SEC Petition Evaluation Report

Petition SEC-00247

Report Rev Number:	0
Report Submittal Date:	November 16, 2018
Subject Expert(s):	Tim Kirkham, Mutty Sharfi
Site Expert(s):	Not Applicable

Petition Administrative Summary

Petition Under Evaluation

Petition Number:	SEC-00247
Petition Type:	83.13
Petition Receipt Date:	May 1, 2018
Qualification Date:	July 19, 2018
DOE/AWE Facility Name:	Superior Steel Co.

Petition Class

Petitioner-Requested Class Definition:	All workers who worked in any area at the Superior Steel Co. facility in Carnegie, PA, during the period from January 1, 1952 through December 31, 1957.
Class Evaluated by NIOSH:	All atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.
NIOSH-Proposed Class(es) to be Added to the SEC:	None

Related Petition Summary Information

SEC Petition Tracking Number(s):	Not Applicable
Petition Type:	Not Applicable
DOE/AWE Facility Name:	Not Applicable
Petition Status:	Not Applicable

Related Evaluation Report Information

Report Title:	Not Applicable
DOE/AWE Facility Name:	Not Applicable

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Evaluation Report Summary: SEC-00247, Superior Steel Co.

The National Institute for Occupational Safety and Health (NIOSH) prepared this evaluation report in response to a petition to add a class of workers at Superior Steel Co. to the Special Exposure Cohort (SEC). The *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, (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,* describe the process for adding new classes to the SEC.

Petitioner-Requested Class Definition

NIOSH received petition SEC-00247 on May 1, 2018, and qualified it on July 19, 2018. The petitioner requested that NIOSH consider the following class: *All workers who worked in any area at the Superior Steel Co. facility in Carnegie, PA, during the period from January 1, 1952 through December 31, 1957.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class. NIOSH evaluated the following class: All atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.

NIOSH Determination about the Proposed Class to be Added to the SEC

NIOSH has obtained operational process data, and air sampling data performed periodically during uranium rolling operations at Superior Steel Co. during the period from January 1, 1952 through December 31, 1957. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

Feasibility of Dose Reconstruction

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 of members of the class more precisely than an estimate of the maximum dose. Information available from the site profile and additional resources is sufficient to estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period.

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

- NIOSH finds that it is feasible to reconstruct occupational medical dose for Superior Steel Co. employees with sufficient accuracy during the period from January 1, 1952 through December 31, 1957. Medical dose is not assigned after 1957 after the AWE covered period for Superior Steel Co.

- The period under evaluation includes the entire AWE operations period for Superior Steel Co. The effective date of the AEC contract with Superior Steel Co. was June 27, 1952, therefore, no operational internal or external exposures associated with rolling activities will be assessed prior to June 27, 1952.

- Principal sources of internal radiation for members of the proposed class included inhalation of uranium dust produced from the manipulation and oxidation of uranium metal during rolling and related processes. NIOSH estimates that Superior Steel Co. processed over 60,000 pounds of uranium metal for AEC contracts. Superior Steel Co. also performed a non-AEC test-scale rolling operation with 700 pounds of thorium metal in March or April 1956 for a commercial customer.

- NIOSH has process-related air monitoring data collected by the AEC during four uranium rolling campaigns; two in 1953 and two in 1955. NIOSH has determined that the available air monitoring data are sufficient to determine the bounding uranium alpha air exposures for the highest potentially exposed workers at Superior Steel Co. for the period January 1, 1952 through December 31, 1957.

- NIOSH has determined that it has sufficient process information to derive airborne thorium concentrations based on the mass loading calculated from the AEC air sampling results associated with the 1955 uranium rollings. Given the large-scale nature of the site’s uranium work and the small-scale nature of the thorium work, this is considered a favorable estimate of thorium-related exposure from the single test-scale thorium campaign.

- NIOSH finds that it is feasible to reconstruct with sufficient accuracy the internal radiation doses from uranium and thorium metal rolling operations for Superior Steel Co. employees during the period from January 1, 1952 through December 31, 1957.

- Principal sources of external radiation for members of the proposed class included direct exposure from being in proximity to the uranium ingots, exposure from contaminated surfaces, and submersion in air contaminated with dust generated via the processing of uranium metal for the AEC. Superior Steel Co. workers also received such exposures during the non-AEC test-scale rolling operation with 700 pounds of thorium metal in March or April 1956 for a commercial customer.

- For AWE sites such as Superior Steel Co. that handled uranium metals, NIOSH procedure Battelle-TBD-6000 presents methods for bounding worker doses due to external exposure from rolling operations with uranium metal. NIOSH has determined that it has sufficient applicable site-specific information, using the methods of Battelle-TBD-6000, to model Superior Steel Co. worker doses due to uranium and thorium metal rolling operations during the period from January 1, 1952 through December 31, 1957.

- NIOSH finds that it is feasible to reconstruct with sufficient accuracy the external radiation doses from uranium and thorium metal rolling operations for Superior Steel Co. employees during the period from January 1, 1952 through December 31, 1957.

- Pursuant to 42 C.F.R. § 83.13(c) (1), NIOSH determined 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.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c) (3), 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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Table of Contents

Tables

Figures

SEC Petition Evaluation Report for SEC-00247

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Tim Kirkham, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing radiation doses for all atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957. 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.

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 (DHHS) 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.[1]

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

[1] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available on the NIOSH Radiation Dose Reconstruction Program webpage.

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 employees 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 (Advisory Board). The Advisory Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Advisory Board considers appropriate, in order to make recommendations to the Secretary of DHHS 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 Advisory Board, the Director of NIOSH will propose a decision on behalf of DHHS. The Secretary of DHHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Advisory 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 DHHS.[2]

3.0 SEC-00247, Superior Steel Co. Class Definitions

The following subsections address the evolution of the class definition for SEC-00247, Superior Steel Co. 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

NIOSH received petition SEC-00247 on May 1, 2018, and it qualified on July 19, 2018. The petitioner requested that NIOSH consider the following class: *All workers who worked in any area at the Superior Steel Co. facility in Carnegie, PA, during the period from January 1, 1952 through December 31, 1957.*

The petitioners provided information in support of their proposal that records and information may be inadequate for dose reconstruction for the Superior Steel Co. employees in question. The basis for their proposal was that certain radiation exposures and doses to the class were not monitored. NIOSH deemed the following information sufficient to qualify SEC-00247 for evaluation:

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[2] See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available on the NIOSH Radiation Dose Reconstruction Program webpage.

- The petitioner provided NIOSH statements made in ORAUT-TKBS-0034, Rev 00-PC-1 that "individual uranium urinalysis data are unavailable for Superior Steel workers and none are known to exist" and "no external dosimetry results are available for Superior Steel employees."

NIOSH concluded that there is sufficient documentation to support, for at least part of the petitioner-requested time period, the petition basis that internal and external radiation exposures and radiation doses were possibly not adequately monitored at Superior Steel Co., either through personal monitoring or area monitoring. Based on its Superior Steel Co. research and data capture efforts for area monitoring, NIOSH determined that it has access to air monitoring data during uranium rolling operations for Superior Steel Co. employees during the period under evaluation. However, for personnel monitoring, NIOSH also determined that internal and external personnel radiological monitoring data records are not available for any radionuclides during the period under evaluation.

The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Advisory Board, and DHHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class because of the need to further evaluate the availability of personnel and workplace monitoring data and related information for estimating radiation doses due to uranium, and potentially thorium, exposures at the facility. Therefore, NIOSH defined the following class for further evaluation: All atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.

3.3 NIOSH Determination about the Proposed Class to be Added to the SEC

NIOSH has air and workplace monitoring data obtained during uranium rolling operations at Superior Steel Co. during the period under evaluation. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

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 Superior Steel Co. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) SciTech Connect database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, the Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, Savannah River Site (SRS) Electronic Document Workflow System (EDWS), and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One includes a summary of Superior Steel Co. documents. The summary specifically includes 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 documented at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored employees, 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. As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Superior Steel Co.:

- *An Exposure Matrix for Superior Steel, Carnegie, Pennsylvania, Period of Operation: January 1, 1952 through December 31, 1957*, ORAUT-TKBS-0034; Rev. 00 PC-1; August 9, 2005; SRDB Ref ID: 20182

- *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*, Battelle-TBD-6000; Rev. 1; June 17, 2011; SRDB Ref ID: 101251

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:

- *Dose Reconstruction from Occupational Medical X-ray Procedures*, ORAUT-OTIB-0006, Rev. 05; effective August 13, 2018; SRDB Ref ID: 172596

- *Internal Dose Overestimates for Facilities with Air Sampling Programs*, ORAUT-OTIB-0018, Rev. 01; effective August 9, 2005; SRDB Ref ID: 19436

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

- *Guiding Reconstruction of Intakes of Thorium Resulting from Nuclear Weapons Programs*, ORAUT-OTIB-0076, Rev. 00; effective July 10, 2014; SRDB Ref ID: 133669

- *Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 02; effective June 15, 2017; SRDB Ref ID: 166967

4.3 Facility Employees and Experts

Interviews for the specific purpose of supporting this SEC-00247 evaluation were not considered likely to produce new information for the period under evaluation. Therefore, additional interviews were not conducted by NIOSH.

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of October 2, 2018)

Table 4-1: Number of Superior Steel Co. Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	35
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1952 through December 31, 1957)	35
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 time period in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the time period 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. No incidents were reported by claimants and no personal monitoring records were provided.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. NIOSH identified 308 documents in this database as pertaining to Superior Steel Co. These documents were evaluated for their relevance to this petition. The documents include historical information regarding the uranium rolling process, dates of rolling campaigns, air monitoring data, and Atomic Energy Commission (AEC) radiological licensing requests and granting documents.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *An Exposure Matrix for Superior Steel, Carnegie, Pennsylvania, Period of Operation: January 1, 1952 through December 31*, 1957, Rev. 00 PC-1; ORAUT-TKBS-0034; ORAU Team Dose Reconstruction Project for NIOSH; effective August 9, 2005; SRDB Ref ID: 20182

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at Superior Steel Co. from January 1, 1952 through December 31, 1957, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered air and workplace monitoring data obtained during uranium rolling operations at Superior Steel Co. during the period under evaluation, historical radiological licensing information, and site remediation survey data. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Superior Steel Co. Plant and Process Descriptions

Superior Steel Co. was located in Carnegie, Pennsylvania, on a 25-acre site. The AEC awarded a contract to Superior Steel Co. on June 27, 1952, because it was one of the few companies that had the technical expertise to roll and clad metal strip and plate (ORAUT-TKBS-0034; SROO, 1979; Young, 1985). The initial contract (AT(30-1)-1412) originated from the AEC New York Operations Office. The contract was transferred for administration to the Oak Ridge Operations Office and on October 15, 1954, was transferred to the Savannah River Operations Office (Young, 1985; SROO, 1979). Records indicate they rolled, cut, and finished uranium metal into strip under a cost-plus-fixed-fee contract, and that the contract was terminated on or about September 30, 1957 (Young, 1985; SROO, 1979). Superior Steel Co.'s source and fission material accounting station authority withdrawal was recorded on November 27, 1957 (Young, 1985).

Table 5-1 shows a summary of approximate size and functions for Areas A, B, and C of the Superior Steel Co. metal processing facilities. Figures 5-1 and 5-2 below, show the layout of the former Superior Steel Co. facility. Figure 5-2 shows Area A where the majority of the metal handling is believed to have occurred. Note that in both figures, the process started at the right of the drawing with the salt bath.

