SEC Petition Evaluation Report
Petition SEC-00200

Report Rev #: 1 Report Submittal Date: December 3, 2012

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Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00200	83.13	March 15, 2012	May 10, 2012	Joslyn Manufacturing and Supply Company

Petitioner-Requested Class Definition

All employees who worked in any area of the Joslyn Manufacturing and Supply Company in Fort Wayne, Indiana, from 1944 through 1952.

Class Evaluated by NIOSH

All employees who worked in any area of the Joslyn Manufacturing and Supply Company in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1952.

NIOSH-Proposed Class to be Added to the SEC

All Atomic Weapons Employees who worked in any buildings/area owned by the Joslyn Manufacturing and Supply Co. (or a subsequent owner) in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1947, 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
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Evaluation Report Summary: SEC-00200, Joslyn Manufacturing

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-00200 was received on March 15, 2012, and qualified on May 10, 2012. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area of the Joslyn Manufacturing and Supply Company, in Ft. Wayne, Indiana, from 1944 through 1952.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH expanded the petitioner-requested class. NIOSH obtained documentation indicating that three uranium ingots cast at Massachusetts Institute of Technology were shipped to Chicago for rolling at Joslyn Manufacturing and Supply Co. on March 13, 1943; therefore, the start date for the NIOSH-proposed class was expanded to March 1, 1943, to include covered work that began earlier than previously determined to be Atomic Energy Commission operations (see Section 3.0 below). NIOSH evaluated the following class: All employees who worked in any area of the Joslyn Manufacturing and Supply Company, in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1952.

NIOSH-Proposed Class 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 in any buildings/area owned by the Joslyn Manufacturing and Supply Co. (or a subsequent owner) in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1947, 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 NIOSH-proposed class does not comprise the entire evaluated class because NIOSH finds it is feasible to perform sufficiently accurate dose reconstruction from January 1, 1948 through the end of radiological operations on December 31, 1952, using the methods described in Section 7.2 and further defined within Battelle-TBD-6000.

Feasibility of Dose Reconstruction

NIOSH finds it is not feasible to estimate internal exposures with sufficient accuracy for all workers at the site from March 1, 1943 through December 31, 1947. The limited air sampling conducted at the time was based on mass samples collected by electrostatic precipitation. NIOSH does not have adequate information regarding the accuracy and uncertainties of this methodology and is not fully aware of the limitations and biases associated with this sample collection method. Additionally, the site made attempts to establish ventilation controls, using tenting structures, to reduce airborne contamination during grinding operations. These efforts to reduce airborne contamination were ultimately unsuccessful and introduce uncertainty about how the monitoring data were collected. There have been no personnel monitoring data located that could be used to support the limited air monitoring results. NIOSH is not able to establish confidence in the ability to perform sufficiently accurate dose reconstruction based on the available data associated with the uranium operations at Joslyn Manufacturing and Supply Co. beginning in March 1943 through December 1947.

The data which Battelle-TBD-6000 bases its methods and conclusions is applicable to rolling and machining operations and can be sufficiently equated to the uranium operations conducted at Joslyn. These data were collected starting in 1948. These data were used to establish dose estimation procedures found in Battelle-TBD-6000, which NIOSH believes are sufficient to bound the potential exposures associated with work at Joslyn from January 1948 through December 1952 with sufficient accuracy. With the exception of the class defined for March 1943 through December 1947, 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 Battelle-TBD-6000 and additional resources are sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period from January 1, 1948 through December 31, 1952.

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

- NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Joslyn Manufacturing and Supply Company workers with sufficient accuracy.

- Principal sources of internal radiation for members of the proposed class included exposures to uranium and uranium oxides released into the work environment during the production and shaping of uranium metal rods. The modes of exposure were inhalation and ingestion during the processing of these metals.

- In addition, there was potential for internal exposure to airborne thorium released on two days as a result of experimental centerless grinding of thorium rods in 1946 and early 1947.

- Based on insufficient information regarding operations and air monitoring during the years of process development (1943-1947), NIOSH has concluded that sufficiently accurate internal dose reconstruction for the period from March 1, 1943 through December 31, 1947, is not feasible. However, NIOSH has identified sufficient information and air monitoring data that can be assessed using existing dose reconstruction methods defined in Battelle-TBD-6000 to support bounding internal dose for the period from January 1, 1948 through December 31, 1952.

- 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 and thorium metals during machining operations. The modes of exposure were direct radiation, submersion in potentially-contaminated air, and exposure to contaminated surfaces.

- NIOSH has determined that reconstruction of external doses for Joslyn workers is feasible using the assumptions and approaches presented in Battelle-TBD-6000.

- 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 for the period at Joslyn Manufacturing and Supply Co. from March 1, 1943 through December 31, 1947.

- 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 Joslyn Manufacturing during the period from March 1, 1943 through December 31, 1947, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

- NIOSH concludes pursuant to 42 C.F.R. § 83.13(c)(1), that there is sufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate for the period at Joslyn from January 1, 1948 through December 31, 1952.

Health Endangerment Determination

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 radionuclides, combined with external exposures to beta and gamma radiation. Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who worked from March 1, 1943 through December 31, 1947, and 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 January 1, 1948 through December 31, 1952, 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-00200

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any area of the Joslyn Manufacturing and Supply Company in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1952. 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 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

[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.

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-00200 Joslyn Manufacturing Class Definitions

The following subsections address the evolution of the class definition for SEC-00200, Joslyn Manufacturing and Supply Company (often referred to as Joslyn and Joslyn Manufacturing throughout this report). 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-00200 was received on March 15, 2012, and qualified on May 10, 2012. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area of the Joslyn Manufacturing and Supply Company, in Ft. Wayne, Indiana, from 1944 through 1952.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Joslyn workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00200 for evaluation:

> Based on a review of the available records for Joslyn Manufacturing and Supply Company claimants who were employed during the petitioner-requested class period, there is an indication that monitoring data are not available and that it was possible that monitoring

[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.

was not adequately performed for those workers who had the potential for radiological exposures. The petitioner's representative, in the form of an affidavit, stated:

There were thorium rollings at Joslyn Manufacturing and Supply Co. and to the best of my knowledge there was no monitoring.

Based on its Joslyn Manufacturing research and data capture efforts, NIOSH determined that it has access to limited air monitoring data and source term information for Joslyn workers during the time period under evaluation. However, NIOSH also determined that air monitoring records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal radiation exposures and radiation doses were not adequately monitored at Joslyn Manufacturing and Supply Company, 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 expanded the petitioner-requested class to include covered work that began earlier than originally determined to be Atomic Energy Commission (AEC) operations because NIOSH located documentation stating that uranium billets were on site as early as March 1943, in conjunction with Joslyn Manufacturing and Supply Company performing Atomic Weapons work under contract for the Manhattan Engineer District (MED). In addition, on July 19, 2012, DCAS received a memo from the Department of Labor (DOL) clarifying a change in the start of the covered period for Joslyn from 1944 to May 1943 (DOL, 2012a). On November 29, 2012, NIOSH received a second memo from DOL regarding the covered period at Joslyn. In this memo, DOL concurred with NIOSH that a March 15, 1943, document titled "Memorandum of Rolling Tube alloy" described the rolling of uranium billets that took place at the Joslyn facility on March 13, 1943 (DOL, 2012b). Thus, DOL agreed that the start date should be altered and that the revised covered period for Joslyn should be March 1943 through 1952. Therefore, NIOSH defined the following class for further evaluation: All employees who worked in any area of the Joslyn Manufacturing and Supply Company in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1952.

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 in any buildings/area owned by the Joslyn Manufacturing and Supply Co. (or a subsequent owner) in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1947, 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.

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 Joslyn Manufacturing and Supply Company. 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 1 contains a summary of Joslyn Manufacturing 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 Joslyn Manufacturing had a significant part in the development of rolling techniques early in the MED's work, it was a small part of the overall project. No Site Profile has been developed for Joslyn. However, Battelle-TBD-6000 includes information and assumptions used to provide generic historic background information and guidance to assist the preparation of dose reconstructions for this category of sites. Battelle-TBD-6000 provides an exposure matrix for workers at AWE facilities that performed metal-working operations with uranium metal, and includes general discussions of operations and exposure conditions at uranium metal-working facilities. Therefore, as part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Joslyn Manufacturing operations or related topics/operations at other sites:

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

- *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals and Thorium Metals-Appendix BB, General Steel Industries*; Battelle-TBD-6000, Appendix B, Rev.00; June 25, 2007; SRDB Ref ID: 47713

4.2 ORAU Technical Information Bulletins (OTIBs)

An ORAU Technical Information Bulletin (OTIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIBs as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 04; June 20, 2011; SRDB Ref ID: 98147

- *OTIB: 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 information, NIOSH interviewed three former Joslyn employees. The interviews were conducted as a Worker Outreach Meeting for Joslyn Manufacturing and Supply Company on July 25, 2012. Representatives of DCAS, Advanced Technologies and Laboratories International, Inc. (ATL), Oak Ridge Associated Universities (ORAU), and Sanford Cohen and Associates (SC&A) were in attendance.

- Personal Communication, 2012, *Personal Communication with Rolling Mill Operators and Centerless Grinder Operator*; face-to face group interview; July 25, 2012; SRDB Ref ID: 118494

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 November 30, 2012)

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

Description	Totals
Total number of claims submitted for dose reconstruction	62
Total number of claims submitted for energy employees who worked during the period under evaluation (March 1, 1943 through December 31, 1952)	62
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)	35
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

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. None of the claims have received responses containing internal or external dosimetry records. Three claims have been linked to data located in NIOSH record holdings, but those data are not related to radiation dosimetry.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. As of November 30, 2012, there were 227 documents in this database identified as pertaining to Joslyn. These documents were evaluated for their relevance to this petition. The documents include historical background on uranium rolling; grinding and cutting operations conducted by Joslyn on behalf of the AEC and relevant to the British and Canadian work by Joslyn; records of specific rolling events, including how many uranium billets were shipped to Joslyn for rolling; and air monitoring survey results.

NIOSH has documentation of four radiological surveys of the former Joslyn Manufacturing and Supply Company performed in 1949, 1976, 2004, and 2005 respectively. Copies of the reports from the 1949, 1976, and 2004 surveys are included within the U.S. Army Corps of Engineers' (ACE) preliminary assessment of Joslyn Manufacturing and Supply Co. (Army Corps, 2005).

The 1949 survey was performed by the AEC Health and Safety Laboratory (HASL) on August 1, 1949. The results of this survey indicated that residual levels of contamination, ranging from 6,000 disintegrations per minute (dpm) to 30,000 dpm, existed in several areas used for AEC metal fabrication operations.

Oak Ridge National Laboratory (ORNL) performed a survey on October 23, 1976, to assess the radiological status of the site. The report associated with the ORNL survey is dated March 1980. ORNL reviewed the 1949 HASL survey; although ORNL was unable to contact the author, they concluded that "...accountability procedures at the time of operation required that all uranium scrap, oxides, residues, and wastes be returned to AEC, it is highly unlikely that quantities of radioactivity sufficient to present a potential health hazard would exist under concrete surfaces and structures" (Army Corps, 2005, PDF pp. 22-28). ORNL did not detect "any significant radioactivity" in their survey. On these bases, ORNL concluded that "no present or potential radiation-related health hazard exists due to MED/AEC operations and no further DOE survey is required..." (Army Corps, 2005, PDF pp. 22-28).

In February and March of 2004, Radiation Safety Services Incorporated (RSSI) performed a limited radiological survey for Valbruna Steel (Army Corps, 2005, PDF pp. 40-121). This survey was performed with the help of an employee with direct knowledge of University of Chicago contracted operations. This survey included the advancement of soil borings (Borings A - D) in the EastWest Bay (Building 8) and in the former burn pit area outside immediately to the north of Building 8 (P-l through P-6). Borehole count rates showed elevated readings at depths 3-10 ft below ground surface (bgs) in the burn pit area, and at depths 4-9 ft bgs in the Processing Building (Building 8). The highest isotopic uranium concentrations were in a sample from Borehole D (4-8 ft bgs interval) which had uranium-235 at 2.07 pCi/g and uranium-238 at 73.5 pCi/g. Uranium-235 was less than 1 pCi/g in the other eight samples for which data were reported, and less than 10 pCi/g for uranium-238.

In January 2005, Science Applications International Corporation (SAIC) performed a focused radiological survey of the center portion of the North-South Bay (Building 9) and an assessment of potential personnel exposure to residual radioactive contamination at the request of the site owner at that time, Fort Wayne Steel (SAIC, 2005). The survey identified additional areas of fixed contamination on columns and beams, but "using extremely conservative assumptions for modeling" concluded that "exposure is 0.02 mrem/year to an equipment operator . . . fixed equipment can be operated . . . with negligible risk to personnel due to exposure due to radioactive material when compared to other hazards in any work environment" (SAIC, 2005).

A site visit was conducted on May 26, 2006, by Earth Tech personnel in conjunction with the ACE project staff, along with representatives of the site owner and personnel from the Indiana Departments of Health and Environmental Management. Input and observations from the site visit were utilized in developing the Field Sampling Plan. The report presents data generated from soil sampling conducted at Joslyn Manufacturing in July 2006 (Earth Tech, 2006).

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the Joslyn Manufacturing and Supply Company from March 1, 1943 to December 31, 1952, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and controls descriptions, information regarding the identity and quantities of the radionuclides of concern, and information describing uranium billet heat treating, hot rolling, quenching, straightening, grinding, cropping, and threading operations 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 Joslyn Manufacturing Plant and Process Descriptions

ATTRIBUTION: Section 5.1 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities and Joe Guido, MJW Corp. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Joslyn Manufacturing and Supply Company, also known as Joslyn Stainless Steel Company, Fort Wayne Steel Corporation, and Slater Steel, performed tempering, hot rolling, quenching, straightening, cooling, grinding, waste burning, and abrasive cutting of natural uranium billets into metal rods for use in Hanford site nuclear reactors. Joslyn Manufacturing was instrumental in developing the procedures for rolling uranium metal rods. Joslyn also performed rolling operations after 1949 for the Chalk River reactor fuel assemblies.

