SEC Petition Evaluation Report

Petition SEC-00250

Report Rev Number:	0
Report Submittal Date:	07/17/2019
Subject Expert(s):	Paul Demopoulos, Joe Guido
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition Number:	SEC-00250
Petition Type:	83.13
Petition Receipt Date:	November 1, 2018
Qualification Date:	March 6, 2019
DOE/AWE Facility Name:	Y-12

Petition Class

Petitioner-Requested Class Definition:	All workers who worked in any area of Y-12 where uranium was fabricated or processed from January 1, 1980, to December 31, 2000.
Class Evaluated by NIOSH:	All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee that may have incurred thorium exposures, during the period from January 1, 1977 through December 31, 1994 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.
NIOSH-Proposed Class(es) to be Added to the SEC:	All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee, during the period from January 1, 1977 through July 31, 1979 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking Number(s):	SEC-00018 SEC-00028 SEC-00098 SEC-00186 SEC-00251
Petition Type:	83.13 83.13 83.14 83.14 83.14
DOE/AWE Facility Name:	Y-12 Plant Y-12 Plant Y-12 Plant Y-12 Plant Y-12 Plant

SEC Petition Tracking Number(s):	SEC-00018 SEC-00028 SEC-00098 SEC-00186 SEC-00251
Petition Status:	Class added to the SEC for March 1943 through December 31, 1947 Class added to the SEC for January 1948 through December 31, 1957 Class added to the SEC for March 1, 1943 through December 31, 1947 Class added to the SEC for January 1, 1948 through December 31, 1957 Class added to the SEC for January 1, 1958 through December 31, 1976

Related Evaluation Report Information

Report Title:	SEC Petition Evaluation Report for Petition SEC-00018 SEC Petition Evaluation Report for Petition SEC-00028 SEC Petition Evaluation Report for Petition SEC-00098 SEC Petition Evaluation Report for Petition SEC-00186 SEC Petition Evaluation Report for Petition SEC-00251
DOE/AWE Facility Name:	Y-12 Plant

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Evaluation Report Summary: SEC-00250, Y-12 Plant

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 the Y-12 Plant 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-00250 on November 1, 2018 and qualified it on March 6, 2019. The petitioner requested that NIOSH consider the following class: *All workers who worked in any area of Y-12 where uranium was fabricated or processed from January 1, 1980, to December 31, 2000.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH evaluated the following class: *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee that may have incurred thorium exposures, during the period from January 1, 1977 through December 31, 1994 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

NIOSH Determination about the Proposed Class(es) to be Added to the SEC

NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes: *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee, during the period from January 1, 1977 through July 31, 1979 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

Feasibility of Dose Reconstruction

Following its analysis of the SEC-00250 Y-12 class under evaluation (January 1, 1977 through December 31, 1994), NIOSH's conclusions fell into three time periods, as follows:

1. 1977-1979: NIOSH finds it is not feasible to estimate internal exposures with sufficient accuracy for all employees at the site from January 1, 1977 through July 31, 1979 due to a lack of sufficient thorium-related lung count data for this period.

2. 1979-1986: For the period from August 1, 1979 through December 31, 1986, 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. The 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 from August 1, 1979 through December 31, 1986.

3. 1987-1994: NIOSH is currently working with the Y-12 site to receive post-1986 thorium data that may allow NIOSH to estimate the maximum internal potential exposure from thorium during the period from January 1, 1987 through December 31, 1994 (discussed below). Until these thorium progeny data become available, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994.

   With the exception of the reserved internal thorium feasibility determination for 1987-1994, per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses more precisely than an estimate of maximum dose. There is enough information available from the site profile and additional resources to document or estimate the maximum external and maximum non-thorium internal potential exposures to members of the evaluated class under plausible circumstances during the specified period from January 1, 1987 through December 31, 1994.

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

- Principal sources of internal radiation for members of the evaluated class include inhalation and ingestion of uranium, thorium (and progeny), and calutron-cyclotron-related radioisotopes from processing and production operations.

- In NIOSH's 2018 evaluation of the Y-12 Plant, *SEC Petition Evaluation Report for Petition SEC-00251, Y-12 Plant* (NIOSH, 2018), NIOSH found that available *in-vivo* monitoring data for thorium (i.e., lung counts) during the period from January 1, 1959 through December 31, 1976 were recorded in total thorium mass units. As such, NIOSH lacked the ability to use these data to determine the associated quantities of thorium-232, thorium-228, and radium-228 with sufficient accuracy. Consequently, a class of Y-12 Plant workers was added to the SEC for the period from January 1, 1958, through December 31, 1976.

- Consistent with the findings of NIOSH's 2018 evaluation, NIOSH has now determined that there are also insufficient *in-vivo* monitoring data for thorium (i.e., lung counts) during the period from January 1, 1977 through July 31, 1979. Available thorium lung count data during this period are also mass-based results. As such, NIOSH does not have the ability to use these data to determine the associated intakes of thorium-232, thorium-228, and radium-228 with sufficient accuracy. Thus, NIOSH cannot determine with sufficient accuracy the internal exposures from thorium lung measurements during the period from January 1, 1977 through July 31, 1979.

- For the period from August 1, 1979 through December 31, 1986, NIOSH has determined that there are sufficient activity-based Pb-212 and Ac-282 *in-vivo* monitoring data to allow NIOSH to determine the associated intakes of Th-232, Th-228, and Ra-228 with sufficient accuracy.

- NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212) that may allow NIOSH to estimate the maximum internal potential exposure from thorium to members of the evaluated class during the period from January 1, 1987 through December 31, 1994. Therefore, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

- NIOSH has determined that there are sufficient *in-vivo* and *in-vitro* monitoring data for uranium (i.e., lung counts and urinalysis) during the period from January 1, 1977 through December 31, 1994 to allow NIOSH to determine the potential intakes of uranium with sufficient accuracy.

- NIOSH has determined that there are currently sufficient calutron-cyclotron-related radioisotope data to estimate the maximum internal potential exposure to members of the evaluated class during the period from January 1, 1977 through December 31, 1994 for Isotopes Group workers on the Y-12 campus based on the evaluation contained in ORAUT-RPRT-0090.

- Principal sources of external radiation for members of the evaluated class included exposures to beta particles, gamma photons, and neutrons. The radiation sources potentially contributing to these exposures would have principally included processing operations related to uranium, thorium (and progeny), and calutron-cyclotron-related radioisotopes.

- Beta, photon, and neutron monitoring data are available for Y-12 in the form of individual dosimetry during the evaluation period from January 1, 1977 through December 31, 1994. Consistent with its findings in prior NIOSH evaluations of the Y-12 Plant, NIOSH finds that there is sufficient monitoring and source term information available to reconstruct external and medical X-ray doses for all workers at the Y-12 Plant during the period from January 1, 1977 through December 31, 1994.

- Pursuant to 42 C.F.R. § 83.13(c)(1), for the period from January 1, 1977 through July 31, 1979, NIOSH has determined that there is insufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

- Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Y-12 during the period from January 1, 1977 through July 31, 1979, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the proposed class from January 1, 1977 through July 31, 1979.

For the period from January 1, 1987, through December 31, 1994, a health endangerment determination will be provided, as required, when a dose estimation feasibility evaluation has been completed (following the expected receipt of additional Y-12 thorium data).

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class have accumulated possible chronic exposures through intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation. In the absence of high-level incident exposures, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under this employment or in combination with work days within the parameters established for one or more other SEC classes.

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SEC Petition Evaluation Report for SEC-00250

ATTRIBUTION AND ANNOTATION: This is a single-author document. Unless otherwise noted for specific sections in this report, all conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Paul Demopoulos, Oak Ridge Associated Universities. 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 employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee that may have incurred thorium exposures, during the period from January 1, 1977 through December 31, 1994 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH. This report also does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

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

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (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.[2]

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

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

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those 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.[3]

[3] 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.

3.0 SEC-00250, Y-12 Plant Class Definitions

The following subsections address the evolution of the class definition for SEC-00250, Y-12 Plant. 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.

NOTE: NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212) that may allow NIOSH to estimate the maximum internal potential exposure from thorium to members of the evaluated class during the period from January 1, 1987 through December 31, 1994. Therefore, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

3.1 Petitioner-Requested Class Definition and Basis

NIOSH received petition SEC-00250 on November 1, 2018, and it qualified on March 6, 2019. The petitioner requested that NIOSH consider the following class: All workers who worked in any area of Y-12 where uranium was fabricated or processed from January 1, 1980, to December 31, 2000.

The petitioner submitted documentation asserting that reconstruction of internal dose at Y-12 was not feasible. NIOSH assessed these documents and discussed the issues voiced by the petitioner in a consultation call. The petitioner provided additional information to support the petitioner's belief that accurate dose reconstruction is not feasible for Y-12 employees due to a NIOSH self-identified need for additional research into the feasibility of reconstructing internal doses to thorium after 1976, as presented in a previous SEC evaluation report for Y-12 (SEC-00251) (NIOSH 2018). Even though NIOSH has access to Y-12 *in-vivo* monitoring from January 1, 1977 through December 31, 1994, it still needed to evaluate whether sufficient activity-based lung count data are available to establish a sufficiently accurate assessment of the thorium dose. After consideration, NIOSH deemed the following information sufficient to qualify SEC-00250 for evaluation:

> NIOSH currently finds support to qualify petition SEC-00250 for evaluation for thorium exposures from January 1, 1977 to December 31, 1994, based upon a NIOSH self-identified infeasibility when using *in-vivo* lung counting data for thorium exposures. In NIOSH's previous evaluation of SEC-00251, it proposed an SEC class due to inability to bound potential thorium exposures for all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee, during the period January 1, 1958 through December 31, 1976 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

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 bases are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

NIOSH changed the start date of the petitioner-requested class from January 1, 1980 to January 1, 1977 so the class would begin at the end of the prior Y-12 evaluation into the feasibility of reconstructing thorium dose, as indicated in the SEC-00251 evaluation report (NIOSH, 2018). NIOSH changed the end date of the petitioner-requested class from December 31, 2000 to December 31, 1994. Beginning in September 1994, the plant was placed in a stand-down mode. This effectively stopped all routine work (and chronic exposure potential) in the process areas. Consequently, NIOSH used this event to establish the end date of the class qualifying for evaluation. Therefore, NIOSH defined the following class for further evaluation: *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee that may have incurred thorium exposures, during the period January 1, 1977 through December 31, 1994 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

3.3 NIOSH Determination about the Proposed Class(es) to be Added to the SEC

NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes: *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee, during the period January 1, 1977 through July 31, 1979 for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

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 the Y-12 Plant. The database search included the Department of Energy (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 searches, the Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One includes a summary of the Y-12 Plant 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. The Y-12 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. As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Y-12 Plant operations or related topics/operations at other sites:

- *TBD for Y-12 National Security Complex Introduction*, ORAUT-TKBS-0014-1; Rev. 01; October 24, 2006; SRDB Ref ID: 30036
- *TBD for Y-12 National Security Complex – Site Description*, ORAUT-TKBS-0014-2; Rev. 02; November 8, 2007; SRDB Ref ID: 36045
- *TBD for Y-12 National Security Complex – Occupational Medical Dose*, ORAUT-TKBS-0014-3; Rev. 01; June 18, 2007; SRDB Ref ID: 32461
- *TBD for Y-12 National Security Complex – Occupational Environmental Dose*, Rev. 01; ORAUT-TKBS-0014-4; July 20, 2006; SRDB Ref ID: 30042
- *TBD for Y-12 National Security Complex – Occupational Internal Dose*, Rev. 03; ORAUT-TKBS-0014-5; March 12, 2012; SRDB Ref ID: 109202
- *TBD for Y-12 National Security Complex – Occupational External Dosimetry*, Rev. 02; ORAUT-TKBS-0014-6; December 18, 2009; SRDB Ref ID: 77701

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. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIBs as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 04; Oak Ridge Associated Universities; effective June 20, 2011; SRDB Ref ID: 98147
- *OTIB: Historical Evaluation of the Film Badge Dosimetry Program at the Y-12 Facility in Oak Ridge, Tennessee: Part 1 – Gamma Radiation*, ORAUT-OTIB-0044, Rev. 01; Oak Ridge Associated Universities; effective April 29, 2013; SRDB Ref ID: 124944
- *OTIB: Historical Evaluation of the Film Badge Dosimetry Program at the Y-12 Plant in Oak Ridge, Tennessee: Part 2 – Neutron Radiation*, ORAUT-OTIB-0045, Rev. 01; Oak Ridge Associated Universities; effective November 30, 2009; SRDB Ref ID: 77243

- *OTIB: Historical Evaluation in the Film Badge Dosimetry Program at the Y-12 Plant in Oak Ridge, Tennessee: Part 3 – Beta Radiation*, ORAUT-OTIB-0046, Rev. 00; Oak Ridge Associated Universities; effective June 22, 2007; SRDB Ref ID: 32523

- *OTIB: Effect of Threshold Energy & Angular Response of NTA Film on Missed Neutron Dose at Oak Ridge Y-12*, ORAUT-OTIB-0051, Rev. 00; Oak Ridge Associated Universities; effective May 15, 2006; SRDB Ref ID: 29977

- *OTIB: Coworker External Dosimetry Data for the Y-12 National Security Complex*, ORAUT-OTIB-0064, Rev. 02, Oak Ridge Associated Universities; April 29, 2013; SRDB Ref ID: 124947

- *OTIB: Potential Missed Dose to Nuclear Weapons Assemblers at the Y-12 Plant During the Period from 1958 to 1990*, ORAUT-OTIB-0074, Rev. 00; Oak Ridge Associated Universities; effective March 13, 2009; SRDB Ref ID: 62716

- *OTIB: Use of Claimant Datasets for Coworker Modeling*, ORAUT-OTIB-0075, Rev. 01; Oak Ridge Associated Universities; effective June 17, 2016; SRDB Ref ID: 157060

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

- *OTIB: Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 01; Oak Ridge Associated Universities; effective March 18, 2016; SRDB Ref ID: 152173

4.3 Facility Employees and Experts

To obtain more information in support of its 2018 evaluation of petition SEC-00251, NIOSH interviewed six former Y-12 Plant employees. These six interviews were reviewed for this SEC-00250 effort; three of the interviews listed below (Personal Communications 2012, 2018d, and 2018e) were determined to have information pertinent to the class currently under evaluation. In addition to these formal interviews, NIOSH has requested information from the Y-12 Knowledge Preservation Group; however, no additional information was provided.

- Personal Communication, 2012, *Personal Communication with Former Oak Ridge National Laboratory employee;* Telephone Interview by ORAU Team and NIOSH; March 15, 2012, SRDB Ref. ID 110639

- Personal Communication, 2018a, *Personal Communication with Former Y-12 Plant employee*; In-person Interview by ORAU Team; August 15, 2018; SRDB Ref ID: 173936

- Personal Communication, 2018b, *Personal Communication with Former Y-12 Plant employee*; In-person Interview by ORAU Team; August 16, 2018; SRDB Ref ID: 173937

- Personal Communication, 2018c, *Personal Communication with Former Y-12 Plant employee*; In-person Interview by ORAU Team; August 16, 2018; SRDB Ref ID: 173938

- Personal Communication, 2018d, *Personal Communication with Former Y-12 Plant employee*; In-person Interview by ORAU Team; August 16, 2018; SRDB Ref ID: 173939

- Personal Communication, 2018e, *Personal Communication with Former Y-12 Plant employee*; In-person Interview by ORAU Team; August 16, 2018; SRDB Ref ID: 174343

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 May 16, 2019)

Table 4-1: No. of Y-12 Plant Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	6525
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1977 through December 31, 1994).	3615
Total number of claims submitted for energy employees who started their employment during the period under evaluation (January 1, 1977 through December 31, 1994)	1825
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).	3211
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	1688
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	3267

There are 3615 Y-12 claims with some employment between the years of 1977 and 1994. NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. As indicated in Table 4-1, for employees who worked during the class period under evaluation, NIOSH has been able to obtain internal and external monitoring data for approximately 47% and 90% of the claims, respectively. The dose reconstruction claimant interviews (CATI) conducted with the claimants provide some detailed information regarding work locations, hours worked, incidents, and hazards encountered. The interviews also identified conditions for which there would have been potential for either internal or external exposures.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. As of June 4, 2019, the SRDB contained 15,254 documents (5067 main documents and 10,187 related subdocuments) that were identified as pertaining to the Y-12 Plant. These documents were evaluated for their relevance to this petition. The documents include historical background on Y-12 plant processes, lung counting, urinalysis, fecal sampling, radiological control program, medical monitoring, and process materials.

4.6 Delta View Imaging System

Maintained by Y-12, the Delta View Imaging System is comprised of scanned images of hard copy reports and monitoring data printouts associated with Y-12 personnel. Delta View stores copied images of documents and is searchable if keywords have been associated with the individual images when initially loaded. The images in Delta View are accessible by individual name and/or ID numbers, analysis, and sample type, among other parameters. Examples of data in Delta View include *in-vivo* lung counts, input forms, multi-channel analyzer output, gamma spectrometry images, and data from Y-12 and X-10 analytical labs. There were approximately 24,000 images of *in-vivo*-related documents obtained for the period from 1989 through 1995 (Delta View Data, 1989–1995).

4.7 Y-12 Electronic Records System

Maintained by the Y-12 internal dosimetry department, these data contain analytical results by individual, ID, bioassay type, date, and radionuclide. Y-12 provided to NIOSH an excerpt from this system in spreadsheet format containing 62,935 individual lung count records from 1984 through 1995 (Lung Count Spreadsheet, 1984–1995).

