 reports on radiological assessments performed to verify decontamination of the Baker Brothers site (Survey, 1996). The document was captured at the DOE LM Grand Junction Office and it identified two areas inside the South building and one area outside the North building with contamination that exceeded DOE Order 5400.5 guideline values. The highest levels observed were 68,000 dpm/100 cm^2 total and 174 dpm/100 cm^2 removable contamination. After these three areas were decontaminated, ORISE reported that the site satisfied release guidelines. Beta scans were performed to show compliance with DOE alpha release criteria using the following ORISE assumption: "Natural uranium emits both alpha and beta radiation in a 1:1 ratio." (Survey, 1996, pdf p. 23).

NIOSH has also obtained worker access registers with contamination survey results, and uranium bioassay results for the DOE remediation performed in 1995 (FUSRAP, 1995a; FUSRAP, 1995b; FUSRAP, 1995c; FUSRAP, 1995d). These documents are Bechtel FUSRAP documents. They were obtained at the Kansas Federal Records Center. The uranium bioassay results are shown in Table 6.3. NIOSH intends to use these data to bound doses during the 1995 remediation effort. NIOSH has also identified Baker Brothers bioassay data (FUSRAP, 1995a; FUSRAP, 1995b; FUSRAP, 1995d; FUSRAP, 1995e) for all 35 workers identified in the access control logs (FUSRAP, 1995c); however, both baseline and follow-up sample results are available for only 24 of the workers. Baseline data are available for three workers with final bioassay results available for the remaining eight. The bioassay results were reported in units of µg/l and each batch of results (a batch = 1 to 4 results) was accompanied by a QA result. The bioassay data are given in Table 6-5 with worker information sanitized.

Table 6-3: Uranium Bioassay Results for Baker Brothers
(This table spans three pages)

Worker	Collection Start Date	Results (µg/l)	Reported Error ± (µg/l)
1	7/23/1995	<0.030	0.000
1	10/3/1995	<0.030	0.000
2	9/16/1995	<0.030	0.000
2	7/20/1995	0.020	0.010
3	7/23/1995	<0.030	0.000
3	9/12/1995	0.060	0.010
4	7/10/1995	0.010	0.002
4	10/3/1995	0.040	0.010
5	7/11/1995	<0.030	0.000
5	9/20/1995	0.020	0.002
6	7/11/1995	<0.030	0.000
6	9/20/1995	0.050	0.010
7	7/10/1995	<0.030	0.000
7	10/4/1995	0.004	0.001
8	10/5/1995	0.110	0.010

Table 6-3: Uranium Bioassay Results for Baker Brothers
(This table spans three pages)

Worker	Collection Start Date	Results (µg/l)	Reported Error ± (µg/l)
9	10/4/1995	<0.030	0.000
9	7/16/1995	0.060	0.010
10	7/13/1995	<0.030	0.000
11	9/11/1995	<0.030	0.000
11	7/20/1995	0.030	0.004
12	7/20/1995	<0.030	0.000
12	9/11/1995	<0.030	0.000
13	7/18/1995	<0.030	0.000
13	9/17/1995	<0.030	0.000
14	10/2/1995	0.060	0.010
15	10/4/1995	<0.030	0.000
15	7/17/1995	0.050	0.010
16	7/10/1995	<0.030	0.000
16	10/4/1995	<0.030	0.000
17	7/11/1995	<0.030	0.000
17	10/4/1995	0.003	0.001
18	10/8/1995	<0.030	0.000
19	10/1/1995	<0.030	0.000
19	7/19/1995	0.020	0.010
20	9/7/1995	0.050	0.010
20	7/12/1995	0.110	0.010
21	8/21/1995	0.030	0.030
22	7/17/1995	0.010	0.010
22	9/11/1995	0.020	0.002
23	7/19/1995	0.050	0.010
23	10/4/1995	0.090	0.010
24	9/17/1995	<0.030	0.000
24	7/22/1995	0.030	0.010
25	9/17/1995	<0.030	0.000
26	10/4/1995	<0.030	0.000
27	7/10/1995	<0.030	0.000
27	9/27/1995	0.050	0.010
28	7/10/1995	0.080	0.010
29	7/11/1995	<0.030	0.000
29	10/4/1995	0.060	0.010
30	10/4/1995	<0.030	0.000
31	7/17/1995	<0.030	0.000

Table 6-3: Uranium Bioassay Results for Baker Brothers (This table spans three pages)			
Worker	**Collection Start Date**	**Results (µg/l)**	**Reported Error ± (µg/l)**
31	9/17/1995	<0.030	0.000
32	7/17/1995	<0.030	0.000
32	10/5/1995	0.040	0.010
33	10/4/1995	<0.030	0.000
33	7/10/1995	0.110	0.010
34	10/5/1995	0.050	0.010
35	9/7/1995	0.010	0.010

Sources: FUSRAP, 1995a; FUSRAP, 1995b; FUSRAP, 1995c; FUSRAP, 1995d

6.2 Available Baker Brothers External Monitoring Data

NIOSH has not identified Baker Brothers or DOE documentation that would show that workers were monitored for external radiation, either during the AWE or the residual radiation periods. However, data contained in contamination and radiation survey documents can be used to bound external doses during the residual radiation period.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determinations for the class of employees under evaluation in this report are governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to 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 to estimate the radiation doses to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.5. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are

available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00204 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Baker Brothers Data

This subsection answers questions that need to be asked before performing a feasibility evaluation. Data Pedigree addresses the background, history, and origin of the data. It requires looking at site methodologies that may have changed over time; primary versus secondary data sources and whether they match; and whether data are internally consistent. All these issues form the bedrock of the researcher's confidence and later conclusions about the data's quality, credibility, reliability, representativeness, and sufficiency for determining the feasibility of dose reconstruction. The feasibility evaluation presupposes that data pedigree issues have been settled.

7.1.1 Internal Monitoring Data Pedigree Review

In this evaluation, NIOSH has determined that it lacks sufficient data relating to worker internal doses from AEC-related work performed at Baker Brothers during the AWE operational period (June 1, 1943 through December 31, 1944). Therefore, a complete internal data sufficiency and pedigree evaluation is not possible for the period from June 1, 1943 through December 31, 1944.