Joslyn Manufacturing was located at 2400 W. Taylor Street in Fort Wayne, Indiana, on a 23-acre site. Fort Wayne is located in northeastern Indiana (Army Corps, 2005, PDF p. 6). The plant is about 1.3 miles west-southwest of downtown Fort Wayne. At the time of site operations the site included

Buildings 1 through 11 (see Figure 5-1). Buildings 6, 7, 8, and 9 were Operational Buildings where uranium was treated and machined. Because there were no documented controls to limit worker movement from any part of the site, in or out of these buildings, Buildings 1 through 11 are all pertinent to this evaluation. For the period under evaluation, the Joslyn Manufacturing workforce consisted of 100 to 200 workers with anywhere from 25 to 75 working on fabricating uranium rods for the AEC.

Source: Maroncelli, 2007, PDF p. 236

Figure 5-1: Partial View of Joslyn Manufacturing Buildings

Considerable early work at Joslyn Manufacturing was for the purpose of determining the best procedures for rolling and machining natural uranium rods, which made it necessary that the procedures changed over time; however, the basic process remained fairly consistent. Natural uranium billets were received by rail at Joslyn Manufacturing, unloaded by an overhead crane onto carts, and stored in a storage area. The billets were taken, as needed, from the storage area to the tempering area, pre-heated in one of eight small natural-gas-atmosphere electric furnaces to a specified temperature, and moved to the rolling mills (an 18-inch roughing stand, 12-inch intermediate mill, and a 9-inch finishing mill were used) where passes occurred (Army Corps, 2005, PDF pp. 6-7). Time was allowed for the rolls to cool between passes in order to prevent the metal from exceeding a specified temperature.

The grinding process was carried out in two widely separated parts of a large shed. The first operation consisted of grinding uranium rods. This process was carried out in a small shed constructed inside a larger shed. The fumes and dust from this smaller shed were vented into the atmosphere of the larger shed. The second operation was a rough cut on the uranium rods inside of the smaller shed. The rods were cropped and moved to the threading area, where they were milled and machined to contract specifications (Army Corps, 2005, PDF p. 7).

As mentioned, activities at Joslyn Manufacturing initially consisted of experimental work in the development of uranium rolling and centerless grinding. Table 5-1 provides activities and approximate quantities. The total quantity processed, based on these activities, is approximately 1, 127,000 lb.

Table 5-1: AEC-Related Uranium Activities and Quantities at Joslyn

Time Frame	Activity	Quantity
6/1943	Experimental Rolling/Straightening	255 lb
7/1943 – 1/1944	Centerless Grinding	35,000 lb
3/1944 – 7/1944	Rolling	130,747 lb
01/25/1945	Special request	24,000 lb
02/03/1945	For Hanford 793 billets (assumed to weigh 260 lb each)	206,000 lb
03/01/1945 – 05/15/1945	Special Request, 220 threaded rods (assumed to weigh 120 lb each)	26,400 lb
11/01/1946	Hanford	22,000 lb
1946	Accounting related to rods supplied to Britain	60,000 lb
2/1948 – 7/1948	Rolling	600,000 lb
01/01/1950	Inventory record	15,400 lb
07/31/1950	Hanford request	5,500 lb
10/01/1951	15 rods (assumed to weigh 120 lb each)	1,800 lb
		Total: 1,127,102 lb

Experimental Work-Rolling/Straightening (1943)

In a 1943 memo, Joslyn is listed as one of 11 commercial companies conducting experimental work involving natural uranium. Joslyn is described as performing hot rolling and cold straightening of 'tuballoy' (Dean, 1943). The date of the earliest rolling at Joslyn within the current covered period was June 29, 1943 (Echo, 1943a; DuPont, 1945, PDF p. 65). Inventory records for this period list a total of 255.7 lb of uranium consisting of one 85.6 lb ingot and 2 ingots weighing a total of 170.1 lb (Cohen, 1943; Receipt, May1943; Chipman, 1943).

Experimental Work-Centerless Grinding (1943/1944)

An August 11, 1943 memo requested the transfer of 20 rods from the "West Stands" to Joslyn to be used in the "machining and grinding program to be set up there" (Crouts, 1943). It is stated that this work will require "very little" metal. Documentation from the period shows Joslyn as having a contract from August 1943 through June 1946 for $35,000 with the nature of work listed as "centerless grinding" (Status Report, 1943-1946, PDF p. 18). The initial experiment involved 14 extruded rods (diameters from 1.345–1.401 inches and length from 63.25–92 inches) and took place on September 7, 1943 (Echo, 1943b). A larger-scale operation was conducted between November and December 1943 during which a total of 34,608 lb of rods were ground (Simmons, 1944, PDF p. 59; Simmons, 1943; Greninger, 1943; Echo, 1943a).

Production Scale Rolling (1944)

A March 25, 1944 memo recommends that "a sizeable lot, for example 30 to 40 tons of metal" be hot rolled, preferably at the Joslyn plant. It was believed at that time that rods produced by this method would not have the defects that were present in material that was extruded. Rolling was conducted during three periods: 60,122 lb between May 9, 1944 and May 11, 1944; 5,900 lb on June 2, 1944; and 64,725 lb between June 22, 1944 and June 24, 1944) (DuPont, 1945, PDF p. 66; Shipping, May1944a; Shipping, May1944b; Shipping, Apr1944; Monthly Report, May1944; Monthly Report, June 1944; Shipping, Jun1944). A fourth rolling was planned for July 1944, but was cancelled (DuPont, 1945, PDF p. 67).

Production Scale Rolling (1948)

A February 26, 1948 memo indicated that the AEC was looking for rolling mills to handle 100 to 115 tons of uranium billets per month. Visits were made to a number of uranium mills, including Joslyn. Rolling periods which appear to be associated with these requests occurred during the following periods: 10 tons between August 5, 1947 and August 6, 1947; 30 tons between February 28, 1948 and March 4, 1948; 30 tons between March 5, 1948 and March 10, 1948; 30 tons between March 19, 1948 and March 22, 1948; 30 tons between March 27, 1948 and March 29, 1948; 90 tons during May 1948; and 80 tons on or about June 29, 1948 (Joslyn, 1948. PDF p. 54; Freitage, 1948; Monthly Report, Apr 1948). It is not clear if the entire 90 tons were actually rolled at Joslyn because the document which listed this material was published on May 5, 1948, and indicated that arrangements were being made with Simonds Saw and Steel Company to roll during that same month (Monthly Report, Apr1948).

Great Britain and Chalk River

Documents indicate that Joslyn rolled uranium for Great Britain in 1946 (Beeler, 1947, PDF p. 2) and Canada (Chalk River) in 1949 (Beeler, 1947; Koenig, 1946; Monthly Report, Feb1949). The January 14, 1947 memo regarding costs of oxide and uranium metal sold to Great Britain is an accounting correction and states a charge had been submitted directly to the British Supply Office by Joslyn for preparing "the above rods." A February 1949, monthly status and progress report states that Joslyn was preparing to submit a formal proposal for the rolling of uranium rods and machining slugs for the Chalk River pile (Monthly Report, Feb1949). This follows the January 1949 monthly status and progress report, which reported a request directed to the Washington Office by the National Research Council of Canada (Monthly Report, Jan1949, PDF p. 9). NYOO, in response to the request, agreed to make arrangements with Joslyn to fabricate slugs for the Chalk River pile. The work was to include rolling of uranium rods and subsequent machining. The January report indicated initial contacts had been made, but definitive arrangements were awaiting the receipt of revised specifications from Canada.

The quantity of uranium associated with the British request was 30 tons. An August 18, 1950 memo (Belmore, 1950a, PDF p. 14) indicated that three uranium jobs were performed at Joslyn in the month of August and that minimal changes in protocols for the control of airborne radioactivity were made.

Thorium Processing

NIOSH has located records of two distinct thorium processing operations at Joslyn: (1) a June 21, 1946 MED monthly report that describes the straightening and centerless grinding of six thorium rods at Joslyn, and (2) a January 21, 1947 report that describes the centerless grinding of five extruded thorium rods. All of these rods were extruded elsewhere, and sent to Joslyn specifically for centerless grinding. The MED monthly report describes six extruded myrnalloy rods, 1.530 inches in diameter that were straightened and centerless ground cold on a Medart straightening machine. Following straightening, the rods were cleaned up by centerless grinding. This resulted in rods with diameters ranging from 1.375 inches–1.425 inches (Monthly Report, Jun1946, PDF p. 3). The rods described in the January 1947 report were extruded at Revere Copper and Brass on October 8, 1946. A total of five rods (1-7/8 inch diameter, 127 cm long) were sent to Joslyn (Macherey, 1947). Based on a density of 11.7 g/cm^3, these rods would constitute ~26.5 kg of thorium metal per rod.

An August 11, 1947 memo discusses possible thorium rolling at Joslyn; however the memo goes on to state that Joslyn would not be viable for the thorium rolling work due to the need to keep thorium and contaminating material (presumably uranium) rolling separated. It is suggested that this work be carried out at the Westinghouse facility (Chapman, 1947a). An August 21, 1947 memo suggesting that personnel be apprised of the hazards in the rolling of thorium confirms that this work was performed at Westinghouse (Chapman, 1947b).

5.2 Radiological Exposure Sources from Joslyn Operations

ATTRIBUTION: Section 5.2 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities; Eugene Potter and Billy Smith, M. H. Chew and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The following subsections provide an overview of the internal and external exposure sources for the Joslyn class under evaluation. Joslyn handled only natural uranium metal and a limited amount of thorium metal for rolling or machining processes.

The primary operations performed at the Joslyn site involved heating, hot rolling, quenching, straightening, cooling, grinding, abrasive cutting, and threading of uranium rods and burning of unrecovered wastes (Army Corps, 2005, PDF p. 6).

One of the first large-scale requirements for uranium metallic products was fuel for the Hanford plutonium production reactors in 1943. In that year more than a dozen industrial facilities were contracted to roll and extrude uranium rods and then produce fuel slugs. Hanford was developing uranium metal-working capabilities, based on lessons from Joslyn and other sites, and was beginning to operate fabrication facilities that provided much of the fuel needed for the Hanford production reactors from 1944 through 1971. The AWE sites like Joslyn developed and tested new metal-working techniques and during some years were major providers of uranium metal to AEC facilities, while during other years they did small production runs to supplement the work performed at Hanford, Fernald, or Weldon Spring. The AWE facilities like Joslyn also performed specialty functions not handled by the large AEC facilities, which accounts for the variability in the scale of uranium operations at Joslyn and thus the radiological source term.

5.2.1 Internal Radiological Exposure Sources from Joslyn Operations

The principal source of internal radiation doses for workers at Joslyn includes inhalation and ingestion of various uranium oxides that resulted from the production and shaping of uranium metal rods.

Intake of these contaminants could have resulted from either routine or non-routine events. Routine operations that could have directly caused airborne radioactivity or release contamination to work surfaces where it could have been resuspended included heating, quenching, rolling, cutting, and grinding.

The potential for some airborne thorium exposure existed at Joslyn as well. Centerless grinding activities were performed on a small scale at Joslyn on two separate occasions. These thorium grinding operations were performed using a liquid coolant (Unknown, 1949) and therefore had a reduced potential for airborne dispersion of the thorium material during grinding operations than would have been the case if performed dry. The operations were performed as an experiment on a known quantity of thorium rods that had been extruded elsewhere.

One memo, referring to rolling samples of 3-inch diameter thorium billets, indicated that this work was to be performed during the week of July 21, 1947; however, no supporting documentation indicating this work was actually performed has been located. This was shortly before the August 11, 1947 memo (Chapman, 1947c) discussing serious concerns with using Joslyn for thorium rolling and fears of contamination of the thorium due to previous rolling work. The August 11, 1947 memo seems to indicate a possibility that the work scheduled for the week of July 21, 1947, was not carried out.

There is evidence that an outdoor area was used to burn waste. According to former worker reports, uranium wastes/residues from machining uranium rods were collected and dumped on the ground each day and were gone when the workers returned the next day. The work experience at Joslyn of these former workers began in 1948 and continued beyond the end of covered operations at the site. These workers could not give any testimony regarding operations prior to 1948. These workers related that they learned much later from a co-worker that the co-worker was in fact responsible for burning these scraps and wastes at the end of the day (Personal Communication, 2012).

Currently available documentation indicates that the primary periods of AEC production activities occurred in 1943–1945 and again in 1948–1949. Outside of these timeframes, activities were of a somewhat smaller scale. Engineering controls, such as ventilation for certain operations, were mentioned in Joslyn documentation, but did not seem to be effective (Belmore, 1950b; Klevin, 1952).

5.2.1.1 Natural Uranium

The principal sources of internal exposure to the natural uranium processed at Joslyn were from the inhalation of dust, oxide scale, or fumes generated during various machining operations including straightening, rolling, cutting and centerless grinding. These activities occurred in Buildings 6, 7, 8, and 9.