Table 5-1: Superior Steel Co. Processing Areas

Area	Approximate Size (ft^2)	Area Functions
A	24,000	This is the location where the majority of the uranium metal handling and shaping is believed to have occurred. This area contained the salt bath, roughing mill, brushing station, finishing stands, and shear.
B	8,250	This area was considered the "clean" side of the mill where the atmosphere was controlled to provide proper conditions for motor and instrument operations. This area housed the motor room and control panels for the mill.
C	12,000	This was the end of the mill process where metal was rolled for shipping prior to further handling. Two pits indicate locations of the bliss downcoiler (to coil the metal) and an upender (to tilt the material to 90 degrees).

Source: Myrick, 1981

Figures 5-1 and 5-2 below, show the layout of the former Superior Steel Co. facility. Figure 5-2 shows Area A where the majority of the metal handling is believed to have occurred. Note that in both figures the process started at the right of the drawing with the salt bath.

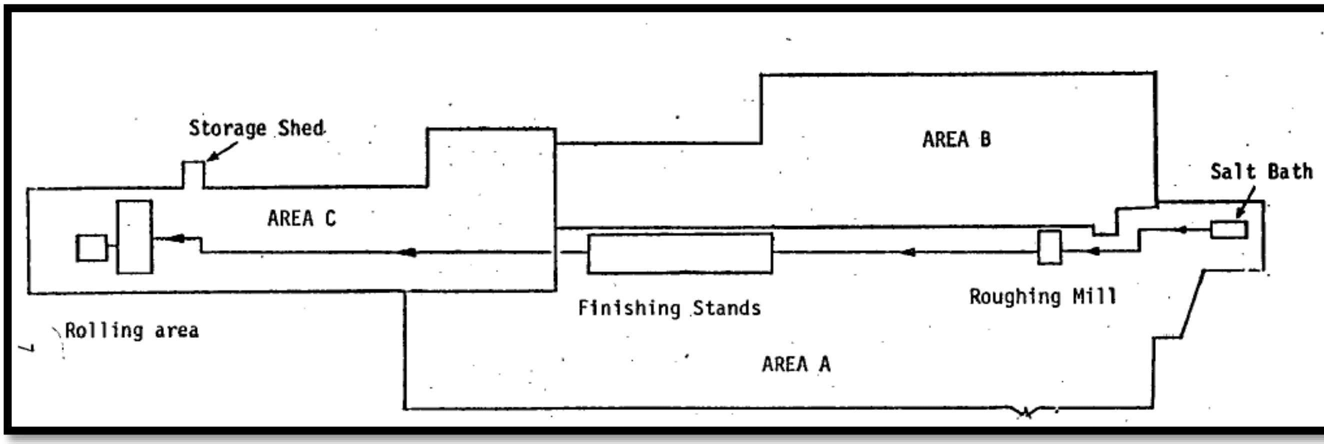

Figure 5-1: Processing Areas (Myrick, 1981)

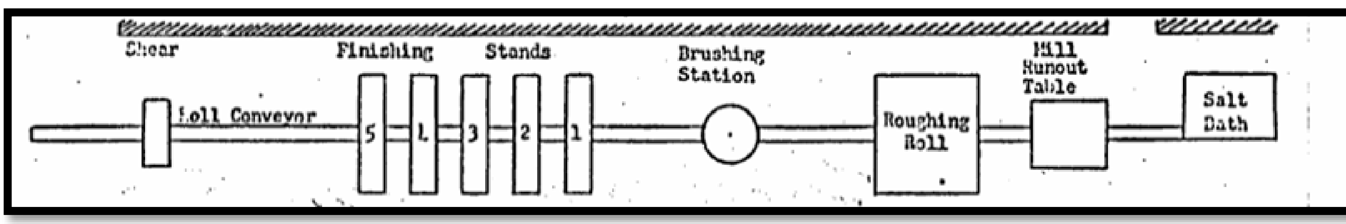

Figure 5-2: Layout of Hot Strip Uranium Mill Operation at Superior Steel Co., 1955 (Myrick, 1981)

5.1.1 Uranium Processing

The AEC performed security inspections related to the source and fission material accounting station at Superior Steel Co. in November 1954, May 1955, November 1955, June 1956, and in January 1957 (Young, 1985; SROO, 1979; Reardon, 1957). Available AEC Health and Safety reports show four rolling dates monitored by the AEC: May 13, 1953, August 3, 1953, May 9, 1955, and September 19, 1955 (Klevin, 1953a, b; AEC, 1955a, b). The last three reports mention the number of uranium slabs rolled: 23, 32, and 30, respectively. AEC reported that six of the slabs rolled on May 9, 1955, were enriched uranium (1.5% U-235) (Angerman, 1955; AEC, 1955a). NIOSH's exposure matrix indicates that the general Superior Steel Co. process involved the following (ORAUT-TKBS-0034; Klevin, 1953a, b; AEC, 1955a):

- A 1-inch thick slab of uranium, from 61 to 89 inches long and from 5.5 to 7 inches wide, was placed into a rectangular steel vessel containing a salt bath (50% LiCl and 50% KCl by volume).
- The salt bath was heated in a gas-fired furnace to a working temperature of approximately 1200°F for 45 minutes and then removed from the furnace. In 1953, a new furnace was installed that included a salt bath.
- The slab was moved by overhead crane to the rolling mill table.

- The slab was passed through a roughing roll five times and sent through the finishing stands.
- The strip was then cut as desired and transferred with tongs to a cooling area.
- The final thickness was between 182 and 191 mils (E. I. du Pont, 1954).

5.1.2 Thorium Processing

In addition to the work performed for AEC, Superior Steel Co. was licensed (AEC license No. C-3480) on March 27, 1956, to receive possession of and/or title to 700 pounds of thorium metal to perform development studies for Babcock & Wilcox Company with an expiration date of April 1, 1957 (Johnson, 1956a). The license was amended one month later (April 30, 1956) for forging, roll cogging, finish rolling, and cutting unlimited quantities of thorium metal for the Babcock & Wilcox Company with an expiration date of April 30, 1958 (Johnson, 1956b). An April 20, 1956 correspondence for this thorium-related license amendment to Superior's License No. C-3480 states "… we are currently evaluating the data secured in connection with our test rollings" (Ferguson, 1956), indicating that at least a portion of the 700 pounds of thorium metal was rolled. To date, NIOSH has not located any documentation indicating any production-scale rollings of thorium metal at Superior Steel Co. Due to the limited size of the Superior Steel Co. facilities and its production capacities, it is assumed that both commercial work and work performed for AEC was done on the same equipment and process line (Adams, 2001; Johnson, 1957).

The AEC C-3480 license allowed Superior Steel Co. to receive source material (thorium metal), owned by Consolidated Edison (Ferguson, 1956) from another commercial licensee (Babcock & Wilcox Company under license No. C-3465) and process it into the desired shape for use in a critical experiment at Babcock & Wilcox Company (Ferguson, 1956). The work performed by Babcock & Wilcox was likely part of their Critical Experiment Laboratory in Lynchburg, Virginia, for the Consolidated Edison Thorium Reactor (Babcock & Wilcox, 1962). According to the NRC, the Superior Steel Co. AEC license expired in 1958 and records indicate that there was neither a closeout survey nor inspection of the facility to support termination of this license (USACE, 2007).

The United States Army Corps of Engineers (USACE) in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) performed a Preliminary Assessment (PA) of the former Superior Steel Co. site (USACE, 2007). The purpose of this PA was to review information to determine the need for further action by USACE under the Formerly Utilized Sites Remedial Action Program (FUSRAP) to ensure the protection of human health and the environment. The scope of the assessment included a review of existing information about the site and a site visit on August 29, 2006. In its PA, USACE states that any residual radioactive contamination associated with commercial operations involving thorium metal is not eligible for cleanup under FUSRAP, which indicates to NIOSH that Superior Steel Co.'s thorium-metal operations during the AWE operations period were determined by USACE to not be AEC-related.

5.2 Radiological Exposure Sources from Superior Steel Co. Operations

The following subsections provide an overview of the internal and external exposure sources for the Superior Steel Co. class under evaluation.

5.2.1 Internal Radiological Exposure Sources

The potential for internal radiation dose existed at the Superior Steel Co. facility in all areas where radioactive materials were handled or stored. Based on the site operations, sources of radionuclide internal exposure included dust generated from the uranium and thorium ingots processed at the site.

The principal source of internal radiation exposure at Superior Steel Co. during the period under evaluation was inhalation of uranium dust produced from the manipulation and oxidation of uranium metal during production-scale rolling and related processes. A secondary source of internal exposures is the resuspension of settled uranium dust. Natural and enriched uranium were rolled at Superior Steel Co. and it is also possible that Superior Steel Co. rolled recycled uranium after 1952. The potential for similar inhalation of thorium dust also existed during smaller-scale test rollings of thorium during a three-week period in 1956.

AEC Health and Safety Laboratory (HASL) performed several visits and air sampling campaigns to review the airborne uranium concentration at the Superior Steel Co. during operations (Klevin, 1953a, b; AEC, 1955a, b). Information regarding HASL recommendations to install additional ventilation and make changes to work practices in order to decrease airborne uranium concentrations, as well as implementation of such recommendations, are available.

5.2.1.1 Uranium

The Superior Steel Co. radiological source term consisted primarily of natural uranium metal, uranium oxides, and natural uranium’s short-lived progeny. The source term was produced from the manipulation and oxidation of uranium metal during rolling and related processes. Long-lived progeny in the uranium series prevent significant ingrowth past U-234 in the U-238 decay series and beyond Th-231 in the U-235 decay series.

After 1952, small quantities of primarily alpha (Pu-239, Np-237, and Th-232/228) and beta (Tc-99) emitting radionuclides found their way into uranium metal via recycling. Assumed activity fractions per unit uranium are presented in Battelle-TBD-6000, and any associated internal doses are assigned as appropriate after 1952.

5.2.1.2 Thorium

The current exposure matrix for Superior Steel Co. (ORAUT-TKBS-0034) does not address potential thorium exposures at the site. During this evaluation, although there is no evidence of large-scale thorium metal handling, NIOSH determined that the site amended its radioactive material license with the AEC to allow for the commercial rolling of thorium metal. As presented in Section 5.1.2 above, Superior Steel Co. was licensed (AEC license No. C-3480) on March 27, 1956, to receive possession of and/or title to 700 pounds of thorium metal to perform development studies for Babcock & Wilcox Company (Johnson, 1956a). In a subsequent amendment request on April 20, 1956, Superior Steel Co. requested license for forging, roll cogging, finish rolling, and cutting unlimited quantities of thorium metal (Johnson, 1956b). In the April 20, 1956 correspondence the site stated “… we are currently evaluating the data secured in connection with our test rollings” (Ferguson, 1956), indicating that at least a portion of the 700 pounds of thorium metal was processed between March 27, 1956 and April 20, 1956. This is the only indication of thorium metal processing found by NIOSH in this evaluation. NIOSH has not located any documentation indicating any production-scale rollings of thorium metal at Superior Steel Co.

To further review potential for large-scale thorium operations at Superior Steel Co., NIOSH reviewed the results of four radiological surveys performed for remediation purposes. Given the timeframe for the potential thorium metal rolling (1956–1958) and the years of the remediation radiological surveys available to NIOSH (1980, 2000, 2003, and 2014), enough time had passed, regardless of the age of the thorium at rolling, that any thorium contamination could be measured and calculated using the daughter products of Th-232, assuming equilibrium similar to that of natural thorium. Since the radiological surveys didn't detect thorium, NIOSH assumes production-level rolling of thorium didn't occur.