Data for the residual radiation period from January 1, 1945 through December 31, 1994 consist of contamination and radiation survey reports. These sources are copies of original reports and are therefore considered primary data sources. Data for the remediation period in 1995 and for the final year of residual radiation in 1996 consist of contamination and radiation survey reports. These sources are copies of original reports and are therefore considered primary data sources. NIOSH also captured results of uranium bioassay of remediation workers sampled from July through October 1995. These sources are copies of original reports and are therefore considered primary data sources.

7.1.2 External Monitoring Data Pedigree Review

As discussed in Section 6.2, NIOSH has not located any documentation indicating that personnel were monitored for external exposure for either the AWE operational period under evaluation (June 1, 1943 through December 31, 1944) or during the residual radiation and remediation periods (January 1, 1945 through December 31, 1996). Therefore, a data sufficiency and pedigree evaluation is not possible for this data type for this period.

NIOSH has source term data in the form of shipping transactions and accountability and contractual recording of uranium materials to be machined by Baker Brothers. The data sources are copies of

original reports and contracts and are therefore considered primary data sources. The data reported by AEC representatives would have been collected in accordance with standard practices using state-of-the-art methods of the day.

7.2 Evaluation of Bounding Internal Radiation Doses at Baker Brothers

The principal source of internal radiation doses for members of the class under evaluation during the AWE operations period was the potential inhalation and ingestion of airborne natural uranium by employees, both those nearby and those directly involved in machining of rods at Baker Brothers. Other employees were potentially exposed to the re-suspension of surface contamination during the course of their work with non-radioactive materials.

The principal source of internal radiation doses for members of the class under evaluation during the residual radiation and remediation periods was the potential inhalation and ingestion of re-suspended uranium contamination.

The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding AWE Process-Related Internal Doses

The following subsections summarize the extent and limitations of information available for reconstructing the process-related internal doses of members of the class under evaluation.

7.2.1.1 Bioassay Results

NIOSH did not locate urinalysis or other bioassay monitoring data for the AWE operations period under evaluation; therefore, internal exposure must be determined based solely on process information, radiological source term information and area monitoring data.

7.2.1.2 Airborne Levels

NIOSH has found only seven air sampling results performed in June 1943 and February and May 1944 (Monitoring, 1944), and shown in Table 5-1. While this limited amount of data shows a decline in uranium air concentration, NIOSH lacks sufficient information to determine if the results are representative of breathing air.

7.2.1.3 Alternative Data Sources for Bounding Internal Dose

Source term data are available through a variety of reports, requests, and memos although the quantities listed are uncertain as they were given in a wide range from 90 to 300 tons, which introduces uncertainty in a bounding model that incorporates source term. Finally, there is uncertainty about coolant and ventilation controls used during the machining operations.

7.2.2 Evaluation of Bounding Residual Radiation and Remediation Period Internal Doses

7.2.2.1 Bioassay Results

NIOSH did not locate urinalysis or other bioassay monitoring data for the residual radiation periods, January 1, 1945 through December 31, 1994 and January 1, 1996 through December 31, 1996. NIOSH has located urinalysis data obtained from workers during the remediation in 1995 and plan to use those urinalysis data to reconstruct doses for remediation workers. Individual results are shown in Table 6-5.

7.2.2.2 Airborne Levels

NIOSH has identified air monitoring data obtained during an ORNL survey of Baker Brothers buildings in 1989 (Survey, 1992, pdf p. 24). The breathing zone sampling results were reported as less than the minimum detectable activity (MDA) of U-238. The available documentation states the MDA was 3% of the guideline value of 1E-13 µCi/ml, from the U.S. DOE Order 5400.5 (April 1990).

NIOSH has identified general area air monitoring data collected within the remediation areas (DOE, 1997). The measured U-238 concentrations ranged from 0.00071 pCi/l to 0.00077 pCi/l, which were less than one-half of the derived concentration guide for U-238 given in DOE Order 5400.5 as 0.002 pCi/l. Using the maximum reported value, NIOSH derived an air concentration of 0.77 pCi/m^3 (0.00077 pCi/l x 1E+3 l/m^3).

7.2.2.3 Alternative Data Sources for Bounding Internal Dose

As presented in Section 6.1, NIOSH has obtained results of contamination surveys performed at Baker Brothers in 1981, 1989, 1995, and 1996. These results are useful in determining intakes of uranium when used with the methodology presented in Battelle-TBD-6000 and ORAUT-OTIB-0070.

7.2.3 Methods for Bounding Internal Dose at Baker Brothers

7.2.3.1 Methods for Bounding AWE Operational Period Internal Dose

NIOSH considered the use of Battelle-TDB-6000 in a possible approach to bound internal doses during the AWE operations period. Baker Brothers changed from just water to the use of an oil-water mixed coolant in July 1943 with a modified coolant flow rate but still experienced some fires. Records show that Baker Brothers experienced frequent fires from the cuttings and fines generated by machining (DuPont, 1945). NIOSH notes that the development of Battelle-TDB-6000 data was based on facilities that used coolant to control fires, with and without ventilation. From the documentation available to NIOSH, Baker Brothers initially used water as a coolant to control fires and fumes, but water alone did not mitigate fires. NIOSH has obtained no documentation on what controls were provided, or exactly when, although a Hanford document suggests that fires had at least been somewhat controlled by August 1943 (Daniels, 1943). However, for 1943, NIOSH has limited information on actual controls that were put in place at Baker Brothers, although it is likely that some controls were implemented. Baker Brothers machining operations included rough turning, grinding, and grooving.

NIOSH reviewed research used as the foundation for radionuclide intake derivations related to uranium machining in Battelle-TBD-6000 (Harris, 1958). This study, *The Industrial Hygiene of Uranium Fabrication* (HASL-39), was published by the AEC's Health and Safety Laboratory in 1958 and represents monitoring of operations conducted after Baker Brothers ceased to machine uranium in 1944. While some of the assumptions presented in HASL-39 and in Battelle-TBD-6000 may have applied to Baker Brothers given the machining of natural uranium, there are sufficient uncertainties that NIOSH cannot use these sources to derive uranium air concentrations and intake rates. The data may not be representative of the airborne conditions present at Baker Brothers in 1943 and 1944. HASL-39 provided an instance where uranium air concentration for one grinding event without ventilation was measured to be 13,000 dpm/m^3. That concentration potentially could be used to bound uranium intakes, but since it is much higher than the daily-weighted average air concentrations reported by HASL-39, a derived intake could be overly high. Temporal considerations from IG-004 were also evaluated to determine the feasibility of using Battelle-TBD-6000. Without more information on controls and ventilation used by Baker Brothers, NIOSH cannot use the intake rates presented in Battelle-TBD-6000 for the Baker Brothers AWE operational period. NIOSH will consider the use of air concentrations provided in Battelle-TBD-6000 to determine the initial air concentration at Baker Brothers during the residual radiation period.