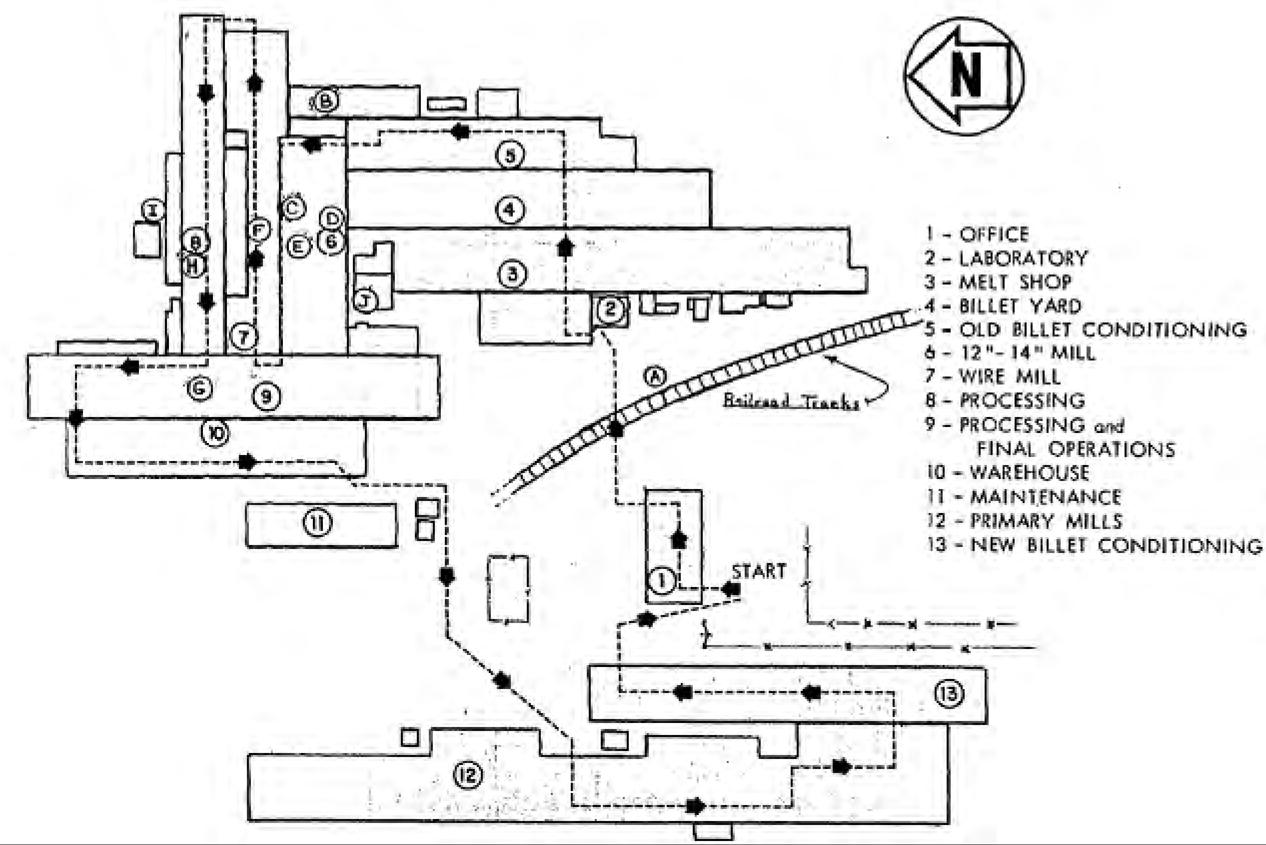

Figure 5-2: Diagram of Joslyn Buildings

Rolling operations were capable of releasing large quantities of uranium dust into the atmosphere. Uranium readily oxidizes when exposed to air at temperatures above 600° F. The oxide scale formed on the surface spontaneously flakes off at elevated temperatures and is easily disturbed upon handling. The oxide formation and flaking produces high air concentrations and dust collection on the workplace floor and other surfaces. Any worker movement on a dusty floor will re-suspend dust into the air, thus creating elevated air concentrations after the rolling has stopped (Battelle-TBD-6000).

After rolling, machining processes were used to reduce the rods to the required diameter and to finish the surface. These machining processes included lathe operations, centerless grinding, cutting, and threading. Because the metal is typically near room temperature for machining, surface oxides are not formed or loosened during machining to the extent that they are during rolling. The biggest generator of uranium dust associated with machining was probably the ignition of small chips and turnings that were generated during machine operations (Battelle-TBD-6000, PDF p. 16). At Joslyn, due to the pyrophoric nature of the uranium, a heavy flow of coolant was used over the cutting/grinding surfaces to minimize sparking. These measures would have also reduced the airborne concentrations to some degree. While the rolling operations were generally open in the mill buildings, the grinding and cutting operations were to be ventilated through the use of a small shed enclosure within the larger building. The grinder had an overhead hood connected to a fan and discharge was into the inside of the larger shed. During MED/AEC surveys the air concentrations around the centerless grinder were still found to be unacceptable and apparently this ventilation was not sufficient to meet the standards in effect at the time.

As billets and rods were moved between the operational areas any dragging or dropping of the hot metal could have resulted in airborne radioactivity and the potential for intakes.

Operations and the clean-up of accumulated dust and fragments resulted in an accumulation of waste uranium metal that had to be accounted for. For accountability purposes, efforts were made to collect the residual cuttings and dust using steel pans to collect shavings and trimmings and by brushing the steel floor plates before, during, and after cutting work. The practice at Joslyn was to burn the waste material so that it would be in the less combustible oxide form for shipment back to the AEC. NIOSH is aware that former workers report that burning operations were performed outdoors by one individual (Personal Communication, 2012). These former workers reporting on burn operations had work history at the site beginning in 1948 through covered operations. The 1950 Kehoe report (SRDB 90891) describes dry burning as the most expeditious and least expensive method for disposal of uranium scraps by conversion to oxide and states for a quantity not exceeding 5 pounds, the scrap may be spread out on a steel plate in an open area and burned to oxide by the flame of an oxy-acetylene torch. Burning uranium metal fines and shavings outdoors creates environmental problems, but would have tended to reduce the airborne concentrations versus burning in a confined area, such as a building.

Since Joslyn only performed work for MED/AEC through 1952, there was no potential for recycled uranium processing (Battelle-TBD-6000, PDF p. 14).

5.2.1.2 Thorium

Joslyn was considered for thorium rolling in 1947, but the decision was made that it could not be used because of possible cross-contamination with other material (most probably uranium) previously rolled there (Chapman, 1947c). However, two small batches of thorium rods, extruded elsewhere, were straightened and centerless ground at Joslyn. Six thorium rods were straightened and centerless ground at Joslyn around June 1946 (Monthly Report, Jun1946). In a second operation, five thorium rods were passed through a roll straightener twice, centerless ground and straightened a third time. The rods were then run through the centerless grinder an unspecified number of times. As a result, the diameter of the rods was reduced from 1.660 inch to 1.575 inch (a reduction of 0.085 inches). This work occurred sometime between October 8, 1946 and January 21, 1947 (Macherey, 1947). Given that 14 uranium rods could be ground in 8 hours (Simmons, 1943; Echo, 1943b) it is likely that each of the thorium grinding operations took less than one day. Although centerless grinding could have created respirable particles, it was performed wet for cooling purposes (DOE, 1987) and the liquid coolant would act to limit the dustiness of the operation.

5.2.2 External Radiological Exposure Sources from Joslyn Operations

The principal sources of external exposure during the operational period (other than medical X-rays) were the direct exposure to natural uranium and thorium metal during the machining operations, submersion in air potentially-contaminated with uranium and thorium metal, and exposure to contaminated surfaces. Tables 5-2 and 5-3 list the radionuclides of concern for external radiation from uranium and thorium during the operational period.

Table 5-2: Principal Radiation Emissions from Natural Uranium and Its Short-Lived Decay Products

Radionuclide	Half-life	Beta Energy (MeV Max)	Photon (x or γ) Energy (MeV)
U-238	4.468 x 10^9 years	None	x: 0.013 (8.8%)
Th-234	24.1 days	0.096 (25%)	x: 0.013 (9.6%)
		0.189 (73%)	γ: 0.063 (3.8%)
			γ: 0.093 (5.4%)
Pa-234m	1.17 minutes	2.28 (98.6%)	γ: 0.765 (0.2%)
		~1.4 (1.4%)	γ: 01.001 (0.6%)
U-235	7.038 x 10^9 years	None	x: 0.013 (31%)
			x: 0.090-0.105 (9.3%)
			γ: 0.144 (10.5%)
			γ: 0.163 (4.7%)
			γ: 0.186 (54%)
			γ: 0.205 (4.7%)
Th-231	25.5 hours	0.206 (15%)	x: 0.013 (71%)
		0.288 (49%)	γ: 0.026 (14.7%)
		0.305 (35%)	γ: 0.084 (6.4%)
U-234	244,500 years	None	x: 0.013 (10.5%)
			γ: 0.053 (0.2%)

Source: Battelle-TBD-6000, PDF p. 20. The table shows the principal radiation emissions from natural uranium and its short-lived decay products that were of concern for external radiation (not including bremsstrahlung).

Table 5-3: Principal Radiation Emissions from Th-232 and its Short-Lived Decay Products
(This table spans two pages)

Radionuclide	Half-life	Beta Energy (MeV Max)	Photon (x or γ) Energy (MeV)
Th-232	1.405 x 10^{10} years	None	0.059 (0.19%)
			0.126 (0.04%)
Ra-228	5.71 years	0.389 (100%)	0.0067 (6 x 10^{-5}%)
Ac-228	6.25 hours	0.983 (7%)	0.338 (11.4%)
		1.014 (6.6%)	0.911 (27.7%)
		1.115 (3.4%)	0.969 (16.6%)
		1.17 (32%)	1.588 (3.5%)
		1.74 (12%)	---
		2.08 (8%)	---
		(+33 more βs)	---
Th-228	1.9116 years	None	0.084 (1.19%)

Table 5-3: Principal Radiation Emissions from Th-232 and its Short-Lived Decay Products (This table spans two pages)			
Radionuclide	**Half-life**	**Beta Energy (MeV Max)**	**Photon (x or γ) Energy (MeV)**
			0.132 (0.11%)
			0.166 0.08%)
			0.216 (0.27%)
Bi-212	60.55 minutes	1.59 (8%)	0.040 (1%)
		2.246 (48.4%)	0.727 (11.8%)
		---	1.620 (2.75%)
Tl-208	3.1 minutes	1.28 (25%)	0.277 (6%)
		1.52 (21%)	0.5108 (21.6%)
		1.80(50%)	0.583 (85.8%)
		---	0.860 (12%)
		---	2.614 (100%)

Notes:
Source: *Handbook of Health Physics and Radiological Health* (Rad Handbook, 1998).
Intensities refer to the percentage of disintegrations of the nuclide itself, not to original parent of the series. Gamma percents are given in terms of observable emissions, not transitions.

5.2.2.1 Photon

The majority of the photons from natural uranium metals are in the 30-250 keV energy range. Solid uranium objects provide considerable shielding of the lower-energy photons and harden the spectrum, causing the majority of the photons emitted from a solid uranium object (such as a billet 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 shows the primary isotopes and photon energies associated with the uranium metal. Exposure to these photons was possible during machining operations from direct radiation during metal handling and from submersion in metal-contaminated air.

Thorium has a significant number of higher-energy photons in the thorium-232 decay chain. Based on the half-lives of the progeny, only a partial equilibrium is possible; therefore, it is conservative to state that equilibrium would be reached in this decay chain. It has been assumed that radium-228 and thorium-228 progeny were in equilibrium with thorium-232. Therefore, air concentrations were assumed equal for all progeny. Under this assumption, the progeny are the major source of both penetrating and non-penetrating external exposure. Table 5-2 shows the primary isotopes and photon energies associated with thorium and its progeny.

5.2.2.2 Beta

Tables 5-2 and 5-3 show the principal beta emitters and their energies for the uranium and thorium metal used during machining operations. As indicated in these tables, there are a significant number of high-energy beta radiations that represent a shallow dose exposure concern to site workers. Workers who handled the uranium and thorium metal would have received shallow dose exposures.

The primary exposure areas would have been the hands and forearms, the neck and face, and other areas of the body that might not have been covered.

5.2.2.3 Neutron

Neutrons were not measured at Joslyn and are not expected to be a source of exposure for the class under evaluation. Neutrons could arise from the alpha-neutron reaction (α-n) with light elements, interactions with the oxides, and through spontaneous fission. According to Battelle-TBD-6000, uranium oxides would be the most common generators of (α,n) reactions. However, the quenching and centerless grinding of the rods would minimize this source of neutrons. Spontaneous fission yields and (α,n) yields in oxides are provided in Table 3.5 of Battelle-TBD-6000. Based on its analysis, NIOSH concludes that none of these sources would be sufficient to result in a significant neutron exposure to Joslyn workers; consequently, neutrons will not be discussed further in this evaluation.

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 Joslyn class under evaluation.

6.1 Available Joslyn Internal Monitoring Data

ATTRIBUTION: Section 6.1 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities; Eugene Potter, M. H. Chew and Associates, Inc.; and Joe Guido, MJW Corporation. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Medical Records

Under the early uranium program, the DuPont Company had the responsibility for directing the medical examinations (Daniels, 1944; Norwood, 1944). These examinations were to consist of complete physical examinations, including blood counts, urinalysis, and chest X-rays. These records have not been located or recovered.

Bioassay Data

No bioassay data for Joslyn workers have been located by NIOSH. References in the site documentation to pre- and post-job urine samples in the early 1940's, were probably to non-radiological medical tests as part of medical monitoring (Fuqua, 1944; Taussig, 1948). Fluorometric measurement techniques for uranium were not widely in use until the late 1940s (Stannard, 1988, PDF p. 132) and NIOSH has found no indications of it ever being used at Joslyn.

Blood counts were normally a part of the required physical examinations before starting work; however, the experimental work at Joslyn appears to have begun before performing these tests (Fuqua, 1944). Blood counts were used in the early years to monitor potential radiation damage to the hematopoietic system. However, it should be noted that blood count information is not normally used as bioassay data for the purpose of radiological dose reconstruction.

