SEC Petition Evaluation Report
Petition SEC-00039

Report Rev #: 2 Report Submittal Date: June 22, 2007

Subject Expert(s):	Tim Vitkus
Site Expert(s):	NA

Petition Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition B Qualification Date	DOE/AWE Facility Name
SEC-00039	83.13	January 11, 2007	Y-12

Petitioner Class Definition
All statisticians who performed statistical analysis of biological experiments related to radiation who worked in all locations at the Y-12 Plant, for the period from January 31, 1951 through June 30, 1959.

Proposed Class Definition
All statisticians who performed statistical analysis of biological experiments (working within the Oak Ridge National Laboratory Biological Sciences Division) in all locations at the Y-12 Plant in Oak Ridge, Tennessee, who were employed by DOE or its contractors between January 1, 1958 and June 30, 1958.

Related Petition Summary Information			
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00026	83.13	Y-12 Plant	Designation Completed
SEC-00028	83.13	Y-12 Plant	Designation Completed

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report SEC-00028	Y-12 Plant

ORAU Lead Technical Evaluator: Timothy J. Vitkus	**ORAU Review Completed By:** Dan Stempfley

Peer Review Completed By:	[Signature on file] *Lavon Rutherford*	06/29/2007 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on file] *J. W. Neton*	06/29/2007 *Date*
SEC Evaluation Approved By:	[Signature on file] *Larry Elliott*	06/29/2007 *Date*

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Evaluation Report Summary: SEC-00039, Y-12

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

Petitioner-Requested Class Definition

Petition SEC-00039, qualified on January 11, 2007, requested that NIOSH consider the following class: *all statisticians who performed statistical analysis of biological experiments related to radiation that worked in all locations at the Y-12 Plant, for the period from January 31, 1951 through June 30, 1959.*

NIOSH-Proposed Class Definition

Based on its research, NIOSH reduced the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all statisticians who performed statistical analysis of biological experiments (working within the Oak Ridge National Laboratory Biological Sciences Division) in all locations at the Y-12 Plant in Oak Ridge, Tennessee, who were employed by DOE or its contractors between January 1, 1958 and June 30, 1958. The time period of the class was reduced (see Section 3.0 below) because of the petition basis that one or more members of the class might have incurred a high level radiation dose from an unmonitored exposure incident in the first or second quarter of 1958.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose incurred by any member of the class; or (2) estimate radiation doses more precisely than a maximum dose estimate. Information available from the site profile and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the proposed class under plausible circumstances during the specified period.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the proposed class.

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1.0 Purpose and Scope

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Tim Vitkus, Oak Ridge Associated Universities. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

This report evaluates the feasibility of reconstructing doses for all statisticians who performed statistical analysis of biological experiments (working within the Oak Ridge National Laboratory Biological Sciences Division) in all locations at the Y-12 Plant in Oak Ridge, Tennessee, where there was a discrete radiological incident that occurred between January 1, 1958 and June 30, 1958. 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 Office of Compensation Analysis and Support's (OCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, OCAS-PR-004.

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.[1]

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also then determine whether or not there is a reasonable

[1] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at http://www.cdc.gov/niosh/ocas.

likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers 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 other SEC classes (excluding aggregate work day requirements).

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 to the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 Petitioner-Requested Class/Basis & NIOSH-Proposed Class/Basis

Petition SEC-00039, qualified on January 11, 2007, requested that NIOSH consider the following class for addition to the SEC: *all statisticians who performed statistical analysis of biological experiments related to radiation that worked in all locations at the Y-12 Plant, for the period from January 31, 1951 through June 30, 1959.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that there was an unmonitored, unrecorded, or inadequately monitored and recorded exposure incident during the first quarter (January, February, or March) of 1958. Additionally, the petitioner provided information to support the claim that a monitoring record for one member of the proposed class was falsified. Prior to the qualification, NIOSH reviewed the submission information and determined that the affidavit did not provide substantive evidence of an exposure incident to support the further consideration of the submission for evaluation. The petitioner then requested an independent NIOSH review of the initial qualification finding. At the completion of the independent review, NIOSH determined the following information and affidavit statements sufficient to qualify SEC-00039 for evaluation:

> Medical records were provided for one individual of the proposed class. The medical records detailed the identification of a depressed white blood cell count (leucopenia) in one member of the proposed class. The initial medical record identifying the condition was

[2] See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available at http://www.cdc.gov/niosh/ocas.

dated August 1958, confirmed in September 1958, and further documented as a continuing medical condition for the next several decades.