Thorium has three abundant naturally-occurring radionuclides: Th-232, Th-230, and Th-228. These three isotopes decay by alpha decay with some associated weak intensity photons.

5.2.2 External Radiological Exposure Sources

The potential for external radiation dose existed at the Superior Steel Co. facility in all areas where radioactive materials were handled or stored. Based on the site operations, sources of external exposure included photon and beta radiation emitted from the uranium and thorium ingots processed at the site. Due to the type of metal being processed, neutron exposure was not significant, as examined below.

The principal potential sources of external dose for the Superior Steel Co. facility employees during the period under evaluation (January 1, 1952 through December 31, 1957) were direct exposure from being in proximity to the uranium ingots, exposure from contaminated surfaces, and submersion in air contaminated with dust generated via the processing of uranium ingots in the areas described in Section 5.1 herein (Areas A, B, and C). The potential for similar external exposures from thorium metal also existed during smaller-scale thorium test rollings during a three-week period in 1956.

No detailed descriptions of how ingots were handled at Superior Steel Co. (e.g., hands-on handling time vs. crane handling time) were located by NIOSH. No site-specific information is available to NIOSH to determine the amount of time a worker spent near the uranium forms versus just being in the general area. For Superior Steel Co., it was stated that stamping numbers into each plate was performed by hand (AEC, 1955b), therefore some time would have been spent by laborers in closer proximity to the plate than during the remote handling operations. External dosimetry records (personnel monitoring) and area monitoring records for Superior Steel Co. employees are not available to NIOSH for the period under evaluation. In the absence of site-specific process data, Battelle-TBD-6000 presents assumptions to be made about a worker's exposure conditions.

5.2.2.1 Photon

The photon exposures for Superior Steel Co. were from processing uranium and, for a short period in 1956, thorium. The work involved rolling uranium slabs (1-inch thick, 61 to 89-inches long, and 5.5 to 7-inches wide) into plates (approximately 0.185-inches thick and 25 to 37-feet long, cut into sections of about 6-feet); therefore largely requiring the use of cranes.

The majority of photons from natural uranium metals are in the 30 to 250 keV energy range. Solid uranium objects provide considerable shielding of the lower-energy photons and harden the spectrum, causing the majority of photons emitted from a solid uranium object, such as a thick plate, to have energies greater than 250 keV.

5.2.2.2 Beta

Uranium metal and compounds emit beta and electron radiation that can irradiate the skin, and to a more limited extent, the shallow organs of the body. Table 5-2, taken from DOE-STD-1136 (DOE, 2004), shows the measured beta surface dose rates from uranium metal and selected uranium compounds, illustrating that dose rates from uranium metal exceed the dose rates from other uranium compounds.

Table 5-2: Beta Surface Exposure Rates from Equilibrium Thickness of U Metal Compounds

Source	Beta Surface Exposure Rate (mrad/h)[a]
U-natural metal slab	233
UO_2	207
UF_4	179
$UO_2(NO_3)_2 6H_2O$	111
UO_3	204
U_3O_8	203
UO_2F_2	176
$Na_2U_2O_7$	167

[a] Beta surface exposure rate in air through a polystyrene filter 7 mg/cm^2 thick

When uranium metal is melted, impurities can separate from the metal matrix. Differences in densities and melting points can then cause impurities (i.e., Th-234, Pa-234m, decay products of U-238, magnesium, slag, hydrogen) to separate from the molten uranium metal and concentrate on the surfaces. The process then causes a high concentration of these beta emitters in the top and other surfaces of the cast ingot, increasing the surface beta dose. These beta emitters have relatively short half-lives, therefore the ingot decays to a normal dose rate rather quickly (e.g., 240 days).

After 1952, small quantities of primarily alpha (Pu-239, Np-237, and Th-232/228) and beta (Tc-99) emitting radionuclides found their way into uranium metal via recycling. Because of their primarily non-penetrating radiation types, relatively low activities, and relatively low external radiation hazard when compared to that of their uranium matrix, their contribution to dose is considered adequately addressed by the uranium external dose estimates. A quick check of the relative penetrating dose from an overestimate of recycled uranium contaminants in ground surface contamination shows that they contribute less than 1% to penetrating dose (Battelle-TBD-6000). The non-penetrating doses from uranium are sufficiently large to bound any small contribution from Tc-99 (Battelle-TBD-6000).

5.2.2.3 Neutron

Battelle-TBD-6000 states that for uranium oxides "the neutron dose rate is about 0.07% of the beta/photon dose rate and need not be included in dose rate calculations. For uranium metal, the neutron dose rate is even less important" (Battelle-TBD-6000). Because uranium metal is the major radionuclide of concern at the Superior Steel Co. site, neutron exposures from uranium were not a significant hazard during the period from January 1, 1952 through December 31, 1957. Similarly, neutrons from thorium metal are not considered a significant hazard during the same period, due to thorium's lower rate of spontaneous fission. Neutron exposures will not be discussed throughout this report.

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

The following subsections provide an overview of the available internal and external monitoring data for the Superior Steel Co. class under evaluation.

6.1 Available Superior Steel Co. Internal Monitoring Data

No personal internal monitoring data have been found for the Superior Steel Co. workers for the evaluated period. NIOSH has found no indication that internal personnel monitoring was performed at Superior Steel Co. during the AWE operations period under evaluation.

Air Monitoring Data

Air sampling was performed at Superior Steel Co. during some of the uranium rolling operations (Klevin, 1953a, b; AEC, 1955a, b). The air samples consisted of collection on filters of radioactive particulate from breathing zones (BZs), and general areas (GAs) during processing. The alpha activity measured on the filter was used to determine airborne alpha-activity concentrations. When multiple samples at a location were collected, AEC used the mean air concentration in subsequent calculations. At most facilities, AEC matched air concentration determinations with information about worker categories, locations, tasks, and workers' time at each location or task; however, AEC noted that this was not feasible at Superior Steel Co. (Harris, 1953), but did not include the reasoning for this conclusion.

Four AEC HASL reports of measured uranium air concentrations have been found for Superior Steel Co. (Klevin, 1953a, b; AEC, 1955a, b). The data from those four sets of measurements are summarized in Tables 6-1 and 6-2. The data appear to have a bi-modal distribution with the first year of measurement (i.e., 1953) being an order of magnitude greater than the later year (i.e., 1955). NIOSH attributes this to implementation of AEC process-improvement recommendations following the first air evaluation.

Table 6-1: General Area Air Concentrations

Date of Sample	Highest Alpha Recorded (dpm/m^3)	Lowest Alpha Recorded (dpm/m^3)	Location of Highest Value	Number of Samples	SRDB Ref ID
May 13,1953	13,200	Not detectable	Between finish roll #4 and #5 north side	28	6898
August 3,1953	49,110	64	West end of roughing roll, over roll	33	6899
May 9, 1955	1,800	Not detectable	Shear vicinity	61	6877
September 19, 1955	3,320	0.5	Midway between roughing roll hood and newly installing brushing station	38	6888, 9677

Table 6-2: Breathing Zone Air Concentrations

Date of Sample	Highest Alpha Recorded (dpm/m^3)	Lowest Alpha Recorded (dpm/m^3)	Location of Highest Value	Number of Samples	SRDB Ref ID
May 9, 1955	38,500	592	BZ - stamping plate (manual operation)	9	6877
September 19, 1955	18,000	450	BZ - stamping 3 sections of plate	6	6888, 9677

Details regarding the sample measurement analyses used and the associated minimum detectable activities are not available.

6.2 Available Superior Steel Co. External Monitoring Data

No external monitoring data have been found for the Superior Steel Co. site. NIOSH has found no indication that external personnel monitoring was performed at Superior Steel Co. during the AWE operations period under evaluation. There is also no indication that pre-employment, employment, or post-employment medical x-ray examinations were required or performed.

6.3 Available Superior Steel Co. Remediation Workplace Monitoring Data

Although the periods of site remediation for Superior Steel Co. facilities are not within the period under evaluation, the following sections examine remediation data for legacy contamination due to AEC and non-AEC operations performed during the site's AWE period under evaluation.

6.3.1 Uranium

Surveys performed at the Superior Steel Co. site show that uranium contamination is still present at this time. There is no evidence available that decontamination or decommissioning of Superior Steel equipment or facilities was performed at the end of the AEC contract (Adams, 2001). There are five known radiological surveys done in support of clean-up efforts that took place after the end of the AEC contract (Table 6-3).

Table 6-3: Radiological Surveys Performed at the Superior Steel Site

Survey	Purpose	Year	Locations	Measurements	SRDB Ref ID
Preliminary Site Survey	Provide information on the present condition and use of the former mill area and to determine the need for a detail survey	1980	Former mill area (Area A), former motor room (Area B), and former rolling area (Area C)	Alpha, beta and gamma scans on surfaces, gamma spec on soil and residue samples	161092
Superbolt contracted Applied Health Physics Inc.	Preliminary radiological characterization due to limited historical data	1997	Peripheral areas outside of buildings and secondary surveys inside former rolling area	Unknown – copies of reports are not available	78280

Survey	Purpose	Year	Locations	Measurements	SRDB Ref ID
NRC ESSAP Phase 1	Determine if significant radiological contamination remained on the site and to provide survey documentation to further support future remediation and/or removal of the site from the ORNL database	2000	Former mill area (Area A), former motor room (Area B), and former rolling area (Area C)	Gross alpha, beta, and gamma scans; beta surface activity measurements; exposure rate measurements; gamma spec of soil sampling; and miscellaneous samples	78280
NRC ESSAP Phase 2	Determine if significant contamination remained on other portions of the site and to provide additional survey documentation for previously surveyed areas to support future remediation of contaminated areas or to identify areas suitable for unrestricted release	2003	Building Complex Number 23 areas: 23A, 23B, 23C, 23D and 23E	Surface scans, soil sampling, and miscellaneous sampling (residue, brick, and dust samples); soil and miscellaneous samples were analyzed by gamma spectroscopy	172190
USACE FUSRAP	AEC-related impacts (i.e., uranium) and other potential radiological impacts	2014	Accessible portions of the ground surfaces of the site	Gamma scan surveys (NaI)	167784

6.3.2 Thorium

To assess whether there are indications of large-scale thorium processing at the Superior Steel Co. site during the evaluation period, NIOSH performed a literature search to determine the residual quantities of thorium detected during remediation work.

In order to assess the amount of contamination at the Superior Steel Co site, a preliminary survey by Oak Ridge National Lab (ORNL) was performed. The results of that survey led to four more site surveys to determine the extent of contamination: details of the initial and follow-up surveys are found in Attachment 2.

Thorium Conclusion, 1952−1957

Due to the limited size of the Superior Steel Co. facilities and its production capacities, it is assumed that both commercial work and work performed for AEC were done on the same equipment and process line (Adams, 2001; Johnson, 1957). Therefore, contamination from commercial thorium work would be found in similar locations to the uranium contamination (i.e., spatially distributed similarly to uranium contamination), allowing for use of the uranium surveys to provide some insight into potential thorium contamination. Data presented in the scoping and remedial investigation surveys indicate uranium contamination, as expected due to the known AEC contract work. While these investigations were not specifically looking for thorium, gamma spectra were reviewed to identify other radionuclides that could be present in the samples. Thorium is detected via the Ac-228 daughter 911keV photopeak, which is distinguishable from uranium, and is expected to be detected if widespread thorium contamination was present. The soil and miscellaneous samples taken from inside the Superior Steel Co. buildings during the Preliminary Site Survey (Myrick, 1980) and the NRC ESSAP surveys (Adams, 2001; Adams, 2003) showed no evidence of thorium contamination. Results of the recent FUSRAP gamma scans survey indicate background levels of, and typical spatial distribution of, naturally-occurring thorium on the Superior Steel Co. grounds. This is in contrast to the uranium contamination levels and spatial distribution seen in those same surveys. Therefore, NIOSH sees no indication of residual levels of thorium contamination that would be indicative of previous large production-scale thorium operations.