Prior to 1943, uranium machining had not been done on a production scale. Baker Brothers was developing methods for machining uranium, and those methods would be used in other plants in later years. Baker personnel were determining the proper machining speeds, proper coolants, optimal coolant application, and optimal coolant flow rate. The methods and controls were designed, developed, and changed concurrent with operations due to the urgent need for the product. References indicate some relatively large episodic fires at Baker Brothers. Due to the evolving methods used at Baker Brothers, fires were likely more frequent and severe, and the fugitive emissions greater, than from the machining at the plants measured in Battelle-TBD-6000; thus, the use of data on exposure to airborne radioactivity in Battelle-TBD-6000 may not necessarily bound operational intakes at Baker Brothers in 1943-1944.

Consequently, NIOSH finds that it is infeasible to bound internal doses received from uranium machining at Baker Brothers from June 1, 1943 through December 31, 1944.

7.2.3.2 Methods for Bounding Residual Radiation Period Internal Dose

First Residual Radiation Period

Internal dose estimates for the residual radiation period from January 1, 1945 through December 31, 1994 can be based on the inhalation and ingestion intakes using methodology presented in Battelle-TBD-6000 and ORAUT-OTIB-0070. In using this methodology, NIOSH must have the uranium air concentration at the start of the residual period or be able to estimate it. NIOSH cannot use any of the seven air monitoring results obtained during the operations period to estimate such an air concentration due to the uncertainties in the results. NIOSH compared the operations and conditions known and postulated for Baker Brothers versus air sampling data for facilities machining uranium in Battelle-TBD-6000, Table 7-5.

NIOSH determined the best method for estimating airborne radioactivity at Baker Brothers at the beginning of the residual period was to use the settling and re-suspension method presented in Battelle-TBD-6000 and ORAUT-OTIB-0070. Although an accurate estimate of airborne radioactivity may not be possible during the AWE operations period due to uncertainty in controls and possible episodic high airborne radioactivity that was not quantified, an estimate of average residual surface contamination present at the start of the residual period can be bounded based on the geometric mean daily weighted average air concentration for machining presented in Battelle-TBD-6000: 5480 dpm/m^3. The estimate of average removable surface contamination was made by assuming continuous settling at a rate of 0.00075 m/s for 30 days, resulting in a floor contamination level of 10,650,000 dpm/m^2. With all uranium metal work completed by September, 1944, and the bulk of turnings having been returned to the MED, average residual surface contamination remaining on January 1, 1945 is likely bounded by this value. A re-suspension rate of 1 x 10^{-6}/m was applied to the residual contamination value to provide an air concentration of 10.65 dpm/m^3 (4.8 pCi/m^3) on January 1, 1945.

From January 1, 1945 through the end of the first residual radiation period (December 31, 1994), the uranium source term was depleted by radioactive decay and somewhat removed through other uses of the facilities (see ORAUT-OTIB-0070, Section 3.4). It is plausible to assume that workers in the Baker Brothers buildings during the first residual radiation period were exposed to re-suspended uranium contamination but at a rate that accounts for the depletion of the source term. NIOSH has identified air monitoring data obtained during an ORNL survey of the Baker Brothers buildings in 1989 (Survey, 1992, pdf p. 24). The results, from breathing zone sampling, were reported as less than the minimum detectable activity (MDA) of U-238. The available documentation states the MDA was 3% of the guideline value of 1E-13 µCi/ml in DOE Order 5400.5 (April 1990) (Survey, 1992, pdf p. 24). NIOSH proposes the use of the MDA value, or 3E-15 µCi/ml (0.003 pCi/m^3) as the bounding air concentration for the start of year 1990.

Using the air concentrations for 1945 and 1990, ORAU calculated the depletion factor for each year from 1945 through 1994 using ORAUT-OTIB-0070, Section 4.1.4:

$$A_{1990} = A_{1945} * e^{-\lambda t} \qquad \text{(Equation 1)}$$

Where:

t = Years since 1945

λ = Depletion factor, and $\lambda = - \ln(A_{1990}/A_{1945}) / t = 0.164/y$

$$A_t = 4.8 \text{ pCi/m}^3 * e^{-\lambda t} \qquad \text{(Equation 2)}$$

Substituting each year since 1945 for *t* in Equation 2, air concentrations were calculated for each year beginning January 1. These derived concentrations are provided in Table 7-1. Note that in 1990, the air concentration is 0.003 pCi/m^3, which is the air concentration used to derive λ. Ingestion dose during this same period is determined based on the methodology in OCAS-TIB-009. The amount of uranium ingested in 1945 is determined by multiplying the air concentration of 5480 dpm/m^3 times 0.2 m^3 times 300 days, which results in a 1.5 E5 pCi ingestion intake for 1945. Ingestion intakes in subsequent years are based on the 1945 intake and the 0.164/y depletion factor similar to what was done for air concentrations in equation 2 above.

Table 7-1: Derived Uranium Air Concentrations			
Date	**pCi/m^3**	**date**	**pCi/m^3**
1/1/1945	4.7987	1/1/1970	0.0795
1/1/1946	4.0729	1/1/1971	0.0675
1/1/1947	3.4568	1/1/1972	0.0573
1/1/1948	2.9339	1/1/1973	0.0486
1/1/1949	2.4902	1/1/1974	0.0413
1/1/1950	2.1135	1/1/1975	0.0350
1/1/1951	1.7938	1/1/1976	0.0297
1/1/1952	1.5225	1/1/1977	0.0252
1/1/1953	1.2922	1/1/1978	0.0214
1/1/1954	1.0967	1/1/1979	0.0182
1/1/1955	0.9309	1/1/1980	0.0154
1/1/1956	0.7901	1/1/1981	0.0131
1/1/1957	0.6706	1/1/1982	0.0111
1/1/1958	0.5691	1/1/1983	0.0094
1/1/1959	0.4830	1/1/1984	0.0080
1/1/1960	0.4100	1/1/1985	0.0068
1/1/1961	0.3480	1/1/1986	0.0058
1/1/1962	0.2953	1/1/1987	0.0049
1/1/1963	0.2507	1/1/1988	0.0042
1/1/1964	0.2127	1/1/1989	0.0035
1/1/1965	0.1806	1/1/1990	0.0030
1/1/1966	0.1533	1/1/1991	0.0025
1/1/1967	0.1301	1/1/1992	0.0022
1/1/1968	0.1104	1/1/1993	0.0018
1/1/1969	0.0937	1/1/1994	0.0016