A 1958 Oak Ridge National Laboratory radiation exposure record and a personnel exposure supplement dated December 22, 1958 was provided in support of the petitioner's claim that monitoring records were falsified. The exposure record for the health physics monitoring period ending the 14th week of 1958 showed that the recorded moderately penetrating eye and penetrating doses of 4,350 mrem had been crossed-out, initialed, and the dose re-entered as "0" for each. A hand-written notation in the irregularity column of the film density stated "100%." The remarks column of the personnel exposure supplement stated that "Evidence of light 100%---Consultation with (employee name omitted from this report) reveals no past history of radiation exposure. In view of this, a recommended dose of 0 is in order" (Atta, 2005c).

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

Based on its research, NIOSH reduced the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all statisticians who performed statistical analysis of biological experiments (working within the Oak Ridge National Laboratory Biological Sciences Division) in all locations at the Y-12 Plant in Oak Ridge, Tennessee, where there was a discrete radiological incident that occurred between January 1, 1958 and June 30, 1958. The class was reduced because the petition basis was that a discrete, unmonitored radiological incident occurred during the first quarter of 1958. The class evaluated covered the dates of January 1, 1958 through June 30, 1958 (to be consistent with the evidence submitted) to address the period during which the petitioner-reported incident would have occurred. For the purpose of ensuring that the review associated with this evaluation was adequate to address the affidavit statements that were provided in the petition as evidence of a radiological incident, this evaluation includes the review of Y-12 and ORNL (X-10) incident reports for the period from October 1, 1957 through June 30, 1958.

4.0 Data Sources Reviewed by NIOSH

NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees proposed for this petition. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis

Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document. As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights intoY-12 Plant operations or related topics/operations at other sites:

- *TBD for the Oak Ridge National Laboratory – Introduction*, ORAUT-TKBS-0012-1; Rev. 0; August 11, 2004; SRDB Ref ID: 20132
- *TBD for the Oak Ridge National Laboratory – Site Description*, ORAUT-TKBS-0012-2; Rev. 1; August 30, 2006; SRDB Ref ID: 30016
- *TBD for the Oak Ridge National Laboratory – Occupational Medical Dose*, ORAUT-TKBS-0012-3; Rev. 01; July 21, 2006; SRDB Ref ID: 30017
- *TBD for the Oak Ridge National Laboratory – Occupational Environmental Dose*, ORAUT-TKBS-0012-4; Rev. 0; May 7, 2004; SRDB Ref ID: 20136
- *TBD for the Oak Ridge National Laboratory – Occupational Internal Dose*, ORAUT-TKBS-0012-5; Rev. 00, PC-1; May 30, 2006; SRDB Ref ID: 30018
- *TBD for the Oak Ridge National Laboratory – Occupational External Dose*, ORAUT-TKBS-0012-6; Rev. 00; August 11, 2004; SRDB Ref ID: 20138
- *TBD for the Y-12 National Security Complex – Introduction*, ORAUT-TKBS-0014-1; Rev. 01; October 24, 2006; SRDB Ref ID: 30036
- *TBD for the Y-12 National Security Complex – Site Description*, ORAUT-TKBS-0014-2; Rev. 00; October 25, 2006; SRDB Ref ID: 30038
- *TBD for the Y-12 National Security Complex – Occupational Medical Dose*, ORAUT-TKBS-0014-3; Rev. 00 PC-3; April 18, 2006; SRDB Ref ID: 30040
- *TBD for the Y-12 National Security Complex – Occupational Environmental Dose*, ORAUT-TKBS-0014-4; Rev. 01; July 20, 2006; SRDB Ref ID: 30042
- *TBD for the Y-12 National Security Complex – Occupational Internal Dose*, ORAUT-TKBS-0014-5; Rev. 02 PC-1; October 10, 2006; SRDB Ref ID: 30047
- *TBD for the Y-12 National Security Complex – Occupational External Dosimetry*, ORAUT-TKBS-0014-6; Rev. 00, PC-3; May 11, 2006; SRDB Ref ID: 30048

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

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 and procedures as part of its evaluation:

- *OTIB: Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, Rev. 3, PC-2, ORAUT-OTIB-0004*;* December 6, 2006; SRDB Ref ID: 29949

- *OTIB: Technical Information Bulletin — Bayesian Methods for Estimation of Unmonitored Y-12 External Penetrating Doses with a Time-Dependent Lognormal Model*, ORAUT-OTIB-0015; September 9, 2004; SRDB Ref ID: 19433