NIOSH reviews indicate (1) a lack of information on thorium shipments to, receipts by, or rolling data in the document and database searches, and (2) a lack of detected thorium contamination despite the expectation it would be present due to the licensing for unlimited quantities, typical batch amounts of 45,000 pounds (Ferguson, 1956), and known rolling operation dispersion. Consequently, NIOSH has determined that, even though Superior Steel Co. had a license to possess thorium source material in unlimited quantities, no large-scale use of that material was realized at Superior Steel.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the class of employees under evaluation in this report is 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. This approach is discussed in NIOSH's SEC Petition Evaluation Internal Procedures which are available on the NIOSH Radiation Dose Reconstruction Program webpage. 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-00247 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Superior Steel Co. Data

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

7.1.1 Internal Monitoring Data Pedigree Review

As discussed in Section 6.1 above, HASL air monitoring data for four rolling campaigns are the only internal monitoring data available to NIOSH for the AWE period under evaluation. These data consist of AEC-tabulated air sample results in the units of dpm/m^3. One 1953 report and two 1955 reports include the recorded raw data for statistics such as background count rate, sample counts, and sample count time. These original data records are considered primary data sources; therefore, further consistency checks of these air data for the years 1953 and 1955 are not required (Klevin, 1953b; AEC, 1955a; Klevin, 1955).

Given the information in Table 7-1 regarding rolling times, number of slabs, and type of material, indications are that the four HASL-attended campaigns in 1953 and 1955 are representative of typical AEC uranium rolling campaigns at Superior Steel. NIOSH has determined that the radiological air monitoring data obtained from the HASL-attended uranium rolling operations at the Superior Steel Co. site adequately represent typical uranium rolling campaigns, and are of sufficient quantity, and are supported by sufficient original data records, to assure that the data adequately represent the evaluated class.

7.1.2 External Monitoring Data Pedigree Review

NIOSH has not found any external monitoring data for AWE employees at the Superior Steel Co. site during the AWE operations period under evaluation. In the absence of site-specific external data, to provide a realistic and accurate upper-bound estimate of external exposure to workers when monitoring data are absent, NIOSH utilizes documents previously developed by NIOSH for this purpose. These documents include the technical basis document Battelle-TBD-6000 for AWE sites that processed uranium metal. This document, and the adequacy of its underlying external data, have been reviewed by the Advisory Board and its contractor.

7.2 Evaluation of Bounding Internal Radiation Doses

For internal dose reconstruction to be feasible, NIOSH must have reliable information about the intake amounts, intake material, and exposure time during the period under evaluation. The period under evaluation includes the entire AWE operations period for Superior Steel Co. from January 1, 1952 through December 31, 1957.

The principal source of internal radiation doses for members of the class under evaluation was inhalation of uranium dust produced from the manipulation and oxidation of uranium metal during rolling and related processes. Superior Steel Co. also performed test-scale rolling operations with thorium metal in March or April 1956.

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

7.2.1 Evaluation of Bounding AWE Period Internal Doses

To perform an internal dose reconstruction, information such as a potential intake amount, a potential timeframe for when the intake occurred, and intake radionuclide data are needed. The following summarizes these assumptions. The period under evaluation includes the entire AWE operations period January 1, 1952 through December 31, 1957. The effective date of the AEC contract with Superior Steel Co. was June 27, 1952 (Mott, 1981; Kelley, 1952). For bounding of internal radiation doses, NIOSH will assume that all workers performed overtime (i.e., 2,500 work hours per year).

Uranium

As discussed above, the AEC-related work involved rolling and handling uranium metal.

Based on the contract information, uranium rolling at Superior Steel Co. was intermittent and not performed on a full-time basis (Young, 1985). The information presented in Table 7-1 is a summary of the data found regarding the rollings performed from May 1953 to mid-1957. The table shows that rolling campaigns were irregular both in timing and number of slabs processed. No definitive evidence could be located that bounded the amount of uranium processed at Superior Steel Co. However, the table does suggest that a minimum of 60,000 pounds of uranium metal was rolled along with approximately 700 pounds of thorium.

Table 7-1: Rolling Notes from Reference Documents

Date of Rolling	Material	No. of Slabs and/or Pounds	Notes	Document Type	SRDB Ref ID
May 13, 1953	Uranium	Not Noted	Hot strip rolling	HASL Air Dust Monitoring	6898
August 1953	Wrought Uranium Plate	Not Noted	Re: Kinetics of the beta transformation of uranium	Technical Report	172157
August 1953	Uranium	Not Noted	Rolling conditioned uranium slabs for DuPont	Technical Report, February 11–April 10, 1954	15189
Unknown, but prior to August 3, 1953	Not Noted	18 slabs	Superior Steel inventory as of June 1954	Correspondence from Production Division to DuPont	78256
August 3, 1953	Uranium	23 slabs	Hot strip rolling	HASL Air Dust Monitoring	6899
August 3, 1953	Uranium	24 slabs, 14,380 pounds	NLO P.O. 117 information provided in SRDB 29522 “NLO Resume of Activities for the Month Ending June 30, 1953”	Correspondence from NLO	78252
August 3, 1953	Not Noted	10 slabs	Superior Steel inventory as of June 1954	Correspondence from Production Division to DuPont	78256

Date of Rolling	Material	No. of Slabs and/or Pounds	Notes	Document Type	SRDB Ref ID
December 12, 1953 (Goal), likely 1st week in January	Uranium	50 slabs	Fernald reported it couldn't get slabs out until next year; DuPont order	Correspondence between AEC counterparts	78274
February 1954 (scheduled rolling)	Not Noted	Not Noted	Scheduled rolling, Feb 1954	Monthly Report	101449
February 1954	Uranium	35 slabs	Required February 11, 1954, arrival of slabs	Correspondence from AEC to AMF	93466
February 15 & 16, 1954	Not Noted	52 slabs	35 slabs for DuPont	Correspondence from AEC to Superior Steel	78254
February 22 & 23, 1954	Uranium	52 slabs	35 for shearing; 17 for operating conditions	Technical Report, *Flat Bonded Fuel Elements February 11–April 10, 1954*	15189
February 22, 1954	Not Noted	Not Noted	Westinghouse (WAPD-PWR)	Correspondence between AEC counterparts	172177
February 22, 1954	Not Noted	36 slabs	Superior Steel Inventory as of June 1954	Correspondence from Production Division to DuPont	78256
February 22, 1954	Uranium	Not Noted	P.O. AX-3104	Correspondence between DuPont and AEC	11035, PDF p. 27
February 22, 1954	Natural Uranium	Not Noted	Natural uranium	Metallurgy Monthly Report	99468
July 1, 1954 to February 28, 1955	Normal Uranium	31,506.2 pounds	14,321 kg normal uranium received by Superior Steel	Survey of the Control Maintained over Source and Special Nuclear Materials NLO	77006
July 1, 1954 to February 28, 1955	Normal Uranium	26,716.8 pounds	12,144 kg normal uranium shipped from Superior Steel	Survey of the Control Maintained over Source and Special Nuclear Materials NLO	77006
April 1, 1954	Not Noted	9 slabs	Superior Steel Inventory as of June 1954	Correspondence from Production Division to DuPont	78256
Not Noted	Uranium	50 slabs	May 19, 1954 shipment of 50 U plates from Superior Steel to AMF	Correspondence from AEC to AMF	93463
July 1954	Uranium	50 slabs	Slabs sent to AMF then to be sent to Superior discussing work at end of July 1954	Telegram from AEC to AMF	69012, 68997
July 1954	Uranium	50 slabs	Letter dated July 1, 1954, discussing work at Superior Steel end of July 1954	Correspondence from AEC to AMF	69000

Date of Rolling	Material	No. of Slabs and/or Pounds	Notes	Document Type	SRDB Ref ID
August 1954	Not Noted	Not Noted	File: REA-(NRX)-U22-15 Plate 62A (Fernald slab #7737) Plate 51A (Fernald slab #6838) SRDB title mistakenly references thorium	Correspondence from DuPont to AEC SROO	58579
August 3, 1954	Not Noted	50 slabs	Rolling temperature suggests the material is uranium	Rolling data from Superior Steel to AEC OROO	132695
December 6, 1954	Natural Uranium	150 slabs	For ANL-E EBWR, Rolling slabs to be shipped	Telegram from AEC OROO to AEC Fernald	132719
December 15, 16−20, 1954 (arrival of 3 U slabs)	Uranium	Not Noted	Shipping Uranium Slabs to Superior Steel	Telegram from AEC SROO to AEC OROO	132695, PDF p. 2
Not Noted	Not Noted	64 slabs; 13,815 pounds	January 1955 shipment from Atlas Steels	Customs documents and tax document related to shipment	101428
May 9, 1955	“Normal” (Natural) Uranium	26 slabs	Hot strip rolling	HASL Air Dust Monitoring	6877
May 9, 1955	Enriched Uranium	6 slabs	Hot strip rolling	HASL Air Dust Monitoring	6877
Not Noted	Uranium Metal	96 slabs; 21,699 pounds	June 1955 shipment	Customs documents and tax document related to shipment	101407
Not Noted	Uranium Metal	98 slabs; 22,865 pounds	June 1955 Shipment to Superior Steel from Atlas Steels	Customs documents and tax document related to shipment	101416
September 19, 1955	“Normal” (Natural) Uranium	30 slabs	Hot strip rolling	HASL Air Dust Monitoring	6888
1955	Normal Uranium	51,470 pounds	Pounds of scrap material shipped in FY 1955	NLO Summary Report	44162
1955	Normal Uranium	6,200 pounds	Pounds of scrap material in inventory at end of FY 1955	NLO Summary Report	44162
Not Noted	Uranium Metal	50 slabs; 11,651 pounds	January 1956	Customs documents related to shipment	101435
Not Noted	Uranium Metal	45 slabs; 10,542 pounds	March 2, 1956	Customs documents related to shipment	101438
February 1956	Uranium Metal	2,750 pounds	2,750 pounds shipped to Superior Steel	Correspondence from AEC St. Louis OO to AEC OROO	132720
Not Noted	Uranium	Not Noted	Research programs in support of Savannah River, fiscal document to extend $200,000 per year for next two FYs	Correspondence dated April 19, 1956, from DuPont to SROO	90056