Whole-Body Counting Data

Whole-body counting, a technique employed to monitor photon-emitting radionuclides in the body, was not generally used until the early to mid-1960s; by that time, radioactive work had concluded at Joslyn. Thus, NIOSH does not have whole-body count data for Joslyn workers.

Air Sample Data

A limited number of uranium air sample results were discovered for the Joslyn operational period. They are listed in Table 6-1 along with their source documents. All results are from MED/AEC consultants who visited the site to review health and safety practices. Initially, medical doctors from the Metallurgical Laboratory were assigned to conduct dust studies and to recommend ventilation improvements and the use of protective devices, such as respirators (see references in the Table). There is no indication that an in-house air sampling program existed. Radioactive material rolling operations, grinding, etc. were performed in the same areas as normal plant operations but under MED/AEC supervision. The samples taken in 1952 were part of a study of time-weighted average (TWA) exposures. In this study, the air concentrations for various jobs and locations were weighted by the amounts of time spent performing the work. The results appear in Table 6-2. There were no air sample results specifically associated with the limited thorium work.

The un-weighted air concentration data for the 1952 study are also available. The data points are displayed in Figures 6-1, 6-2, and 6-3 with the lines representing the lognormal fits of the data. Figure 6-1 shows all of the data, while Figures 6-2 and 6-3 show the breathing zone (BZ) data and general area (GA) data, respectively. From Figures 6-2 and 6-3 it is evident that the BZ data are significantly higher than the GA data.

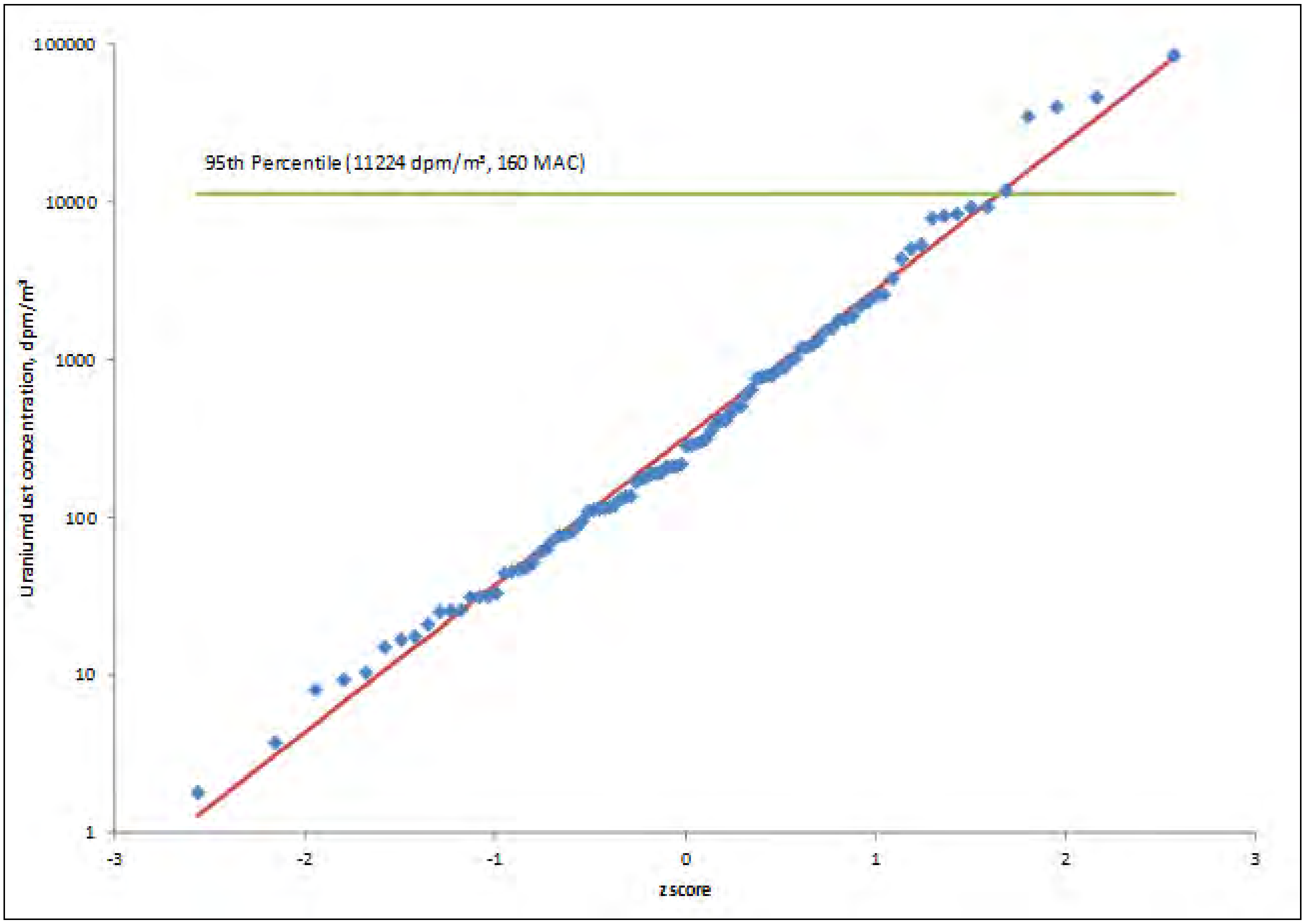

Figure 6-1: Lognormal Fit of All 1952 Un-weighted Air Concentration Data (GM = 323 dpm/m3, GSD = 8.63)

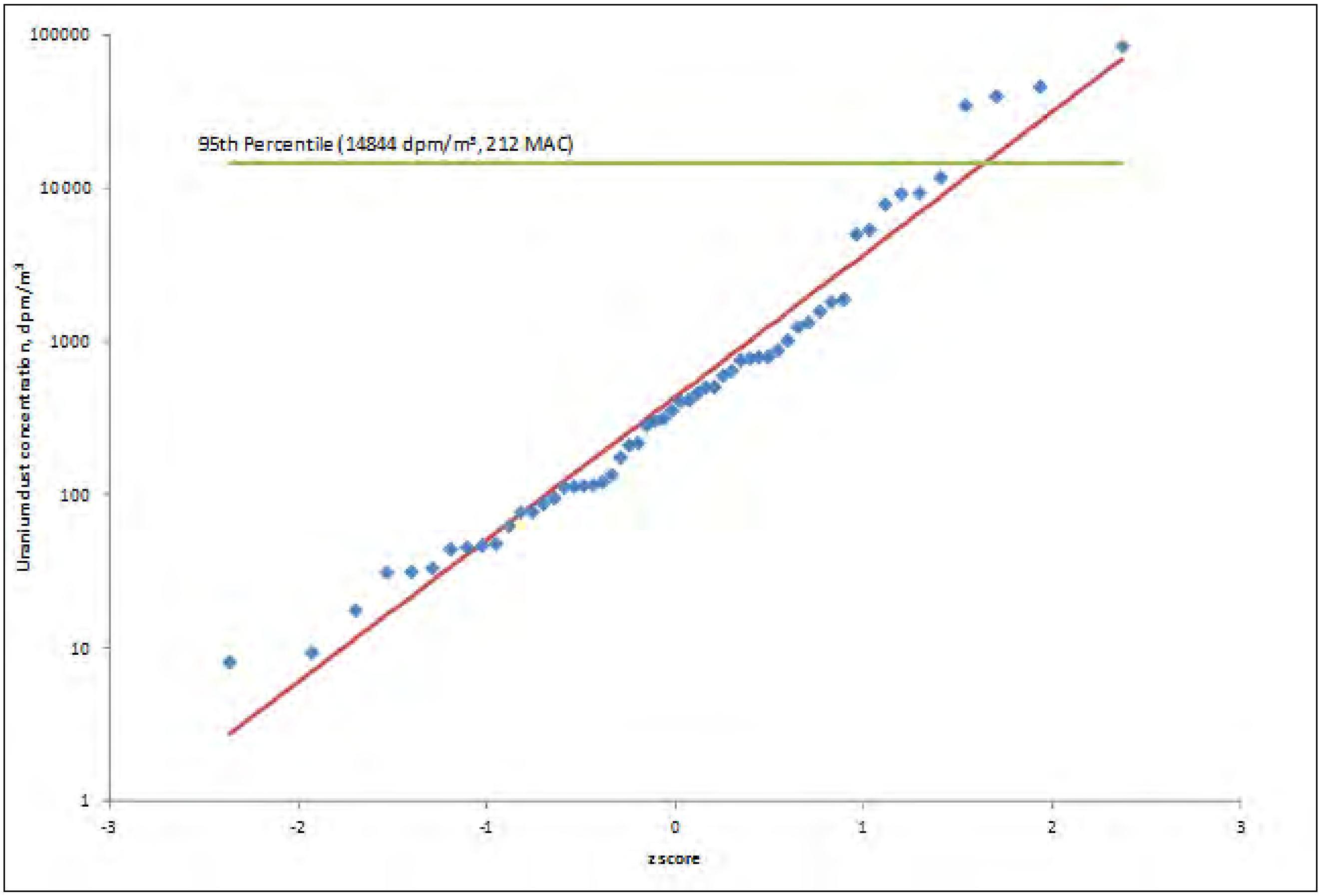

Figure 6-2: Lognormal Fit of the 1952 Un-weighted Breathing Zone Air Concentration Data (GM = 437 dpm/m3, GSD = 8.51)

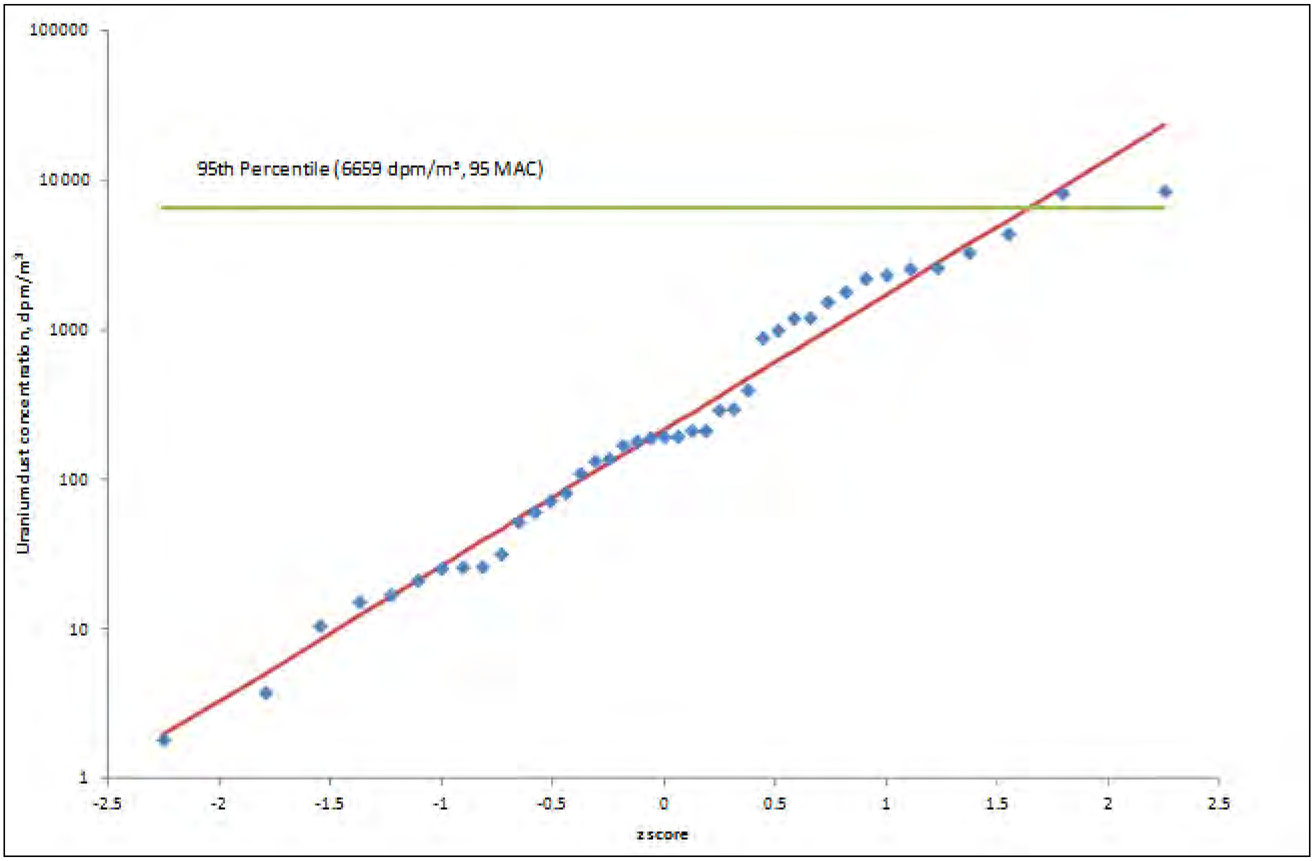

Figure 6-3: Lognormal Fit of the 1952 Un-weighted General Area Air Concentration Data (GM = 214 dpm/m3, GSD = 8.06)

Operational Survey Data

Smear surveys may or may not have been routinely performed during the operational period by the MED/AEC or their consultants; however, NIOSH has only located a 1949 survey for the operational period (Piccot, 1949). This survey was conducted on August 1, 1949, after uranium rolling and machining operations for the AEC had ceased at Joslyn, but prior to the area being completely decontaminated. AEC rolling and machining appears to have concluded at Joslyn by July 1948. According to the report, all work on uranium had ceased except for the removal of drums containing scraps and clean-up material that were to be shipped out the following day. Alpha contamination results were reported in disintegrations per minute (dpm) without the area of the reading (i.e., dpm/100 cm^2). The 1952 survey (Klevin, 1952) gives a value of 50,000 alpha dpm/100 cm^2 in the mill area after initial clean-up. The report states that the clean-up of the working area was excellent in spite of the high dust concentrations and lack of dust control.