1995 Remediation and 1996 Residual Radiation Period

NIOSH has identified records of workers assigned to perform remediation work at Baker Brothers from July through October 1995 (FUSRAP, 1995c). NIOSH has also identified Baker Brothers bioassay data (FUSRAP, 1995a; FUSRAP, 1995b; FUSRAP, 1995d; FUSRAP, 1995e) for all 35 workers identified in the access control logs; however, both baseline and follow-up sample results are available for only 24 of the workers. Of the eleven workers not having both baseline and follow-up samples, three have baseline data only, and eight have final bioassay results only. If these eleven workers become claimants, doses can be reconstructed using data from the maximally-exposed co-worker with complete bioassay results. The bioassay results were reported in units of µg/l and each batch of results (a batch was 1 to 4 results) was accompanied by a QA result. NIOSH proposes to use actual uranium bioassay data to assign doses to any of the 24 workers with complete bioassay results involved in 1995 remediation should they become claimants.

For other perimeter workers who may have been in proximity of the clean-up but not monitored by bioassay, NIOSH has identified general area air monitoring data collected within the remediation

areas (DOE, 1997). The data, given only as maximum concentrations of U-238, ranged from 0.00071 pCi/l to 0.00077 pCi/l, which are less than one-half of the derived concentration guide for U-238 given in DOE Order 5400.5 as (0.002 pCi/l). Using the maximum reported value, NIOSH derived an air concentration of 0.77 pCi/m^3 (0.00077 pCi/l x 1E+3 l/m^3).

In 1996, ORISE performed a verification radiological survey of the Baker Brothers facility to ensure that the property was remediated below DOE release criteria. During the verification, ORISE identified a small area of contamination that had not been cleaned. The highest alpha total contamination result obtained was 16,000 dpm/100cm^2. The maximum surface contamination level of 16,000 dpm/100cm^2 was converted to an air concentration using a value of 1E-06 m^{-1} for the re-suspension factor (from ORAUT-OTIB-0070), which provides a projected airborne concentration of:

$$(16{,}000 \text{ dpm})(1E{+}4 \text{ cm}^2/\text{m}^2)(1E{-}6 \text{ m}^{-1} \text{ re-suspension factor})/100 \text{ cm}^2 = 1.6 \text{ dpm/m}^3$$
$$\text{or } 0.72 \text{ pCi/m}^3$$

The derived value of 0.72 pCi/m^3 is nominally equal to the value of 0.77 pCi/m^3 using air monitoring data. Therefore, NIOSH proposes to use an air concentration of 0.77 pCi/m^3 to bound potential uranium intakes for perimeter workers in 1995 and for any worker on the Baker Brothers site in 1996 (post-remediation). The amount of uranium activity ingested on an annual basis in 1995 and 1996 is determined by multiplying the measured air concentration of 0.77 pCi/m^3 times 0.2 m^3 times 300 days, which results in an annual ingestion intake of 46 pCi.

In summary, air concentrations derived by NIOSH for the years 1945, 1990, 1994, 1995, and 1996 are provided in Table 7-2. The air concentrations for 1995 and 1996 are significantly larger than in 1994; remediation activities would have been expected to stir up and re-suspend contamination, which is bounded by this assumption.

Table 7-2: Summarized air concentrations (pCi/m^3)

Year	Air Concentration
1945	4.799
1990	0.003
1994	0.0016
1995 remediation workers	Use bioassay data
1995 perimeter workers	0.77
1996	0.77

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH concludes that it is not feasible to reconstruct uranium internal radiation doses at Baker Brothers for the period from June 1, 1943 through December 31, 1944.

NIOSH concludes that there are methods available in Battelle-TBD-6000 and ORAUT-OTIB-0070, as well as post-AWE breathing zone air data and remediation period bioassay data, so that uranium internal radiation doses can be completely reconstructed for the Baker Brothers residual radiation and remediation periods from January 1, 1945 through December 31, 1996.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from June 1, 1943 through December 31, 1944, 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 site name during the period from June 1, 1943 through December 31, 1944, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at Baker Brothers

7.3.1 Evaluation of Bounding AWE Process-Related External Doses

The principal source of external radiation doses for members of the evaluated class was exposure to gamma and beta radiation associated with handling and working in proximity to uranium while involved in the machining of materials during the AWE operations period. Some employees were also potentially externally exposed to radiation from re-suspended contamination from uranium metal surfaces and the floor during the course of their work with these radioactive materials; however, the doses assigned from handling metal are far greater and alone adequately bound their external dose.

7.3.2 Evaluation of Bounding Residual Radiation Period External Doses

NIOSH has not identified any external personnel monitoring records applicable to the residual radioactive material remaining from uranium machining during the AWE operations period. NIOSH has identified radiation survey data from surveys performed in 1989 and 1995 (see Section 6.1) that can be used to estimate the external dose rate for the remediation period. During the residual radiation period, employees were also potentially externally exposed to radiation from re-suspended contamination from surfaces and the floor.

7.3.3 Baker Brothers Occupational Medical X-Ray Examinations

NIOSH has found records to indicate that a medical monitoring program existed from the start of AWE operations (DuPont, 1945, pdf pp. 16-17, 242). Chest X-rays were scheduled in June 1943 for Robin Hood Hospital in Toledo (Nickson, 1943). Therefore, NIOSH finds that it is not applicable to reconstruct occupational medical dose for Baker Brothers workers because medical X-ray procedures were performed at an off-site, non-EEOICPA-covered facility. Therefore, based on the documented evidence, NIOSH concludes that medical X-ray dose is not a consideration for Baker Brothers workers and will not be discussed further in this evaluation.