4.8 ORAU Center for Epidemiologic Research Database

From 1978 through the 1980s, the Y-12 Site delivered electronic files of worker data to the ORAU Center for Epidemiologic Research as a resource for the Health and Mortality Studies conducted for the DOE and its predecessor agencies. Included were records for Y-12 workers. This data are currently maintained by Oak Ridge Institute for Science and Education (ORISE) (Watkins, 1993).

NIOSH obtained the following datasets:

- External Dosimetry dataset: 520,354 records covering the period 1950-1988
- Internal *in-vitro* dataset: 479,446 records covering the period 1950-1988
- The Internal *in-vivo* dataset: 66,274 records covering the period 1961-1988

4.9 Documentation Provided by Petitioners

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

- *Cover letter for SEC-00250 from* [name redacted], October 18, 2018; SRDB Ref ID: 176782, PDF pp. 20-21
- *Y-12 National Security Complex – Occupational Internal Dose*, ORAUT-TKBS-0014-5, Rev. 03, Oak Ridge Associated Universities, March 12, 2012; SRDB Ref ID: 109202
- *Y-12 Uranium Exposure Study*, Eckerman, K. F., and G. D. Kerr, ORNL/TM-1999/114, Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee; August 5, 1999; SRDB Ref ID: 11600
- *Y-12 Plant Dosimetry Summary Report for* [name redacted] SEC Petition, 2018, *Special Exposure Cohort (SEC) Petition for Y-12 Plant (SEC-00250),* National Institute for Occupational Safety and Health (NIOSH), November 1, 2018; SRDB Ref ID: 176782, PDF p. 22
- *Y-12 Electrician Radiation Dose Report*, no date, no author; SRDB Ref ID: 176789
- *Y-12 Radiation Dose Report 2;* no date, no author; SRDB Ref ID: 176790
- *Memorandum to Defense Nuclear Facilities Safety Board for Oak Ridge Program*, McConnell, J.J.; April 9, 1993*;* SRDB Ref ID: 57709
- *DFNSB audit report Review of Chemical Safety at the Y-12 Plant,* Van Holle, December 11, 1998; SRDB Ref ID: 176787, PDF pp. 7-8
- *NIOSH Dose Reconstruction Report for NOCTS Claim #[redacted]*, no author, no date; SRDB Ref ID: 176788
- *Additional Supporting Document from Petitioner re Contaminated Machines*, no date, no author; SRDB Ref ID: 176786
- *Letter to Defense Nuclear Facilities Safety Board from, G. Podonsky,* (DOE), January 1996: SRDB Ref ID: 176785
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1980*, no author, February 1982: SRDB Ref ID: 26888
- *Radiation Exposures Report for DOE and DOE Contractor Employees –1983,* no author, March 1983: SRDB Ref ID: 26890
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1982*, no author, February 1984: SRDB Ref ID: 26892

- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1983*, no author, October 1984: SRDB Ref ID: 26895
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1984*, no author, December 1985: SRDB Ref ID: 26896
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1985*, no author, December 1986: SRDB Ref ID: 26897
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1986*, no author, December 1987: SRDB Ref ID: 26898
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1987*, no author, October 1989: SRDB Ref ID: 26899
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1988*, no author, December 1990: SRDB Ref ID: 26900
- *Radiation Exposures Report for DOE and DOE Contractor Employees – 1989*, no author, December 1992: SRDB Ref ID: 16122
- *Recycled Uranium mass balance project Y-12 national security complex site report,* Y/LB-16,036, Rev. 1, Y-12 National Security Complex, December 2000; SRDB Ref ID: 16500
- *Report of Survey of Oak Ridge Isotope Enrichment (Calutron) Facility Building 9204-3,* U. S. Department of Energy Office of Environmental Management & Office of Nuclear Energy, May 5, 2000; SRDB Ref ID: 17691
- *Characterization of the Radioactive Material Inventory in the Building 9204-3 Actinide Facility,* Oak Ridge National Laboratory, Walker, May 8, 2012; SRDB Ref ID: 176792
- *Y-12 continues missions while focusing on environment*, no author, no date; SRDB Ref ID: 176793

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize radiological operations at the Y-12 Plant from January 1, 1977 to December 31, 1994 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources, NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of available information.

5.1 Y-12 Plant and Process Description

ATTRIBUTION: Section 5.1 was completed by ORAU Team Subject Expert Joe Guido, MJW Corporation. All conclusions drawn from the data presented were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in subsequent sections of this document related to Y-12 plant and process descriptions are explained in the associated text.

The Y-12 Plant is located in Oak Ridge, Tennessee on an 811-acre (0.67-mile wide by 3.2-mile long) site. At its peak, the Y-12 Plant employed approximately 22,000 workers (ORAUT-TKBS-0014-2). In later years (including the period under evaluation, January 1, 1977 through December 31, 1994), downsizing had resulted in there being approximately 5733 employees by June 1998 (Pepper, 2000, PDF p. 56). The following subsections summarize the radiological operations at the Y-12 Plant from January 1, 1977 through December 31, 1994.

Y-12 Plant operations discussed in this section are divided into the following functional areas:

- Uranium Processes
- Thorium Processes
- Isotopes Group Activities

5.1.1 Y-12 Key Uranium Processes

Table 5-1 summarizes the key uranium processes, buildings, and dates of operation relevant for the evaluation period of this petition (1977-1994) (Oak Ridge, 1999, PDF p. 171; Oliver, 2003; Oliver, 2007).

Table 5-1: Key Uranium Operations

Key Uranium Operations	Buildings Involved	Dates of Operation
Uranium Recovery and Recycle: Y-12 stopped enriching uranium after WWII and operations centered on uranium recovery and recycling of residual uranium found on equipment and scrap material. Operations included mechanical scraping and brushing, nitric-acid washing, and distillation and recovery of solid uranium compounds adhered to surfaces. Uranium-contaminated materials included condensates, scrubber solutions, raffinates, destructive distillates, oils, and miscellaneous residues. These Y-12 facilities handled mostly natural uranium and depleted uranium.	9202, 9203, 9206, 9212: • 9202, 9203 received depleted uranium, slightly enriched uranium, and normal uranium. • 9206 was the main uranium recovery and recycle facility and housed sanding, grinding, chemistry, and incinerator operations. • 9212 housed the largest chemical operations for enriched uranium purification, recovery, and chemical conversion as well as normal and depleted uranium-machining operations.	1950s-1990s

Key Uranium Operations	Buildings Involved	Dates of Operation
Uranium Preparation/Recycle for Weapons Component Operations: Y-12 began a continuous growth of uranium weapons component manufacturing operations and handled a variety of uranium compounds and enrichments. Enriched uranium prepared for reduction to metal involved conversion of uranium hexafluoride to uranium fluoride, purification of uranyl nitrate solutions, precipitation for uranium recovery, and then reduction to uranium metal.	9212: • 9212 housed the largest chemical operations for enriched uranium purification, recovery, and chemical conversion as well as normal and depleted uranium-machining operations.	1952-1995
Uranium Forming/Machining for Weapon Component Operations: Y-12 had operations capable of casting, rolling, and machining uranium metal. These operations handled enriched uranium, depleted uranium, and normal uranium. Uranium was pressed, rolled, shaped, and machined into finished weapon components.	9206, 9207, 9211: • 9206 housed salvage operations and process operations similar to those in 9207 and 9211. • 9207 and 9211 processed incinerated solid waste and recovered normal and lightly-enriched uranium.	1952-1995
Uranium Component Assembly: Machined components were sent through finishing operations that included drilling, welding, brazing, polishing, and final specification checks. Assembly operations generally were not associated with significant releases of uranium compounds. Any measurable amounts of uranium were recovered and recycled back into the production stream. Uranium was routinely recovered from articles such as rags, paper towels, oils, and liquid waste products. Process exhaust stacks were equipped with high-efficiency particulate air (HEPA) filters and periodically inspected for build-up of uranium.	9202, 9204-2, 9204-2E: • 9202 was primarily used for early pilot-scale operations that involved design and implementation of fabrication and assembly processes and final inspection procedures. • 9204-2, 9204-2E housed uranium assembly operations.	1952-1995

5.1.2 Y-12 Thorium Processes

Y-12's involvement in the production of thorium metal shapes began as a pilot program in 1959. It was a continuation of work previously performed at the Bureau of Mines in Albany, Oregon. Bureau of Mines operations included arc-melting, forging, rolling, and forming of thorium (Hibbs, 1961). Y-12 completed its initial order in October 1959. Table 5-2 lists the Y-12 buildings involved in these initial thorium activities.

Table 5-2: Y-12 Buildings Involved in Initial Thorium Operations

Building No.	Thorium Operation(s)
9202	Arc-melting Double hammer forging Machining to final dimensions Annealing Development
9766	Machining
9215	Cold rolling Drawing to shape (hydroforming)
9201-5	Pellet/scrap preparation Arc-melting Crop and trim machining Sawing
9204-4	Mold press sintering Ingot forging Annealing after first cold roll Final inspection/assembly
9201-1	Ingot canning
9206	Cleaning and final plating
9902	Storage
9995	Storage

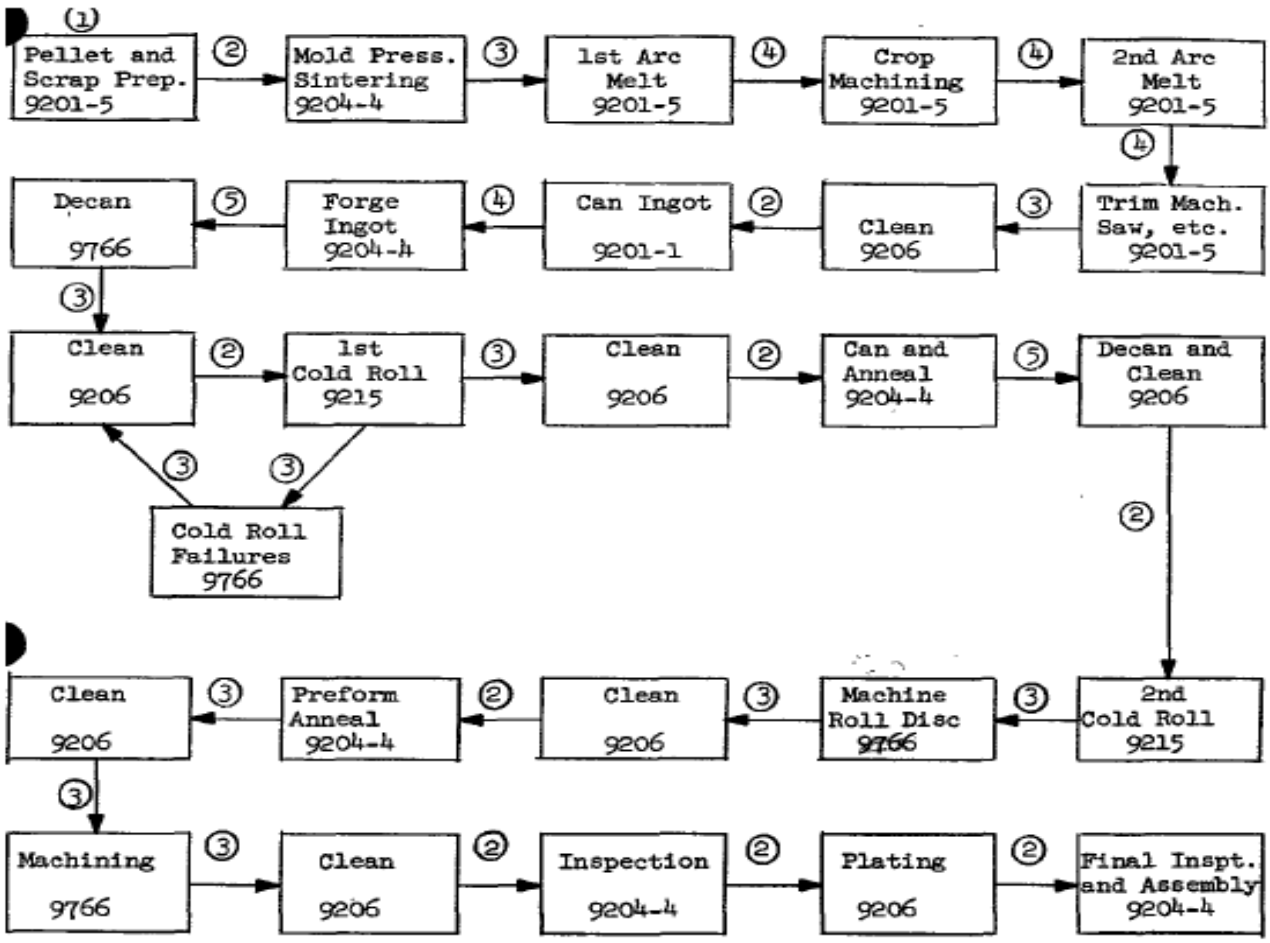
Source: Hibbs, 1960; Hibbs, 1961; Thorium Machining, 1960, RCO/TR-013, 2001, PDF pp. 11-12

Thorium activities were expanded in the 1960s with facilities dedicated to these operations constructed in Building 9201-5 and 9204-2E. Other areas with thorium operations included Building 9204-4 (mold press, ingot forging), Building 9201-1 (canning ingots), and Building 9206 (cleaning and final plating). Buildings 9902 and 9995 were also used for thorium storage (RCO/TR-013, 2001, PDF pp. 11-12). Y-12 contracted with other companies for thorium pellets and then pressed the metal into electrodes; subsequently, two arc-meltings were performed (Thorium Flow Chart, 1963, PDF p. 1).

The primary thorium process at Y-12 is consumable-electrode arc-melting in which the material to be cast serves as one electrode of an electric-arc gap, and the heat of the arc melts the electrode. The opposite electrode is in a water-cooled crucible in which the molten metal solidifies. The consumable electrode is gradually lowered to maintain the proper arc gap, resulting in the melting of the consumable electrode and the casting of an ingot in the water-cooled crucible. Volatile impurities tend to move toward the cold walls of the crucible where they may be removed by light machining of the ingot (Cofield, 1961).

After arc-melting, which removed most of the impurities, the thorium metal was then pressed, rolled, and formed or machined. The metal scraps were salvaged and pressed into electrodes for the arc-melting process. Figure 5-1 shows a summary of the Y-12 thorium production-scale activities.

Fabrication: Thorium Flow Chart – Contamination Control



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① Unpacked in Control Area With Respiratory Protection.

② Health Physics "Green Tag" Transfer Clearance Required - Transfer in Container or Plastic Bag - No Other Special Precautions.

③ Health Physics "Contamination Tag" Required. Transfer in Container or Plastic Bag - Other Special Precautions As Prescribed on Tag.

④ Health Physics Survey not Required.

⑤ Health Physics Survey not Required Unless Can Failure During Operation.

NOTES

(a) All movements or transfers of thorium material from thorium control areas to non-thorium areas should be accompanied by appropriate Health Physics tag.

(b) All samples and specimens should be transferred on Health Physics "Green Tag".

Source: Thorium Flow Chart, 1963

Figure 5-1: Thorium Flow Chart for Contamination Control

An interview with a former worker indicated that the major activities involving thorium continued through the mid-1970s, after which the demand for thorium components diminished. He indicated that from 1960 through 1977, metric tons of thorium were processed at Y-12. Processing included molding/pressing of thorium pellets, arc-melting, and machining. In 1975, the major arc-melting campaign stopped (due to the SALT II treaty ending of the W-71 weapons program) (Personal Communication, 2018e). Another interview of a Y-12 employee who worked in [redacted] indicated that he was aware of thorium work in 1974; however, once the W-71 weapons program was completed there was not much need for thorium and he did not know of any additional thorium work (Personal Communication, 2018d). A February 25, 1969 document states:

> *The thorium monitoring program in the arc melt area has been discontinued and added back to monitor for uranium. No changes have been made in the thorium program in the chip and press areas at this time. Tentative plans call for elimination of these area programs around July after complete phase out and decontamination* (Thorium Melt, 1969).

One employee that NIOSH interviewed indicated that, after the cessation of major thorium operations in 1975, a small amount of thorium processing (including arc-melting) continued for the refurbishment of parts through 1989 (Personal Communication, 2018e).

From September 1994 through August 1998, the Y-12 plant was placed in a stand-down mode (Eckerman, 1999), which effectively stopped all routine work (and chronic exposure potential) in the process areas. After this stand-down, area controls were put in place to restrict access, and a small amount of special-project thorium work (including arc-melting for the development of detector plates) was performed until 1999 (Personal Communication, 2018e).

On December 8, 1999, there was a catastrophic event involving depleted uranium operations with a Y-12 furnace, which injured multiple employees (NaK Accident, 2000). As a result of this incident, all arc-melting activities (which were primarily depleted uranium but did include the special projects mentioned above) were suspended (Personal Communication, 2018e).

5.1.3 Isotopes Group Activities

Y-12 facilities were used by the ORNL Isotopes Group for isotope production, separation, and purification. Although both radioactive and stable materials were processed, this evaluation only focuses on radioactive isotopes. Facilities used by the Isotopes Group on the Y-12 campus include calutrons located in Building 9204-3, the 86-inch cyclotron located in Building 9201-2, and the conversion laboratory located in Building 9204-3. Operations at all three of these facilities are summarized below.

Calutron Facility (Building 9204-3)

Calutron operations at Y-12 extend back to the early 1940s when they were used for uranium enrichment. After that effort, small portions of the existing calutrons were used by the Isotopes Group (and their predecessor, the Electronuclear Research Division) for the separation of both radioactive and stable materials. In 1962, a containment facility was built in Building 9204-3 that included separations areas, chemical processing areas, a change room, and a locker room. One track in Building 9204-3 was divided into four segments, and eight calutrons were isolated within a containment facility for radioisotope separations. Two of these calutrons were designated for plutonium and four for uranium production. The actinide area operated continuously from 1962

until the mid-1970s when it was put on standby. The facility was operated again in the late-1970s for the separation of Pu-242; it was again placed on standby in 1980 (ORNL, 1995; Wilcox, 2001).