Table 6-1: Available Uranium Air Sample Results for the Joslyn Operational Period
(This table spans two pages)

Date	Description of Activity	Location	Value (pCi/m^3)	SRDB Reference
12/7/1943	Uranium - Centerless Grinding	GA – in path of fumes	Range = 215 – 6,156 Avg = 3,185	11036
		GA - outside of grinding shed	616	11036
		GA - outside of grinding shed, after grinding stopped	68	11036
5/8/1944	Uranium - Rolling	GA – furnace area	802	5890
		GA – at rolling machine	1,499	5890
		GA – general room air	1,197	5890
10/24/1951	Uranium - Centerless Grinding/Cutting	GA – general area	Range = 14 – 23 Avg = 20	11036
		BZ – operator	Range = 14-811 Avg = 487	11036
1/8/1952	Uranium Rolling	GA – production areas	Range = 7.8 – 3,871 Avg = 789 GM = 238 GSD = 6.5 95th %ile = 5,111	9664
		BZ – production areas	Range = 14 – 39,230 Avg = 4,555 GM = 776 GSD = 7.8 95th %ile = 23,000	9664
	Centerless Grinding	GA – production areas	Range = 11.8 – 133 Avg = 64.5 GM = 50.6 GSD = 2.3 95th %ile = 200	9664
		BZ – production areas	Range = 4.3 – 614 Avg = 93.6 GM = 42.4 GSD = 3.27 95th %ile = 297	9664
	Cutting	GA – production areas	Range = 9.7 – 546 Avg = 183 GM = 66.1 GSD = 5.6 95th %ile = 1117	9664
		BZ – production areas	Range = 55.7 – 574 Avg = 237 GM = 195 GSD = 1.99 95th %ile = 606	9664
	Lathe Operations	GA – production areas	Range = 0.8 – 6.9 Avg = 3.6 GM = 2.6 GSD = 2.6 95th %ile = 12.9	9664

Table 6-1: Available Uranium Air Sample Results for the Joslyn Operational Period (This table spans two pages)				
Date	**Description of Activity**	**Location**	**Value (pCi/m^3)**	**SRDB Reference**
		BZ – production areas	Range = 3.7 – 164 Avg = 43.9 GM = 18.5 GSD = 4.2 95th %ile = 196	9664

Table 6-2: Results of a 1952 Time-Weighted Average Exposure Study	
Work Area/Job Description	**Time Weighted Average Exposure (pCi/m^3)**
18" Rough Roll East	3,322
18" Rough Roll West	375
Roller Forman	725
Asst Roller (Ass't Foreman)	725
Furnace Heaters	16
Recorder	16
12" Rough Roll East	605
12" Rough Roll West	570
Drag Down (Billet)	310
9" Finishing Roll East	16,542
9" Finishing Roll West	5,791
Quench Tank	155
Draggers	831
Rod Stamper	242
Rod Bundler	128
Lathe Operation	12
Centerless Grinder	100
Grinder (portable)	277
Cutomatic	191

6.2 Available Joslyn External Monitoring Data

ATTRIBUTION: Section 6.2 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities and Billy Smith, M. H. Chew and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

NIOSH has found no external personnel monitoring results for the Joslyn operations. The only survey to include area monitoring data located by NIOSH was the survey performed by HASL on August 1, 1949, which indicated levels of contamination ranging from 6,000 dpm to 30,000 dpm in several areas of the facility.

NIOSH does have documentation regarding the metal-rolling operations contracted to Joslyn by the government for AEC operations and for other activities. This documentation is summarized in Table 6-3 for uranium and Table 6-4 for thorium.

Table 6-3: Available Uranium-Related External Monitoring Data
(This table spans two pages)

SRDB Ref ID	PDF Page: Notes	Document Date	Quantity of Uranium
82395	Inventory record from Metallurgy Laboratory to Joslyn	May 1943	202 lb and 4 metal rods
82369	Inventory record. Listed as ingots (1) 85.6 lb and ingots (2) 170.1 lb	Jun 1943	255 lb
31576	7: Mass balance summary "completed operations"	6/25/1943	32 tons
11036	244: Accounting of test rolling and straightening	6/29/1943	3 billets
11036	41: Summary of hot rolling. Billets from MIT and Union Carbide	7/3/1943	Three 90 lb billets and three 200 lb billets
101163	Request to send 20 rods from West Stands	8/11/1943	20 rods
11036	84: Description of experimental centerless grinding on 14 extruded rods	9/7/1943	14 rods
11036	223: Memo states that proposed grinding of 450 rods at Joslyn will begin in near future.	11/18/1943	450 rods
11036	136: Summary of work in December 1943	12/21/1943	27 rods
11036	69: Mention made of work to begin in January	12/31/1943	158 rods
11036	69: Memo accounting for material processed from 11/26/43 to 12/15/1943	12/31/1943	2,8000 lb
11036	53: Operations began 11/29/43 and suspended on 12/15/43. Resumed 1/5/44 and completed 1/14/44.	1/26/1944	5000 lb
82409	Internal transfer record	2/16/1944	105 lb
11036	130: From 2/25 to 2/26/44. Rods are 10 ft and are 1.2 inch in diameter.	3/6/1944	20 rods
82390	Shipping record for rods and billets.	5/1/1944	1,150 lb
82391	Shipping record for billets.	5/2/1944	1,358 lb
82397	Shipping record	5/3/1944	2,122 lb
33190	67: Rolled 231 billets between may 9 and 11	5/9/1944	60,122 lb
31137	5: ElectroMet shipped 30 tons of double-length billets for rolling at Joslyn	5/13/1944	30 tons

Table 6-3: Available Uranium-Related External Monitoring Data (This table spans two pages)			
SRDB Ref ID	**PDF Page: Notes**	**Document Date**	**Quantity of Uranium**
82383	Shipping record 5 rods.	6/1/1944	355 lb
33190	67: Rolled 23 billets into 46 rods	6/2/1944	5,900 lb
33190	67: Rolled June 22-24; 252 billets	6/22/1944	65,000 lb
101152	Record of rolling, indicating loss of material	9/15/1944	5,944lb
30859	Scrap inventory, 12/1/44 -12/28/44	12/28/1944	1400 lb
31145	237: Rolling operations with double length billets discontinued. 793 billets left over. 493 billets shipped to Hanford. 300 kept at Joslyn for special work.	2/3/1945	
31145	196: 1945 progress report discussing on-going work on a special request for 220 rods going on at Joslyn.	3/1/1945	220 rods
93775	6: Record of receipt	10/28/1946	4407 lb
31145	16: 11 tons of rods shipped to Hanford from Joslyn	Nov 1946	11 tons
90948	2: Record of cost analysis for providing material to Great Britain. Work is anecdotally indicated to have occurred about September 1946.	1/14/1947	15 tons rods from 30 tons (450 billets)
37390	44: Arrangements completed for rolling 10 tons of UM and G billets. Approximately 500 slugs made from this rolled material are to be canned by the lead dip process.	7/1/1947	10 tons
37586	38: Alpha phase rolling of uranium	February 1948	30 tons
16511	3: Rolled between August 5 and 6; received July 28, 1947.	9/9/1947	10 tons
37587	54: 2/28 - 3/4/48 3/5-3/10/48 3/19-3/22/48 3/27-3/29/48	March 1948	30 tons 30 tons 30 tons 30 tons
11036	19: 90 tons for Hanford.	May 1948	90 tons
59249	6: Record of shipment from ElectroMet to Joslyn.	5/1/1948	95,526 lb
11036	14: Memo from Hanford requesting 80 tons of billets to be shipped to Joslyn (on or about 6/29/1948	6/25/1948	80 tons of billets
11996	652: Quantity of U material handled 1/1/1950 - 12/31/1950 (from Joslyn to Lake Ontario office)	1/1/1950	7,000 kg (6,621 kg rods and ~294 kg returned billets)
11036	15: Hanford request for 5500 lb of normal rolled uranium rods be shipped to Joslyn	7/31/1950	5,500 lb rods to Joslyn
11036	231: Memo requesting shipment of 15 rods to Joslyn, Fort Wayne.	4/11/1952	15 rods to Joslyn
11036	232: Memo requesting shipment to Joslyn. One rod is 20 feet long the other 3 are 10 feet long. Diameter is 13/16 inch.	1/23/1952	4 rods to Joslyn

Table 6-4: Available Thorium-Related External Monitoring Data			
SRDB Ref ID	**PDF Page: Notes**	**Document Date**	**Quantity of Thorium**
80171	6 thorium (myrnalloy) extruded rods, 1.53 inch diameter straightened and centerless ground at Joslyn.	6/21/1946	6 rods
81068	Activity sometime between 10/8/1946 (date extruded) and memo date. Rods were 4 cm in diameter and 127 cm long.	1/21/1947	5 rods

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-00200 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Joslyn Data

ATTRIBUTION: Section 7.1 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

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 Joslyn Manufacturing and Supply Co. during part of the operational period; from March 1, 1943 through December 31, 1947. Therefore, a complete internal data sufficiency and pedigree evaluation is not possible for the period from March 1, 1943 through December 31, 1947.

Data for AEC-related uranium work, for the period from January 1, 1948 through December 31, 1952, consist of work place air monitoring survey reports and information regarding work practices consistent with other rolling operations. These sources are copies of original reports and are therefore considered primary data sources. Data collection performed by AEC representatives would have been in accordance with standard practices using state-of-the-art methods during that time period.

7.1.2 External Monitoring Data Pedigree Review

As discussed in Section 6.2, NIOSH has not located any documentation indicating that routine air sampling or external dosimetry programs for uranium or thorium were conducted during Joslyn operations. NIOSH did not locate any external monitoring data for the operational period under evaluation (March 1, 1943 through December 31, 1952). Therefore, a data sufficiency and pedigree evaluation is not possible for this data type for this period.

NIOSH has data consisting of source term data in the form of shipping transactions and accountability and contractual recordings of uranium materials to be machined by Joslyn. The data sources are copies of original reports and contracts and are therefore primary data sources. The data reported by AEC representatives would have been collected in accordance with standard practices using state-of-the-art methods during that time period.

7.2 Evaluation of Bounding Internal Radiation Doses at Joslyn

ATTRIBUTION: Section 7.2 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities and Eugene Potter, M. H. Chew and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal sources of internal radiation doses for members of the class under evaluation were the potential inhalation and ingestion of airborne natural uranium and thorium by employees, both those near and those directly involved in the rolling, centerless grinding, quenching, straightening, and cutting of the billets and rods being machined at Joslyn. Other employees were potentially exposed to the re-suspension of contamination on surfaces during the course of their work with non-radioactive materials. 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 Process-Related Internal Doses

NIOSH did not locate urinalysis or other bioassay monitoring data for the period under evaluation, therefore internal exposure must be determined based solely on radiological source term and area monitoring data. Source term data are available through a variety of reports, requests, and memos over time. Area monitoring data consist solely of air monitoring reports providing snapshot images of airborne contamination.

Workers not directly involved in the rolling and grinding operations were potentially exposed to airborne contamination during operations as well as to the re-suspension of contamination deposited in the buildings by radioactive material operations.

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 Uranium Airborne Levels

During the operational period, air samples were taken on at least four occasions during uranium work (see Section 6.1). The air samples were not consistently taken in the same areas; furthermore, information is generally lacking on the relationship of the sample locations to the areas occupied by workers with the exception of samples labeled "BZ" (i.e., breathing zone). Some of the air concentrations were quite high compared to the desired limit or "tolerance" values in use during the early part of the operational period (150 µgm uranium) (Fuqua, 1944). Comparison of air samples across the operational period is problematic because the tolerance levels changed, the sampling methods changed, uranium dust control practices changed, and practices changed in order to incorporate experience gained both at Joslyn and other facilities for the purposes of improving health conditions, reducing the potential for fire, and to better meet the specifications for the products. Early air samples were collected, but the reports do not provide details on the collection medium or the efficiency of the counting methods. The reports did mention that throughout the operations the engineering controls were not effective in controlling the airborne contamination (Klevin, 1952).

Under close scrutiny, the limited and intermittent air sample results collected in 1943 and 1944 do not meet the criteria for being sufficient to support establishing a bounding dose estimate for uranium internal exposures. The samples during this period are in the nature of a snapshot of the conditions during a time of testing and evaluation. NIOSH does not have the supporting documentation to establish confidence in the sampling methods or to account for uncertainties possibly introduced by the sampling methodologies and by the introduction of the tenting structures over the grinding operations. NIOSH cannot justify considering these samples either representative of the machining activities of the period or indicative of the highest exposures potentially available to the Joslyn workers.

In 1948, Joslyn entered into the largest production-scale uranium rolling campaign of its operations. By this time HASL had been formed as a small central laboratory facility to assist contractors who could not adequately perform the industrial hygiene and industrial functions necessary. This group was called upon frequently to aid in controlling airborne dusts and used fairly standard sampling and analysis protocols consistently in their operations. With the advent of HASL sampling, NIOSH has confidence in the procedures and protocols as well as an understanding of the uncertainty associated with the air sampling data from 1948 and on**.** This allows NIOSH to make an appropriate comparison between the Joslyn site specific air sample data and the data upon which Battelle-TBD- 6000 bases its methods and conclusions. Battelle-TBD-6000, Appendix B utilizes data (Christofano, 1960) which were collected starting in 1948 as a foundation for its methodologies. Therefore, the data for Joslyn taken before 1948 and the conditions represented by that data may not be sufficiently characterized to analyze in comparison with the data represented in the basis for Battelle-TBD-6000.