Date of Rolling	Material	No. of Slabs and/or Pounds	Notes	Document Type	SRDB Ref ID
Not Noted	Uranium Metal	111 slabs; 26,678 pounds	Shipment April 30, 1956	Customs documents related to shipment	101395, 101399
Not Noted	Uranium Metal	28 slabs; 6,328 pounds	Shipment July 1956	Customs documents related to shipment	101393
December 1956	Uranium	20,000 pounds	Work for WAPD and KAPL NOTE: "plant is organized for quantity production and processing of small lots (such as one 500 pound ingot)"	GE Hanford Trip Report, Zirconium Alloy Fabrication	172173, PDF p. 9
Not Noted	Uranium Ingots	22 slabs	December 6, 1956, shipment from Simonds Saw and Steel to Superior Steel Co.	Correspondence from NLO	81545
1956	Normal Uranium	48,600 pounds	Expected scrap production for FY 1956 was 4050 lb/month	NLO Summary Report	44162
April 1957	Normal Uranium	26,860 pounds	26,860 pounds net, shipped 4/29/1957 (NLO-SSC-23X) hard to read	Correspondence regarding completion of AEC Production Order A-60	81553
May 1957	Forged Uranium Slabs	20 slabs	25 shipped, 5 for later date	Correspondence from DuPont to Superior Steel	34495
Not Noted	Uranium Metal	90 slabs; 21,654 pounds	May 28, 1957, shipment	Customs documents related to shipment	101426
FY1953−FY1999	Depleted Uranium	0 pounds	FY1953-FY1999 Receipts by SRS from Superior Steel	Report regarding recycled uranium at SRS	16499
FY1953−FY1999	Enriched Uranium	2,635.6 pounds	1198kg EU FY1953-FY1999 Receipts by SRS from Superior Steel	Report regarding recycled uranium at SRS	16499
FY1953−FY1999	Natural Uranium	133,625.8 pounds	60,730kg NU FY1953-FY1999 Receipts by SRS from Superior Steel—total may be less than expected, possibly only recycled uranium	Report regarding recycled uranium at SRS	16499

According to available documentation, the vast majority of the uranium work performed by Superior Steel Co. was associated with natural uranium (see Table 7-1). The only enriched uranium material identified by NIOSH was the rolling of six ingots of uranium enriched to 1.5% U-235 (Angerman, 1955; Fisher, 1955). These rollings occurred on May 9, 1955 along with the rolling of 25 other normal uranium slabs. The enriched uranium rollings were a small portion of the overall material rolled in that campaign, and even less significant compared to the total amount of normal uranium rolled during Superior Steel Company's AWE operational period.

Thorium

As non-AEC work, the exposures associated with the commercial thorium rolling operations will be assigned only during the AWE period through December 31, 1957. Non-AEC-related exposures are not considered during an AWE site's designated residual radiation period. Based on the number of uranium rollings that Superior Steel Co. could complete in a day (Table 7-1), and the small scale of the single thorium test rolling, involving four ingots at most (Reardon, 1956), the thorium test rollings are assumed to have occurred in a single workday (i.e., 10 hours).

As presented in Section 5.1, during this evaluation NIOSH determined that the site was licensed on March 27, 1956, to receive possession of and/or title to 700 pounds of thorium.

7.2.2 NIOSH Proposed Methods for Bounding AWE Period Internal Doses

The following information summarizes the methods for bounding internal dose at Superior Steel Co. during the period from January 1, 1952 through December 31, 1957. Specific methods regarding the post-1957 residual radiation period are not addressed in this report. NIOSH intends to implement the dose reconstruction methodologies summarized below in a revision to ORAUT-TKBS-0034. The effective date of the AEC contract with Superior Steel Co. was June 27, 1952 (Mott, 1981; Kelley, 1952). Therefore, no operational exposures associated with rolling activities will be assessed prior to June 27, 1952. NIOSH has reviewed its telephone interviews with Superior Steel Co. dose reconstruction claimants and determined that overtime was common during the period under evaluation.

Uranium

Because uranium exposures were AEC-related at Superior Steel Co., the exposures associated with the uranium rolling operations must be assigned during both the AWE period and the residual radiation period from January 1, 1958 through present.

According to contract information, the total amount paid to Superior Steel Co. through fiscal year (FY) 1957 was $356,849 (SROO, 1952–1957). Superior Steel Co. had a cost-plus-fixed-fee contract that included payments for equipment upgrades (SROO, 1952–1957). Based on the annual payments for FY 1954 through FY 1957, the year with the maximum payment was FY 1956 at $217,246. However, the payments for the other three years were all consistently in the range of $40K to $55K. Based on the rolling data presented in Table 7-1, NIOSH sees no indication that the production rate for FY 1956 was significantly different than the other years under evaluation. The highest payment in the other three years was for FY 1957 at $54,632. NIOSH assumes that the entire payment for FY 1957 was associated with mill work. NIOSH considers it reasonable to conclude that the Superior Steel Co. hourly billing rate was similar to that of Vulcan Crucible for a 1949 AEC contract (SRDB 11996, PDF p. 99), at $132 per mill-hour. Assuming $132 per mill-hour billing rate, the number of Superior Steel Co. mill hours would be approximately 414 mill-hours for FY 1957. NIOSH will assume 500 mill-hours per year as a bounding estimate for AEC-related uranium rolling operations during the AWE period under evaluation. This estimate of mill-hours is comparable to the rolling information in Table 7-1. An additional 250 pre-rolling hours and 250 post-rolling hours (total of 500 hours) will be assumed by NIOSH to account for time the material was stored onsite before and after any rolling operations.

Airborne contamination data for the 1953 and 1955 HASL-attended uranium rollings will be used to estimate the 95th percentile uranium alpha air concentration levels. NIOSH intends to consider only the process and breathing zone air data, and to exclude the general area air data.

The geometric mean associated with the 1953 air data is statistically higher than for the 1955 air data. Therefore, NIOSH concludes that they represent separate exposure distributions. NIOSH reviews of post-operations reports indicate that the site instituted improvements to the engineering controls after evaluation of lessons learned from each HASL-attended rolling (AEC, 1955a,b; Klevin, 1953a,b). NIOSH has found no specific dates of implementation for these process improvements. Consequently, NIOSH intends to use the more claimant-favorable 1953 data for exposures up until the May 9, 1955 rolling date. NIOSH intends to use the 1955 data for exposures starting on May 9, 1955 and continuing through the end of AWE operations on December 31, 1957.

The 95th percentile uranium alpha air exposures will be assigned to all operator and laborer job categories. The post-rolling slab stamping work, performed by hand, represents work likely associated with the laborer category, and resulted in some of the higher air data results. NIOSH has not found justification to assume that the exposures for the operator and laborer categories were different. Consequently, laborers will be assigned the same exposure as operators based on a NIOSH analysis of the air data. Supervisor and administrative exposures will be prorated based on guidance in Battelle-TBD-6000 to account for differences in occupancy time in the production areas.

Potential exposure to contaminants in recycled uranium will be assigned based on guidance in Battelle-TBD-6000. Assumed ingestion intakes values will be based on guidance in NUREG/CR-5512.

NIOSH will assume worker exposure to operational rolling airborne levels for 500 hours per year. The remaining 2000 hours of the assumed 2500 hours work year, will be considered to be non-uranium mill hours. Non-uranium mill exposures will be based on the following:

- 2000 non-uranium mill hours per year;
- Air concentrations will be based on dust-settling calculations;
- Post-rolling surface contamination levels will be determined assuming 500 uranium mill-hours of contamination was deposited on the surface of the facility at a rate of 0.00075 m/s;
- A resuspension factor of 1E-5 m^{-1} will be applied to the post-rolling surface contamination levels to determine post-rolling airborne contamination levels;
- Operators and laborers will be assigned the full value, and supervisor and administrative exposures will be prorated; and
- Long-term residual uranium exposure will be decreased based on guidance in ORAUT-OTIB-0070.

Thorium

As non-AEC work, the exposures associated with the commercial thorium rolling operations must be assigned only during the AWE period through December 31, 1957. Non-AEC-related exposures are not considered during an AWE site's designated residual radiation period.

Assuming the specific activity for natural uranium, and using the HASL gross-alpha air sampling results associated with the 1955 uranium rollings, NIOSH can determine a mass dust load associated with the rolling process. Assuming the same mass load for thorium as for uranium, a bounding thorium activity airborne concentration can be determined by using the specific activity of Th-232 (because most of the thorium mass would be associated with Th-232). Given the large-scale nature of the uranium work and the small-scale nature of the thorium work, this is considered a claimant-favorable estimate of thorium-related exposure. A similar approach used by NIOSH for Bridgeport Brass has been reviewed by the Advisory Board Subcommittee on Dose Reconstruction. Associated with the Subcommittee's review, the Board's contractor reported "SC&A agrees that, for dose reconstruction, the assumption that the mass of processed thorium is 10% of the mass of processed uranium is bounding and claimant favorable" (Mauro, 2017). In the case of Superior Steel Co., NIOSH is assuming the thorium mass loading is equal to that of the uranium rollings, rather than making an assumption of the total mass of thorium work compared to the total mass of uranium work (i.e., rather than assuming only 10% of the uranium loading as was approved for Bridgeport Brass).

NIOSH will assume that the thorium is natural, assuming that the thorium daughters (Ra-228, Ac-228, Th-228, and Ra-224) are in secular equilibrium with the Th-232. Because NIOSH is assuming that all of the mass suspended in the air is Th-232, the resulting dose associated with natural thorium is higher than if calculated assuming triple-separated thorium. This is due to the fact that natural thorium would have more Th-232 daughter activity in equilibrium. This additional daughter activity would also result in a higher external dose. Therefore, for the approach being implemented at Superior Steel, the assumption of natural thorium is considered more favorable to the claimant than triple-separated thorium.

Based on the number of uranium rollings that Superior Steel Co. could complete in a day (Table 7-1), and the small scale of the single thorium test rolling, involving four ingots at most (Reardon, 1956), the thorium test rollings are assumed to have occurred in a single workday (i.e., 10 hours). Based on the short duration and small scale of the thorium test rolling work, thoron exposure is assumed to be negligible. Assumed thorium ingestion intake values will be based on guidance in NUREG/CR-5512. Thorium post-rolling exposures will be based on:

- Thorium air concentrations derived with dust-settling calculations;
- Post-rolling surface thorium contamination levels will be determined assuming 10 mill-hours of contamination was deposited on the surface of the facility at a rate of 0.00075 m/s;
- A resuspension factor of 1E-5 m^{-1} will be applied to the post-rolling surface contamination levels to determine post-rolling thorium airborne contamination levels;
- Operators and laborers will be assigned the full value, and supervisors and administrative exposures will be prorated; and
- Post-rolling residual thorium exposure will be decreased based on guidance in ORAUT-OTIB-070 and will only be assigned until the end of the AWE operations period on December 31, 1957.

7.2.3 Internal Dose Reconstruction Feasibility Conclusion

For internal dose reconstruction to be feasible, NIOSH must have enough reliable information about the intake amounts, intake material, and exposure time during the period under evaluation to be able to bound the dose. The period under evaluation includes the entire AWE operations period for Superior Steel Co.: January 1, 1952 to December 31, 1957.

For AEC uranium rolling operations at the Superior Steel Co.: (1) NIOSH has reliable air concentration data, which provides data for calculating bounding uranium intake amounts, (2) NIOSH has reliable process information about uranium rolling operations to determine bounding uranium intake material assumptions (i.e., uranium enrichment, potential uranium contaminants), and (3) NIOSH has reliable process information to determine bounding exposure time assumptions (i.e., exposure hours per day/year). For commercial thorium rolling operations at the Superior Steel Co. during the evaluation period: (1) NIOSH has reliable process information about the commercial thorium test rolling to use uranium rolling air mass concentrations to calculate bounding thorium intake amounts, (2) NIOSH has reliable process information for thorium rolling operations to determine bounding thorium intake material assumptions (i.e., thorium isotopic compositions), and (3) NIOSH has reliable process and license information to determine bounding exposure time assumptions (i.e., exposure hours per day/year).