86-inch Cyclotron (Building 9201-2)

The 86-inch cyclotron was operated almost constantly from 1950 for research, development, and as a production facility for medical radioisotopes; it was shut down in 1983 (Kerr, 1992; Kerr, 2004). From its earliest operations, this cyclotron was often run for hundreds of hours before shutdown, which was usually necessary only due to target limitations (CCCC, 1951). The device was used as a resource by practically all of the ORNL divisions, including Aircraft Nuclear Propulsion, Biology, Chemistry, Health Physics (HP), Operations, Physics, and Electronuclear Research. It was also used substantially for projects at the Oak Ridge Institute of Nuclear Studies, which later became ORAU (Livingston, 1952).

Conversion Lab (Chemical Processing Area of Building 9201-3)

The Conversion Lab was a radiochemistry facility located in the containment area in Building 9204-3. Its activities included preparation of calutron feed materials, radiochemical separations, source preparation, and radioassay. Radionuclides handled in the Conversion Lab included materials from the calutrons and from ORNL.

5.1.4 Weapons Assembly and Disassembly

Weapons assembly/disassembly work began as early as 1952-1953. Typically, weapons components were assembled at Y-12 and then sent to another site(s) for further assembly. Much more assembly work was done than disassembly work. Prior to 1960, work was done in glove boxes or in open areas, which were, by necessity, very clean environments. The exposure potential was from external radiation only because the parts for assembly were essentially clad or otherwise sealed. Dosimeters were worn on company-issued work clothing.

During the weapons assembly and disassembly operations, a small crew (a maximum of three plus one foreman) was used. These crews never included maintenance or crafts-people. The interviewed workers agreed that the presence of pipefitters, plumbers, and steamfitters in the assembly areas was infrequent and only after the assemblies were either covered and/or removed, thus making radiation exposure potential unlikely. In addition, when maintenance personnel were needed in the area, they were always required to wear personal dosimeters.

5.2 Radiological Exposure Sources from the Y-12 Plant Operations

The following subsections provide an overview of the internal and external exposure sources for the Y-12 Plant class under evaluation. During Y-12's operational radiation period from January 1, 1977 through December 31, 1994, the primary source of potential exposure was from uranium facility weapons-related work. Potential exposures also existed from thorium work activities involving the production of thorium metal shapes, and other radionuclides produced and handled by the Isotopes Group.

5.2.1 Internal Radiological Exposure Sources from the Y-12 Plant Operations

This section addresses exposures to alpha-emitting radionuclides. The primary sources of potential internally-deposited radioactivity for Y-12 employees during the operational period were inhalation and ingestion of uranium and thorium activity occurring during uranium and thorium metal operations and legacy contamination remaining because of those operations.

5.2.1.1 Uranium

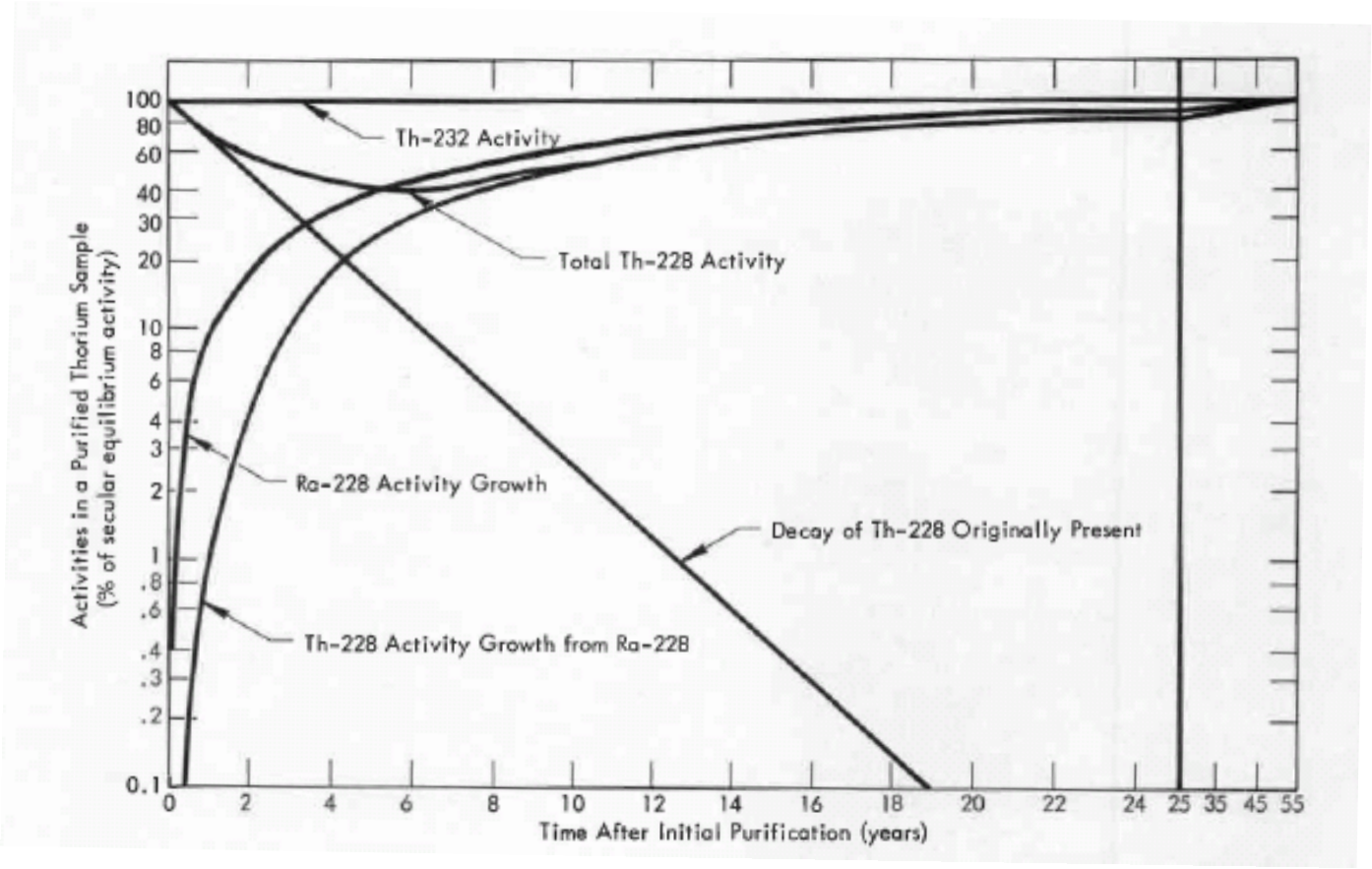
The principal source of internal radiation doses for members of the evaluated class was airborne uranium particulate material. This dust could be inhaled by individuals and then be deposited in the respiratory tract. The dust would also settle onto surfaces and be available for re-suspension back into the air where it could be inhaled or ingested in the body by transfer from contaminated surfaces via hand to mouth.

Trace quantities of plutonium, neptunium-237, and technetium-99 were introduced through the processing of recycled uranium. Contributions from these nuclides are detailed in ORAUT-TKBS-0014-5.

5.2.1.2 Thorium

Another source of internal radiation doses for members of the evaluated class was airborne thorium particulate material. This dust could be inhaled by individuals and then be deposited in the respiratory tract. The dust would also settle onto surfaces and be available for re-suspension back into the air where it could be inhaled or ingested in the body by transfer from contaminated surfaces via hand to mouth.

Undisturbed, the Th-232 and Th-228 activity reach a state of equilibrium wherein the radiological activity of Th-232 and Th-228 are equal. Because of the half-lives of the nuclides in the thorium chain, removal of the Ra-228 component will result in a decrease in the Th-228 activity for a period of time, during which the Ra-228 activity will increase, as shown in Figure 5-2 (NIOSH, 2018, PDF p. 16).



Source: West, 1965

Figure 5-2: Activities in a Purified Thorium Sample

The casting of ingots by consumable-electrode arc-melting was expected to produce a much greater disruption of the thorium decay chain than the other treatments such as acid "pickling," machining, forging, or shaping.

The effects of arc-melting were well studied by the health physics staff at Y-12 (Cofield, 1960; Cofield, 1961; West 1961a; West, 1961b; West, 1965; West 1977) who learned that arc-melting of thorium effectively removes the radium and other daughters from thorium, but all of the daughters except Ra-228 and Ac-228 return very quickly and remain with the Th-228 present. In addition, the arc-melting of thorium releases large quantities of Ra-228. For example, in the casting of a typical 200-kg ingot of thorium, about 9.6 mCi of Ra-228 will be removed with more than half or at least 5 mCi of this radioisotope vaporized completely out of the ingot. The 5 mCi of Ra-228 becomes more of a radiological hazard as separated material than it was when distributed within the 200 kg of metal (NIOSH, 2018, PDF p. 18).

5.2.1.3 Radionuclides Produced and/or Handled by the Isotopes Group

The Isotopes Group produced and/or handled 213 individual radionuclides at facilities on both the ORNL X-10 footprint and that of Y-12. Y-12 separations facilities could have been used to process materials produced at X-10 reactors. Material transfers between Isotopes Group facilities located at Y-12 and ORNL X-10 were common. For this reason, with some exceptions, it can be generally

assumed that all of the materials detailed in ORAUT-RPRT-0090 may have been present in Isotopes Group facilities on the Y-12 campus (particularly the Conversion Laboratory). A detailed list of the radionuclides handled is contained in Table 6-3 of ORAUT-RPRT-0090. Radiological properties of these materials are detailed in Attachment B of that same document.

5.2.2 External Radiological Exposure Sources from the Y-12 Plant Operations

The potential for external radiation dose existed at the Y-12 Plant 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 thorium and uranium metal processed at the site. Due to the type of metal being processed, neutron exposure was not significant, as examined below.

The processing of thorium metals at Y-12 began in the late 1950s or early 1960s (ORAUT-TKBS-0014-2, West, 1965; Wilcox, 2001). In general, the same Y-12 facilities were involved in the processing and fabrication of both thorium and DU metals (ORAUT-TKBS-0014-2; McLendon, 1963; McRee, 1965). The external beta/photon doses to the thorium workers were found to be lower than or at the same order of magnitude as those doses to depleted-uranium workers (West, 1965, PDF p. 27).

5.2.2.1 Photon

Though less of an exposure potential than internal exposure, significant external exposure potential existed at times in specific locations or while engaged in certain activities. The external workplace radiation fields of most concern were due to processes involving either enriched uranium or depleted uranium. Additional radiation fields of concern involved industrial radiation-generating equipment (X-rays and electron accelerators) and isotopic gamma-ray and neutron sources for testing purposes (e.g., Co-60, Cf-252, and radium-beryllium or polonium-beryllium neutron sources) (NIOSH, 2006, PDF p. 21).

The U-235 and U-238 contained in Y-12 uranium materials are primarily alpha-emitters. However, U-235 does emit a 185-KeV photon in 54% of its decays. Short-lived U-238 decay products (Th-234, Pa-234m, and Pa-234) are beta and photon emitters. From an external dose standpoint, the most significant radiations emitted by these decay products of U-238 are: (1) the 2.29-MeV beta particle from Pa-234m: and (2) the photons emitted by Pa-234 with energies as large as 1.962 MeV (NIOSH, 2006, PDF pp. 20-21).

The largest workplace exposures at Y-12 have historically occurred in DU process areas (Henderson, 1991). In the foundry and forming areas, workers handled both large and small pieces of DU metal; however, the workers were not typically in close contact with the material for long periods of time (Ashley, 1995, PDF p. 10). Large parts were lifted with mechanical assistance and the workers usually remained 2-3 feet from the material. Smaller parts might be loaded by hand but the operator then moves to a control center several feet away, where the operator remains for the majority of the time spent working with the material (Ashley, 1995, PDF p. 10). Similar workplace conditions are found in the facilities of the Ultrasonic Testing Group of the Y-12 Quality Assurance department (Ashley, 1995, PDF p. 11). In contrast, workers in the Machine Shops, Mechanical Properties Inspection Laboratories, Dimensional Inspection Group, and Radiographic Laboratories could spend a

considerable part of their time working in close contact to the material (less than 30 cm) for extended periods (Ashley, 1995, PDF p. 11).

A concern with the workplace response of the Y-12 beta/gamma dosimeters involves workers who performed waist-level uranium handling of small metal objects in the DU areas (Henderson, 1991, PDF p. 46). A personnel dosimeter worn at the collar might underestimate both the Hp(0.07) and Hp(10) doses at the waist by a rather significant factor. Y-12 now instructs these workers to wear the dosimeters at the waist, but many workers might have worn them on the collar in the past. (Henderson 1991, PDF p. 47; ORAUT-TKBS-0014-6).

Photo emissions information on radionuclides handled at Isotopes Group facilities is discussed in detail in ORAUT-RPRT-0090 (Tables 7-4 and Attachment B).

5.2.2.2 Beta

When uranium metal is melted, impurities can separate from the metal matrix. Differences in densities and melting points can then cause impurities to separate from the molten uranium metal and concentrate on the surfaces (i.e., Th-234, Pa-234m, decay products of U-238). The process then causes a high concentration of these beta-emitters on the surfaces of the cast ingot, increasing the surface beta dose.

Beta emissions information on radionuclides handled at Isotopes Group facilities is discussed in detail in ORAUT-RPRT-0090 (Tables 7-4 and Attachment B).

5.2.2.3 Neutron

There are four buildings at Y-12 where the majority of the site's neutron-emitters were present during the period under evaluation (1977 through 1994) (ORAUT-TKBS-0014-6, 2009, PDF p. 42):

- Calibration Laboratory in Building 9983
- Nondestructive Analysis Laboratory in Building 9720-5
- HEU Storage Area in Building 9212
- Cyclotron operations in Building 9201-2

Calibration Facility (Building 9983)

The Calibration Facility had encapsulated sources that produced neutrons by spontaneous fission in Cf-252 or by alpha particle reactions with boron or beryllium providing convenient sources of neutrons for a variety of applications. Known locations of such sources producing neutrons by alpha particle reactions are Buildings 9201-2, 9203, 9204-3, 9737, and 9983 (ORAUT-TKBS-0014-2, PDF pp. 21-22).

Once the handling procedures for an encapsulated neutron source were established, the services provided by the HP Department evolved into routine periodic checks. Instrumentation calibrations with Po-Be, Pu-Be, Am-Be, and Am-B sources were a standardized operation in that the majority of calibrations were made at one location and usually by the same operator. Any unusual operations or transfers involving encapsulated neutron sources were done under the supervision of the HP Department (ORAUT-TKBS-0014-6, PDF p. 31).

Nondestructive Analysis Laboratory (Building 9720-5)

The Nondestructive Analysis Laboratory had Cf-252 sources that undergo spontaneous fission and create neutrons. These sources have been used for testing materials and recovery of highly-enriched uranium (HEU) from waste products. This laboratory contained instruments for the gamma and neutron monitoring of containers of solid wastes, gamma analysis of solution samples, and measurements of solution density (ORAUT-TKBS-0014-6, PDF p. 32-33).

HEU Storage Area (Building 9212)

The HEU Storage Area was another source of neutron exposure. Recycled uranium process streams involved the processing of other material forms. The potential for worker exposure to neutrons generated by (α,n) reactions in uranium compounds is not very high unless workers needed access near containers of uranium-fluoride or uranium-oxide compounds, or near storage or processing areas with large quantities of those materials (ORAUT-TKBS-0014-6, PDF p. 33-34).

Cyclotron Facility (Building 9201-2)

The 86-in. cyclotron was another source of neutron exposure. The cyclotron was used primarily by ORNL Isotopes Group for production of medical radioisotopes until it was shut down permanently in 1983 (Kerr, 1992; Kerr, 2004).

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

The following subsections provide an overview of the state of the available internal and external monitoring data for the Y-12 class under evaluation.

External penetrating and shallow exposures to particulate and photon radiation were monitored using radiation-sensitive materials within personnel badges worn by workers. Detailed historical evaluations of the Y-12 gamma, neutron, and beta monitoring programs, including applicable radiation protection guidelines, can be found in the external dosimetry technical basis document for the Y-12 plant, ORAUT-TKBS-0014-6.

Internal exposures to radionuclides were monitored by counting radioactive emissions in workers' excreta (urine) and via air sampling. Routine *in-vivo* chest counting at Y-12 was not initiated until 1961. Detailed historical evaluations of the Y-12 *in-vivo, in-vitro*, and air sampling monitoring programs including applicable radiation protection guidelines can be found in the internal dosimetry technical basis document for the Y-12 plant (ORAUT-TKBS-0014-5).

Radiological monitoring and controls at the Isotopes facilities on the Y-12 campus were managed and provided by ORNL (Redacted Name1, 2012; Redacted Name2, 2012). These operations were staffed and managed by ORNL X-10, with some Y-12 workers supporting operations. Records from 1965 indicate that some construction support contract staff (Harrold Knudson Ferguson [HKF] at the time) were among the individuals monitored at the calutron facility (NIOSH, 2018).

6.1 Available Y-12 Plant Internal Monitoring Data

The subsections below address the availability of data related to uranium and thorium. Details regarding the various analyses used and the associated minimum detectable activities are presented in the Technical Basis Document for the Y-12 Plant-Occupational Internal Dose (ORAUT-TKBS-0014-5).

6.1.1 Available Uranium Data

ATTRIBUTION: Section 6.1.1 was completed by ORAU Team Subject Expert Joe Guido, MJW Corporation. All conclusions drawn from the data presented were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in subsequent sections of this document related to available uranium data are explained in the associated text.