During the steel rolling operations (non-MED/AEC work), Joslyn workers could have potentially been exposed to resuspended uranium from incompletely-decontaminated surfaces. Though respirators were recommended for workers directly involved in MED/AEC work (Fuqua, 1944; Cantril, 1944), there are indications (Site Visit, 1944) of poor compliance with respirator use. Respirator use was unlikely to have been required during non-MED/AEC work when re-suspension could have produced exposures. In any case, NIOSH does not consider the protection that may have been provided by respirator use during dose reconstructions.

7.2.1.2 Thorium Airborne Levels

There is documentation of two separate thorium grinding operations at Joslyn in 1946—one order of six extruded thorium rods in June 1946 and one order of five thorium rods between October 1946 and January 1947. The rods were to be straightened and centerless ground. NIOSH did not locate any air monitoring data for thorium. Each of these operations was likely to have taken less than one day to perform on such a small quantity of thorium rods. NIOSH has indications that these grinding operations would have been performed using a liquid coolant which would have reduced any airborne thorium contamination from the operations. The thorium mass removed from the rods by the grinding operations can be calculated, given the original dimensions of the rods and the specification diameter required of Joslyn.

7.2.2 Evaluation of Bounding Residual Period Internal Doses

NIOSH verified with two sources that there is no residual radioactive period specified for the Joslyn Manufacturing and Supply Co.: (1) *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*, Appendix A-1, *Residual Radioactive Contamination-Summary of All Sites*; and (2) Department of Energy Office of Health, Safety and Security Facility List Database [http://www.hss.doe.gov/healthsafety/fwsp/advocacy/faclist/showfacility.cfm].

7.2.3 Methods for Bounding Operational Period Internal Dose at Joslyn

Internal dose estimates for the operational period from January 1, 1948 through December 31, 1952, can be based on the inhalation and ingestion intakes in Battelle-TBD-6000. This TBD provides an exposure matrix for workers at AWE facilities that performed metal-working operations with uranium metal. For some sites, an appendix was developed which contains site-specific information that can be used for dose reconstruction. For sites like Joslyn, information that can be used to perform dose reconstructions is provided in the main body of Battelle-TBD-6000.

Uranium

As detailed in Section 6 and Table 6-1, uranium air sample results are available to NIOSH for the Joslyn operational period. The samples collected prior to 1952 were taken to determine the worst-case conditions rather than average or typical exposures (e.g., December 7, 1943 sample "in path of fumes"). They were not adjusted by the worker's actual hours and proximity during a workday to estimate the actual TWA exposure. The samples taken in 1952 were part of a TWA study. In this study, the air concentrations for various jobs and locations were weighted by the amounts of time spent performing the work.

As detailed in Section 7.2.1.1, the results of the 1952 study included in Table 6-2 are the best site-specific data available to NIOSH. The samples were taken using standard sampling protocols. The air concentration results from the 1952 study represent weighted average values. A study on a different day would produce different averages due to both differences in the work and to statistical variation. The values in Battelle-TBD-6000 are the geometric means (GM) and are intended to be applied as lognormal distributions with a geometric standard deviation (GSD) of 5, to account for the uncertainty in the results. The results from the 1952 TWA study and air concentrations calculated for 1951–1955 from Battelle-TBD-6000 are presented in Table 7-1. The arithmetic means (AM) for the Battelle-TBD-6000 data calculated from the GMs and the GSD of 5 are also presented for direct comparison with the TWAs. In most cases, the AM from Battelle-TDB-6000 data is higher. The 95th percentiles are also shown to illustrate that the distributions used for dose reconstruction would encompass all of the TWA values.

Table 7-1: Comparison of 1952 Time-Weighted Average (TWA) Study with Battelle-TBD-6000					
Joslyn Work Area/Job Description	**TWA (pCi/m^3)**	**Battelle-TBD-6000 Equivalent Description**	**GM (pCi/m^3)**	**95% (pCi/m^3)**	**AM (pCi/m^3)**
18" Rough roll east	3322	Rolling Operator	1472	20784	5375
18" Rough roll west	375	Rolling Operator	1472	20784	5375
Roller Forman	725	Rolling Supervisor	136	1918	496
Asst Roller (Ass't Foreman)	725	Rolling Supervisor	136	1918	496
Furnace Heaters	16	Rolling General Labor	271	3829	990
Recorder	16	Rolling General Labor	271	3829	990
12" Rough Roll East	605	Rolling Operator	1472	20784	5375
12" Rough Roll West	570	Rolling Operator	1472	20784	5375
Drag Down (Billet)	310	Rolling General Labor	271	3829	990
9" Finishing Roll East	16542	Rolling Operator	1472	20784	5375
9" Finishing Roll West	5791	Rolling Operator	1472	20784	5375
Quench Tank	155	Rolling General Labor	271	3829	990
Draggers	831	Rolling General Labor	271	3829	990
Rod Stamper	242	Rolling General Labor	271	3829	990
Rod Bundler	128	Rolling General Labor	271	3829	990
Lathe Operation	12	Machining Operator	2283	32238	8337
Centerless Grinder	100	Machining Operator	2283	32238	8337
Grinder (portable)	277	Machining Operator	2283	32238	8337
Cutomatic	191	Machining Operator	2283	32238	8337

Similarly, the average and maximum air concentrations for 1951 are compared to the appropriate air concentrations from Battelle-TBD-6000 in Table 7-2 below. TWA values like those in Table 7-1 are not available. Where a two-value range was available, the average was calculated. If only a single value was given, this value was assumed to represent the arithmetic mean. The comparison shows that the average calculated from Battelle-TBD-6000 is higher than the Joslyn values. Again, the 95th percentiles are shown for the Battelle-TBD-6000 distributions.

Table 7-2: Comparison of 1951 Air Concentrations to Battelle-TBD-6000						
Joslyn Work Area/Job Description	**Average (pCi/m^3)**	**Maximum (pCi/m^3)**	**Battelle-TBD-6000 Equivalent Description**	**GM (pCi/m^3)**	**95% (pCi/m^3)**	**AM (pCi/m^3)**
Centerless grinding 1951 general area	20	23	Machining Operator 1/1/1951 to 12/31/50	2283	32238	8337
Centerless grinding 1951 operator	605	1800	Machining Operator 1/1/1951 to 12/31/50	2283	32238	8337

Table 7-1 compares the time-weighted data for Joslyn to that in Battelle-TBD-6000. To verify that the time-weighted data are conservative, the 1952 un-weighted air concentration data for rolling operations can be compared to the air concentration data which are the basis for Battelle-TBD-6000.

Figure 7-1 shows the lognormal fit of the Joslyn air concentration data and the lognormal distributions for the two highest-exposure rolling jobs documented in Battelle-TBD-6000. This figure shows that the distributions assumed in Battelle-TBD-6000 are higher for all percentiles.

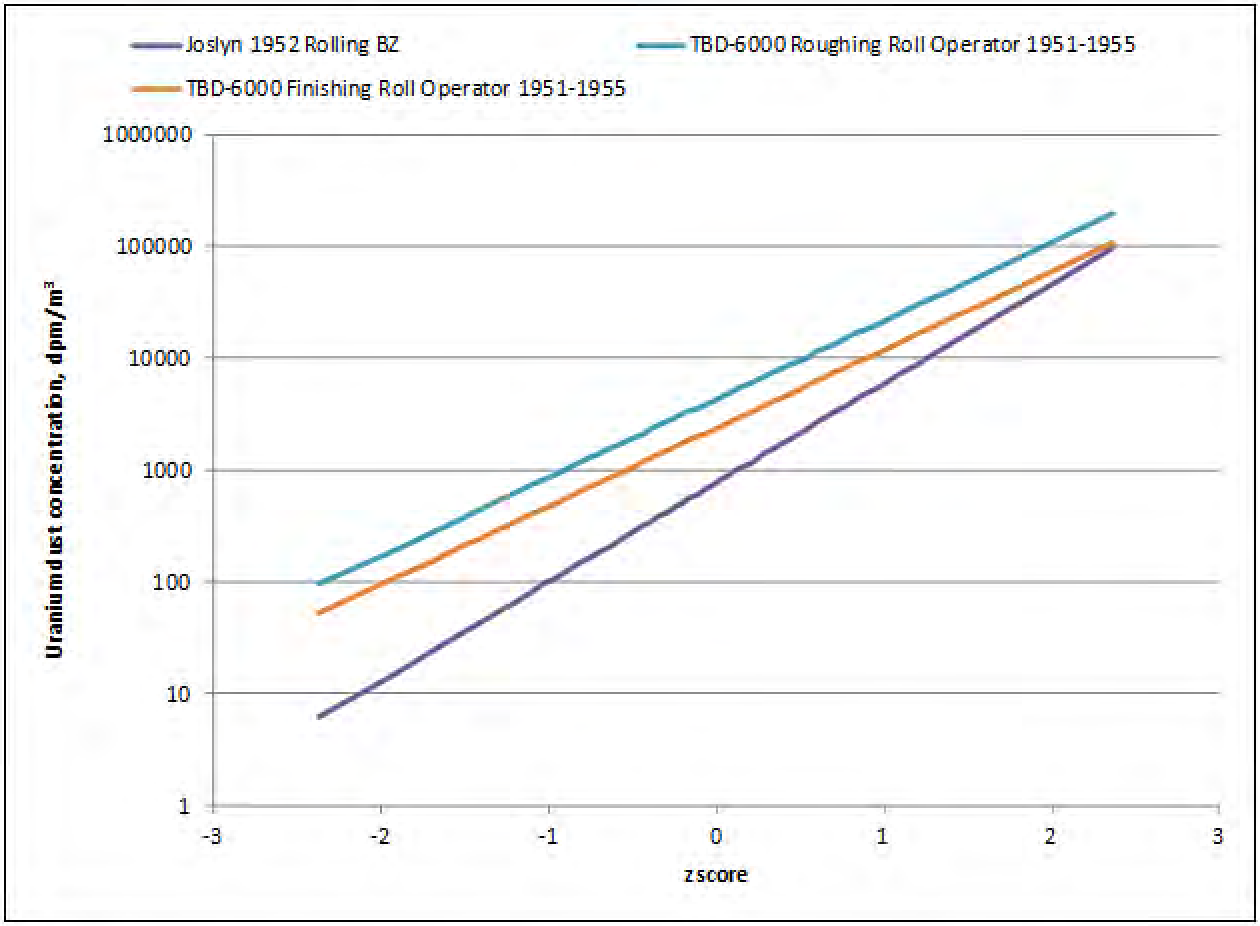

Figure 7-1: Comparison of the Lognormal Fit of the Joslyn 1952 BZ Air Concentration Data to the Lognormal Air Concentration Data in Battelle-TBD-6000 for the Highest Two Rolling Jobs

Another view of the data is presented in Figure 7-2 which shows both the BZ data for rolling at Joslyn and their lognormal fit. All of the data points for the roughing roll operator are below the 95th percentile of the air concentration data in Battelle-TBD-6000. It is also shown that the upper 95th percentile of the Joslyn lognormal fit (z score = 1.645) is below the 95th percentile in Battelle-TBD-6000. From this information, NIOSH concludes that the calculations in Battelle-TBD-6000 bound the dose from Joslyn rolling operations. Lognormal fits of the Joslyn 1952 BZ air concentration data for rolling, centerless grinding, cutomatic, and lathe operations all fall below the lognormal fit for rolling. Therefore, it is possible to use Battelle-TBD-6000 to bound the doses to all Joslyn operations beginning in 1948. The fact that rolling was the most hazardous operation should be expected since Joslyn did not treat the billets by heating in either a lead or a salt bath to reduce the surface oxidation. These techniques were employed successfully at other sites.