7.3.4 Methods for Bounding External Dose at Baker Brothers

There is an established protocol for assessing external exposure when performing dose reconstructions (these protocol steps are discussed in the following subsections):

- Photon Dose
- Beta Dose
- Neutron Dose
- Medical X-ray Dose (as applicable per Section 7.3.3)

7.3.4.1 Methods for Bounding AWE Operational Period External Dose

Although no external personnel monitoring data are available to NIOSH for Baker Brothers, Table 6-1 of Battelle-TBD-6000 can be used to bound the operational period photon dose; this table provides dose rates at the surface, one foot, and one meter from various uranium shapes. Section 5 of this evaluation report discusses the Baker Brothers process and estimates the amount of uranium rods machined. During the machining operation, Baker Brothers workers were observed throughout the program carrying uranium rods without gloves. The operators also worked shifts to support the plant operations 24-hours per day and 7-days per week through much of the AWE operation effort. Baker Brothers doses were based on 48-hour workweeks and working near bare uranium metal. The calculated doses for 1943 (shown in Table 7-3) are pro-rated for the seven-month period June 1 through December 31. Air submersion dose was also derived from Battelle-TBD-6000 but the summed dose is less than 1 mR for both years and is not included. Non-penetrating skin doses can be derived from radiation survey data found in the 1989 radiological survey of the Baker Brothers site (Survey, 1992).

Table 7-3: Baker Brothers External Dose from Bare Metal While Machining Uranium

Job Title	Year	Whole-Body Dose (mR/yr)
Operator	1943	1460
Operator	1944	2500

NOTE: For doses to claimants who do not match the job title of Operator, doses are to be reconstructed by selecting the correct job title from Table 6.4 of Battelle-TBD-6000 and prorating them accordingly.

7.3.4.2 Methods for Bounding Residual Radiation and Remediation Period External Doses

In estimating external doses received during the residual radiation and remediation periods, NIOSH considered potential external doses received during radiation survey and radiological remediation operations to be bounding. NIOSH tabulated and analyzed radiation survey data obtained in 1981, 1989, 1995, and 1996, as presented in Attachment 1. The data were taken inside buildings and in soil (Aerospace, unknown date; Survey, 1992, pdf pp. 48, 50, 55, 82, 90-93; DOE, 1997, pdf pp. 30-31; Survey, 1996, pdf pp. 21, 51). The data represented photon exposures from point and planar sources taken at varying distances. NIOSH converted each result to exposure rate at one meter (μR/hr). NIOSH derived the 95th percentile and maximum exposure rates to be 12 μR/hr and 15.36 μR/hr, respectively. NIOSH used the maximum value to derive an annual whole body exposure rate by assuming that a worker (e.g., a security guard) could have worked as much as 2400 hours per year resulting in bounding annual whole body and skin doses of 37 mrem each year from January 1, 1945 through December 31, 1996.

7.3.5 External Dose Reconstruction Feasibility Conclusion

NIOSH concludes it is feasible, using methods available in Battelle-TBD-6000, to reconstruct external radiation doses for the period from June 1, 1943 through December 31, 1944 at Baker Brothers.

NIOSH concludes that it is feasible, using available radiation survey data obtained at Baker Brothers, to bound external radiation doses potentially received during the residual radiation and remediation periods from January 1, 1945 through December 31, 1996. NIOSH finds that these external doses during the residual radiation and remediation periods can be completely reconstructed.

7.4 Evaluation of Petition Basis for SEC-00204

The following subsections evaluate the assertions made on behalf of petition SEC-00204 for Baker Brothers.

7.4.1 Lack of Monitoring During AWE Operations Period

SEC-00204: Radiation exposures and radiation doses potentially incurred by members of the proposed class that relate to this petition (for the AWE operations period) were not monitored, either through personal monitoring or through area monitoring.

Neither external personnel monitoring nor bioassay data have been found. Results of seven air samples taken on three different days have been found but are insufficient to bound internal doses. NIOSH's review indicates that, in the absence of personnel monitoring data, the available process data are insufficient to bound potential internal radiation doses received during the AWE period under evaluation. NIOSH has proposed an SEC class in this evaluation report for this period, June 1, 1943 through December 31, 1944.

7.4.2 Lack of Monitoring During Residual Radiation and Remediation Periods

SEC-00204: Radiation exposures and radiation doses potentially incurred by members of the proposed class that relate to this petition (for the residual radiation and remediation periods) were not monitored, either through personal monitoring or through area monitoring.

NIOSH has not identified external personnel monitoring or bioassay data for the residual radiation period. NIOSH has found bioassay results for the DOE remediation period in 1995. NIOSH has also identified FUSRAP survey data that were useful in bounding doses for the residual radiation period, as described in Sections 7.2 and 7.3, and has presented methods for reconstructing with sufficient accuracy doses received during the residual radiation and remediation periods.

7.5 Summary of Feasibility Findings for Petition SEC-00204

This report evaluates the feasibility for completing dose reconstructions for employees at Baker Brothers from June 1943 through December 1996. NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete dose reconstructions for the AWE contract period of the evaluated class of employees.

Table 7-4 summarizes the results of the feasibility findings at Baker Brothers for each exposure source during the time period June 1, 1943 through December 31, 1944 (AWE operations) and from January 1, 1945 through December 31, 1996 (residual radiation and remediation periods).

Table 7-4: Summary of Feasibility Findings for SEC-00204
June 1, 1943 through December 31, 1944 (AWE operations);
January 1, 1945 through December 31, 1996 (residual radiation and remediation periods)

Source of Exposure	Jun 1, 1943 through Dec 31, 1944 (AWE operations)		Jan 1, 1945 through Dec 31, 1996 (Residual and Remediation Periods)	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal		**X**	**X**	
- Natural Uranium		X	X	
External	**X**		**X**	
- Gamma	X		X	
- Beta	X		X	
- Neutron	N/A	N/A	N/A	N/A
- Occupational Medical X-ray	N/A	N/A	N/A	N/A

As of October 24, 2012, four claims have been submitted to NIOSH for individuals who worked at Baker Brothers during the period under evaluation. Dose reconstructions have been completed for all four individuals, two of whom worked during the AWE contract period of the proposed SEC class from June 1, 1943 through December 31, 1944.

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 Baker Brothers during the period from June 1, 1943 through December 31, 1944, 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-00204

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. Section 83.13 requires 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.