- *OTIB: Interpretation of Dosimetry Data for Assignment of Shallow Dose*, Rev. 1, ORAUT-OTIB-0017; October 11, 2005; SRDB Ref ID: 19434

- *OTIB: Use of Coworker Dosimetry Data for External Dose Assignment*, ORAUT-OTIB-0020; October 7, 2005; SRDB Ref ID: 19440

- *OTIB: External Coworker Dosimetry Data for the X-10 Site*, ORAUT-OTIB-0021; November 7, 2006; SRDB Ref ID: 29957

- *OTIB: Internal Dosimetry Coworker Data for Y-12*, ORAUT-OTIB-0029; April 5, 2006; SRDB Ref ID: 19452

- *OTIB: External Radiation Dose Estimates for Individuals Near the 1958 Criticality Accident at the Oak Ridge Y-12 Plant*, ORAUT-OTIB-0057; May 15, 2006; SRDB Ref ID: 29981

- *Procedure: Occupational Onsite Ambient Dose Reconstruction for DOE Sites*, Rev. 1, ORAUT-PROC-0060; June 28, 2006; SRDB Ref ID: 29986

- *Procedure: Occupational X-Ray Dose Reconstruction for DOE Sites*, Rev. 1, ORAUT-PROC-0061; July 21, 2006; SRDB Ref ID: 29987

4.3 Facility Employees and Experts

NIOSH interviewed two former employees to obtain first-hand knowledge of dose recording practices and anomaly investigation processes and procedures in place during the late 1950s.

- Personal Communication, 2007a, *Personal Communication with ORNL Health Physics Division Employee—Cyclotron and Health Physics Division*; Telephone Interview by ORAU employee; May 16, 2007; OSA Ref ID: Petition ID: 39, Under Communications Tab, dated 5-16-2007

- Personal Communication, 2007b, *Personal Communication with ORNL Health Physics Division Employee—Field Survey Health Physicist*; Telephone Interview by ORAU employee; May 16, 2007; OSA Ref ID: Petition ID: 39, Under Communications Tab, dated 5-16-2007

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH OCAS Claimant Tracking System (NOCTS) dose reconstruction database to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review for the period of January 1, 1958 through June 30, 1958. (NOCTS data available as of June 22, 2007)

Table 4-1: No. of Y-12 Plant Claims Submitted Under the Dose Reconstruction Rule
(January 1, 1958 through June 30, 1958)

Description	Totals
Total number of claims submitted for energy employees who meet the proposed class definition criteria	1
Number of dose reconstructions completed for energy employees who were employed during the years identified in the proposed class definition	1
Number of claims for which internal dosimetry records were obtained for the identified years in the proposed class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the proposed class definition	1

NIOSH reviewed the claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. The claim indicates that the worker was externally monitored during the period of this evaluation and the external monitoring records were available. These external records were used in the worker's dose reconstruction. There were no incidents described in the claim record.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class. Five hundred and seventy documents were identified as pertaining to Y-12, eight of which were related to the June 1958 criticality. Additionally, NIOSH reviewed ORNL and Y-12 Occurrence Reports, located in the SRDB, for the three-month time period before and after the timeframe evaluated in this evaluation report.

4.6 Y-12 Delta View Imaging System

NIOSH reviewed the Y-12 Delta View Imaging System to locate documents supporting the evaluation of the proposed class. Maintained by Y-12, Delta View 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 that are searchable to the extent that key words have been associated with the individual images when initially loaded. The images contained within Delta View are accessible by individual name and/or ID numbers, analysis, sample type, and other parameters. Examples of data stored within Delta View include information describing special studies, non-uranium urinalyses, medical evaluations, incident reports, and corrections to memos.

4.7 Other Technical Sources

NIOSH reviewed other technical sources to compile background information on the clinical manifestations and physiological changes associated with acute whole-body exposures from radiological incidents. Additionally, NIOSH reviewed sources of error in film badge optical density determination. NIOSH reviewed the following technical sources:

- National Academy Press, 1989, *Film Badge Dosimetry in Atmospheric Nuclear Tests*; National Academy Press: 1989; SRDB Ref ID: 1905

- Bolus, 2001, *Basic Review of Radiation Biology and Terminology;* Journal of Nuclear Medicine Technology, Volume 29, Number 2, 2001; SRDB Ref ID: 31096

- Waselenko, 2004, *Medical Management of the Acute Radiation Syndrome: Recommendations of the Strategic National Stockpile Radiation Working Group*; Annals of Internal Medicine, Volume 140, Number 12, June 15, 2004; SRDB Ref ID: 31097