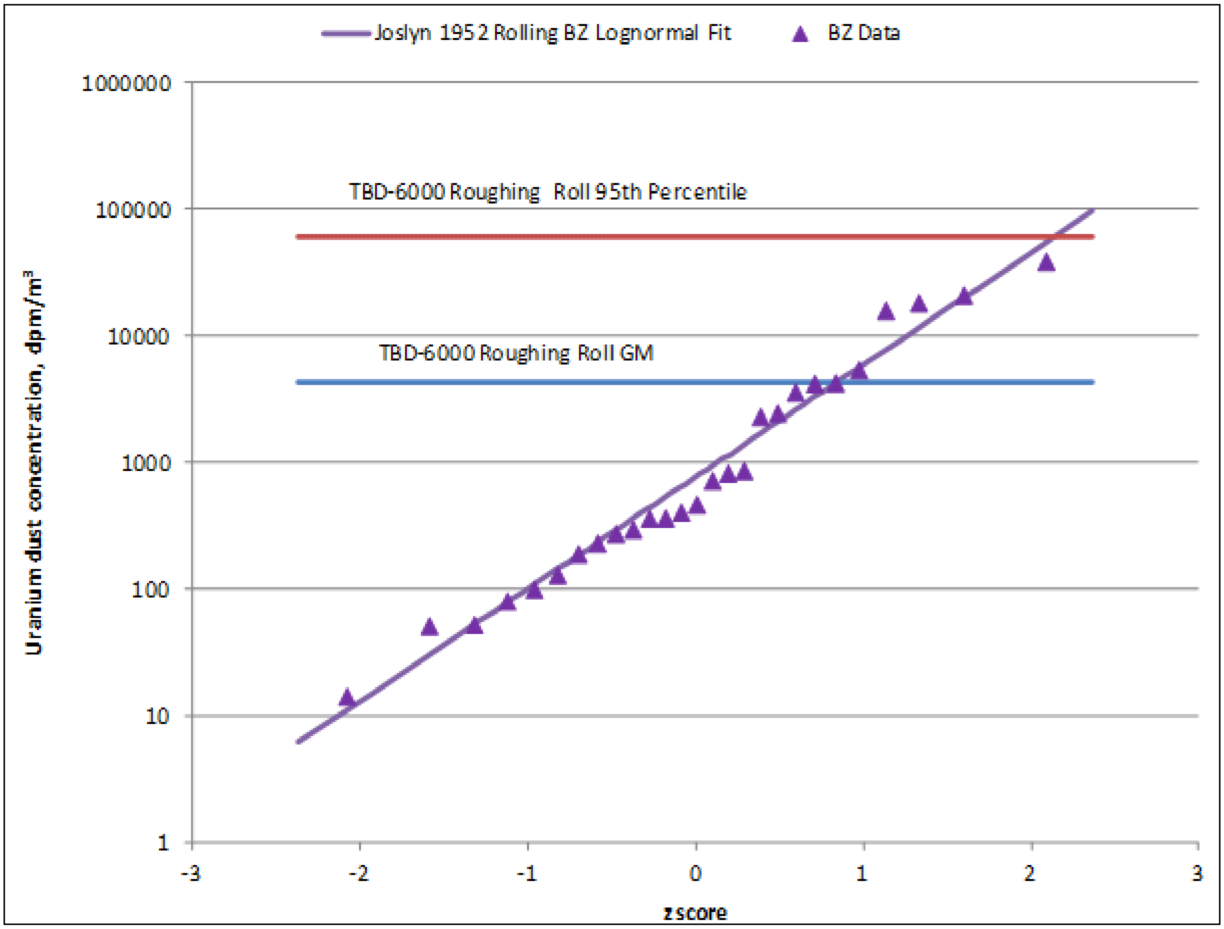

Figure 7-2: Comparison of the Lognormal Fit of the Joslyn 1952 BZ Air Concentration Data to the GM and 95th Percentile for the 1951-1955 Roughing Roll Operator Distribution in Battelle-TBD-6000

To bound the doses, the Battelle-TBD-6000 tables of inhalation and ingestion intakes are used. The annual intakes found in Battelle-TBD-6000 were calculated from the air concentrations by multiplying by the breathing rate, the hours worked per week, and the number of weeks worked per year. The daily intakes are then determined by dividing by 365 days. A lognormal distribution multiplied by a constant is also a lognormal. The intakes calculated from Battelle-TBD-6000 are therefore also lognormally distributed with a GSD of 5. The intake values for bounding the doses are shown in Table 7.8 of Battelle-TBD-6000. The values for the operations at Joslyn are reproduced below, in Table 7-3.

Table 7-3: Daily Intake Rates for Joslyn from Battelle-TBD-6000				
Work Area/Job Description	Inhalation	Ingestion	Inhalation	Ingestion
	1/1/1948-12/31/1950		1/1/1951-12/31/1952	
	(pCi/day)	(pCi/day)	(pCi/day)	(pCi/day)
Rolling Operator	12671	260	11615	238
Rolling General Labor	2335	48	2140	44
Rolling Supervisor	1169	24	1072	22
Rolling Clerical	118	2.4	108	2.2
Machining Operator	19654	403	18016	369
Machining General Labor	9827	201	9008	185
Machining Supervisor	4914	101	4504	92
Machining Clerical	491	10.1	450	9.2

The burning of uranium scrap was conducted in an outside area. No air sample data are available. Since it was not done in a confined area, the air concentrations during this activity should be bounded by the values in Battelle-TBD-6000.

The uranium operations at Joslyn caused contamination to be deposited on surfaces. Indications are that this contamination was cleaned between operations (Klevin, 1952; Piccot, 1949). Intakes from the re-suspension of uranium could be calculated from the residual contamination reported in the 1949 and 1952 surveys of the operations.

Once bounding inhalation intakes are determined using Battelle-TBD-6000, the ingestion intakes may be calculated using *Estimation of Ingestion Intakes*, OCAS-TIB-009. These intakes have already been calculated and appear in Table 7.9 in Battelle-TBD-6000. The values extracted for Joslyn appear in Table 7-3 above with the inhalation values. Both solubility types M and S are considered to maximize the radiation dose to the organ(s) of interest. This results in bounding doses for Joslyn.

Thorium

All indications are that the extruded thorium rods were centerless ground on two occasions at Joslyn during 1946 and 1947. As these operations were in the period that NIOSH finds it is not feasible to reconstruct internal exposures adequately, no further exploration of reconstructing thorium exposure will be handled in this evaluation.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH concludes it is not feasible to reconstruct uranium internal radiation doses with sufficient accuracy for the period from March 1, 1943 through December 31, 1947 at Joslyn.

NIOSH concludes that there are site specific data and existing dose reconstruction methods available in Battelle-TBD-6000 to support reconstructing internal radiation doses with sufficient accuracy for the period from January 1, 1948 through December 31, 1952.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from March 1, 1943 through December 31, 1947, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Joslyn during the period from March 1, 1943 through December 31, 1947, 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 Joslyn

ATTRIBUTION: Section 7.3 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities and Billy Smith, M. H. Chew and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal sources of external radiation doses for members of the evaluated class were exposure to gamma and beta radiation associated with handling and working in proximity to uranium and uranium compounds while involved in the rolling, quenching, straightening, and cutting of the materials. Some employees were also potentially externally exposed to the radiations from resuspended contamination from uranium metal surfaces and the floor during the course of their work with these radioactive materials. Additionally, eleven thorium rods (~57 kg) underwent centerless grinding at Joslyn, providing potential exposures to thorium (Macherey, 1947; Monthly Report, Jun1946, PDF p. 3). Documentation available to NIOSH indicates that the centerless grinding of thorium was performed over a period of several days, on an experimental basis and consisted of these small quantities (as compared to the production quantities of uranium).

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

7.3.1 Evaluation of Bounding Process-Related External Doses

NIOSH has not identified any external monitoring records, external area monitoring data, or personal dosimetry data associated with the uranium and thorium processing conducted during the period under evaluation. The sources of exposure at Joslyn were the beta, gamma, and X-ray radiation from the uranium metal, uranium oxides, and thorium metal. NIOSH has identified internal correspondence containing gamma and alpha hand-held instrumentation results from measurements taken at the various plant process that are useful in bounding external doses (Piccot, 1949).

While the specifics in regards to dates of rolling or grinding activities are sometimes unknown, the documented Joslyn uranium through-put is 1,127,000 pounds of uranium products. Documented rolling and centerless grinding activities at Joslyn are described in Section 5.1 of this report under subheadings for five different categories. All of the uranium processed in these categories is tabulated in Table 5-1. The activities identified in Table 5-1 account for 90% of the uranium materials that were processed through Joslyn.

The uranium was processed in specific campaigns between 1943 and 1952. The major campaigns can be described as experimental rolling/straightening, centerless grinding, production rolling, Great

Britain/Canada work, and special requests. Between campaigns, the plant processed non-radioactive steel products. The exposure to uranium can be estimated using the processing rate of uranium through the plant. Joslyn could process uranium, via rolling, at a rate of 90 tons per month (Monthly Report, Apr1948). Using this rate and the total uranium through-put (1,127,000 lbs), Joslyn rolled uranium for a cumulative 190 days over the span of the covered period. NIOSH did not find similar documentation to determine the cumulative time to allocate for centerless grinding, but assumes it may have been similar to days for rolling operations. NIOSH estimates that time allotted to centerless grinding of uranium would not exceed half the quantity of days rolling uranium (i.e., 95 days). This provides an overall estimate of 285 days of exposure to uranium processing activities over the span of the covered period for the Joslyn facility. NIOSH recognizes that uranium machining campaigns were not evenly spaced throughout the 1943 to 1952 covered period; however, this rate translates to monthly campaigns of an average of approximately 2.5 days/month, including the periods when there is no documented evidence of uranium rolling. This estimate of exposure duration can be used to calculate external dose from uranium metal to workers, using the methods and assumptions in Battelle TBD-6000.

NIOSH has identified methods in Battelle-TBD-6000 useful in support of bounding external uranium dose for the type of metal work performed during the operational period at Joslyn. However, NIOSH has not identified specific radiological data on thorium to support direct bounding of the thorium external exposures associated with the centerless grinding work during the very short period this work was performed. The bounding of thorium external dose from the centerless-grinding processing of the eleven thorium rods (125 lbs) (Macherey, 1947; Monthly Report, Jun1946) occurred over a period of several days. Exposure can be estimated by using a conservative grinding period of one week (5 days) and applying the Battelle TBD-6000 modeling for thorium. NIOSH also has information regarding the radiological hazard associated with thorium relative to uranium. Using this information on the quantities and relative hazards, NIOSH is able to bound possible external exposure to the thorium machined at Joslyn.

In light of the information above, NIOSH has concluded that sufficient data and information are available to estimate a bounding external dose from uranium and thorium.

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

Photon

The majority of the photons from natural uranium metals are in the 30–250 keV energy range. Solid uranium objects provide considerable shielding of the lower-energy photons and harden the spectrum, causing the majority of the photons emitted from a solid uranium object (such as a billet 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 shows the primary isotopes and photon energies associated with the uranium metal. Exposure to these photons was possible during machining operations from direct radiation during metal-handling and from submersion in air contaminated with the uranium metal.

Thorium has a significant number of higher-energy photons in the thorium-232 decay chain. Based on the half-lives of the progeny, only a partial equilibrium is possible; therefore, it may be stated with confidence that equilibrium would be reached in this decay chain. Assuming radium-228 and thorium-228 progeny were in equilibrium with thorium-232, air concentrations were equal for all progeny. Under these assumptions, the progeny are the major source of both penetrating and non-penetrating external exposure. Table 5-3 shows the primary isotopes and photon energies associated with thorium and its progeny. The amount of thorium processed through Joslyn was extremely small (125 lbs).

Beta

Tables 5-2 and 5-3 show the principal beta emitters and their energies for the uranium and thorium metal used during machining operations. As indicated in these tables, there are a significant number of high-energy beta radiations that represent a shallow dose exposure concern to site workers. Workers who handled the uranium and thorium metal would have received shallow dose exposures. The primary exposure areas would have been the hands and forearms, the neck and face, and other areas of the body that might not have been covered.

Alternative Data Sources for Bounding External Dose

The model that NIOSH will use to bound external doses is contained in Battelle-TBD-6000 and will rely on the information from the 1949 HASL final survey of the Joslyn facility (Piccot, 1949) and the quantities of uranium and thorium materials handled and processed. From June 1943 through July 1948, the plant processed 1,104,000 lbs of uranium. From January 1950 through October 1951, the plant processed ~23,000 lbs, for a total throughput of 1,127,000 lbs of uranium. Additionally, it is known that the plant performed experimental centerless grinding on 11 thorium rods with a total mass of ~125 lbs. The form of the materials received for processing was billets and rods.

7.3.2 Evaluation of Bounding Residual Period External Doses

NIOSH verified with two sources that there is no residual radioactive period specified for the Joslyn Manufacturing and Supply Co.: (1) *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*, Appendix A-1, *Residual Radioactive Contamination-Summary of All Sites*; and (2) Department of Energy Office of Health, Safety and Security Facility List Database [http://www.hss.doe.gov/healthsafety/fwsp/advocacy/faclist/showfacility.cfm].

7.3.3 Joslyn Occupational X-Ray Examinations

Documents from as early as May 1944 indicate that the AEC was aware of potential exposure hazards at the Joslyn facility and was making recommendations for improving the hazard and health monitoring of the workers. A May 1944 memo (Fuqua, 1944) recommends complete medical examinations before and after the job and discusses arrangements to have complete blood and urine "determinations and chest X-rays taken" for 75 men. The recommendation goes on to suggest that if operation is to continue beyond July 1, 1944, arrangements for monthly blood and urine studies be made. The same file contains a copy of a DuPont memo outlining procedures for invoicing medial examinations of Joslyn and Du Pont employees. To date, NIOSH has found no records of the X-rays or copies of the invoices for such medical examinations. Information presented to NIOSH during a worker outreach meeting with previous site employees indicated that medical X-ray examinations were performed at local medical facilities. NIOSH has no further data regarding if medical X-ray examinations may have been performed onsite versus offsite. Per ORAUT-OTIB-0079, *Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*, NIOSH has determined that it is applicable to reconstruct occupational medical X-ray exposures for Joslyn Manufacturing and Supply Co. workers during the period from March 1, 1943 through December 31, 1952.

7.3.4 Methods for Bounding Operational Period External Dose at Joslyn

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)

Operational period external dose at the Joslyn facility can be reconstructed applying the basic information on plant conditions and understanding of photon energies and beta energies expected from the natural uranium metal. Methods to address exposure to the penetrating photon and non-penetrating photon and electron spectrum are addressed in Battelle-TBD-6000 and are to be applied in the case of AWE sites where estimation of dose is necessary in the absence of dosimetry data.

<u>Photon Dose</u>

Photon dose at Joslyn would be primarily made up of exposure to photons from the uranium metal being worked at the site for operators, with exposure to contaminated surfaces being a lesser contributor to any exposure dose. While the preferred indicator of external dose is dosimetry measurements, that is not the only avenue to assess photon dose.

Section 6.2 of Battelle-TBD-6000 provides guidance on estimating external dose rates due to penetrating radiation emitted from the surface of uranium metal. Using the results of Monte Carlo N-Particle Transport Code (MCNP) calculations performed for a number of basic shapes, it provides calculated dose rates for distances of 1 centimeter, 1 foot, and 1 meter from the surface of the natural uranium metal. These dose rates can be used to estimate the component of whole-body dose that a worker would receive while handling or near uranium metal, applying information that may be available about the specific conditions of a worker's likely exposure. If no information is available about the specific conditions of exposure, Battelle-TBD-6000 provides for generic worst-case assumptions to be made about a worker's exposure conditions. The methods allow for differing assumptions based on work assignment (i.e., operator vs. general laborer). NIOSH understands that exposure to the uranium metal was not a continuous exposure over the course of the year; thus, annualized exposure calculations would be a significant overestimate of the actual exposure potential. The monthly exposure duration described in Section 7.3.1 of 2.5 days/month provides an annual exposure potential of 30 days/yr for worker exposures.