Based on the sum of information available from available resources, NIOSH's evaluation determined that it is not feasible to estimate radiation dose with sufficient accuracy for members of the NIOSH-evaluated class for the time period from June 1, 1943 through December 31, 1944. Therefore, the resulting NIOSH-proposed SEC class must include a minimum required employment period as a basis for specifying that health was endangered for this time period. NIOSH further determined that it is feasible to estimate radiation dose with sufficient accuracy for members of the NIOSH-evaluated class for the time period from January 1, 1945 through December 31, 1996. Therefore, a health endangerment determination is not required for this time period.

9.0 Class Conclusion for Petition SEC-00204

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employees who worked at the Baker Brothers site in Toledo, Ohio, during the period from June 1, 1943 through December 31, 1944, 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. NIOSH finds it does have sufficient data and methods to estimate internal and external radiation doses with sufficient accuracy for Baker Brothers workers for the period from January 1, 1945 through December 31, 1996.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database, for information relevant to SEC-00204. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

These actions are based on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing dose for the class under evaluation.

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FUSRAP, 1995d, *Report of Analysis and Bioassay Sample Routing Log*; Formerly Utilized Sites Remedial Action Program (FUSRAP); S&H Transmittal/Review; October 3, 1995; SRDB Ref ID: 53191

FUSRAP, 1995e, *Report of Analysis and Bioassay Sample Routing Log*; Formerly Utilized Sites Remedial Action Program (FUSRAP); S&H Transmittal/Review; October 25, 1995; SRDB Ref ID: 53194

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Morse, 1944, *Work Completed at Baker Brothers and Scrap Shipping Plan*, correspondence by R. D. Morse; August 1, 1944; SRDB Ref ID: 68572

Nickson, 1943, *Uranium Metal Machining*, correspondence to C. E. Daniels from J. J. Nickson; June 29, 1943; SRDB Ref ID: 11581

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OCAS-TIB-009, *Estimation of Ingestion Intakes*, Rev. 0, NIOSH Office of Compensation Analysis and Support; April 13, 2004; SRDB Ref ID: 22397

ORAUT-OTIB-0070, *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, Rev. 01; ORAU Team Dose Reconstruction Project for NIOSH; effective March 5, 2012; SRDB Ref ID: 108851

ORAUT-OTIB-0079, *Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*, Rev. 00; ORAU Team Dose Reconstruction Project for NIOSH; effective January 3, 2011; SRDB Ref ID: 89563

Rad Handbook, 1970, *Radiological Health Handbook*, Revised Edition; compiled and edited by the Bureau of Radiological Health and the Training Institute Environmental Control Administration; revised January 1970; SRDB Ref ID: 75017

Rad Handbook, 1998, *Handbook of Health Physics and Radiological Health*, 3rd Edition; editors B. Schleien, L. Slaback, B. Kent; 1998; SRDB Ref ID: 22737

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Site Characterization, 1995, *Characterization Results for the Former Baker Brothers Site, Toledo, Ohio*, Job No. 14501, FUSRAP Project; transmittal letter author is G. L. Palau; transmittal letter dated August 2, 1995; SRDB Ref ID: 46630

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Site Visit, Sep1943, *Visit to Baker Brothers, Inc., Toledo, Ohio in September 1943*; report by John Ferry; report dated September 21, 1943; SRDB Ref ID: 9495

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Survey, 1992, *Radiological Survey of the Former Baker Brothers, Inc. Site, 2551-2555 Harleau Place, Toledo, Ohio (BTO001)*, ORNL/RASA-90/8; prepared by R. D. Foley and L. M. Floyd; published March 1992; SRDB Ref ID: 9445

Survey, 1996, *Verification Survey of the Former Baker Brothers, Inc., Site Toledo, Ohio*, Final Report, ORISE 96-1100; prepared by J. R. Morton and T. J. Vitkus; December 1996; SRDB Ref ID: 68779

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Attachment 1: Compilation of Radiation Survey Readings

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers
(This table spans six pages)

Survey Reading (µR/hr)	Adjusted at 1 Meter	Year	SRDB Ref ID	Pdf Page No.
12	0.001	1981	68815	4
15	0.002	1981	68815	4
32	1.003	1989/1990	9445	48
13	0.075	1989/1990	9445	48
13	0.075	1989/1990	9445	48
18	0.564	1989/1990	9445	48
15	0.470	1989/1990	9445	48
9	0.052	1989/1990	9445	48
13	0.075	1989/1990	9445	48
130	4.076	1989/1990	9445	48
13	0.075	1989/1990	9445	48
13	0.075	1989/1990	9445	48
11	0.064	1989/1990	9445	48
11	0.064	1989/1990	9445	48
35	0.203	1989/1990	9445	48
470	14.737	1989/1990	9445	48
20	0.627	1989/1990	9445	48
39	1.223	1989/1990	9445	48
160	5.017	1989/1990	9445	48
10	0.058	1989/1990	9445	48
10	0.058	1989/1990	9445	48
10	0.058	1989/1990	9445	48
490	15.364	1989/1990	9445	48
490	15.364	1989/1990	9445	48
240	7.525	1989/1990	9445	48
240	7.525	1989/1990	9445	48
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
15	0.087	1989/1990	9445	50
15	0.087	1989/1990	9445	50
15	0.087	1989/1990	9445	50
15	0.087	1989/1990	9445	50
15	0.087	1989/1990	9445	50
15	0.087	1989/1990	9445	50
18	0.105	1989/1990	9445	50

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers (This table spans six pages)				
Survey Reading (µR/hr)	**Adjusted at 1 Meter**	**Year**	**SRDB Ref ID**	**Pdf Page No.**
18	0.105	1989/1990	9445	50
15	0.087	1989/1990	9445	50
10	0.058	1989/1990	9445	50
9	0.052	1989/1990	9445	50
12	0.070	1989/1990	9445	50
10	0.058	1989/1990	9445	50
7	0.041	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
18	0.105	1989/1990	9445	50
13	0.075	1989/1990	9445	55
16	0.093	1989/1990	9445	55
29	0.168	1989/1990	9445	55
16	0.093	1989/1990	9445	55
12	0.070	1989/1990	9445	55
12	0.070	1989/1990	9445	55
12	0.070	1989/1990	9445	55
14	0.081	1989/1990	9445	55
15	0.087	1989/1990	9445	55
15	0.087	1989/1990	9445	55
15	0.087	1989/1990	9445	55
12	0.070	1989/1990	9445	55
15	0.087	1989/1990	9445	55
12	0.070	1989/1990	9445	55
15	0.087	1989/1990	9445	55
12	0.070	1989/1990	9445	55
29	0.168	1989/1990	9445	55
12	0.070	1989/1990	9445	55
9	0.052	1989/1990	9445	55
12	0.070	1989/1990	9445	55
12	0.070	1989/1990	9445	55
9	0.052	1989/1990	9445	55
10	0.058	1989/1990	9445	55
12	0.070	1989/1990	9445	55