Throughout the evaluation period, the Y-12 Plant monitored workers for exposure to uranium through both *in-vivo* (lung counting) and *in-vitro* (urinalysis) methods (ORAUT-TKBS-0014-5). The Y-12 Radiation Safety Manual instructions for frequency of urine monitoring stated:

> *Sample at the frequency necessary to assure, with at least 95% confidence, that 95% of the individuals in a department have a quarterly average below the plant action limit* (McLendon 1963).

Urinalysis sampling frequency was reviewed monthly and adjusted semiannually. Through 1990, lung counting was performed using a sodium iodide (NaI) scintillation detector system; thereafter, a high-purity germanium (HPGe) detector system was used. Samples were analyzed by either fluorometry or alpha-counting (after electro-deposition), depending on the enrichment of material to which the individual was exposed.

NIOSH has uranium urine and lung data through 1988 from the CER datasets described in Section 4.8. Table 6-1 below provides a summary of the data available from the CER. Note that the percentage-monitored data in Table 6-1 was determined by dividing the number of individuals monitored for each urine sampling and lung counting by the number of individuals monitored by external dosimetry (see Table 6-4). For the 1977-1988 time period, the number of individuals monitored for external dose is an approximation of the number of individuals working on the site based on the high frequency of external monitoring data observed for NOCTS claimants (for the period from 1977 through 1988, 91% of NOCTS claimants have external monitoring). Urine and lung-counting data are available for individual claimants within NOCTS with approximately 47% of claimants having internal monitoring data (see Section 4.4).

Table 6-1: Summary of Available CER Data

Year	No. of Urine Samples	No. of Individuals Monitored by Urine Sampling	Percent of Individuals Monitored by Urine Sampling	No. of Lung Count Measurements*	No. of Individuals Monitored by Lung Counting* **	Percent of Individuals Monitored by Lung Counting*
1977	3475	664	12%	1411	1061	20%
1978	3409	689	12%	1512	1173	21%
1979	3504	840	14%	1794	1362	23%
1980	3985	952	15%	1798	1366	22%
1981	4842	1004	16%	2091	1588	26%
1982	5836	1211	18%	3051	2264	33%
1983	5504	1313	19%	3149	2471	35%
1984	6389	1356	19%	3087	2350	33%
1985	6265	1296	17%	2960	2216	28%
1986	6629	1125	15%	2430	1674	23%
1987	6164	1043	15%	2131	1709	24%
1988	5559	1359	19%	3028	2130	29%
Total	**61561**	**3675**	**30%**	**28442**	**4801**	**40%**

* Cited value is for all lung counts performed (i.e., not limited to U).

** NOTE: The values in Columns 3 and 6 represent the number of unique individuals monitored during each specific year. The Total value in the last record in Column 6 does not represent the sum of the values in that column. It represents the actual number of unique individuals monitored from 1977-1988.

ORAUT obtained a set of lung count data in the form of a spreadsheet from Y-12 Internal Dosimetry department from its electronic record keeping system (Lung Count Spreadsheet, 1984–1995) (see Section 4.7). Table 6-2 summarizes the total number of uranium-related measurements by year. NIOSH was able to use the 'analysis type' (see Table 6-2) provided in the spreadsheet to identify uranium-related counts. There are 23,708 data points for uranium-related measurements for 4,652 individuals available between 1977 and 1986.

Table 6-2: Type Analysis Chart

Type Analysis	Elements Reported*	Description**
0	None	Background Runs
1	Enriched Uranium, Potassium, Cesium	U-235
3	Lead, Actinium, Potassium, Cesium	Thorium
4	Total Uranium, Potassium, Cesium	U-238 and U-235
6	Enriched Uranium, Lead, Actinium, Potassium, Cesium	Thorium and U-235
7	Enriched Uranium, Total Uranium, Lead, Actinium, Potassium, Cesium, Technetium	U-235 and Thorium

* "Elements Reported" column data from Batte, 1983

** "Description" column data from Detail File Layout, undated

Table 6-3: Uranium-related Records 1977-1986

Year	No. of Individuals*	No. of Uranium-related Measurements
1977	1075	1431
1978	1176	1512
1979	1370	1808
1980	1368	1799
1981	1684	2252
1982	2284	3152
1983	2513	3227
1984	2397	3139
1985	2217	2960
1986	1672	2428
Grand Total	**4652**	**23708**

* NOTE: The values in Column 2 represent the number of unique individuals with U-related measurements during each specific year. The Grand Total value in the last record in Column 2 does not represent the sum of the values in that column. It represents the actual number of unique individuals with U-related measurements from 1977-1988.

6.1.2 Available Thorium Data

ATTRIBUTION: Section 6.1.2 was completed by ORAU Team Subject Expert Joe Guido, MJW Corporation. All conclusions drawn from the data presented were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in subsequent sections of this document related to available thorium data are explained in the associated text.

Thorium-related lung count data are available from several data sources representing different parts of the evaluation period (January 1, 1977 through December 31, 1994). These measurements were performed at the Y-12 *in-vivo* counting facility using a NaI-based detector system. The available thorium-related lung count data sources include:

- Thorium lung-count data from 1958 through 1982 from a Y-12 spreadsheet (Thorium Lung Counts, 2005). There are 518 thorium lung counts from 1979 through 1982 in mass units (i.e., mg).

- Ac-228 and Pb-212 data associated with analysis sequence codes 3, 6, and 7 (which included thorium, as indicated in Table 6-2 above) performed from 1979-1986 and contained in the excerpt file from the Y-12 electronic records system (described in Section 4.7). There are 1007 counts with Ac-228 and Pb-212 results in activity units (i.e. nCi) for 808 individuals.

- Between 1979 and 1982, monitoring data for thorium are available in NOCTS claimant files and are reported as ‘Th’ in units of ‘mg’. These files do not contain data specific to “Th” between 1982 and 1986. Figure 6-1 shows the number of thorium counts available for each year (documented in mg units) from 1979 through 1982, the number of Ac-228/Pb-212 counts (documented in nCi) through 1986, and the number of thorium counts contained within a collection of NOCTS files for Y-12 claimants. Note that for the purpose of the chart, all

Ac-228/Pb-212 measurements were used (not just the ones assigned as Types 3, 6, and 7). This was done so that an accurate comparison can be made between the Ac-228/Pb-212 dataset and the Th(mg) dataset since the Th(mg) dataset did not contain the analysis type field. The large discrepancy between the Ac-228/Pb-212 dataset and the Th(mg) dataset in 1979 is due to the fact that the Ac-228/Pb-212 dataset only covers August – December of that year. For the NOCTS dataset, thorium lung-count data from all available Y-12 claims were compiled up to NOCTS claim number 48453, comprising 2105 individual claims (NIOSH, 2018, PDF p. 25).

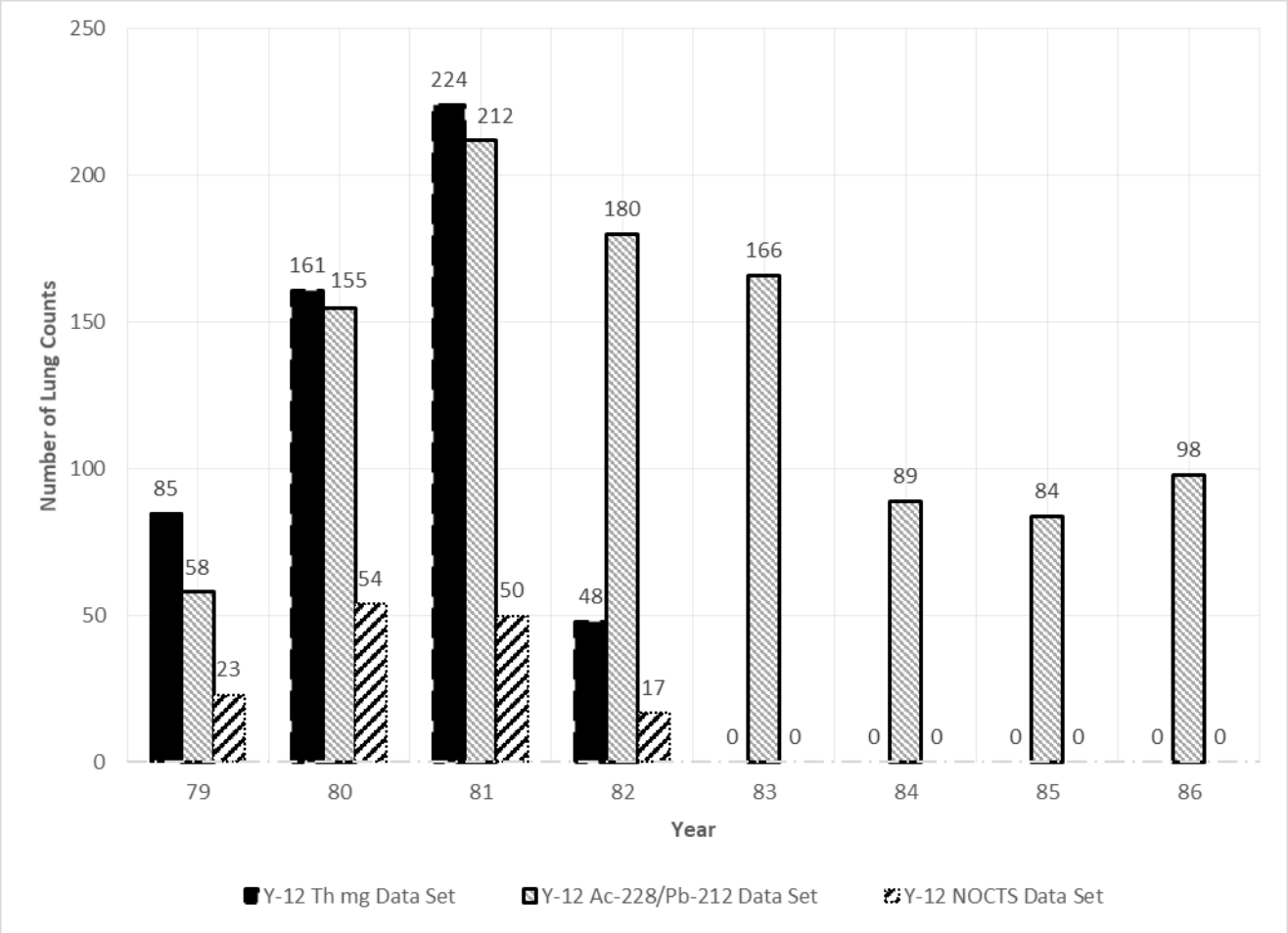


Figure 6-1: Thorium Lung Count Measurements

NIOSH cannot use source term data to determine internal exposures because such data are not available to NIOSH (NIOSH, 2018, PDF pp. 31-33).

NIOSH continues to work with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212) that may allow NIOSH to estimate the maximum internal potential exposure from thorium to members of the evaluated class during the period from January 1, 1987 through December 31, 1994. Therefore, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

Available Thorium-related Air Sampling Data

NIOSH received a spreadsheet from Y-12 (Thorium Air Samples, 1960-76) containing the results (in dpm/m^3) of 79,997 air samples specific to thorium operations that span the period from 1960 through 1976. These air sample results appear to have been fixed sample locations based on the presence of assigned location IDs with each result (NIOSH, 2018, PDF p. 22).

6.2 Available Y-12 Plant External Monitoring Data

NIOSH has access to the photon, beta, and neutron external dosimetry results, as well as other supporting data representing Y-12 site operations throughout the time period under evaluation in this report (January 1, 1977 through December 31, 1994). Details regarding the various analyses used, and the associated minimum detectable doses, are presented in ORAUT-TKBS-0014-6. In addition, NIOSH has external dosimetry data through 1988 from the CER datasets described in Section 4.8. Table 6-4 below provides a summary of the data available from CER.

Table 6-4: Summary of Available CER (External Dose) Data

Year	No. of External Dose Measurements	No. of Individuals Monitored for External Dose
1977	19757	5361
1978	20162	5573
1979	21239	5964
1980	16877	6156
1981	8049	6157
1982	8855	6779
1983	8638	7074
1984	8895	7185
1985	9599	7797
1986	9318	7345
1987	8132	7173
1988	8757	7317
Total	**148278**	**12058**

* NOTE: The values in Column 3 represent the number of unique individuals monitored during each specific year. The Total value in the last record in Column 3 does not represent the sum of the values in that column. It represents the actual number of unique individuals monitored from 1977-1988.

To assess potential external dose to unmonitored employees, NIOSH developed a co-worker dose distribution model, ORAUT-OTIB-0064, using the external dose data contained in CER. Summaries of the monitoring techniques and typical exchange frequencies for the various personnel dosimeters used at the Y-12 Plant during different periods of time are provided in ORAUT-TKBS-0014-06.

Detailed information on external monitoring provided by ORNL X-10 (which would be applicable to individuals working at Isotopes facilities on the Y-12 campus) is presented in the Technical Basis Document for the ORNL Site - Occupational External Dose (ORAUT-TKBS-0012-6) and External Coworker Dosimetry Data for the X-10 Site (ORAUT-OTIB-0021).

Details regarding the various analyses used and the associated minimum detectable doses are presented in the Technical Basis Document for the Y-12 Plant-Occupational External Dose (ORAUT-TKBS-0014-6).

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination/s 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 ensure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 3.2. 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-00250 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Y-12 Plant 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.

In addition, as part of evaluating the pedigree and sufficiency of Y-12 internal and external monitoring data, NIOSH evaluated the following:

- The overall suitability of Y-12's internal and external monitoring program
- Internal and external exposure sources and exposure potential of the workforce
- Internal and external exposure monitoring data availability and quality
- Internal and external reviews and assessments of Y-12 monitoring data
- Doses assigned by Y-12

With the exception of a current need to retrieve thorium lung-count data for the period from January 1, 1987 through December 31, 1994, NIOSH's evaluation concludes that data of sufficient quality, credibility, reliability, and representativeness are available to reconstruct Y-12 occupational exposures from August 1, 1979 through December 31, 1986. Y-12's radiological source terms and monitoring program were well-documented during the period under evaluation and the relevant documents have been extensively captured and reviewed for appropriateness. In addition, much of the available internal and external monitoring data are available as original results or images of original results and, as such, can be considered "primary" data sources. Available electronic datasets, though not always true primary data, have undergone extensive QA/QC and verification processes by other organizations such as the Oak Ridge Associated Universities' (ORAU) Center for Epidemiological Research group.

7.1.1 Internal Monitoring Data Pedigree Review

The following paragraphs briefly summarize the pedigree determinations (and conclusions regarding sufficiency for dose reconstruction) of several types of internal monitoring data captured or made available to NIOSH over the course of this evaluation. Additional details regarding these data can be found in Section 6.1.

Y-12 urinalysis data for the period under evaluation are available to NIOSH from multiple data sources, including NOCTS and ORAU's CER database for uranium (see Section 6.1). There is a sufficient quantity of good pedigree data for uranium analysis using ORAU CER data for the evaluated period up through 1988. This is evidenced in the co-worker analysis presented in Appendix B of ORAUT-TKBS-0014-05 and within ORAUT-OTIB-0075-01. This dataset was developed by the ORAU Center for Epidemiologic Research for use in epidemiology studies (Watkins, 1993) and has undergone detailed verification of its integrity. This same data source was used for uranium analysis for the SEC-00028 Y-12 evaluation report (NIOSH, 2006) and it is of sufficient pedigree to bound uranium doses for this evaluation (SEC-00250).

NIOSH has determined that the available *in-vivo* monitoring data for thorium (i.e., lung counts) are insufficient to bound doses for the proposed class during the period from January 1, 1977 through July 31, 1979. This is due to these lung-count data being reported in terms of mg of thorium versus the required Pb-212 and Ac-228 activity. As such, NIOSH does not have the ability to use these lung-count data to determine the associated exposures to thorium-232, thorium-228, and radium-228 with sufficient accuracy during this specific period; i.e., the current infeasibility for thorium is not a data pedigree issue.

For the period starting in August 1979, NIOSH has obtained a useful set of lung-count data from the Y-12 Internal Dosimetry Department's electronic record-keeping system. Within this dataset, there are 1007 thorium-related measurements of Ac-228 and Pb-212 by year available for 512 individuals from August 1979 through December 31, 1986. These data have been determined to be of sufficient pedigree to be used for bounding internal thorium doses from August 1, 1979 through December 31, 1986.

7.1.2 External Monitoring Data Pedigree Review

The following paragraphs briefly summarize the pedigree (and conclusions regarding sufficiency for dose reconstruction) of external monitoring datasets captured or made available to NIOSH over the course of this evaluation. Details regarding these data, such as monitoring devices used, analyses performed, data sources, and the quantity of available data can be found in Section 6.2 of this report and in ORAUT-TKBS-014-6.

There are sufficient high-quality external dosimetry data available to NIOSH for reconstructing doses for the class under evaluation. These data exist as primary data records or images of primary data and/or reside in electronic databases that have undergone quality control verification processes. The volume of data results from nearly all workers having been monitored for external exposures annually (at least) during the evaluation period (January 1, 1977 through December 31, 1994). Workers identified as having greater external exposure potential were monitored quarterly (West, 1993; Souleyrette, 2003, PDF p. 5). The frequency and availability of Y-12 external monitoring data are further evidenced via EEOICPA claims-processing results. As shown in Table 4-1, of the 3,615 claimants who worked within the SEC-00250 evaluation timeframe, external dosimetry records have been supplied for 3,267 of these workers (90%).

NIOSH has also captured information indicating that the external exposure data were obtained from badges with known and sufficient performance characteristics. Furthermore, the badges were calibrated using sources appropriate for the radiation fields likely to exist at the site during the evaluation timeframe (ORAUT-TKBS-014-6).

Based on NIOSH's assessment of the Y-12 external dosimetry program, the results of its extensive data capture efforts, document reviews, and interviews with Y-12 personnel, NIOSH concludes that Y-12's external monitoring data pedigree is sufficient to support bounding all potential external doses for the class under evaluation (January 1, 1977 through December 31, 1994).