NIOSH has airborne contamination data for AEC-monitored uranium rollings in 1953 and 1955. NIOSH has determined that the available air monitoring data are sufficient to allow NIOSH to model the 95th percentile uranium alpha air exposures for the highest potentially exposed operator and laborer job categories at Superior Steel Co. for the period from January 1, 1952 through December 31, 1957. For the period from January 1, 1952 through December 31, 1957, NIOSH has determined that it has sufficient information to derive airborne thorium concentrations based on the mass loading calculated for the HASL air sampling results associated with the 1955 uranium rollings. Given the large-scale nature of the site's uranium work and the small-scale nature of the thorium work, this is considered a favorable estimate of thorium-related exposure. A similar approach used by NIOSH for Bridgeport Brass has been reviewed by the Advisory Board Subcommittee on Dose Reconstruction.

The principal source of internal radiation doses for members of the class under evaluation was inhalation of uranium dust produced from the manipulation and oxidation of uranium metal during rolling and related processes. The vast majority of the uranium work performed was associated with natural uranium. The only enriched uranium material identified by NIOSH was the rolling of six ingots of uranium (enriched to 1.5% U-235) on May 9, 1955. The enriched uranium rollings were a small portion of the overall material rolled in that campaign, and even less significant compared to the total amount of normal uranium rolled during Superior Steel's AWE operational period. Between March 27, 1956 and April 20, 1956, Superior Steel Co. conducted one test rolling operation with up to 700 pounds of thorium metal to perform development studies for its commercial client Babcock & Wilcox Company.

Since uranium exposures were AEC-related at the Superior Steel Co., the exposures associated with the uranium rolling operations will be assigned during both the AWE period, and the residual radiation period from January 1, 1958 through present. As non-AEC work, the exposures associated with the commercial thorium rolling operations will be assigned only during the AWE evaluation period through December 31, 1957. Non-AEC-related exposures are not considered during an AWE site's designated residual radiation period.

Because the effective date of the AEC contract with Superior Steel Co. was June 27, 1952, no operational exposures associated with rolling activities will be assessed prior to June 27, 1952. NIOSH has determined that overtime was common during the period under evaluation, and will assume that all workers performed overtime (i.e., 2,500 work hours per year) during the period under evaluation.

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate internal radiation doses with sufficient accuracy, including potential exposures to uranium and thorium metals. This class includes: all atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.

7.3 Evaluation of Bounding External Radiation Doses

For external dose reconstruction to be considered feasible, NIOSH must have enough reliable information about the amounts of material, form of material, exposure distances, and exposure time during the period under evaluation. The period under evaluation includes the entire AWE operations period for Superior Steel Co.: January 1, 1952 to December 31, 1957. Since external monitoring data has not been found and is not thought to exist for Superior Steel Co., this section provides a discussion of the ability to bound external doses for Superior Steel Co. workers.

The principal source of external radiation doses for members of the evaluated class was direct exposure from being in proximity to the uranium ingots, exposure from contaminated surfaces, and submersion in air contaminated with dust generated via the processing of such. Superior Steel Co. also performed test-scale rolling operations with thorium metal in April 1956.

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

7.3.1 Evaluation of Bounding AWE Period External Doses

To perform sufficiently accurate external dose reconstructions, information such as a potential distance between the worker and the source of exposure, a potential timeframe in which the exposure occurred, and exposure radionuclide data are needed. The following summarizes these assumptions.

Uranium

As stated above in Section 7.2.1 for Internal Doses, because uranium exposures were AEC-related at the Superior Steel Co., the external exposures associated with the uranium rolling operations will be assigned during both the AWE period, and the residual radiation period from January 1, 1958 through present. NIOSH has enough reliable process information to determine the uranium enrichment, typical uranium amounts, and exposure time information to determine bounding external doses for the Superior Steel Co. using the default worker assumptions in Battelle-TBD-6000.

Thorium

As presented in Section 7.2.1 for Internal Doses, between March 27, 1956 and April 20, 1956, Superior Steel Co. conducted one test rolling operation with up to 700 pounds of thorium metal to perform development studies for its commercial client Babcock & Wilcox Company. This small-scale test rolling is the only indication of thorium metal processing found by NIOSH for the period under evaluation. NIOSH has determined it has enough reliable thorium process information to determine the exposure material makeup, type, and exposure time to determine bounding external doses for the Superior Steel Co. using the default assumptions in Battelle-TBD-6000.

Occupational Medical X-ray Examinations

Per ORAUT-OTIB-0079, NIOSH has found no historical evidence that occupational medical X-ray examinations were performed offsite and no claimant statements were made regarding X-ray examinations. In the absence of information, NIOSH Dose Reconstruction Guidance documents (e.g., Technical Information Bulletins) provide enough information to bound occupational medical x-ray doses at the Superior Steel Co.

7.3.2 NIOSH Proposed Methods for Bounding External AWE Period Doses

The following information summarizes the methods for bounding external dose during the AWE period under evaluation at Superior Steel Co. during the period from January 1, 1952 through December 31, 1957. NIOSH intends to implement the dose reconstruction methodologies summarized below in a revision to ORAUT-TKBS-0034. The effective date of the AEC contract with Superior Steel Co. was June 27, 1952; therefore, no operational exposures associated with rolling activities will be assessed prior to June 27, 1952. NIOSH has determined that overtime was common during the period under evaluation, and will assume that all workers performed overtime (i.e., 2,500 work hours per year).

Uranium

For AWE sites such as Superior Steel Co. that handled uranium metals, Battelle-TBD-6000 presents methods for bounding estimation of worker doses from: 1) submersion in contaminated air; 2) contaminated surfaces; 3) whole-body penetrating radiation emitted from uranium metal surfaces; and 4) non-penetrating radiation emitted from uranium metal surfaces. NIOSH intends to use the methods specified in Battelle-TBD-6000 with the following site-specific assumptions:

- 500 hours per year of external dose associated with rolling operations in Battelle-TBD-6000;
- 500 hours per year of external dose associated with submersion in rolling operations airborne contamination, based on Dose Conversion Factors in EPA-FGR-12;
- 500 hours per year of external dose associated with storage of on-site material based on external 1-meter dose rates in Battelle-TBD-6000; and
- 2,000 hours per year of external dose associated with submersion in post-rolling airborne contamination and direct exposure associated with post-rolling surface contamination, based on Dose Conversion Factors in EPA-FGR-12.

Thorium

As presented above, Superior Steel Co. conducted one non-AEC-related test rolling operation with up to 700 pounds of thorium metal between March 27, 1956 and April 20, 1956. NIOSH intends to perform MCNP modelling of thorium metal-related exposures in accordance with the methods presented in Battelle-TBD-6000. NIOSH intends to use the methods specified in Battelle-TBD-6000 with the following site-specific assumptions for potential thorium metal handling exposures:

- 10 hours of external dose associated with thorium rolling operations in 1956 will be calculated using MCNP and guidance in Battelle-TBD-6000;
- 10 hours per year of external dose associated with submersion in rolling operations airborne contamination in 1956 will be calculated based on Dose Conversion Factors in EPA-FGR-12;
- 190 hours per year of external dose associated with storage of on-site thorium material based on MCNP calculations at 1 meter (190 hours assumes exposure to thorium for all of the 19 workdays between March 27, 1956 and April 20, 1956); and

- For the remainder of 1956 (post-March 27, 1956) and all of 1957, external dose associated with submersion in post-rolling airborne contamination and direct exposure associated with post-rolling surface contamination, will be assigned based on Dose Conversion Factors in EPA-FGR-12.

Occupational Medical X-ray Examinations

NIOSH intends to assign pre-employment, annual, and termination medical X-ray doses for all employees during the AWE operational period. No medical X-ray doses will be assigned during the site's residual radiation period. Medical X-ray doses will be based on guidance in ORAUT-OTIB-0006.

7.3.3 External Dose Reconstruction Feasibility Conclusion

For external dose reconstruction to be feasible during the period under evaluation, NIOSH must have enough reliable information about the exposure time, the distance from the source of the exposure, and the radionuclide concentrations providing the external exposure to be able to bound the dose. The period under evaluation includes the entire AWE operations period for Superior Steel Co.: January 1, 1952 to December 31, 1957. The following provides the known information regarding the external source of exposure.

The principal sources of external radiation doses for members of the class under evaluation were direct exposure from being in proximity to the uranium and thorium ingots, exposure from contaminated surfaces, and submersion in air contaminated with dust generated via the processing of such. The vast majority of the uranium work performed was associated with natural uranium. The only enriched uranium material identified by NIOSH was the rolling of six ingots of uranium (enriched to 1.5% U-235) on May 9, 1955. The enriched uranium rollings were a small portion of the overall material rolled in that campaign, and even less significant compared to the total amount of normal uranium rolled during Superior Steel Co.'s AWE operational period. Between March 27, 1956 and April 20, 1956, Superior Steel Co. conducted one test rolling operation with up to 700 pounds of thorium metal to perform development studies for its commercial client Babcock & Wilcox Company.

Because uranium exposures were AEC-related at the Superior Steel Co., the external exposures associated with the uranium rolling operations will be assigned during both the AWE period, and the residual radiation period from January 1, 1958 through present. As non-AEC work, the external exposures associated with the commercial thorium rolling operations will be assigned only during the AWE evaluated period through December 31, 1957. Non-AEC-related exposures are not considered during an AWE site's designated residual radiation period.

The period under evaluation includes the entire AWE operations period from January 1, 1952 through December 31, 1957. Because the effective date of the AEC contract with Superior Steel Co. was June 27, 1952, no operational external exposures associated with rolling activities will be assessed prior to June 27, 1952. NIOSH has determined that overtime was common during the period under evaluation, and will assume that all workers performed overtime (i.e., 2,500 work hours per year) during the period under evaluation.

For AWE sites such as Superior Steel Co. that handled uranium metals, Battelle-TBD-6000 presents methods for bounding estimation of worker doses from rolling operations with uranium metal. NIOSH has determined that it has sufficient applicable site-specific information, using the methods of

Battelle-TBD-6000, to model Superior Steel Co. worker doses due to uranium and thorium metal rolling operations during the period from January 1, 1952 through December 31, 1957.

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate external radiation doses with sufficient accuracy, including potential exposures to uranium and thorium metals, and occupationally required medical X-ray examinations. This class includes: all atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.

7.4 Evaluation of Petition Basis for SEC-00247

The following subsections evaluate the assertions made on behalf of petition SEC-00247 for Superior Steel Co.

7.4.1 Lack of Personnel Urinalysis Data

Petitioner Issue: The petitioner quoted text in NIOSH's 2005 exposure matrix for Superior Steel Co., ORAUT-TKBS-0034: "*individual uranium urinalysis data are unavailable for Superior Steel Workers and none are known to exist.*"

Response: NIOSH qualified the petition for evaluation based on the petitioner's assertion. NIOSH reviewed the methods in the current ORAUT-TKBS-0034, which uses air monitoring data obtained during Superior Steel Co. uranium rolling operations to assign internal doses associated with uranium metal rolling operations. In instances when personal internal monitoring data are unavailable, NIOSH uses air-monitoring data from worker breathing zones and work areas, in accordance with NIOSH's OCAS-IG-002, *Internal Dose Reconstruction Implementation Guideline*. As presented in Section 7.2 above, NIOSH has determined that it has sufficient site-specific air monitoring data and process data to allow it to estimate worker internal uranium doses with sufficient accuracy.

