Baker Brothers
Special Exposure Cohort
Petition Evaluation Report

James W. Neton, PhD, CHP
Associate Director for Science
National Institute for Occupational Safety and Health
Division of Compensation Analysis and Support

December 2012
Knoxville, TN

EEOICPA Facility Listing

- **Baker Brothers**
- **State: Ohio Location: Toledo**
- **Atomic Weapons Employer (AWE) 1943-1944; Residual Radiation 1945-1994, 1996; Department of Energy (DOE) 1995 (remediation)**
- **Facility Description: Between June 1943 and July 1944, DuPont and the University of Chicago subcontracted the Baker Brothers company to machine roll metal rods into uranium slugs that were used for fuel in the world's first production reactors located in Oak Ridge, TN and Hanford, WA**

Petition Overview

- June 5, 2012: NIOSH received an 83.13 petition for period of 1943 through 1996
- July 24, 2012: Petition qualified for evaluation
- November 14, 2012: Evaluation Report approved
- SEC class recommended: 1943 - 1944

Petition Overview—cont.

Basis for Qualification

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

Petition Overview—cont.

- **Petitioner requested class:**

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

- **NIOSH recommended class:**

  All employees who worked in any area of Baker Brothers, in Toledo, Ohio, from June 1, 1943 through December 31, 1944

Class Evaluated by NIOSH

- All employees who worked in any area of Baker Brothers, in Toledo, Ohio, from June 1, 1943 through December 31, 1996
- The start date of the evaluation period is consistent with the start of Manhattan Engineer District (MED) operations at Baker Brothers
- The end date of evaluation represents the last day of the calendar year that Baker Brothers is listed as covered on the EEOICPA facility list

Sources of Available Information

- Site Profile Battelle-TBD-6000, used to model external doses for the machining process, and to estimate contamination levels from operations
- ORAUT-OTIB-0070 methods used to model residual period doses
- NIOSH Site Research Database: 154 documents researched
- Normal data searches were also conducted

Previous Dose Reconstructions

NIOSH DCAS Claims Tracking System

Information current as of November 28, 2012

- **Baker Brothers claims submitted for dose reconstruction** **4**
- **Claims with employment in the AWE contract period only** **1**
- **Claims with employment in the residual period only** **2**
- **Claims with employment in both AWE and residual periods** **1**
- **Claims for which dosimetry records were obtained** **0**