7.2 Evaluation of Bounding Internal Radiation Doses at Y-12 Plant

The principal source of internal radiation doses for members of the class under evaluation was airborne uranium or thorium particulate material. The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding Process-Related Internal Doses

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

7.2.1.1 Urinalysis Information and Available Data

Urinalysis data for uranium are available to NIOSH for the period under evaluation (January 1, 1977 through December 31, 1994) from NOCTS and from ORAU's CER database. Based on information in the CER database, monitoring data are available from 61,561 uranium urine samples collected between 1977 and 1988; approximately 30% of the site population was monitored for uranium intakes by urinalysis each year during this period (see Table 6-1). The ORAU CER database was used by the ORAUT to develop a co-worker model that covers the period 1976 through 1988.

No urinalysis data are available specific to thorium.

7.2.1.2 Lung Counting Information and Available Data

Lung counting data for uranium are available to NIOSH for the entire period under evaluation (January 1, 1977 through December 31, 1994) from the Y-12 dosimetry database extract (as described in Section 4.7), from NOCTS, and from ORAU's CER database.

NIOSH was able to use the 'analysis type' (as shown in Table 6-2) provided in the spreadsheet containing lung-count data to identify Pb-212 and Ac-228 results within thorium-related lung counts (e.g., analysis types 3, 6, and 7) (Lung Count Spreadsheet, 1984–1995). The total number of thorium-related measurements of Ac-228 and Pb-212 by year is summarized below in Table 7-1. One thousand-seven (1007) data points for thorium counts containing Pb-212 and Ac-228 data are available for the time period between August 1979 and December 1986.

Table 7-1: Thorium Records 1979-1986

Year	No. of Individuals**	No. of Ac/Pb Measurements Used in Analysis
1979*	43	55
1980	110	128
1981	142	208
1982	83	179
1983	130	166
1984	87	89
1985	83	84
1986	95	98
Grand Total	**512**	**1007**

* Data starts in August 1979

** NOTE: The values in Column 2 represent the number of unique individuals monitored during each specific year. The Total value in the last record in Column 2 does not represent the sum of the values in that column. It represents the actual number of unique individuals monitored from 1979-1986.

NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212).

Thorium lung-count data are also available for the period 1977 through 1982. These data were received directly from Y-12 in spreadsheet form (Thorium Lung Counts, 2005). There are 772 thorium lung counts from 1977 through 1982. All of these data are reported as total thorium in units of mass (mg).

7.2.1.3 Airborne Levels

NIOSH reviewed the available site information describing process activities conducted during the period under evaluation. The air-monitoring program in-place during that time period emphasized sample collection in those process areas with higher potential for airborne contamination. In addition to general area airborne uranium concentration levels, there are data available from job-specific breathing-zone air-sampling events.

Air-sampling data specific to thorium for the period under evaluation (January 1, 1977 through December 31, 1994) are not available to NIOSH.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

For workers who were monitored with the *in-vitro* or *in-vivo* bioassay program at Y-12, any ambient environmental exposures would have been accumulated with the occupational exposures.

The Occupational Environmental Dose TBD (ORAUT-TKBS-0014-4) applies to workers who were not monitored for external or internal radiation exposure. The environmental internal dose is that which workers could have received from inhalation of radioactive materials while being outdoors on the Y-12 plant site during or shortly after airborne releases.

The Occupational Environmental Dose TBD provides a table of annual average airborne concentration and intake data for U-234/235 and U-238. An empirical relationship was developed using on-site measured air concentrations and estimated uranium release estimates. This approach circumvents the need for air-dispersion modeling by providing a direct relationship between uranium air concentrations and uranium releases (ORAUT-TKBS-0014-4, PDF p. 19). The intake values that can be used for bounding dose estimates are presented in Table D-6, "Maximum Uranium-234/235 and Uranium-238 Air Concentrations and Intakes". This information should be sufficient to allow bounding of ambient environmental internal dose for all members of the class who were not monitored with internal radiation dosimetry (ORAUT-TKBS-0014-4).

7.2.3 Methods for Bounding Internal Dose at the Y-12 Plant

The following subsections summarize the methods for bounding internal dose from uranium and thorium at Y-12.

Principal sources of internal radiation for members of the evaluated class include inhalation and ingestion during processing operations related to uranium, thorium (and progeny), and calutron-cyclotron-related radioisotopes. Based on the evaluation documented in ORAUT-RPRT-0090, *Monitoring Feasibility Evaluation for Exotic Radionuclides Produced by the Oak Ridge National Laboratory Isotopes Division*, the ORNL X-10 monitoring program encompassed the wide range of radionuclides that were produced by the Isotopes Group, including those produced and handled at the Isotopes facilities located on the Y-12 campus.

7.2.3.1 Methods for Analyzing Uranium Bioassay Data

For the evaluation period from January 1, 1977 through December 31, 1994, based on a review of DOE-provided records for claims and records in repositories such as the ORAU CER database (described in Section 6.1), uranium-monitoring data are available. The methodologies to interpret the available monitoring data for use in dose reconstruction are contained in ORAUT-TKBS-0014-5. In addition, a co-worker study (also documented in ORAUT-TKBS-0014-5) is available for NIOSH to evaluate uranium intakes to unmonitored workers between 1977 and 1988.

The data presented in ORAUT-TKBS-0014-5 indicate a downward trend in intake quantities over time. This is consistent with the summary of uranium urinalysis data for 1987-1992 presented in the Quarterly Plant Health Physics Report for fourth-quarter 1992, which indicates a downward trend in the number of individuals exceeding the site administrative control level for uranium (Hunt, 1992). Therefore, NIOSH can use the co-worker data provided in ORAUT-TKBS-0014-5 to provide a bounding estimate of uranium intake for unmonitored individuals from 1989 through 1994.

7.2.3.2 Methods for Analyzing Thorium Bioassay Data

Prior to August 1979, NIOSH confirmed that the available thorium-monitoring data are presented in mass units of total thorium. As discussed in the SEC-00251 evaluation report (NIOSH, 2018), NIOSH does not have the necessary information to employ these data for reconstructing internal dose to Th-228, Th-232, and Ra-228. For this reason, these data were not used in this current evaluation report.

Thorium-related doses from August 1979 through December 1986 can be bounded using the lung-count data retrieved from the Y-12 Electronic Records System, as illustrated in Table 7-1. The Ac-228 and Pb-212 data are used, as indicated in ORAUT-OTIB-0076, *Guiding Reconstruction of Intakes of Thorium Resulting from Nuclear Weapons Programs.*" In summary, intakes of thorium are evaluated using chest counts and DCAL (Dose and Risk Calculation) software computational methods to account for disequilibrium and independent kinetics. In addition, NIOSH uses methods (i.e., Integrated Modules for Bioassay Analysis [IMBA]) to make conservative assumptions when bounding doses. The assumptions include:

- Pb-212 and/or Ac-228 activities can be established.
- A two-separation thorium production process operated at Y-12 (Personal Communication, 2018e); however, since the thorium may have been separated once before Y-12 received the thorium, three separations will be assumed (this is more claimant-friendly).
- Independent kinetics are considered when necessary. For example, when thorium decays to radium, the kinetics are not shared but based on biokinetic differences because they are different elements. However, when thorium decays to other progeny, the kinetics are shared or assumed the same.

Generally, Ac-228 activity can be used to calculate the Ra-228 activity, and Pb-212 can be used to calculate the Th-228 activity, which can then be used to calculate the Th-232 activity. Alternatively, when Pb-212 activity data alone are available, a conservative estimate of Th-232 activity can be made.

Assuming Y-12's thorium underwent three separations, this means that Th-232 has a 0.19:1 Th-228-to-Th-232 ratio and that there are no significant changes to the mixture over time, and that the thorium mixtures did not initially contain Ra-228 (ORAUT-OTIB-0076, PDF pp. 12-13). NIOSH determined that the maximum Pb and Ac result in the Y-12 dataset were 0.7 nCi for Pb-212 and 0.66 nCi for Ac-228, which could be used in bounding or maximum-dose calculations.

As indicated in Section 6.2, NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212). NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH has determined that *in-vivo* monitoring data for thorium (i.e., lung counts) are insufficient to support reconstructing internal doses for the January 1, 1977 through July 31, 1979 portion of the evaluated class.

NIOSH has determined that there are sufficient activity-based Pb-212 and Ac-228 *in-vivo* monitoring data to allow NIOSH to determine the associated intakes of thorium-232, thorium-228, and radium-228 with sufficient accuracy for the period from August 1, 1979 through December 31, 1986.

NIOSH has determined that there are sufficient *in-vivo* and *in-vitro* monitoring data for uranium (i.e., lung counts and urinalysis) during the period from January 1, 1977 through December 31, 1994 to allow NIOSH to determine the potential intakes of uranium with sufficient accuracy.

NIOSH has determined that there are currently sufficient calutron-cyclotron-related radioisotope data to estimate the maximum internal potential exposure to members of the evaluated class during the period from January 1, 1977 through December 31, 1994 for Isotopes Group workers on the Y-12 campus based on the evaluation contained in ORAUT-RPRT-0090.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Y-12 during the period from January 1, 1977 through July 31, 1979, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at Y-12 Plant

The principal sources of external radiation doses for members of the evaluated class were uranium, thorium, calutron, and cyclotron operations (NIOSH, 2006).

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 Process-Related External Doses

NIOSH has access to the photon, beta, and neutron external dosimetry results, as well as other supporting data representing Y-12 site operations throughout the time period under evaluation in this report. Details regarding the various analyses used, and the associated minimum detectable doses, are presented in ORAUT-TKBS-0014-6.

Photon

The external dosimetry data are sufficient to perform bounding dose reconstructions for photon exposures from all external gamma and X-ray sources that were present at Y-12 for all workers in the evaluated class. External radiation exposure data have been provided for claimants employed during the entire period under evaluation. In addition, the NIOSH has developed a co-worker study based on Y-12 external monitoring data (ORAUT-OTIB-0064).

Beta

The external dosimetry data are sufficient to perform bounding dose reconstructions for beta exposures from all sources that were present at Y-12 for all workers in the evaluated class. External radiation exposure data have been provided for claimants employed during the entire period under evaluation. In addition, the NIOSH has developed a co-worker study based on Y-12 external monitoring data (ORAUT-OTIB-0064).

Records of the external radiation dose to the extremities (hands and forearms) are also available for some individual workers who handled uranium metals. The so-called extremity personnel monitors for a worker's hands consisted of finger rings containing photographic film from 1952 to 1980, and finger rings or wristbands containing thermoluminescent dosimeter (TLD) chips after 1980 (ORAUT-TKBS-0014-6, PDF, p. 12).

Neutron

The external dosimetry data are sufficient to perform bounding dose reconstructions for neutron exposures from all sources that were present at Y-12 for all workers in the evaluated class. Neutron exposures have been monitored at Y-12 since 1961 and continued for the duration of the period under evaluation, with the resulting data available in personnel files. During the period from January 1, 1977 through December 31, 1994, there were three Y-12 buildings where the majority of neutron-emitters were present: the Calibration Laboratory in Building 9983, the Nondestructive Analysis Laboratory in Building 9720-5, and the Enriched Uranium Storage Areas in Building 9212 (ORAUT-TKBS-0014-6, PDF p. 42). Radiation dosimetry was required for all workers entering such areas. If there is a need to estimate neutron exposures for an unmonitored worker, ORAUT-TKBS-0014-6 provides a protocol.

A review of DOE-provided records for claims confirms that monitoring records have been present in employee files The missed dose and bias/uncertainty factors derived in ORAUT-TKBS-0014-6 should be applied. With these adjustments, the available data are sufficient to establish a bounding neutron dose estimate for the entire class under evaluation.

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

Ambient external environmental monitoring data are available for the period from 1959 to beyond the end of the period under evaluation. NIOSH determined that the results of the 1987 outdoor scoping survey could be used for estimating external exposures for all years from 1948 to 2002. For this analysis, the highest exposure reading from either the scan or the direct measurement presented in the scoping survey was used. This approach presented the most conservative method of estimating exposures and ensures that areas of high exposure levels within each grid were included in the site-wide average. An evaluation of the ambient external radiation exposures is discussed in Section 4.5.4 of ORAUT-TKBS-0014-4. The values provided in Table 4.4.4-1 of ORAUT-TKBS-0014-4 are sufficiently bounding for occupational exposures and could be used for unmonitored workers. However, the availability of personnel monitoring data obviates the need for area monitoring data as a substitute (ORAUT-TKBS-0014-4).

7.3.3 Y-12 Plant Occupational X-Ray Examinations

Y-12 medical X-rays were provided by the Y-12 Medical X-ray Department since February 1945 and therefore covered the SEC-00250 period under evaluation, January 1, 1977 through December 31, 1994. The medical practices used at Y-12 are assumed to have followed the adoption of standards of radiology practice to minimize dose to the patient as technology improved. The type of medical X-ray equipment used, the frequency of X-rays (annual or less) by department, and techniques employed for all relevant projections and organ radiation doses over the Y-12 plant history are presented in ORAUT-TKBS-0014-3. Consistent with prior NIOSH evaluations, NIOSH concludes that it is feasible to reconstruct the occupational medical dose for Y-12 employees with sufficient accuracy during the period under evaluation.

7.3.4 Methods for Bounding External Dose at Y-12 Plant

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

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

7.3.4.1 Methods for Bounding Operational Period External Dose

NOTE: For individuals within the Isotopes Group working on the Y-12 campus, whose external dosimetry was provided by ORNL X-10, external dosimetry results are available in the form of primary documentation and summary reports for both photon and beta exposure for individual workers. These data are relevant to a portion of the class under evaluation from January 1, 1977 until the end of Isotopes Group operations on December 31, 1983 (See Section 5.1.3).

Photon Dose

The primary method for reconstructing photon dose is the use of individual records. Badge-reading frequencies and thresholds of detection are known and documented. Methods are available for interpretation and adjustment of individual dosimetry data as needed (ORAUT-TKBS-0014-6; ORAUT-OTIB-0045; ORAUT-OTIB-0074).

Beta Dose

The primary method for reconstructing beta dose is the use of individual records. Methods are available for interpretation and adjustment of individual dosimetry data as needed (ORAUT-TKBS-0014-6; ORAUT-OTIB-0046).

Neutron Dose

The primary method for reconstructing neutron dose is the use of individual records. Badge-reading frequencies and thresholds of detection are known and documented. Methods are available for interpretation and adjustment of individual dosimetry data as needed (ORAUT-TKBS-0014-6; ORAUT-OTIB-0045; ORAUT-OTIB-0051).

Medical X-ray Dose

Occupational medical exposures to X-rays, when such screening X-rays are a condition of employment, are also included in EEOICPA dose reconstructions. During this time period, individuals at the Y-12 Site were required to have pre-employment, annual, and termination chest X-ray examinations. The Y-12 Occupational Medical Dose TBD (ORAUT-TKBS-0014-3) documents the method and feasibility of reconstructing these medical exposures.

7.3.4.2 Methods for Bounding Ambient Environmental External Doses

The bounding analysis uses the highest exposure reading from either the scan or the direct measurement presented in the scoping survey. This approach presented the most conservative method of estimating exposures and ensures that areas of high exposure levels within each grid were included in the site-wide average. An evaluation of the ambient external radiation exposures is discussed in Section 4.5.4 of ORAUT-TKBS-0014-4. The values provided in Table 4.4.4-1 of ORAUT-TKBS-0014-4 are sufficiently bounding for occupational exposures and could be used for unmonitored workers. However, the availability of personnel monitoring data obviates the need for area monitoring data as a substitute (ORAUT-TKBS-0014-4).

7.3.5 External Dose Reconstruction Feasibility Conclusion

The data sources for photon, beta, and neutron doses, as well as occupational medical X-ray examinations and ambient environmental external doses, have been examined and found to be adequate for bounding EEOICPA external doses for monitored Y-12 workers for the entire period under evaluation; this includes those working at the Isotopes Group facilities managed by ORNL X-10 but located on the Y-12 campus.

The assessment of doses for unmonitored workers can be determined from the ambient environmental external dose methods defined in ORAUT-TKBS-0014-4. Based on NIOSH's assessment of the available external data and the dose calculation methods available in ORAUT-TKBS-0014-4, NIOSH

concludes that it is feasible to bound external dose with sufficient accuracy for all monitored and unmonitored members of the evaluated class from January 1, 1977 through December 31, 1994.

7.4 Evaluation of Petition Basis for SEC-00250

NIOSH did not find support for qualifying petition SEC-00250 for evaluation under any of the identified bases for work related to uranium. NIOSH did find support for qualifying petition SEC-00250 for evaluation under basis F.4., based on statements made in the SEC-00251 Y-12 evaluation report related to thorium. The following subsections evaluate the assertions made on behalf of petition SEC-00250 for the Y-12 Plant.

7.4.1 Uranium and Thorium Contamination Existed in the Machine Shop

Issue: The petitioner submitted *Additional Supporting Document re contaminated machines* (Contaminated Machines, 2012).

Response: The cited document indicates that uranium and thorium contamination existed in the machine shop and that Y-12 workers handled thorium and uranium in the machining areas in 2012. While the source of the contamination detected in 2012 was not discussed in this document, it can be reasonably assumed to have been present throughout the period evaluated in this report (January 1, 1977 through December 31, 1994). This report concludes that the reconstruction of internal dose from uranium is feasible during the entire evaluated period. Conclusions related to thorium are presented in this report for the period from January 1, 1977 through December 31, 1986. Evaluation of the period from 1987 through 1994 is currently reserved and will be addressed in the future. The justification of ending the evaluation period in December 31, 1994 is discussed in section 5.1.2.