In the course of its evaluation, NIOSH determined that Superior Steel Co. also conducted commercial rolling operations with thorium metal. As with the site's uranium rolling operations, NIOSH does not have evidence of any personal internal monitoring for thorium at Superior Steel Co. for the period from 1952 through 1957. As presented in Section 7.2 above, NIOSH has determined that it can apply airborne mass loading calculations to available uranium process air monitoring data to allow NIOSH to estimate worker internal thorium doses with sufficient accuracy. This approach has been used by NIOSH for Bridgeport Brass dose reconstructions, and has been reviewed by the Advisory Board Subcommittee on Dose Reconstruction.

7.4.2 Lack of External Dosimetry Data

Petitioner Issue: The petitioner quoted text in NIOSH's 2005 exposure matrix for Superior Steel Co., ORAUT-TKBS-0034: "*no external dosimetry results are available for Superior Steel employees.*"

Response: NIOSH qualified the petition for evaluation based on the petitioner's assertion. NIOSH reviewed the methods in the current ORAUT-TKBS-0034, which uses AEC data available for a surrogate uranium processing site, Simmonds Saw and Steel Co. in Lockport, NY. As presented in Section 7.3, NIOSH has determined that it now has sufficient applicable site-specific information, using the methods of Battelle-TBD-6000, to better model potential external uranium exposures.

NIOSH also intends to use similar MCNP modelling of thorium metal-related exposures in accordance with the methods presented in Battelle-TBD-6000.

7.5 Summary of Feasibility Findings for Petition SEC-00247

This report evaluates the feasibility for completing dose reconstructions for employees at Superior Steel Co. from January 1, 1952 through December 31, 1957. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-2 summarizes the results of the feasibility findings at Superior Steel Co. for each exposure source during the period from January 1, 1952 through December 31, 1957.

Table 7-2: Summary of Feasibility Findings for SEC-00247

January 1, 1952 through December 31, 1957

Source of Exposure	Reconstruction-Feasible (Yes or No)
Internal[1]	**Yes**
Uranium	Yes
Thorium	Yes
External	**Yes**
Gamma	Yes
Beta	Yes
Neutron	Yes
Occupational Medical X-ray	Yes

[1] Internal includes an evaluation of airborne dust data.

As of October 2, 2018, a total of 35 claims have been submitted to NIOSH for individuals who worked at Superior Steel Co. during the period under evaluation in this report. Dose reconstructions have been completed for 35 individuals (100%).

8.0 Evaluation of Health Endangerment for Petition SEC-00247

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 employees who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has determined that it has sufficient site-specific process data and available process air monitoring data. NIOSH's evaluation determined that it is feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Therefore, a health endangerment determination is not required.

9.0 Class Conclusion for Petition SEC-00247

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes all atomic weapons employees who worked in any area at Superior Steel Co. in Carnegie, Pennsylvania, during the period from January 1, 1952 through December 31, 1957.

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 SRDB, for information relevant to SEC-00247. 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 radiation dose for the class under evaluation.

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Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for Superior Steel Co.

Data Capture Information	Data Capture Description	Date Completed	Number Uploaded into SRDB
Primary Site/Company Name: Superior Steel Co. AWE 1952-1957; Residual Radiation 1958-March 1, 2011 **Alternate Site Names:** Copperweld, Inc. and Lot and Block 102J210 **Physical Size of the Site:** 25 acres, Building/Area 23a~25,000ft^2; 23d~13,000ft^2 and 23e~14,000ft^2 **Site Population:** Hot Strip Mill had approximately 100 personnel including labor, management, and operating personnel in 1953.	The PA Department of Environmental Protection indicated any relevant records, if still in existence, would be likely to reside with the U.S. Army Corps. of Engineers (USACE), who have been contacted. Note: Please see United States Army Corps of Engineers (USACE) row below.	09/18/2018	0
State Contacted: [Contact information redacted]	No relevant data identified.	09/18/2018	0
Babcock & Wilcox	Babcock & Wilcox is searching for related material, but initially indicated they do not anticipate finding information from the 1950's period.	OPEN	Not Applicable
Carnegie Library of Pittsburgh	Excerpts from annual reports to stockholders for years 1952-1956.	10/10/2018	1
DOE Germantown	Radiological history and summary, radiological survey, elimination report and distribution of uranium plates, and an authority review for the former Superior Steel Company.	03/07/2011	11
DOE Legacy Management - Grand Junction Office	Accountability for uranium slabs, commercial facilities used by National Lead Company of Ohio, companies occupying former Superior Steel Co. sites, comprehensive radiological survey, conditioning uranium slabs, expert system license evaluation report for license C-03480, thorium licensing, final radiological scoping survey of portions of the former Superior Steel Company, hot strip mill procedure and sample data for rolling operations, inventory information, licensing amendments to process thorium, machining of plates - contract AT(30-1)-1247, monthly reports for 1952-1954, orders for rolling of slabs, rolling at Superior Steel Co., shipment of uranium, thorium source material license, and working draft historical summaries.	03/07/2011	82
DOE Legacy Management - Morgantown	Resurvey program and an assessment of contaminated properties.	04/04/2016	2
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Notice of change to source and Special Nuclear Materials accountability station symbols listing, resumption of activities for the month ending June 20, 1953, research and development expenditures, and completion of AEC production order A-60.	05/13/2010	7

Data Capture Information	Data Capture Description	Date Completed	Number Uploaded into SRDB
DOE Oak Ridge Operations Records Holding Task Group (RHTG)	Supplement to Production Division monthly activity report 1952.	04/05/2011	1
Hagley Museum and Library	Research programs in support of Savannah River Site.	09/28/2010	1
Hanford	Activity #132 has been submitted requesting additional key word searches be conducted on all Hanford databases to supplement what has been obtained to date. Monthly reports and transfer to Oak Ridge contract AT(30-1)-1412.	OPEN	4
Health and Safety Laboratory (HASL)	Thorium sampling and storage.	03/08/2005	1
Internet - Defense Technical Information Center (DTIC)	No relevant data identified.	09/20/2018	0
Internet - DOE Legacy Management	Site management guide 2012.	01/28/2014	2
Internet - DOE Legacy Management Considered Sites	No relevant data identified.	05/17/2018	0
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	09/20/2018	0
Internet - DOE Noncompliance Tracking System	No relevant data identified.	09/20/2018	0
Internet - Occurrence Reporting and Processing System	No relevant data identified.	09/20/2018	0
Internet - DOE OpenNet	Trip report and a quarterly report of Working Committee on Uranium Quality and Fabrication.	05/15/2018	2
Internet - DOE OSTI Energy Citations	Report 3, Flat Plate Bonded Fuel Elements 1953.	03/25/2010	1
Internet - DOE OSTI Information Bridge	Material tasks and advanced material program.	04/01/2013	1
Internet - DOE OSTI SciTech Connect	Analysis of the extended Zero Power Experiments on the Army Package Power Reactor (ZPE-2), Argonne National Laboratory annual report for Metallurgy Division, boiling water reactor technology status report, mechanical properties of uranium plate, plutonium recycle program monthly report, and a Reactor Engineering Division quarterly report.	05/15/2018	13
Internet - Energy Employees Claimant Assistance Project (EECAP)	No relevant data identified.	09/20/2018	0

Data Capture Information	Data Capture Description	Date Completed	Number Uploaded into SRDB
Internet - Google	Status of decommissioning program-annual update, AEC research programs in support of Savannah River, Formerly Utilized Sites Remedial Action Program (FUSRAP) fact sheet and update, new approach to gamma scans for processed natural uranium at a FUSRAP site, residual radioactivity summary, status of the decommissioning program annual report, and a Superior Steel description.	09/20/2018	63
Internet - Hanford Declassified Document Retrieval System (DDRS)	Monthly activity report.	01/11/2008	1
Internet - Health Physics Journal	No relevant data identified.	09/20/2018	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant data identified.	09/20/2018	0
Internet - National Academies Press (NAP)	No relevant data identified.	05/17/2018	0
Internet - National Environmental Publications Internet Site (NEPIS), U.S. Environmental Protection Agency (EPA)	No relevant data identified.	05/17/2018	0
Internet - National Institute for Occupational Safety and Health (NIOSH)	Report on residual radioactive and beryllium contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities.	08/31/2011	3
Internet - NRC Agencywide Document Access and Management (ADAMS)	Briefing on decommissioning activities and status, extension of contract AT(30-1)-1412 with Superior Steel, records search for Superior Steel, preliminary site survey report, request for uranium slabs for rolling, shipment of slabs to American Machine & Foundry Co. and 22 slabs to Superior Steel, application for amendment to source material license C-3480, and uranium rolling 1954.	09/20/2018	51
Internet - Oak Ridge National Laboratory Library	Aircraft Nuclear Propulsion Project quarterly progress report.	07/06/2012	1
Internet - USACE/FUSRAP	Fact sheet and a preliminary assessment.	05/17/2018	4
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	05/17/2018	0
National Archives and Records Administration (NARA) - College Park	Uranium rolling at Superior Steel and contract information.	10/18/2018	6
National Archives and Records Administration (NARA) - Kansas City	Assessment of Superior Steel.	04/01/2005	1
Oak Ridge Associated University (ORAU)	Records review and evaluation report for the former Superior Steel site.	09/28/2018	1

Data Capture Information	Data Capture Description	Date Completed	Number Uploaded into SRDB
Oak Ridge National Laboratory (ORNL)	Procedure manual for radiological survey activities.	03/28/2008	1
ORAU Team	ORAUT-OTIB-0004 Estimating The Maximum Plausible Dose To Workers At Atomic Weapons Employer Facilities, ORAUT-TKBS-0034 Exposure Matrix for Superior Steel, and ORAUT-OTIB-0079 Guidance On Assigning Occupational X-ray Dose Under EEOICPA For X-rays Administered Off-Site.	06/16/2017	6
Savannah River Site	Process requirements for uranium rolling, health physics area survey report, shipment of thorium plate elements, and a monthly progress report.	09/22/2018	20
United States Army Corps of Engineers (USACE)	USACE Buffalo District has been contacted and is performing search for additional information.	OPEN	Not Applicable
Unknown	Air dust, breath, water, smears, and urine sample results (1952-1964), Battelle Memorial Institute site operations and facility descriptions, data analysis results 1951 through 1963, Report 5 flat bonded fuel elements period (1954), survey sheet (1953), and Sylvania Corning Plant and Fernald recycled uranium receipts and shipments.	01/12/2005	21
TOTAL	**Not Applicable**	**Not Applicable**	**308**

Table A1-2: Database Searches for Superior Steel Co.