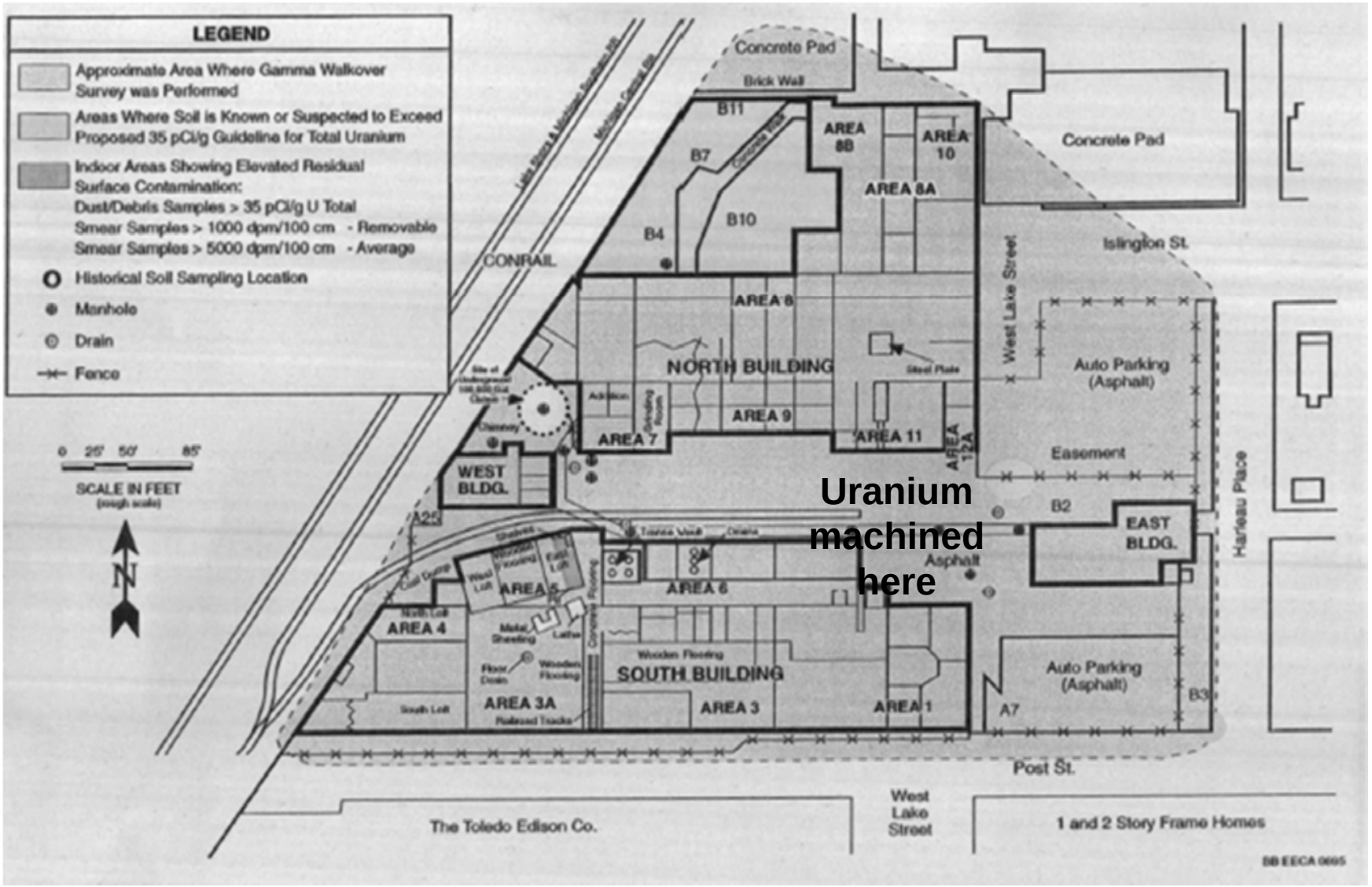
Baker Brothers AWE Operations

- Baker Brothers was a DuPont subcontractor used for production level machining of uranium slugs
- The uranium slugs were used in the first production reactors at the Clinton Engineer Works and the Hanford Engineer Works

Baker Brothers AWE Operations—cont.

- Machining work started in June 1943
- Utilized four lathes for both rough and finish turning
- Machining work was completed in August 1944
- Shipping records indicate scrap metal and turnings remained on site through October 1944

Baker Brothers Site



Slug Production

- First order was for Clinton Engineer Works
  - 41,133 slugs produced from 2,107 rods
  - Rods received were about 8 feet long; finished slug size varied from about 4” to 6” long and up to about 1.3” diameter
  - Initial order of slugs were shipped out by the end of October 1943

Slug Production—cont.

- **Additional slug work by Baker Brothers:**
  - **Milling grooves into previously machined Clinton slugs**
  - **Development work for the Hanford slugs**
  - **Reclaiming used experimental slugs**
  - **Production of slugs for Hanford in 1944**

Amount of Uranium Processed

- **Total number of slugs machined:**
  - **41,133 slugs produced for Clinton**
  - **12,435 slugs grooved and refaced**
  - **16,899 slugs produced for Hanford**
  - **Approximately 90 tons of uranium metal received and shipped in 1943**
  - **Precise tonnage of uranium metal handled in 1944 not available**

Facility Status Post Production

- DOE (Formerly Utilized Sites Remedial Action Program - FUSRAP) documents reported that the Baker Brothers facility was decontaminated to existing guidelines at the end the contract.

- A Corps of Engineer letter from 1944 indicates that the Baker Brothers contract was to be closed out as soon as all scrap, turnings, and sweepings were shipped.

- The Baker Brothers assets were eventually liquidated and the machinery and equipment were sold at auction. The property was subsequently used primarily for offices and motor brokerage and electrical services.

Potential Radiation Exposures During the Evaluated Period

- **Sources of internal dose**
  - **Inhalation and ingestion of uranium from machining operations**
  - **Inhalation and ingestion of uranium from residual contamination**
- **Sources of external dose**
  - **Photon and beta exposure from uranium metal**
  - **Photon and beta exposure from residual contamination**

Radiological Monitoring Data

- **AWE Contract Period, 1943-1944**
  - **Workers had periodic medical monitoring, but no personal monitoring data is available or known to exist**
  - **Limited air sample data:**

    1943 (3 samples); 1944 (4 samples);

    Samples were collected during visits by doctors from the Metallurgical Laboratory

Radiological Monitoring Data—cont.