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers (This table spans six pages)				
Survey Reading (µR/hr)	**Adjusted at 1 Meter**	**Year**	**SRDB Ref ID**	**Pdf Page No.**
32	0.186	1989/1990	9445	55
18	0.105	1989/1990	9445	55
32	0.186	1989/1990	9445	55
10	0.058	1989/1990	9445	55
13	0.075	1989/1990	9445	55
15	0.087	1989/1990	9445	55
15	0.087	1989/1990	9445	55
18	0.105	1989/1990	9445	55
15	0.087	1989/1990	9445	55
13	0.075	1989/1990	9445	55
12	0.070	1989/1990	9445	55
12	0.070	1989/1990	9445	55
13	0.075	1989/1990	9445	55
15	0.087	1989/1990	9445	55
13	0.075	1989/1990	9445	55
15	0.087	1989/1990	9445	55
13	0.075	1989/1990	9445	55
15	0.087	1989/1990	9445	55
15	0.087	1989/1990	9445	55
13	0.075	1989/1990	9445	55
13	0.075	1989/1990	9445	55
13	0.075	1989/1990	9445	55
13	0.075	1989/1990	9445	55
13	0.075	1989/1990	9445	55
13	0.075	1989/1990	9445	55
15	0.087	1989/1990	9445	55
13	0.075	1989/1990	9445	55
14	0.081	1989/1990	9445	55
14	0.081	1989/1990	9445	55
9	0.052	1989/1990	9445	55
20	0.002	1989/1990	9445	90
10	0.001	1989/1990	9445	90
30	0.003	1989/1990	9445	90
20	0.002	1989/1990	9445	90
20	0.002	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
20	0.002	1989/1990	9445	90

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers (This table spans six pages)				
Survey Reading (µR/hr)	**Adjusted at 1 Meter**	**Year**	**SRDB Ref ID**	**Pdf Page No.**
20	0.002	1989/1990	9445	90
20	0.002	1989/1990	9445	90
2250	0.225	1989/1990	9445	90
30	0.003	1989/1990	9445	90
7000	0.700	1989/1990	9445	90
20	0.002	1989/1990	9445	90
20	0.002	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
30	0.003	1989/1990	9445	90
5000	0.500	1989/1990	9445	90
40	0.004	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
10	0.001	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
30	0.003	1989/1990	9445	91
30	0.003	1989/1990	9445	91
20	0.002	1989/1990	9445	91
30	0.003	1989/1990	9445	91
40	0.004	1989/1990	9445	91
20	0.002	1989/1990	9445	91
30	0.003	1989/1990	9445	91
30	0.003	1989/1990	9445	91
40	0.004	1989/1990	9445	91
30	0.003	1989/1990	9445	91
30	0.003	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	91

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers (This table spans six pages)				
Survey Reading (µR/hr)	**Adjusted at 1 Meter**	**Year**	**SRDB Ref ID**	**Pdf Page No.**
20	0.002	1989/1990	9445	91
20	0.002	1989/1990	9445	92
30	0.003	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
40	0.004	1989/1990	9445	92
20	0.002	1989/1990	9445	92
30	0.003	1989/1990	9445	92
20	0.002	1989/1990	9445	92
30	0.003	1989/1990	9445	92
30	0.003	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
30	0.003	1989/1990	9445	92
20	0.002	1989/1990	9445	92
30	0.003	1989/1990	9445	92
30	0.003	1989/1990	9445	92
30	0.003	1989/1990	9445	92
30	0.003	1989/1990	9445	92
30	0.003	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
20	0.002	1989/1990	9445	92
40	0.004	1989/1990	9445	93
30	0.003	1989/1990	9445	93
30	0.003	1989/1990	9445	93
30	0.003	1989/1990	9445	93
50	0.005	1989/1990	9445	93
30	0.003	1989/1990	9445	93
20	0.002	1989/1990	9445	93
20	0.002	1989/1990	9445	93
20	0.002	1989/1990	9445	93
10.52	10.520	1995	68812	30
12.81	12.810	1995	68812	30
9.1	9.100	1995	68812	31

Table A1-1: Compilation of Radiation Survey Readings Taken at Baker Brothers
(This table spans six pages)

Survey Reading (µR/hr)	Adjusted at 1 Meter	Year	SRDB Ref ID	Pdf Page No.
9.4	9.400	1995	68812	31
8	8.000	1996	68779	51
8	8.000	1996	68779	51
10	10.000	1996	68779	51
11	11.000	1996	68779	51
15	15.000	1996	68779	51
11	11.000	1996	68779	51
14	14.000	1996	68779	51
12	12.000	1996	68779	51
13	13.000	1996	68779	51
13	13.000	1996	68779	51
12	12.000	1996	68779	51
12	12.000	1996	68779	51