7.4.2 Petition Basis E.5. - Four Statements of Concern

Issue: The petitioner included statements in the petition regarding potential issues in support of the E.5 petition basis: *The petition is based on one or more unmonitored, unrecorded, or inadequately monitored or recorded exposure incidents.* The statements are:

1. *Y-12 Plant did not monitor for internal dose before 1980.*

2. *Y-12 Plant incorrectly assumed that all uranium exposure involved soluble uranium when enriched uranium exposures involved insoluble uranium.*

3. *Workers exposed to uranium prior to the shutdown would not have routine fecal samples taken.*

4. *The presence of fecal sample results in an individual's monitoring records is a strong indicator that the worker was exposed to insoluble uranium compounds. This is incorrect.*

Response:

1. NIOSH has many claims-related documents that indicate Y-12 did monitor for internal exposure before 1980. Details are listed in the technical basis document for Y-12 (ORAUT-TKBS-14-5).

2. The *Y-12 Uranium Exposure Study* indicated that the insoluble uranium environment likely developed after the stand-down in 1994 and during the Y-12's D&D phase (Eckerman, 1999).

During the EEIOCPA dose reconstruction process, all possible uranium solubility forms are considered, as stipulated in claimant dose-reconstruction reports. As shown in the excerpt below, which is typical, no internal dosimetry data were available; therefore, the dose from co-workers who were monitored was employed with all solubility types being assessed.

> *Internal dose monitoring records were not provided for the claimant. Since the claimant was not monitored for internal intakes during his employment at the Y-12 Plant, Y-12 coworker intakes were assigned based on the Technical Basis Document for the Y-12 National Security Complex Occupational Internal Dose. A review of the telephone interview indicated that the claimant worked at various areas throughout the Y-12 Plant where he performed duties as an* [job title redacted] *and* [job title redacted]. *Therefore, it is reasonable to apply coworker data for the claimant because no other information is available. Solubility Type F, Type M, and Type S uranium-234 were evaluated using the 95th percentile intake rates; the Type S uranium provided the highest doses and was used for the dose estimate. Associated radionuclides, including neptunium-237, plutonium-239, thorium-228, and technetium-99, were added in accordance with the Technical Basis Document for the Y-12 National Security Complex – Occupational Internal Dose.*

3. It is true that prior to the Y-12 stand-down (September 1994 through August 1998), routine fecal samples were not required. However, routine urinalysis and chest counts occurred throughout the period covered by this petition. Before the shutdown, fecal sampling was used on a non-routine basis and had been since the early 1960s. During the 1960s, fecal, urine, and *in-vivo* measurements were used jointly to investigate the clearance of less-soluble forms of uranium. Fecal sampling was discontinued several times but was reinstated in 1998 due to changes in workplace exposure conditions (ORAUT-0014-05, PDF p. 31).

4. The statement, "The presence of fecal sample results in an individual's monitoring records is a strong indicator that the worker was exposed to insoluble uranium compounds," is considered true in cases before and after the 1994-1998 stand-down. This statement was taken out of context from ORAUT-TKBS-0014-5, which states:

> *If a worker entered an area that was determined to contain Type S material, fecal and urine bioassays were implemented. If the worker entered an area that contained a more soluble form of uranium, urine bioassay only was used to estimate intakes. Thus, the presence of fecal sample results in an individual's monitoring records is a strong indicator that the worker was exposed to insoluble uranium compounds.* (ORAUT-0014-05, PDF pp. 50-51)

7.4.3 Petition Basis F.1. - One Statement of Concern

Issue: The petitioner included a statement from a cover letter from a former Y-12 worker (Redacted Name3, 2018) that was written to accompany the petition in support of the F.1 petition basis, *Radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored either through personal monitoring or through area monitoring.* The cover letter author states, "Y-12 did not monitor for internal dose prior to 1990." The author then refers to the following footnotes from a Y-12 Plant Dosimetry Summary Report:

> *(a) Monitoring not required,*

(b) In accordance with regulations, internal dose and total dose were not calculated prior to 1989.

Response:

This statement and referenced document indicate that the worker in question was *not required* to be internally monitored for specified periods of work at Y-12. The document does not describe monitoring performed for any other member of the petitioner-proposed class.

7.4.4 Petition Basis F.2. - One Statement of Concern

Issue: The petitioner included a document in his petition, "Records Transmittal and Receipt Form, Document Accession Number Form," to support the F.2 petition basis, *Documents or statements provided by affidavit that indicate that radiation monitoring records for members of the proposed class have been lost, falsified, or destroyed; or that there is no information regarding monitoring, source, source term, or process from the site where the energy employees worked.*

To support this basis, the petitioner refers to the cited document, which expresses concerns with employment records, but does not refer to lost, falsified, or destroyed radiation monitoring records. The petitioner indicated that from the cited abstract for *Y-12 Uranium Exposure Study:*

> *Following the recent restart of operations at the Y-12 Plant, the Radiological Control Organization (RCO) observed that the enriched uranium exposures appeared to involve insoluble rather than soluble uranium that presumably characterized most earlier Y -12 operations. These observations necessitated changes in the bioassay program, particularly the need for routine fecal sampling* (Eckerman, 1999).

Response:

During the NIOSH dose reconstruction process for internally-exposed workers, all solubility types are evaluated, and the most claimant-favorable result is used. Although fecal analysis can aid in the analysis of soluble uranium, routine urinalysis and other monitoring methods can also establish exposure to insoluble uranium (See E.5 basis discussion above).

7.4.5 Petition Basis F.4. - One Document and Several Statements of Concern

Issue: The petitioner submitted a technical report to support basis F.4, *A scientific or technical report, issued by a government agency of the Executive Branch of Government or the General Accounting Office, the Nuclear Regulatory Commission, or the Defense Nuclear Facilities Safety Board, or published in a peer-reviewed journal, that identifies dosimetry and related information that are unavailable (due to either a lack of monitoring or the destruction or loss of records) for estimating the radiation doses of energy employees covered by the petition*

To support this basis, the petitioner submitted a technical report, the *Y-12 Uranium Exposure Study*, to support basis F.4. The petitioner also submitted statements by email that indicate his desire to submit qualifying information that would allow NIOSH to expand the current SEC class for Y-12, which is discussed in the SEC-00251 petition evaluation report. The petitioner has discussed and commented on the contents of the SEC-00251 petition evaluation report and asked questions about submitting additional information relevant to thorium dose reconstruction.

Response:

The submitted technical report, *Y-12 Uranium Exposure Study* (Eckerman, 1999), was written in response to an observation that urinary and fecal bioassay data accumulated in the 1990s were not consistent with the guidance in use at Y-12, which was International Commission on Radiological Protection (ICRP) 54. This report is authored by Oak Ridge National Laboratory (ORNL), which is not a government agency of the Executive Branch of Government or the General Accounting Office, the Nuclear Regulatory Commission, or the Defense Nuclear Facilities Safety Board, or published in a peer-reviewed journal, as required for an F.4 basis.

NIOSH does, however, consider the SEC-00251 evaluation report to be a scientific or technical report, issued by a government agency of the Executive Branch of Government, and therefore considers its own previous report for Y-12 as evidence as well.

In NIOSH's previous evaluation of SEC-00251, it proposed an SEC class due to inability to bound potential thorium exposures for all employees at Y-12 for the period 1956-1976. This was due to the nature of the thorium *in-vivo* lung count results, which were reported in terms of milligrams (mg) of thorium in the lung. Without additional counter and calibration data for thorium decay products (Ac-228 and Pb-212), these results cannot be used to calculate bounding doses for internal thorium exposure (NIOSH, 2018).

The SEC-00251 evaluation report indicated that isotopic-specific results (i.e., for Ac-228 and Pb-212) for thorium lung counts might be available starting in 1977. However, further evaluation of the data is required to verify this, as stated in SEC-00251: *NIOSH has not ascertained the availability of these data at this time; therefore, it will continue to evaluate the feasibility of internal dose reconstruction for thorium at the Y-12 site beginning January 1, 1977* (NIOSH, 2018).

Since NIOSH was aware of the additional need to evaluate thorium dose-reconstruction feasibility for the period after 1976, and because the expansion of the SEC class was a stated desire of the petitioner, NIOSH accepted that this petition should qualify under basis F.4.

Beginning in September 1994, the plant was placed in a stand-down mode. This effectively stopped all routine work (and chronic exposure potential) in the process areas. Consequently, NIOSH used this event to establish the end date of the class to be evaluated.

7.5 Summary of Feasibility Findings for Petition SEC-00250

This report evaluates the feasibility for completing dose reconstructions for employees at the Y-12 Plant from January 1, 1977 through December 31, 1994. NIOSH found that the available monitoring records, process descriptions, and source term data available are not sufficient to complete thorium internal dose reconstructions for the proposed class of employees from January 1, 1977 through July 31, 1979. Thorium dose reconstruction feasibility after December 31, 1986 is reserved and will be evaluated in the future once data become available.

Table 7-3 summarizes the results of the feasibility findings at Y-12 Plant for each exposure source during the following periods: January 1, 1977 through July 31, 1979; August 1, 1979 through December 31, 1986; and January 1, 1987 through December 31, 1994. These feasibility findings also apply to those working at the Isotopes Group facilities managed by ORNL X-10 but located on the Y-12 campus.

Table 7-2: Summary of Feasibility Findings for SEC-00250

Source of Exposure	January 1, 1977 through July 31, 1979 Reconstruction Feasible (Yes or No)	August 1, 1979 through December 31, 1986 Reconstruction Feasible (Yes or No)	January 1, 1987 through December 31, 1994 Reconstruction Feasible (Yes or No)
Internal (U)	Yes	Yes	Yes
Internal (Th)	No	Yes	Reserved[1]
Internal (calutron-cyclotron-related radioisotopes)	Yes	Yes[2]	NA[2]
External (Gamma, Beta, Neutron)	Yes	Yes[2]	Yes
Occupational Medical X-ray	Yes	Yes	Yes

[1] NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212). Therefore, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

[2] Isotopes Group calutron and cyclotron operations managed by ORNL X-10 but located on the Y-12 campus ended on December 31, 1983.

As of May 17, 2019, 3615 claims have been submitted to NIOSH for individuals who worked at Y-12 Plant during the period under evaluation in this report. Dose reconstructions have been completed for 3211 individuals (~89%).

Although NIOSH found it not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals who worked at the Y-12 Plant from January 1, 1977 through July 31, 1979, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00250

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 reviewed internal and external radiological monitoring data, various databases, technical basis documents, primary references, employee interviews, procedures, and activity reports to gain an understanding of the scope of the potential exposure scenarios during the period under evaluation. NIOSH's evaluation found that some employees that worked during the period from January 1, 1977 through July 31, 1979 may have accumulated chronic radiation exposures through intakes of thorium (and associated progeny). Consequently, NIOSH is specifying that health was endangered for those employees covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC. NIOSH's evaluation also determined that it is feasible to estimate the radiation dose for members of the NIOSH-evaluated class from August 1, 1979 through December 31, 1986 with sufficient accuracy based on the sum of information from available resources. Therefore, a health endangerment determination is not required for that section of the evaluated period.

9.0 Class Conclusion for Petition SEC-00250

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC is: all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Y-12 Plant in Oak Ridge, Tennessee, from January 1, 1977 through July 31, 1979.

Bounding dose calculations cannot be performed because the thorium lung-count data are not available in the appropriate form (i.e., activity units for Ac-228 and Pb-212). Thorium lung-count data in mass units are available; however, they cannot be used to estimate sufficiently accurate doses.

Bounding dose calculations can be performed from August 1, 1979 through December 31, 1986 because thorium lung-count data are available in the appropriate form (i.e., activity units for Ac-228 and Pb-212).

NIOSH is currently working with the Y-12 site to receive post-1986 activity-based thorium progeny data (i.e., Ac-228 and Pb-212) that may allow NIOSH to estimate the maximum internal potential exposure from thorium to members of the evaluated class during the period from January 1, 1987 through December 31, 1994. Therefore, NIOSH is reserving its evaluation of internal exposure from thorium for the period from January 1, 1987 through December 31, 1994 until activity-based thorium progeny data are available.

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-00250. 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 the Y-12 Plant

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Primary Site/Company Name: Y-12 Plant 1942-present, DOE Alternate Site Names: Y-12 National Security Complex Physical Size of the Site: 811 acres holding over 350 buildings. Site Population: In 1945, more than 22,000 workers at the site. During the Cold War 8,000 people worked around the clock. Noted 6,866 employees in June 1963 and 6,000 in 2011. In October 2018, Y-12 reported more than 4,700 federal and contractor employees work at the site.	Awaiting release of a Documented Communication from DOE Headquarters, whole body count records, and an external dosimetry flat file. Bioassay data, 86-inch cyclotron program and radiation protection, buildings and years where thorium was present, external exposure information, foundry health physics, handling and working with Np, in-vivo monitoring program and results, list of names and badge numbers, neutron field measurement, uranium air limits and their impact on Y-12, personnel notebooks, plant procedures, plutonium air problem, progress reports, radiation generating devices, radiation safety manual, radiological incidents, radiological surveys (airborne, contamination, etc.), record book of materials, run sheets from 86-inch cyclotron, separation of isotopes, neutron film results, sunflower foundry employees, thorium program lung count results, transuranic hazard assessment, uranium in effluent, urinalysis and fecal sample program related information, various technical basis documents, applying thorium surface contamination limits, internal dosimetry program, background subtraction and critical level for ET1 dosimeters, calibration factors, estimating the shallow dose equivalent using HBG element four readings, dosimetry quality control program information, building radiation and contamination periodic surveys, neutron-photon radiation surveys, container surveys for outgoing shipments, calibration and operation of the in-vivo lung counter, individual employee bioassay and film/TLD reports, plant health physics quarterly reports, thorium contamination survey results, thorium air sample results, air sampling system and locations, thorium fabrication, thorium machining, thorium processing, a process knowledge expert interview, data reduction software for in-vivo counting, dosimetry data with thorium in-vivo counts for a Y-12 employee, a 1964 Y-12 radiation safety manual, a whole body count column header key, and 1989-1995 whole body count data.	OPEN	804
State Contacted: NA	State was not contacted due to Y-12 being an active Department of Energy site.	NA	NA

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Albany Research Center	A 1950 report on the chemical properties of californium.	03/21/2013	2
Ames Laboratory	Ames histories, 1951-1953 radiation work permits, survey reports, and thorium shipments to other facilities.	01/25/2016	8
Argonne National Laboratory-East	Organization of National Nucleonic Program, personnel procedure for transferring to Y-12 in 1943, and plutonium scrap processing information.	04/02/2008	4
Battelle Laboratory-King Avenue	Thorium reports, a 1951 material balance report, and a nuclear battery report.	04/14/2011	5
Brookhaven National Laboratory	Ambient air monitoring parameters at DOE facilities and monthly reports.	10/22/2008	4
Cincinnati Public Library	A Manhattan Project History.	08/06/2008	1
Cincinnati Operations Center Library	Y-12 photographs and map key, urinalysis reports, an ORNL visitor guide, modifications to the ORNL Health Center, external exposure summaries 1989-1991, a DOELAP status report for the Centralized External Dosimetry System, a 1994 internal dosimetry review, the 1990 survey and characterization of Building 9201-2, a DOELAP reaccreditation application, the technical basis for augmenting the criticality alarm system, the air monitoring technical basis document, the DOE Office of Oversight Radiological Task Team reports, the survey and release protocol for wooden items, the implementing order for 10 CFR 835, and a survey and release plan for heavy equipment.	07/16/2018	16
Claimant Provided	Work products from inter-agency working groups and links between exposure to occupational hazards and illnesses in the DOE contractor workforce, an extrusion video, radon measurements, a site walking tour, a contamination survey and environmental report, a hearing before the workers' compensation board state of New York, and a Y-12 building directory.	05/10/2018	7
Colorado Mesa University	Recovery of uranium from carnotite ores, progress reports of carnotite studies, separation of uranium from urine, stack sampling, radiation emergencies, and new methods for interpreting neutron data from various dosimeter types.	10/16/2012	10
Curtiss-Wright	Shipping information and orders.	04/24/2009	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Department of Labor / Paragon	Background report and evaluation of resurvey requirements for the former Atomic Energy Commission portion of the Lake Ontario Ordinance Works (LOOW), request for scrap evaluation, shipment of Schenectady wastes to Oak Ridge, a complex-wide mixed waste report, a mercury waste management report, and a visit from Cotter Corporation personnel.	10/29/2014	12
DOE Albuquerque Complex NNSA	NURE activation analysis system correspondence.	01/13/2012	1
DOE Environmental Consolidated Business Center (EMCBC) - Denver	Rocky Flats thorium shipments to Y-12.	02/12/2014	1
DOE Environmental Information Center	Y-12's receipt of gold from the Paducah metals recovery program.	07/20/2011	1
DOE Environmental Measurements Laboratory	Air sampling for the control of internal exposure from enriched uranium at Y-12, a beryllium study, criticality alarms and accident dosimetry, and in-vivo counting as a device for evaluating uranium exposure.	01/21/2011	4
DOE Germantown	Beryllium history, waste disposal, monthly accountability reports, thorium information, site histories, Manhattan District History sections, records holding area search procedures, DOE reasonable search protocol spreadsheet, and a data tracking spreadsheet.	09/17/2015	19
DOE Legacy Management - Grand Junction Office	Accomplishments of the National Lead Company of Ohio, Electro Metallurgical weekly production report, requests for material transfers, storage/disposal requests, electromagnetic separation of isotopes at Oak Ridge, results of mobile gamma scanning activities, results of soil sample analysis, return of thorium from Savannah River programs, return of thorium from Davison Chemical, LOOW production report describing materials shipped to Y-12, budget reviews, an accidental radiation excursion at Y-12, a contractor list, and history of Hanford.	08/30/2011	51