- **Residual and Remediation Periods, 1945-1996**
  - **Bioassay data available for the remediation period in 1995**
  - **Air sampling conducted in 1989 and in 1995**
  - **No personal external dosimetry data**
  - **Radiation and contamination surveys performed in 1981, 1989, 1990, 1995 and 1996**

Dose Reconstruction, AWE Period

- **Internal Dose 1943-1944**
  - **Six air sample results from three days in 1943-1944 are insufficient to characterize episodic exposures from operations and fires**
  - **Data in Battelle-TBD-6000 from other sites in later years not necessarily representative of exposure from machining in 1943-1944**
  - **Internal dose cannot be reconstructed with sufficient accuracy**

Dose Reconstruction, AWE Period—cont.

- **External Dose 1943-1944**
  - **No radiation measurements from Baker Brothers are available for the AWE contract period**
  - **External dose data in Battelle-TBD-6000 is representative of external dose rates from uranium metal in 1943-1944**
  - **External dose from exposures in 1943-1944 can be reconstructed with sufficient accuracy**

Dose Reconstruction, Residual Period

- **Internal Dose 1945-1996**
  - **Calculation of airborne radioactivity in 1945 made from estimates of bounding contamination levels at the beginning of the residual period**
  - **Detection limit of air samples taken in 1989 was used with the 1945 airborne radioactivity estimate to determine a source term depletion rate of 0.164/yr**
  - **Annual inhalation and ingestion intakes for each year were calculated through 1994**

Dose Reconstruction, Residual Period—cont.

- **Internal Dose 1945-1996, cont.**
  - **For the remediation period in 1995, bioassay data are available for remediation workers**
  - **General area airborne radioactivity data is available for other workers in 1995**
  - **1995 dose bounds dose from work in 1996, which consisted of confirmation surveys and decontamination of a couple spots identified during the surveys**

Dose Reconstruction, Residual Period—cont.

- **External Dose 1945-1996**
  - **Characterization data indicated relatively low radiation levels, not significantly higher than background for whole body exposures in most areas**
  - **Highest dose rates and soil contamination levels were found in the outdoor courtyard where the uranium metal had been staged in 1943-1944**
  - **Bounding external dose of 0.037 mrem per work year was calculated based on continuous exposure in the courtyard from 1945 to 1996**

Feasibility of Dose Reconstruction

- **AWE Contract Period, 1943-1944**
  - **NIOSH found that the available air monitoring records are insufficient to estimate intakes**
  - **Baker Brothers was one of the first companies to machine uranium on a production scale**
  - **Methods of applying coolant, controlling fires, and controlling exposures were developed concurrent with operations at Baker Brothers**
  - **Intakes cannot be estimated with sufficient accuracy**

Feasibility of Dose Reconstruction—cont.

- **AWE Contract Period, 1943-1944**
  - **NIOSH found that external dose from exposure to uranium metal can be estimated using available uranium metal dose rate measurement data**
  - **External dose during the AWE Contract Period can be reconstructed with sufficient accuracy**

Feasibility of Dose Reconstruction—cont.

- **Residual and Remediation Periods, 1945-1996**
  - **NIOSH found that internal doses can be estimated with sufficient accuracy based on estimates of bounding contamination levels at the start of the residual period and air sampling results from the later residual period**
  - **Internal dose during remediation can be estimated using available worker and area monitoring data**
  - **External dose during the residual and remediation periods be estimated based on measured dose rates**

Summary

Feasibility Findings for Baker Brothers Petition June 1943 – December 1944		
Source of Exposure	**Reconstruction Feasible**	**Reconstruction NOT Feasible**
Internal		
- Uranium		X
External		
- Uranium beta-gamma	X	
- Neutron	N/A	
- Medical X-ray	N/A	

Summary

Feasibility Findings for Baker Brothers Petition January 1945 – December 1996		
Source of Exposure	**Reconstruction Feasible**	**Reconstruction NOT Feasible**
Internal		
- Uranium	X	
External		
- Uranium beta-gamma	X	
- Neutron	N/A	
- Medical X-ray	N/A	

Recommended Class

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