Database/Source	Keywords	Number of Hits	Number Uploaded into SRDB
Defense Technical Information Center (DTIC) COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called “Superior Steel Synopsis Rev 01, (83.13) 11-06-18.”	102	0
DOE Hanford Declassified Document Retrieval System (DDRS) and Public Reading Room COMPLETED 05/16/2018	Database search terms and Internet URL are available in the Excel file called “Superior Steel Synopsis Rev 01, (83.13) 11-06-18.”	0	0
DOE Legacy Management Considered Sites COMPLETED 05/17/2018	Database search terms and Internet URL are available in the Excel file called “Superior Steel Synopsis Rev 01, (83.13) 11-06-18.”	5	0

Database/Source	Keywords	Number of Hits	Number Uploaded into SRDB
DOE National Nuclear Security Administration (NNSA) - Nevada Site Office COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0
DOE Noncompliance Tracking System COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0
DOE Occurrence Reporting and Processing System COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0
DOE OpenNet COMPLETED 05/15/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	23	2
DOE OSTI SciTech Connect COMPLETED 09/05/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	177,784	14
Energy Employees Claimant Assistance Project (EECAP) COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0
Google COMPLETED 09/04/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	49,686,791	42
Health Physics Journal COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	2	0
Journal of Occupational and Environmental Hygiene COMPLETED 09/20/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0
National Academies Press COMPLETED 05/17/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	6,748	0
National Service Center for Environmental Publications (NEPIS) COMPLETED 05/17/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	6,920	0
NRC ADAMS Reading Room COMPLETED 09/05/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	176	37

Database/Source	Keywords	Number of Hits	Number Uploaded into SRDB
United States Army Corps of Engineers (USACE) COMPLETED 05/17/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	132	1
U.S. Transuranium & Uranium Registries COMPLETED 05/17/2018	Database search terms and Internet URL are available in the Excel file called "Superior Steel Synopsis Rev 01, (83.13) 11-06-18."	0	0

Attachment Two: Thorium Contamination

Oak Ridge National Laboratory (ORNL) 1980 Preliminary Site Survey

In July 1980, at the request of DOE, a preliminary radiological survey at the former Superior Steel Co. plant was conducted by members of the Health and Safety Research Division of ORNL. The objective was to "provide information on the present condition and use of the former mill area and to determine the need for a detailed survey" (Myrick, 1980, PDF p. 27). This survey covered the former mill area (referred to as Area A), the former motor room (referred to as Area B), and the former rolling area (referred to as Area C). *Preliminary Site Survey Report for the Former Superior Steel Mill at Carnegie, Pennsylvania* (Myrick, 1980) states that the survey consisted of the following five methods:

1. External-gamma scan of floor and lower-wall surfaces in all buildings via gamma scintillation survey meter;
2. Fixed alpha measurements on floor and wall surfaces in random locations in all areas via an alpha scintillation survey meter;
3. Beta-gamma dose rate measurements at selected locations via beta-gamma sensitive GM tube with open/closed window option;
4. External gamma and fixed alpha measurements on original machinery surfaces via gamma scintillation survey meter and alpha scintillation survey meter; and
5. Sampling and analysis of mill residues via laboratory analysis (Myrick, 1980, PDF p. 28).

The first four survey methods would result in gross data, not yielding radionuclide-specific information. Only the fifth method, sampling and analysis of mill residues via laboratory analysis, could yield radionuclide-specific results; thus NIOSH's ORNL 1980 site survey data review would focus on results from method 5.

A sample of residues from the bottom of the rolling area pit was taken and sent to ORNL for analysis. The sample was a combination of steel shavings, soil, and various other unidentified materials. There are no details on the instrumentation or procedures used for the sample analysis. The only radionuclide identified by ORNL was U-238; it was indicated that "no other radionuclides were present in sufficient quantities to be detected" (Myrick, 1980, PDF p. 29). Another sample was taken under the wooden floor of the storage shed in this same former rolling area. The results of the analysis indicated the material under the floor was similar in makeup to that found in the pit (i.e., U-238 and the statement "no other radionuclides were detected" (Myrick, 1980, PDF p. 30).

Based on the results of this survey, it was recommended that a formal, detailed survey of the building be conducted (Myrick, 1980, PDF p. 30). According to a memo dated October 28, 1981, from DOE Environmental and Safety Engineering Division (EP-32) to the State of Pennsylvania, the full radiological survey of Superior Steel Co. would be postponed, because the contaminated areas had been made inaccessible by the current owner of the property (Mott, 1981).

NRC Environmental Survey and Site Assessment Program (ESSAP) Phase 1

In 2000, at the request of the NRC Division of Waste Management, Oak Ridge Institute for Science and Education (ORISE)'s ESSAP performed radiological scoping survey activities on various portions of the Superbolt facility during the period of August 28 through September 1, 2000 (Adams, 2001). These ORISE Phase 1 ESSAP survey activities were performed in the former mill area (same as ORNL Area A), former motor room (same as ORNL Area B), and former rolling area (same as ORNL Area C) and consisted of the following:

1. Alpha, beta, and gamma surface scans of 25% of the floors in the former mill area and former rolling area, as well as 25% of the lower walls in the former rolling area;
2. Gamma/beta surface activity measurements and smear surveys for removable gross alpha and gross beta in 37 areas of elevated radiation levels determined by the surface scans;
3. Exposure rate measurements in 5 locations within the former rolling area;
4. Soil sampling for laboratory analysis of locations in the former mill and rolling areas; and
5. Miscellaneous sampling for laboratory analysis from areas of elevated activity determined in direct measures of the former rolling area and former mill area.

Survey methods 1-3 provide gross or total activity information and are not radionuclide-specific. Survey methods 4 and 5 can provide radionuclide-specific information. Therefore, NIOSH's NRC ESSAP Phase I data review focused on results from methods 4 and 5. Forty-six soil samples (approximately 1kg each) were taken from the following:

- Under four flooring excavations/backfill removal above former trenches/pits;
- Subsurface samples (under concrete flooring, asphalt, and concrete roadway) in various sections of Areas A, B, and C;
- Excavated trenches with Area A;
- Excavated trench in the salt bath area; and
- Randomly selected locations inside and outside of the facility.

The miscellaneous samples consisted of the following:

- Five dust and residue samples collected from horizontal surfaces in the overhead beams and lower walls in Area C;
- Two paint/primer/concrete chip samples from the floor of Area C;
- One concrete rubble sample collected from the former storage shed area; and
- One water sample from Trench Pit #2 in Area A.

Samples were prepared per the ESSAP procedures and analyzed at ORISE's ESSAP laboratory in accordance with the ORISE/ESSAP Laboratory Procedures Manual. The soil and miscellaneous samples were analyzed by gamma spectroscopy using HP Extended Range Intrinsic detectors and multichannel analyzers. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks were reviewed for consistency of activity. Detection limits, or minimum detectable concentrations (MDC), were based on 3 plus 4.65 times the standard deviation of the background count. Samples results less than the MDC were reported as less than the MDC for counting purposes. Uranium-235 was measured directly via the 143keV photopeak (10.96%); U-238 was measured indirectly via daughter products and assuming secular equilibrium: Th-234 with 63keV photopeak (4.8%) or Pa-234m with 1001keV photopeak (0.83%) (Adams, 2001). According to Adams, 2011, "The radionuclide of interest was uranium; however, spectra were reviewed for other identifiable total absorption peaks (photopeaks)." NIOSH has concluded that if thorium contamination were present, it did not exceed the maximum detectable concentration and therefore is not a significant contributor to exposure.

After gamma spectroscopy, some soil samples were selected for alpha spectroscopy and were prepared by a potassium fluoride and pyrosulfate fusion followed by a barium precipitation and liquid-liquid extraction for uranium (Adams, 2001). If thorium was present in the original sample it would have been removed during the separation phase of the uranium-specific sample. Therefore, the alpha spectroscopy preparation precludes the ability to make conclusions about any thorium presence.

NRC ESSAP Phase 2

In August 2003, the NRC's Division of Waste Management requested that ORISE ESSAP perform additional radiological evaluations of portions of the Superbolt (i.e., Superior Steel Co.) facility that were not addressed during Phase 1 (Adams, 2001). This survey was performed in accordance with a site-specific survey plan created in line with the ORISE/ESSAP Survey Procedures and Quality Assurance Manual and approved by the NRC. The areas evaluated included all five Superbolt warehouses that comprised Superbolt Building Complex Number 23: 23A (former mill area, ORNL Area A), 23B (not previously surveyed, but was used as AHP remediation/radiological waste storage), 23C (not previously surveyed), 23D (former rolling area, ORNL Area C), and 23E (former motor room, ORNL Area B). ESSAP also reviewed existing site data associated with further evaluation and cost estimates for work required to perform studies to determine the radiological status of the under-floor trench that runs through Areas 23A and 23D (Adams, 2003).

This survey was limited in scope, but included:

1. Alpha, beta, and gamma surface scans of the floor—80% surveyed in 23A and 23E, 90% surveyed in 23C and 23D, and 50% for 23B, as well as 25% of the lower walls and 5% of upper walls in all locations;
2. Gross alpha and gross beta surface activity measurements and smear samples for removable contamination in locations of elevated radiation areas determined from surface scans;
3. Exposure rate measurements throughout all areas;
4. One surface soil sample taken from elevated radiation area within 23B for laboratory analysis; and
5. Ten miscellaneous samples (residue, brick, and dust samples) collected from areas of elevated radiation determined by surface scans for laboratory analysis (Adams, 2003).

Survey methods 1-3 provide only total (gross) results and don't provide radionuclide-specific results. Survey methods 4-5 can provide radionuclide-specific results; therefore, NIOSH's NRC ESSAP Phase II data review focused on these results. Samples were analyzed and interpreted at the ESSAP laboratory in Oak Ridge, similar to the Phase 1 procedures. "Soil and miscellaneous material samples were analyzed by gamma spectroscopy… The radionuclides of interest were those associated with natural processed uranium; however, spectra were also reviewed for natural thorium and other identifiable total absorption peaks (photopeaks)" (Adams, 2003). NIOSH has concluded that if thorium contamination were present, it did not exceed the minimum detectable concentration and therefore is not a significant contributor to exposure.

USACE FUSRAP

In 2014, a Remedial Investigation survey was performed by the Amec Foster Wheeler Company at the request of USACE for FUSRAP purposes. The primary objective was to measure the nature and extent of AEC-related contamination across the site and determine other radiological impacts related to potential commercial work performed on site. The survey included a gamma scan using two types of spectroscopy-grade sodium iodide (NaI) detectors of accessible portions of the ground surfaces of the site (Lively, 2015).

Because this survey was for FUSRAP purposes, thorium was not considered a primary contaminant of concern. However, radiological surface surveys were analyzed for thorium constituents in order to differentiate between the impacts at the site from FUSRAP-related contaminants of concern and other potential radiological impacts that might be present, such as those related to the commercial license authorizing possession of thorium for Babcock and Wilcox. Surveys were conducted using both custom NaI detectors, specifically engineered for detection of processed uranium metal (i.e., designed for detection of low-energy U-238 photon emissions) and 3x3-inch NaI detectors which are sensitive to thorium source material, Naturally Occurring Radioactive Material (NORM) constituents and other radionuclides associated with uranium metal. The array of detectors were placed next to each other so that the scans were simultaneously collecting data (Lively, 2015).

Visually, the Th-232 had a spatial layout similar to the two isotopes representing the naturally occurring radioactivity: K-40 and Ra-226 (progeny of U-238 in soil), which had fairly consistent activity levels throughout the complex. The total gamma activity spatial plots showed distinct spatial patterns of high areas of radioactivity, unlike the naturally occurring radionuclides and thorium plots. This leads one to believe that the Th-232 detected could be due to the natural background; Th-232 is a primordial radionuclide present in earthen materials. A conclusion made by the document states, "Interestingly, there is no significant spatial structure observable in the Th-232 data set suggesting that radiological impacts in the near surface soils from licensed activities involving thorium at the site are insignificant" (Lively, 2015); thus, there were no indications of high thorium activity levels in any specific areas at the facility.

Due to questioning of the accuracy of the data presented in the 2014 Remedial Investigation (Lively, 2015), USACE and Amec Foster Wheeler performed a supplemental quality control test. Questions were raised about the low concentrations of uranium that were reported. The conclusion reached, by reanalyzing a subset of 18 samples on other gamma spectroscopy and ICP-MS counters, was that the original results were valid, lending credibility to the sample analysis performed in 2014 (Watson, 2016).