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
DOE Legacy Management - Morgantown	Health and mortality studies of federal nuclear workers, uranium in urine samples, appraisal of occupational medical program, bioassay department highlights report, comparison of FMPC's uranium in urine sample results with Y-12's results, comprehensive epidemiologic data resource, DOE studies finding excess cancer mortality at several DOE nuclear facilities, disposal of thorium residues, Extrusion Plant (RMI) receipts and shipments, progress and production reports and orders, material balance report by facility, plutonium content of NLO feed materials, production order enriched uranium to Y-12, results of uranium urines, thorium shipments, thorium bioassay, recycled uranium data, trip reports, FUSRAP reports, environmental reports, uranium urine exchange program information, report of analysis, and TLD monitoring.	04/07/2016	164
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Air emissions annual report, annual report of the Health and Safety Division, Colonie site receipts of depleted uranium, DOE health and mortality study, environmental reports, Grand Junction processing of feed material scraps, incineration of radioactive solid wastes, major thorium campaigns and accountability documents, radioactive waste shipments, radiological incidents, shipping and receipt documents for enriched uranium and thorium, thorium bioassay investigations, thorium derby metal for Y-12, thorium nitrate specifications, trip reports, and Y-12 Plant thorium powder or pellet procurement specifications.	02/01/2012	83
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database) / Albany Research Center	The 1958 symposium on uranium industry occupational health experiences.	09/30/2003	1
DOE Legacy Management - Westminster	Complex-wide external dosimetry technical basis document, plutonium/actinide recovery history, lifetime dose calculations from systemic burden and lung count data, technical services quarterly report, Elza Gate bioassays sampling logs, and reports of analysis.	01/14/2016	5
DOE Nuclear Materials Management and Safeguards System (NMMSS)	Material transfers between Y-12 and Rocky Flats.	07/10/2013	2

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
DOE Oak Ridge Operations	Material accountability reports, description of thorium processing, safety meetings, PCB meetings, bioassay results, external exposure results, TLD processing, fluorine control, artificial urine reports, asbestos worker files, the mobile body counter, U-233 history and inventories, trip reports, TLD problems, respiratory program occurrence report, periodic progress reports, and environmental reports.	01/13/2014	64
DOE Oak Ridge Operations Records Holding Task Group Vault	Building index, contamination control, discontinuation of DuPont film, employee work history records, external exposure reports, film badge program, foundry beta radiation control, health physics records, internal exposures at Y-12 , personnel participating in decontamination work, monthly health physics report, collection and recovery of airborne tuballoy, monthly production reports, production statistics and thorium inventories, radiological incidents, radiological surveys, reduction of radiation exposures, technical basis for beta skin dose calculations at the Y-12 plant, uranium dust concentrations, urinalysis and whole body count information, African Metals invoices, materials in 0101 area - Clinton Engineer Works, and the storage of U-235 from Los Alamos at Clinton Engineer Works.	08/14/2015	162
DOE Office of Scientific and Technical Information (OSTI)	Closed-cycle beta process, alpha II calutron development, uranium recovery by spray cleaning, thorium receipts, radiological surveys, pocket meter logbook notes, material transfers, coating of metallic thorium, material inventories, health physics logbooks, personnel monitoring, internal exposure study, applied health physics program review, calibrating and reading TLDs, periodic reports, and airborne uranium.	09/24/2018	85
East Tennessee Technology Park (ETTP) & Oak Ridge Gaseous Diffusion Plant (K-25)	Special form material procedures, health physics procedures, implementation plan for DOE Order 5480.11, the ETTP internal dosimetry program, technical basis, and evaluations, 10 CFR 835 implementing program documents, worker safety and health program documents, a nondestructive assay survey, 1958 radiation protection training programs, and Oak Ridge Reservation annual air emission reports.	01/11/2017	43
Federal Records Center - Atlanta	Uranium tolerances, finger film, biological research at Mound, tritium information, and an Oak Ridge Operations Office health protection status report.	08/12/2004	5
Federal Records Center - Boston	Personnel termination exposure summaries.	04/27/2012	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Federal Records Center - Chicago	Contamination control limits, a tritium release limits position paper, radiological control manuals, and technical basis documentation.	06/20/2013	6
Federal Records Center - Dayton	Radiation dose determinations from indium foils in multi-plant security badges, limits for material from K-25 and Y-12 potentially contaminated with tritium, a Health Physics Division annual report, transfers of highly enriched uranium, a RCRA facility investigation, and dose estimates for a Y-12 incident.	06/02/2014	7
Federal Records Center - Denver	Mortality among radiation workers at a plutonium weapons facility, beryllium purchasing, fire protection workshop proceedings, a 1967 review of criticality accidents, and a listing of mixed waste streams.	01/25/2012	5
Federal Records Center - Kansas City	Reports of urinalysis with sample routing logs, Tiger Team findings, and the process for handling contaminated parts returned to Kansas City Plant.	10/09/2013	3
Federal Records Center - Kansas City, Bannister	1990-1991 bioassay sample results and 1990 occupational exposure report summaries.	07/16/2008	2
Federal Records Center - Lee's Summit	DOE unusual incident reports, a volumetric release analysis, environment, safety, and health performance indicators, 1988 bioassay results, a West Valley fact book, analyses of Tiger Team findings, waste minimization, mixed waste evaluation and strategies, and an effluent system report.	05/19/2016	34
Federal Records Center - San Bruno	Beta run reports, personnel medical records handling, personnel assignment logs, schedule for track B, a personnel dosimetry intercomparison, medical and health physics quarterly reports, plutonium and fission products metabolism, and health chemistry accident reports.	02/12/2018	14
Fernald / SC&A	Mobile in-vivo radiation monitoring laboratory brochure.	06/26/2003	1
General Atomics	The 1958 criticality incident at Y-12.	08/16/2005	1
Goldberg, Persky, and White PC - Mancuso Collection	A 1973 contractor list, a records retention discussion, correspondence, and a local news article regarding a small fire in 1976.	01/10/2017	8
Hagley Museum & Library	General history of Clinton Engineer Works, race for the bomb, the Hanford story, and uranium experimental program on heat treatment.	09/29/2010	8

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Hanford	In-vivo counting method for determining the uranium lung burden, annual and monthly progress reports, environmental monitoring and protection committee information, smelting uranium-contaminated ferrous metal scrap, production of tritium, health physicist reports, a waste water treatment review, inventories, material losses, uranium mass balance project document index and attachments, accountability reports, accountability survey data, and inspection criteria for enriched uranium powder.	04/16/2019	43
Idaho National Laboratory (INL)	Material transfers between Y-12 and INL facilities, handling of Y-12 material at INL, correspondence, visitor badge reports, criticality safety evaluations, a documented communication, a list of publications, visitor traffic logs, a contaminated rail car report, and employee previous exposure histories.	08/29/2018	52
INL Electronic Document Management System (EDMS)	The results of an EDMS keyword search.	06/29/2016	1
Interlibrary Loan	Environmental levels of radioactivity at Atomic Energy Commission installations, work history reports for oxide conversion facility, proceedings of a short criticality safety course, the Seaborg journal, and the proceedings of an incineration conference.	05/29/2012	24
Internet - Defense Technical Information Center (DTIC)	An occupational dose reconstruction bibliography, uranium alloy metallurgy bibliography, defense nuclear facilities safety board reports to Congress, actinide research quarterly reports, physical metallurgy of uranium alloys, the characterization of enriched uranium oxide particles, best manufacturing practices, Y-12 nuclear forensic capabilities and experience, and the Defense Nuclear Facilities Safety Board 23rd annual report to Congress.	03/26/2019	24
Internet - DOE Comprehensive Epidemiologic Data Resource (CER)	Health physics hygiene progress report and the impact of downsizing and reorganization on employee health and well-being at the DOE Y-12 Plant.	01/23/2010	3
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Fourth Atomic Energy Commission Air Cleaning Conference, specifications for Savannah River Site slugs, periodic department reports, a trip report, and a shipment of uranium rods to Y-12.	09/22/2015	7
Internet - DOE Health, Safety, and Security (HSS)	10 CFR 835 exemption requests.	02/07/2017	2
Internet - DOE Legacy Management	Preliminary survey of the Elza Gate warehouse area, removal of uranium from soil, beryllium-associated worker registries, annual occupational exposure reports, a former worker medical screening report, and documentation supporting the over packing of waste thorium at Fernald including Y-12 generated waste.	04/08/2019	11

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE Legacy Management Considered Sites	A 1951 monthly progress report and a mixed waste inventory report.	04/24/2012	2
Internet - DOE National Nuclear Security Administration (NNSA) Library	Violation citations related to a uranium fire, the final site-wide environmental impact statement, the history of the Nuclear Materials Management and Safeguards System, and the consolidation of the site's nuclear footprint.	11/16/2015	5
Internet - DOE Noncompliance Tracking System (NTS)	Noncompliance with Nevada Test Site waste acceptance criteria, a discussion of isolated non-uranium contamination areas, inadequate control of materials used in maintenance of enriched uranium oxide, calibration program deficiencies, a glovebox fire, deficiencies in radiological work permit compliance, missed routine bioassay samples, and unanalyzed material in Building 9720.	03/11/2019	9
Internet - DOE Oak Ridge Operations	Release of a parcel of land to the city of Oak Ridge, the demolition of Building 3704, photographs of Building 9401-2, and the 2016 Oak Ridge Reservation annual environmental report.	05/01/2018	4
Internet - DOE Occurrence Processing and Reporting System (ORPS)	Personnel contamination reports and roll-ups, legacy contamination discoveries, contaminated items discovered areas controlled for contamination, personnel intakes of radioactive material, radioactive material spills, uranium fires, and criticality safety infractions.	05/03/2019	51
Internet - DOE Office of Scientific and Technical Information (OSTI)	The 2006 Oak Ridge Reservation annual environmental report, a 1958 Argonne National Laboratory Chemical Engineering Division report, a 2016 air emissions report, and a scoping package for environmental remediation.	04/02/2019	4
Internet - DOE OpenNet	Criticality accident at the Y-12 Plant, declassification of the quantity of enriched lithium produced at Y-12, Manhattan District history, monthly status and progress reports, semiannual reports of the Atomic Energy Commission, operational accidents and radiation exposure experience, release of radioactivity to the environs request by AEC, uranium dust exposure and lung cancer risk in four uranium processing operations, trip reports, Oak Ridge Institute of Nuclear Studies medical research reports, a californium-252 report, fuel slug studies, Manhattan Project field progress reports, material transfers, a plant tour, National Radiobiology Project interviews, Massachusetts General Hospital uranium study, calculation of potential incident doses, radiobiology reports, neutron exposure dosimetry by in-vivo sodium-24 measurements, organization charts, material transfer security requirements, and an injury claim.	09/06/2018	149

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE OSTI Energy Citations	Clean atmosphere approach to radiological decontamination of concrete surfaces, model for uranium lung clearance at the Y-12 Plant, Y-12 discharge of enriched uranium to the sanitary sewer, study of TLD beta calibration factor for exposure to depleted uranium, coaxial germanium detectors in the Y-12 in-vivo monitor, disposal of United Nuclear Company materials at the Y-12, environmental survey report, modeling of Elza Gate contaminated material, a Pinellas Plant feasibility study, a mathematical model for lung counting, the feasibility of in-vivo thorium measurements, ORNL Chemical Technology Division reports, a 2011 DOE occupational radiation exposure report, a nuclear accident dosimetry intercomparison study, and the abstracts from a pollution prevention conference.	08/28/2013	47
Internet - DOE OSTI Information Bridge	DOE Complex buried waste characterization assessment, Conversion and Blending Facility highly enriched uranium to low enriched uranium as uranium hexafluoride, disposition of highly enriched uranium obtained from the Republic of Kazakhstan environmental assessment, electromagnetically enriched isotopes inventory, environmental evaluation and reports, export license issued for DOE Oak Ridge for shipment of uranium-235, human radiation experiments, in-vitro data and comments, list of ERDA radioisotope customers, occupational dose reduction, post construction report for the United Nuclear Corporation disposal site, radiological risk assessment of a radioactively contaminated site, remedial investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, sampling approach for characterization of the Scarboro community, testing of the Y-12 Plant criticality accident alarm system detectors at the Sandia Pulsed Reactor Facility, metal fabrication program for the Clinton Engineering Works and the Hanford Engineering Works including the dummy slug program, waste vitrification projects, Y-12 salvage yard scrap metal characterization study, Y-12 Plant solid waste management system, a beryllium exposure assessment, a uranium hydride report, and hazardous and mixed waste generation.	08/26/2013	170

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE OSTI SciTech Connect	High-level radioactive waste reports, low-level radioactive waste reports, spent nuclear fuel strategic plans, spent fuel storage, environmental reports, groundwater protection and quality reports, waste generation and pollution prevention reports, a tank characterization survey, a Y-12 Tiger Team assessment, dosimetry quality assurance, the status of environmental initiatives, periodic project reports, life cycle analysis approach to D&D projects, strategic special nuclear material inventory differences, an Oak Ridge dose reconstruction report, and control technology for radioactive atmospheric emissions.	08/28/2018	107
Internet - Energy Employees Claimant Assistance Project (EECAP)	A RCRA landfill analysis for the United Nuclear Corporation disposal site, assessment of enriched uranium storage safety issues, Development Division periodic reports, operation of the chip oxidation facility, uranium removal from contaminated soils, and reduction of airborne radioactivity levels at the Building 9201-5 arc melt sawing operation.	03/26/2014	13
Internet - Google	Accountability and control of sealed radioactive sources, annual site environmental reports, Clinton Engineer Works photos, Clinton Laboratory expands to Y-12 buildings, depleted uranium operations at Y-12, division progress reports, Eastman at Oak Ridge during World War II, environment monitoring assessment and reports, epidemiological studies, evaluation of iodine-131 releases, historical evaluation of the film badge dosimetry program at Y-12, liquid waste disposal at Oak Ridge National Laboratory, major relocation of highly enriched uranium completed at Y-12, Manhattan Engineer District history, neutron and gamma dosimeter intercomparison study, Oak Ridge, Tennessee, warehouses site fact sheet, operating Oak Ridge's calutrons, radiological incidents, site X, Oak Ridge, Tennessee (map), status of highly enriched uranium processing capability at Y-12 building 9212, study of metal hydrides, Oak Ridge 86-inch cyclotron, urine bioassay program, personal air sampling (PAS) data in the internal dosimetry program, Y-12 history and fact sheet, environmental restoration, DOE occupational radiation exposure reports, characterization of contaminated scrap metal, oral history interviews, transuranic waste management, the characterization strategy for Building 9201-5, contractor performance evaluation reports, the determination of thorium in thorium metal, and a Y-12 fact sheet.	09/13/2018	508

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - Hathitrust	A 1962 dosimetry badge orientation experiment.	10/21/2015	1
Internet - Health Physics Journal	Identification of Oak Ridge Reservation emission sources, a urinalysis intercomparison study, an analysis of cesium body burdens, the retention of uranium in the chest, radioactivity distributions in the metallurgical processing of thorium, and a comparison of lung dose estimates from air sampling and bioassay data.	03/26/2019	7
Internet - Idaho National Laboratory (INL)	Shipments of purified uranium powder to Oak Ridge.	07/13/2016	3
Internet - International Atomic Energy Agency (IAEA)	The status of stable isotope enrichment and services.	12/19/2016	1
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	03/26/2019	0
Internet - National Academies Press	Complex-wide safety and health management, research opportunities in D&D projects, Dr. Frank Spedding biographical memoirs, and radioactive waste reports.	03/17/2015	5
Internet - National Environmental Publications Information System (NEPIS, US EPA)	Environmental radiation data, environmental cleanup standards and regulations, transuranium elements dose limits and radiation protection, Y-12 records of decision, and an overview of waste solidification and stabilization at Superfund sites.	02/09/2016	15
Internet - National Institute for Occupational Safety and Health (NIOSH)	Special exposure cohort petition evaluation reports, NIOSH residual radioactive and beryllium contamination reports, designation of additional members of the SEC, the minutes of Work Group meetings, the Kansas City Plant issues matrix, and an Advisory Board on Radiation and Worker Health review of the Y-12 site profile.	11/01/2018	30
Internet - National Technical Information Service (NTIS)	Feasibility study of the correlation of lifetime health and mortality experience of AEC and AEC contractor employees' progress reports.	08/21/2006	2
Internet - Nuclear Regulatory Commission (NRC) Agencywide Document Access and Management (ADAMS)	DOE inventory report, evaluation of the potential for recycling of scrap metals from nuclear facilities, feasibility study for the United Nuclear Corporation disposal site at the Oak Ridge Y-12, integrated database U.S. spent fuel and radioactive waste inventories, projections, and characteristics, a soil management plan for the Oak Ridge Y-12, disposition of surplus highly enriched uranium, environmental impact statements, a Y-12 safety analysis report, advance notifications of shipments, facility hazard assessments, export licenses and shipments, NRC export license applications, and a 60-day notification of a materials transfer incident.	09/28/2017	131