Attachment 2: Data Capture Synopsis

Table A2-1: Data Capture Synopsis for Baker Brothers			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site/Company Name: Baker Brothers; AWE 1943-1944; Residual Radiation 1945-1994, 1996; DOE 1995 (remediation) Alternate Site Names (Not successor companies): Rems, Inc. Doug Beet Company Romanoff Industries Physical Size of the Site: Approximately 26.4 acres, with approximately 103,000 square feet under roof. Site Population: 1943 and 1944 reports indicate that approximately 30 employees were involved in uranium machining. By 1944 most of these employees were women.	Baker Brothers assets were liquidated in 1944. There is no company or successor company to contact.	07/01/2012	0
State Contacted: Ohio Department of Health, Bureau of Radiation Protection; Ohio Environmental Protection Agency	No relevant documents identified that were not already in the SRDB.	08/31/2012	0
DOE Germantown	A list of covered facilities under EEOICPA, the designation of the Baker Brothers site for remediation, and reference to Baker Brothers having machined uranium slugs for Oak Ridge National Laboratory (known as the Clinton Laboratory at that time) and Hanford.	09/11/2002	3
DOE Legacy Management - Grand Junction Office	A letter confirming the planned completion of Baker Brothers work for Clinton Laboratory in August 1944, FUSRAP documents and radiological surveys, 1943 site visits, April 1944 Clinton Laboratory uranium requirements, a 1943 accountability report, and the transfer and testing of swaged rods.	06/13/2011	69
DOE Oak Ridge Operations Office	No relevant documents identified.	08/28/2012	0
DOE Oak Ridge Operations Office, Sanitized Records Holding Task Group Finding Aid	No relevant documents identified.	08/28/2012	0
DOE Office of Scientific and Technical Information	No relevant non-publicly available documents identified.	07/25/2012	0
Federal Records Center (FRC) - Kansas City/Lenexa	FUSRAP surveys and documentation, bioassay samples from the site remediation, and the remediation controlled area access log.	08/12/2008	12

Table A2-1: Data Capture Synopsis for Baker Brothers			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Hagley Museum and Library	Verification of Baker Brothers having machined 130 tons of uranium for the Clinton Laboratory.	09/29/2010	1
Hanford	A search request was made on 08/13/2012. At this time all Hanford requests are on hold due to budget issues.	OPEN	0
Internet - Defense Technical Information Center (DTIC)	The 1995 baseline environmental management report for Manhattan Engineer District and AEC sites.	07/20/2012	2
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	08/23/2012	0
Internet - DOE Legacy Management Considered Sites	Site fact sheet, FUSRAP documentation, and an aerial photograph of the site.	07/01/2012	5
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	07/01/2012	0
Internet - DOE OpenNet	Historical references to Baker Brothers participation in the nuclear weapons complex.	12/31/2007	2
Internet - DOE OSTI Energy Citations	An introduction to DOE's decommissioning experience, the investigation and mitigation of fire hazards from uranium turnings, and a review of Baker Brothers machining procedure.	07/17/2012	3
Internet - DOE OSTI Information Bridge	A detailed discussion of Baker Brothers processes and contracts and the 1994 DOE general environmental impact statement for complex-wide environmental remediation.	06/22/2007	2
Internet - Google	FUSRAP documents, confirmation that Baker Brothers received some uranium from Revere Copper and Brass, an Ohio Department of Health listing of radiological sites, and news articles.	07/07/2012	13
Internet - Hanford Declassified Document Retrieval System (DDRS)	A 1944 report of health hazards at Baker Brothers.	03/25/2010	1
Internet - Health Physics Journal	No relevant documents identified.	08/23/2012	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	08/23/2012	0
Internet - National Academies Press (NAP)	No relevant documents identified.	07/01/2012	0
Internet - NIOSH	A 2006 NIOSH report on residual contamination at Atomic Weapons Employer facilities.	01/25/2007	1
Internet - NRC Agencywide Document Access and Management (ADAMS)	NRC evaluations of contaminated sites reported in the September 2006 USA Today article, FUSRAP policies manual included as a response to a petition for rulemaking, and Baker Brothers identified as a FUSRAP site.	09/03/2011	5
Internet - Savannah River Site	No relevant documents identified.	08/23/2012	0

Table A2-1: Data Capture Synopsis for Baker Brothers			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - Toledo Public Library	No relevant documents identified.	08/20/2012	0
Internet - University of Toledo	No relevant documents identified.	08/20/2012	0
Internet - USACE/FUSRAP	No relevant documents identified.	07/01/2012	0
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	07/01/2012	0
National Archives and Records Administration (NARA) - Atlanta	Surveys and air sampling at Baker Brothers, accountability reports, material transfers, and descriptions of health programs for Clinton Laboratory subcontractors.	05/01/2010	10
National Archives and Records Administration (NARA) - College Park	No relevant documents identified.	08/20/2012	0
National Institute for Occupational Safety and Health (NIOSH)	The cost of the Baker Brothers Clinton Laboratory contract.	11/04/2008	1
Oak Ridge National Laboratory	A report on health hazards at Baker Brothers and a reference to potential health hazard similarities between Baker Brothers and Joslyn Manufacturing and Supply.	09/07/2012	2
ORAU Team	The ORAU Team Technical Information Bulletin on estimating the maximum plausible dose to atomic weapons employer workers.	02/09/2007	1
S. Cohen & Associates / NIOSH	A report which identifies Baker Brothers as a source of uranium slugs for Hanford in 1944.	08/14/2003	1
Unknown	FUSRAP documents, a description of Baker Brothers machining process dust and chip fire control, and Baker Brothers identified as a FUSRAP site.	07/09/2004	22
TOTAL			**156**

Table A2-2: Databases Searched for Baker Brothers			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel files called "Baker Brothers Rev 00 (83 13) 09-28-12 (2)"			
Defense Technical Information Center (DTIC) https://www.dtic.mil/ COMPLETED 07/11/2012	See Note above	10	1
DOE CEDR https://www.orau.gov/cedr COMPLETED 08/23/2012	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 07/01/2012	See Note above	0	0
DOE Legacy Management Considered Sites http://www.lm.doe.gov/considered_Sites/ COMPLETED 07/01/2012	See Note above	55	2
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 07/01/2012	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 07/01/2012	See Note above	0	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 07/01/2012	See Note above	28	2
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 07/01/2012	See Note above	24	1
Google http://www.google.com COMPLETED 07/07/2012	See Note above	25,553	3
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 08/23/2012	See Note above	0	0

Table A2-2: Databases Searched for Baker Brothers			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 08/23/2012	See Note above	0	0
National Academies Press http://www.nap.edu/ COMPLETED 07/01/2012	See Note above	925	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 07/01/2012	See Note above	1,069	0
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 07/01/2012	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 07/01/2012	See Note above	0	0

Table A2-3: OSTI Documents Requested for Baker Brothers			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DUH-10917 Ref ID: 116470	Project 9536, Metal Turnings - Fire Hazard, 8/27/1943	07/10/2012	07/17/2012
HW-3-92 Ref ID: 116471	Observation on Machining Speeds and Feeds, 3/2/1944	07/10/2012	07/17/2012