The potential exposure accrued from the presence of contamination on work surfaces would be minor in comparison with the primary exposure to the uranium metal.

Beta Dose

The non-penetrating beta dose is primarily associated with the hands and forearms, and then other skin surfaces, of a worker who handles uranium metal in close proximity. At Joslyn, the handling of the uranium during the rolling process was commented on as a strength of the process at that facility. Section 6.3 of Battelle-TBD-6000 details a method to estimate skin doses for the hands and forearms of a worker who handles uranium metal, as well as the other skin surfaces of such a worker. The assumptions, based on annual dose by job category and dose relations as described in Battelle-TBD-6000 for estimating beta dose to metal workers will be used to bound the dose for the workers at Joslyn by applying the annual exposure duration of 30 days/yr as suggest in the photon subsection above.

Medical X-ray Dose

Although NIOSH has not located specific parameters associated with occupational medical X-rays (i.e., specific information on the X-ray devices) default values of entrance kerma, developed for the three most commonly-used occupational medical diagnostic procedures, are available in ORAUT-OTIB-0006. These values can be used to support bounding the medical X-ray dose for the time period under evaluation. These default values are maximum, or upper limit, values developed from review of patient doses as reported in the literature, machine characteristics, and knowledge of X-ray procedures used during different time periods. These default values can be used in lieu of actual measurement data or entrance kerma derived from technique factors to bound the occupational X-ray exposures for Joslyn Manufacturing and Supply Co. NIOSH believes this methodology supports its ability to bound occupational medical X-ray doses for the Joslyn class under evaluation.

7.3.5 External Dose Reconstruction Feasibility Conclusion

There are methods available to NIOSH to support bounding external uranium and thorium dose for the operational period at Joslyn. NIOSH has identified sufficient information or data to support the bounding conclusion. For the operational period, NIOSH was unable to determine a worker's actual work locations or whether a worker was restricted to one location. Workers may have been able to move about freely; therefore, all workers' exposures will be treated similarly. The uranium and thorium activities at Joslyn were consistently routine over time and therefore the exposures to workers can be extrapolated from a snapshot in time. Therefore, NIOSH has determined that reconstruction of external doses for Joslyn workers with sufficient accuracy, including occupational medical dose, is feasible for the operational period from March 1, 1943 through December 31, 1952.

7.4 Evaluation of Petition Basis for SEC-00200

ATTRIBUTION: Section 7.4 was completed by Monica Harrison-Maples, Oak Ridge Associated Universities. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The following subsections evaluate the assertions made on behalf of petition SEC-00200 for the Joslyn site.

7.4.1 Unmonitored Radiation Exposures

SEC-00200: (F.1) Radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored either through personal monitoring or through area monitoring.

NIOSH determined that it has access to only a limited number of air sample and source term information for Joslyn during the time period under evaluation. Medical records, bioassay data, and external monitoring results are not available. NIOSH has concluded that the available information is insufficient to bound the internal dose for Joslyn early operations from March 1, 1943 through December 31, 1947; however, the internal dose from January 1, 1948 through December 31, 1952, and the external dose from March 1, 1943 through December 31, 1952 (the entire evaluated period) can be bound using the approaches described in Battelle-TBD-6000, as discussed within this evaluation report.

7.4.2 Unmonitored Thorium Exposure Activities

SEC-00200: *There were thorium rollings at Joslyn Manufacturing and Supply Co. and to the best of my knowledge there was no monitoring.*

While there is evidence of the two thorium centerless grinding activities, NIOSH did not locate any official documentation indicating that there had in fact been thorium rolling activities at Joslyn. NIOSH has sufficient information regarding the thorium grinding events, including how many rods were worked on and the differential between the initial size of the rods and the final size, to be able to determine how much thorium was removed from the rods and thus available for potential internal exposure to workers. While NIOSH could define an upper bound of thorium internal dose given the information on the mass of thorium available for intake, since the grinding operations took place during the period recommended for inclusion into the SEC, no additional development of these methods at Joslyn is necessary in this evaluation report.

7.5 Summary of Feasibility Findings for Petition SEC-00200

This report evaluates the feasibility for completing dose reconstructions for employees at the Joslyn Manufacturing and Supply Co. from March 1, 1943 through December 31, 1947. NIOSH found that the available monitoring records, process descriptions, and source term data available are not sufficient to complete dose reconstructions for the entire evaluated class of employees.

Table 7-4 summarizes the results of the feasibility findings at Joslyn for each exposure source during the time period from March 1, 1943 through December 31, 1947 and from January 1, 1948 through December 31, 1952.

Table 7-4: Summary of Feasibility Findings for SEC-00200
March 1, 1943 through December 31, 1947;
January 1, 1948 through December 31, 1952

Source of Exposure	March 1, 1943 through Dec. 31, 1947		Jan. 1, 1948 through Dec. 31, 1952	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal[1]		**X**	**X**	
- Uranium		X	X	
- Thorium		X	N/A	
External	**X**		**X**	
- Gamma	X		X	
- Beta	X		X	
- Neutron	N/A	N/A	N/A	N/A
- Occupational Medical X-ray	X		X	

[1] Internal includes an evaluation of airborne dust data

As of October 9, 2012, a total of 48 claims have been submitted to NIOSH for individuals who worked at Joslyn during the period under evaluation in this report. Dose reconstructions have been completed for 26 individuals (~54%).

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 Joslyn during the period from March 1, 1943 through December 31, 1947, 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-00200

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 March 1, 1943 through December 31, 1947. 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, 1948 through December 31, 1952. Therefore, a health endangerment determination is not required for this time period.

9.0 Class Conclusion for Petition SEC-00200

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 in any buildings/area owned by the Joslyn Manufacturing and Supply Co. (or a subsequent owner) in Fort Wayne, Indiana, from March 1, 1943 through December 31, 1947, 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 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 (SRDB), for information relevant to SEC-00200. 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.

10.0 References

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

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

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Joslyn Manufacturing and Supply Company			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site / Company Name: Joslyn Manufacturing and Supply Co.; May 1943-1952 AWE Alternate Site Names: Joslyn Stainless Steel Company Slater Steel Company Slater Stainless Steel Valbruna Slater Stainless Physical Size of the Site: 63 Site Population: In 1944, 75 workers were involved with uranium rolling. In 1952, 47 workers were involved with uranium rolling.	No relevant documents identified. The site Environmental Safety and Health Associate reported that a records search has been conducted in response to former employee inquiries and that no records from the uranium rolling operations were located.	06/26/2012	0
State Contacted: Indiana Department of Homeland Security, (Nuclear Regulatory Commission designated Point of Contact)	Historical FUSRAP site information.	07/05/2012	1
Atomic Energy of Canada Limited	Metallurgical reports on the effects of irradiation on Joslyn rods.	07/20/2012	2
Department of Labor / Paragon	Progress reports, an accountability report, a resurvey recommendation for Lake Ontario Ordnance Works, and a documented communication.	12/30/2008	5
DOE Legacy Management - Grand Junction Office	Progress reports, uranium rolling and grinding reports, accountability and material losses reports, survey reports, FUSRAP reports, inventory and material transfer reports, responses to Joslyn health questions, and a 2005 SAIC North-South Bay survey.	09/13/2012	58
DOE Legacy Management - Morgantown	A list of covered facilities and their operations.	06/30/2010	1
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Radiological survey samples and a report on uranium rolling.	04/10/2008	2
DOE Oak Ridge Operations, Records Holding Task Group	A report on drawing uranium rods.	12/14/2010	1
DOE Office of Scientific and Technical Information (OSTI)	A NIOSH researcher's notes and a 1945 Hanford report describing uranium rolling at Joslyn.	08/10/2012	2

Table A1-1: Data Capture Synopsis for Joslyn Manufacturing and Supply Company			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
DOE Germantown, EM File Room	References to Joslyn as a facility that rolls uranium.	09/11/2002	2
Hagley Museum and Library	No relevant documents identified.	10/01/2010	0
Hanford	A 1946 accountability report. Note: An additional search of Hanford records has been requested, however, all Hanford requests are on hold until funding becomes available.	OPEN	1
Internet	Photographs of the 1983 flood.	07/25/2012	2
Internet - Defense Technical Information Center (DTIC)	Metallurgy in the Development of Atomic Power.	05/22/2012	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	06/22/2012	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford progress reports referencing Joslyn, uranium rolling reports, trip reports to Joslyn, and health hazard inspections at Joslyn.	08/04/2012	20
Internet - DOE Legacy Management Considered Sites	No relevant documents not already in the SRDB identified.	08/09/2012	0
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	08/09/2012	0
Internet - DOE OpenNet	1948 and 1949 Hanford monthly status reports referencing Joslyn, references to Joslyn in the Medical Program of the Manhattan District history, trip reports to Joslyn, and a 1944 discussion of filter analyses.	08/09/2012	11
Internet - DOE OSTI Energy Citations	No relevant documents not already in the SRDB identified.	08/06/2012	0
Internet - DOE OSTI Information Bridge	Reference to Joslyn in the Clinton and Hanford metal fabrication program.	08/06/2012	1
Internet - Google	News articles pertaining to Joslyn, FUSRAP documents, and a search for former employees from a former employee's blog.	05/06/2012	15
Internet - Health Physics Journal	No relevant documents identified.	06/22/2012	0
Internet - Indiana Department of Environmental Management Virtual File Cabinet	No relevant documents identified.	06/26/2012	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	06/22/2012	0
Internet - National Academies Press (NAP)	No relevant documents identified.	08/09/2012	0
Internet - NIOSH	A 2006 report on radioactive and beryllium contamination at Atomic Weapons Employer sites.	01/25/2007	1
Internet - NRC Agency wide Document Access and Management (ADAMS)	NRC staff evaluations of sites identified in a USA Today article, a petitioner's motion mentioning Joslyn, and service bulletins for pressure regulators.	05/11/2012	5
Internet - USACE/FUSRAP	No relevant documents identified.	08/09/2012	0

Table A1-1: Data Capture Synopsis for Joslyn Manufacturing and Supply Company			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	08/09/2012	0
National Archives and Records Administration (NARA) - Atlanta	Progress reports, accountability reports, health and safety inspection of Joslyn, a listing of uranium subcontractors, and materials code symbols.	12/07/2011	8
National Archives and Records Administration (NARA) - College Park	Trip reports, rolling operations data, material balances and losses, thorium fabrication, and a NIOSH researcher's notes.	08/17/2010	10
National Archives and Records Administration (NARA) - Kansas City	A site survey, decontamination documents, and a site visit.	03/30/2005	5
National Institute for Occupational Safety and Health (NIOSH)	Reports on rolling and centerless grinding uranium rods, a memo on hazardous work performed by Metallurgical Laboratory subcontractors, and worker outreach meeting documents.	08/27/2012	6
New York State Archives	Reference to billet length limitations at Joslyn in a 1948 Electro Metallurgical Company to the AEC.	03/20/2012	1
Oak Ridge National Laboratory (ORNL)	An evaluation of health measures at Joslyn, uranium rolling reports, industrial hygiene conditions, a purchase order for medical examinations, and Joslyn's contract with the University of Chicago. Note: Awaiting 6 Central Files reports.	OPEN	11
ORAU Team	A technical bulletin on estimating maximum plausible dose at Atomic Weapons Employer sites.	02/09/2007	1
Pacific Northwest National Laboratories (PNNL)	A 1944 report on uranium rolling and grinding at Joslyn.	07/19/2005	1
Unknown	Air samples, progress reports, uranium rolling reports, health and safety issues, FUSRAP reports, and an occupational exposure to radioactive dust report.	07/21/2004	23
US Army Corp of Engineering (USACE)	FUSRAP reports.	07/31/2012	5
TOTAL			**202**

Table A1-2: Databases Searched for Joslyn Manufacturing and Supply Company			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**

Table A1-2: Databases Searched for Joslyn Manufacturing and Supply Company			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Joslyn Manufacturing and Supply Co Rev 01, (83.13) 10-04-12"			
Defense Technical Information Center (DTIC) https://www.dtic.mil/ COMPLETED 05/16/2012	See Note above	6	1
DOE CEDR https://www.orau.gov/cedr COMPLETED 06/22/2012	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 08/09/2012	See Note above	16	9
DOE Legacy Management Considered Sites http://www.lm.doe.gov/considered_Sites/ COMPLETED 08/09/2012	See Note above	35	2
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 08/09/2012	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 08/09/2012	See Note above	81	12
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 08/06/2012	See Note above	531	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 08/06/2012	See Note above	359	1
Google http://www.google.com COMPLETED 05/06/2012	See Note above	13,015	7
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 06/22/2012	See Note above	0	0

Table A1-2: Databases Searched for Joslyn Manufacturing and Supply Company			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
Indiana Department of Environmental Management Virtual File Cabinet http://www.in.gov/idem/6551.htm COMPLETED 06/26/2012	See Note above	26	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 06/22/2012	See Note above	0	0
National Academies Press http://www.nap.edu/ COMPLETED 08/09/2012	See Note above	4,024	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 08/09/2012	See Note above	1,362	1
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 08/09/2012	See Note above	6	1
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 08/09/2012	See Note above	69	0

Table A1-3: OSTI Documents Requested for Joslyn Manufacturing and Supply Company			
Document Number	**Document Title**	**Requested Date**	**Received Date**
No documents requested.			