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - Oak Ridge National Laboratory (ORNL)	ORNL Division and Laboratory periodic reports mentioning Y-12, radiation safety for Y-12 Building 9204-3 isotope separation operations, report on a calutron ion source, the recovery of uranium from acid liquors, a 1979 thorium utilization progress report, and Oak Ridge Reservation annual environmental reports.	09/26/2017	164
Internet - University of North Texas	The evaluation of Organic Moderated Reactor Experiment fuel elements containing uranium oxide from Oak Ridge.	09/18/2018	1
Internet - US Army Corps of Engineers (USACE)	A 2016 Formerly Utilized Sites Remedial Action Program (FUSRAP) update.	05/17/2018	1
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant documents identified.	04/08/2019	0
Internet - Y-12	Y-12 anecdotes including one on thorium production.	08/01/2018	1
Iowa State University Library	An interview with Dr. Frank Spedding.	09/18/2013	1
Iron Mountain Storage Facility, Cranberry, PA	Survey of control over source and special nuclear materials, National Distillers and Chemicals Corporation.	09/11/2006	1
Kansas City Plant	Statement of Dr. Victor H. Reis before the subcommittee on Military Procurement Committee on National Security, US House of Representatives, radiological incidents, receipt of potentially contaminated parts, radiological surveys and air samples, operations reports, and dosimetry services.	03/04/2015	21
Kansas City Plant / SC&A	Notes from the review of Kansas City Plant classified documents.	08/16/2013	1
Lawrence Berkeley National Laboratory (LBNL)	Laboratory contracts 1948.	02/06/2007	1
Lawrence Berkeley National Laboratory (LBNL) / SC&A	Long-range studies of uranium workers and Oak Ridge radiation worker population.	05/13/2009	1
Lawrence Livermore National Laboratory (LLNL)	Project Pluto meeting minutes, a glove box incident report, determinations of possible excursion yields and exposure rates, feasibility of liquid material transfers, and the Rocky Flats body counter.	11/16/2017	11
Los Alamos National Laboratory (LANL)	Excursions at the Oak Ridge criticality experiments facility, nonnuclear consolidation environmental assessment, polonium contamination at Pajarito, low-level mixed waste streams for the DOE Complex, corrected information on a plutonium shipment, a uranyl nitrate slurry problem, decontaminating plutonium from oralloy parts for Y-12, and radioactive waste disposal and related issues.	01/16/2018	11

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Los Alamos National Laboratory (LANL) - LAHDRA	Waste minimization at a plutonium processing facility, a low-level complex-wide mixed waste report, and an environmental impact statement for the storage and disposition of weapons-usable fissile material.	11/30/2006	3
Mel Chew & Associates	A 1994 radiation exposure summary, laboratory procedures for thorium analyses, individual and group exposure histories, fecal uranium measurements, the uranium in urine program, recycled uranium data spreadsheets, and plutonium urine results.	12/14/2014	62
Metals & Controls Corp	Analysis of possible nuclear material losses and possible liabilities associated with present fuel manufacturing.	08/24/2004	1
MJW	Proceedings of a short nuclear criticality safety course.	10/16/2003	1
Mound Museum	Disposition of depleted salvage material, exposure to polonium from a neutron source, fabrication of weapon components, a shipment of irradiated bismuth slugs, polonium characteristic X-rays, polonium hazards, and correspondence concerning a lithium compound.	05/18/2010	12
National Archives and Records Administration (NARA) - Atlanta	AEC handbook on Oak Ridge operations, annual health protection review, bioassay results and procedures, calutron beam study, control of radiation hazards by Carbide and Carbon Chemicals Division, environmental data, equipment numbering system, film badge program description, hazards of piles at Y-12, monthly accountability reports, organization charts, personnel exposure data, progress reports, radiological and criticality incidents, radiological surveys, report of annual health protection review - New Brunswick Lab, reports of destruction of classified material, radiochemistry reports, shipments from Metal Hydrides to AEC facilities, shipping receipts, work done at Iowa State College, and handling fissionable material.	09/01/2015	135
National Archives and Records Administration (NARA) - Atlanta / SC&A	Decontamination of gloves.	09/26/2003	1
National Archives and Records Administration (NARA) - Chicago	Fuel preparation for the ZPR-III Reactor.	06/12/2015	1
National Archives and Records Administration (NARA) - College Park	Meteorological conditions, machining of uranium metal, accountability reports, thorium reports, researcher notes, Manhattan District history sections, and monthly status and progress reports.	03/11/2014	21

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
National Archives and Records Administration (NARA) - Kansas City	Historical information from property insurance association on Niagara Falls Storage Site / African Metals leased areas, a survey of the Nuclear Chemicals and Metals Facility before and after a shipment to Y-12, radon emission data, TLD occupational exposure reports, and the 1995 transuranic waste baseline report.	07/11/2016	5
National Archives and Records Administration (NARA) - Seattle	Material transfers and a continuous air monitor calibration.	08/23/2017	5
Nevada Test Site (NTS)	The Y-12 electron beam welder and shipment of reactor fuel and waste from NTS to Y-12.	04/14/2008	2
New York State Archives	A Manhattan District history section and waste disposal at Lake Ontario Ordnance Works.	03/19/2012	2
New York Department of Environmental Conservation	Recovery of uranium from Sylvania scrap and disposal of special material under Contract AT(40-1)-2558.	07/31/2008	2
NIOSH	Production and use of recycled uranium, audit report confirmatory bioassay testing at selected sites, highly enriched uranium safety and health vulnerabilities associated with storage of highly enriched uranium, Los Alamos Scientific Laboratory information, nondestructive testing of uranium, radioactive waste shipment, recycled uranium mass balance project, history of the Oak Ridge National Laboratory's first 25 years, strikes at Y-12, the evaluation of health physics problems in thorium processing, trip reports, AEC reports to Congress, documented communications, worker outreach meeting minutes, and recycled uranium processing at Fernald.	11/22/2017	55
NIOSH - Health Related Energy Research Branch (HERB) Library	Oxide conversion facility work history reports.	09/08/2003	1
NIOSH / SC&A	BWXT-ORAU correspondence 2003-2005, recycled uranium project report, highly enriched uranium working group reports, Np-237 and U-238 alloy radiation safety requirements, remarks on personnel monitoring at Y-12, technical basis document for the internal dosimetry program at Y-12, uranium urinalysis program, and a Y-12 Complex description.	02/05/2009	16
NIOSH OCAS Claims Tracking System (NOCTS)	A 1957 special separations logbook and a log entry regarding an Am-241 lung burden.	10/16/2018	2

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Nuclear Regulatory Commission (NRC) Public Document Room	A trip report, the sixth intercomparison of nuclear accident dosimeters, the draft environmental assessment for treatment of low-level and mixed waste, in-vivo counts for two Kerr-McGee employees involved in a thorium explosion, and references to Y-12 in a NUMEC license renewal application.	08/15/2017	5
Oak Ridge Associated Universities (ORAU)	Brief history of the Y-12 external monitoring program, correction factors for film badge data, dosimetry records and radiation hazards questionnaire, film badge data, names of persons having dosimetry information, radiation dosimetry for epidemiologic lung cancer study, history of buildings at Y-12, information on the calutron program for uranium enrichment, plutonium urinalysis results, health physics reports for buildings and departments, polonium urinalysis reports, uranium and plutonium urinalysis reports, individual employee bioassay reports, tritium urinalysis reports, Building 9805-1 tritium reports, and high dose investigation reports.	05/14/2012	230
Oak Ridge Associated Universities (ORAU) / Mel Chew & Associates	Tritium urinalysis reports.	05/14/2012	4
Oak Ridge Institute for Science and Education (ORISE)	Data collection and validation for the Oak Ridge nuclear facilities mortality study.	06/11/2003	1
Oak Ridge Library for Dose Reconstruction	Status report on Clinch River study, high-flux isotope reactor description, engineering development of hydraulic fracturing as a method for permanent disposal of radioactive wastes, contaminant releases, uranium releases, annual applied health physics reports, environmental levels of radioactivity, aerial radiological surveys, annual environmental reports, waste disposal reports, recovery of uranium from fiberglass air filters, incident reports, historical uranium releases, fallout measurements, material accountability reports, stack sampling, facility and department periodic reports, analysis of the 1989 UF6 release, and worker mortality rates.	08/15/2011	298

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Oak Ridge National Laboratory (X-10)	Radiological incidents, history of the Analytical Chemistry Division of Oak Ridge National Laboratory, Aircraft Nuclear Propulsion Project progress report, cyclotron operations, electromagnetic isotope separations, evaluation of neutron dosimetry, exposures received from typical diagnostic X-ray examinations at ORNL, health physics instrument manual, neutron dosimetry with the ORNL badge, Oak Ridge 86-inch cyclotron, X-ray facility reviews, production of radioisotopes in the ORNL 86-inch cyclotron, quarterly progress report, radiation safety manual, stable isotope separation in calutrons, technical basis for nuclear accident dosimetry, inventory of electromagnetically enriched isotopes, X-10 medical X-ray compliance survey, Y-12 film monitoring program, releases of thorium in Building 9204-1, 86-inch cyclotron target ruptures, area, equipment, and personnel contamination occurrence reports, periodic ORNL Division reports including material accountability, isotopic power materials, isotopes development center, and operations and individual dosimetry records.	09/03/2015	289
ORAU Team	Accounting for incomplete personal monitoring data on penetrating gamma doses, exposure matrix for the Mallinckrodt Chemical Company, effect of threshold energy and angular response of NTA film on missed neutron dose at Y-12, annual report radiation exposures for DOE and contractor employees, radiological incidents, external radiation monitoring at Y-12, health and mortality among contractor employees at DOE facilities, history and evaluation of the film badge dosimetry program at Y-12, potential missed dose to nuclear weapons assemblers, specific tables of isotopic production, Tiger Team assessment of the Pantex Plant, Y-12 exposure database, analysis of electronic personnel exposure data from Y-12, documented communications, technical basis documents, technical information bulletins, thorium air sample data spreadsheet, Y-12 quarterly health physics reports, in-vivo input and output radiation monitoring reports, quarterly health physics and industrial hygiene reports, annual body counter reports, an example of actinium and lead body counting reporting, and neutron dose from highly enriched uranium.	03/28/2019	254

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Paducah Gaseous Diffusion Plant	Alpha hazards from neptunium, computer program for whole body count, disposal of stored "tru" waste, environmental assessments and reports, estimates of transuranium alpha fed to Paducah cascade, exposure assessments, health protection information on uranium metal, in-vivo monitoring results, inventory of radioactivity released to environment, land burial of radioactive waste at the Paducah Plant, licensing of byproduct material, neptunium and plutonium plant material balance, dust studies, radiation protection program, radioactive contaminants in Paducah scrap, radioactive effluent release, monitoring and control, radioactive waste management, radiological incidents, study of plutonium and fission products, technical basis for the Centralized External Dosimetry System, trip reports, waste disposal criteria, and Y-12 TLD results that include Paducah area dosimeters.	10/06/2006	13
Pantex	Monitoring procedures for items received at Pantex.	07/19/2011	1
Personal Files – [Name redacted]	The sixteenth through the twenty-first DOE annual reports of radiation exposure.	10/11/2006	6
Personal Files - [Name redacted]	A DOE contractor health and mortality report.	04/06/2010	1
Personal Files - [Name redacted]	Office of Oversight Radiological Protection task team reports.	07/16/2018	1
Portsmouth Gaseous Diffusion Plant	Eighth Analytical Services Forum Paducah Gaseous Diffusion Plant, transfer of enriched uranium, and the neutron threshold detection project.	01/30/2013	3
Reactive Metals, Inc. (RMI)	Historic radionuclide releases from Oak Ridge Operations facilities.	08/17/2006	1
Rocky Flats Environmental Technology Site (RFETS)	The flammability and explosion potential of transuranic waste and audit responses.	08/31/2012	2
Sandia National Laboratories-Albuquerque	Technical basis for workplace air monitoring of airborne radioactive material at Y-12, Ross Aviation shipment surveys and documents, the 1991-1993 ORNL bioassay QC program, Webdose database external doses 2006-2008, and approval of the revised Radiological Control Manual.	09/09/2014	7
Savannah River Site (SRS)	Dosimetry visitors cards, radiation survey log sheets, a trip report, material transfers, SRS monthly reports, the thoria fuel irradiation program, laboratory fume hood minimum acceptable face velocities, and the SRS response to the 1998 DOE Bioassay Enforcement Moratorium.	02/28/2019	14

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
S. Cohen & Associates (SC&A)	Assessment for acceptance of enriched uranium at Y-12, radiation worker health at Y-12, Oak Ridge reservation annual site environmental report, photographic film as a pocket radiation dosimeter, recycled uranium mass balance project information, a trip report, criteria for acceptance of enriched uranium at Y-12, incident reports, unclassified thorium documents, special nuclear material licensing, and documented communications.	04/26/2011	18
SC&A / Atlanta NARA	Thorium metal processes.	09/26/2003	1
SC&A / Idaho National Laboratory	Environmental report, airborne radionuclide waste management information, a mercury shipment, a survey of waste management practices, and Idaho Chemical Processing Plant periodic reports.	06/24/2010	13
SC&A / Internet - DOE OpenNet	Linking Legacies.	05/24/2017	1
SC&A / NIOSH	The generation and flow of recycled uranium.	08/14/2003	1
SC&A / Y-12	Mobile lung counter data and fires and explosives investigations.	07/28/2010	2
Science Applications International Corporation (SAIC)	Annual summaries of whole body radiation exposures to external penetrating radiation.	09/02/2004	9
Southern Illinois University	Nuclear fuel fabrication, Oak Ridge site description, observations on uranium exposures, visit requests, and the transcript of day two of the fifty-sixth Advisory Board on Radiation and Worker Health meeting.	10/29/2008	8
University of Colorado Norlin Library	A formal safety program cost/benefit study.	04/10/2006	1
University of Rochester Radiation Safety Office	Return of uranium peroxide to Oak Ridge.	08/20/2008	1
University of Tennessee Library	Creation of Clinton Engineer Works, a health physics report, health physics and exposure records, a calutron newspaper article, personnel monitoring records, the Biology Division Hot Laboratory, the decontamination of Building 9204-1, burial of Y-12 wastes, and a survey of Building 9206.	10/11/2011	14

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Unknown	Annual radiation dose reports, annual environmental reports, designation of race tracks by number Y-12 and extension, dosimeter response characterization, estimation of radiation doses to the lungs of early uranium workers, excretion of uranium from mixed exposures under industrial conditions, fifth semiannual report of the atomic energy commission, flow of materials through the nuclear weapons complex, glossary of Y-12 coded terminology, health physics survey instruments used at Clinton, in-vivo method to determine uranium lung burden, Mallinckrodt Plant inspections, miscellaneous Fernald documents, monthly status and progress reports, neutron dose equivalent and energy spectra measurements at ORNL and Y-12, overview of the history of Y-12, protective equipment evaluation, radiation safety manual, radiological incidents, radiological surveys, relationship between in-vivo and urinalysis data collected, Rocky Flats site history, Simonds Saw & Steel material balance report, Westinghouse Nuclear Fuels Division and Westinghouse Atomic Power Development information, and X-ray radiation measurements in calutron cubicles.	02/10/2011	219
Unknown / SC&A	Y-12 references in Linking Legacies and a DOE indoor radon study.	10/09/2003	2
Unknown / Y-12	The Y-12 outdoor scoping survey.	06/10/2004	1
United States Army Corps of Engineers (USACE)	Lake Ontario Ordnance Works document search and remediation reports.	11/29/2007	2
United States Enrichment Corporation (USEC)	A 1977 radiation termination report, the ERDAM 0525 annual occupational exposure reporting form, and a US Navy report on radioactive wastes.	10/06/2006	3
Weldon Spring	Analysis of long term data on uranium in air.	11/29/2004	1
Westinghouse Site (MO)	Accidental radiation excursion at Y-12, estimated lung exposure, in-vivo count results, and procedures and assignments for restricted personnel.	04/09/2009	7
Y-12 / SC&A	Medical examination reports, occupational medical review reports, environmental pollution and control data, radiation exposure data, and Y-12 specifications for recycle material receipts.	07/28/2010	5
TOTAL	NA	NA	**5,067**

Table A1-2: Database Searches for the Y-12 Plant

Database / Source	Keywords / Phrases	Hits	Selected
Defense Technical Information Center (DTIC) http://www.dtic.mil/dtic/ COMPLETED 03/26/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	14,950	6
DOE Hanford Declassified Document Retrieval System (DDRS) and Public Reading Room http://reading-room.labworks.org/Catalog/Search.aspx COMPLETED 04/05/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	4	1
DOE Legacy Management Considered Sites https://www.lm.doe.gov/Considered_Sites/Summary/ COMPLETED 04/08/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	3,872	2
DOE National Nuclear Security Administration (NNSA) - Nevada Site Office https://nnsa.energy.gov/library COMPLETED 04/01/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	1,468	4
DOE Noncompliance Tracking System https://appaccess.ntc.doe.gov/Authentication/Login?applicationID=1&returnURL=https%3a%2f%2fnts.ntc.doe.gov%2fAuthentication%2fADFSSignIn COMPLETED 10/04/2018	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	158	1
DOE Occurrence Reporting and Processing System https://www.energy.gov/ehss/policy-guidance-reports/databases/occurrence-reporting-and-processing-system COMPLETED 10/04/2018	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	817	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 04/05/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	3,882	133
DOE OSTI SciTech Connect http://www.osti.gov/scitech/ COMPLETED 04/22/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	409,550	50
Energy Employees Claimant Assistance Project (EECAP) http://www.eecap.org COMPLETED 03/26/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	19	0
Google http://www.google.com COMPLETED 04/09/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	4,732,597,100	36
Health Physics Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 03/26/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	219	1

Database / Source	Keywords / Phrases	Hits	Selected
Journal of Occupational and Environmental Health http://www.maneyonline.com/loi/oeh COMPLETED 03/26/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	9	0
National Academies Press http://www.nap.edu/ COMPLETED 04/08/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	15,124	0
National Service Center for Environmental Publications (NEPIS) http://nepis.epa.gov/ COMPLETED 04/09/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	317	14
NRC ADAMS Reading Room https://www.nrc.gov/reading-rm/adams.html#web-based-adams COMPLETED 04/05/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	1,210	83
United States Army Corps of Engineers (USACE) http://www.usace.army.mil/ COMPLETED 04/08/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	10	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 04/08/2019	Database search terms and Internet URL are available in the Excel file called "Y-12 Rev 02, 06-04-19"	29	0