- Dainiak, 2003, *The Hematologist and Radiation Casualties*; American Society of Hematology Education Program Book. Hematology, 2003; SRDB Ref ID: 31099

- Dainiak, 2003, *Introduction to Health Physics;* Herman Cember; McGraw-Hill Inc.; 1983; SRDB Ref ID: Not Available in SRDB—Publicly Available

4.8 Documentation and/or Affidavits Provided by Petitioners

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

- Form B, 2007, *Special Exposure Cohort Petition—Form B*, [Name Redacted]; May 31, 2007; OSA Ref ID: 101345

- Author Unknown, 1958, *Personnel Exposure Supplement*, radiation exposure record for [Name Redacted]; December 22, 1958; OSA Ref ID: 101344, page 4

- ORNL, 1958, *ORNL Radiation Exposure Record for 1958*, Oak Ridge National Laboratory; 1958; OSA Ref ID: 101344, page 5

- Andrews, 1958a, *Prospective Patient Note*, Dr. Andrews; September 5, 1958; OSA Ref ID: 101344, page 9

- ORINS, 1958, *Patient Admittance Agreement*, for admittance into the Research Hospital operated by the Oak Ridge Institute of Nuclear Studies; September 9, 1958; OSA Ref ID: 101344, page 10

- Andrews, 1958b, *Outpatient Note*, Dr. Gould Andrews; September 11, 1958; OSA Ref ID: 101344, page 11

- White, 1960, *Outpatient Note*, Dr. D. A. White; June 14, 1960; OSA Ref ID: 101344, page 12
- Kuiseley, 1960, *Bone Marrow Report*, Dr. R. M. Kuiseley; June 14, 1960; OSA Ref ID: 101344, page 13
- White, 1962, *Outpatient Note*, Dr. D. A. White; September 18, 1962; OSA Ref ID: 101344, page 14
- White, 1963, *Outpatient Note*, Dr. D. A. White; March 7, 1963; OSA Ref ID: 101344, page 15
- White, 1964, *Outpatient Note*, Dr. D. A. White; February 13, 1964; OSA Ref ID: 101344, page 16
- Emory University Clinic, 1965, *Letter from Emory University Clinic to Dr. D. A. White*, Dr. James Lea; November 24, 1965; OSA Ref ID: 101344, page 17
- ORINS, 1966, *Letter from Oak Ridge Institute of Nuclear Studies to [Name Redacted]*, Oak Ridge Institute of Nuclear Studies; June 7, 1966; OSA Ref ID: 101344, page 18
- *Bone Marrow Report*, Department of Pathology and Laboratory Medicine; August 13, 1991; OSA Ref ID: 101344, page 19
- *Affidavit*, [Name Redacted]; October 1, 2005; OSA Ref ID: 101354
- Atta, 2005a, *Letter to Larry Elliott*, [Name Redacted]; June 13, 2005; OSA Ref ID: 101361, page 1
- Atta, 2005b, *Letter to Larry Williams of DOL*, [Name Redacted]; June 22, 2005; OSA Ref ID: 101361, page 5

5.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize both radiological operations for the Oak Ridge National Laboratory-Biological Sciences Division (ORNL-BSD) located at Y-12 from January 1958 through June 1958 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 both processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 BSD Activities at the Y-12 Plant

Due to a moratorium on construction activities immediately after World War II, insufficient space at the Oak Ridge National Laboratory (ORNL) caused the Biological Sciences Division (BSD) to move into available space at the Y-12 National Nuclear Security Complex, which included multiple

buildings. The BSD conducted animal research concerning carcinogens (typically using low-strength radiological sources), determined the relative biological effectiveness of differing radiation types and source strengths, and researched radiation dose associated with space flight. Many of the studies were conducted in Building 9210, known as the Mouse House.

The type of radiological studies conducted used sealed radioactive sources, which consisted of welded metal capsules (ORAUT-TKBS-0012-2, Section 2.3.5). The greatest potential for direct radiation exposure was from an unshielded capsule. However, an unshielded capsule was unlikely to have presented a contamination hazard or potential for internal exposures, except in the event of a broken capsule weld. As will be discussed later in this report, NIOSH has not located any information indicating that this type of accident ever occurred in the ORNL-BSD facilities. In addition to the use of sealed radioactive sources, administrative controls were also in place to prevent accidental personnel exposures. The room that housed the sealed sources was constructed with lead-lined walls and doors at all locations where there was a potential for personnel or public exposure. Safety procedures and safety-interlocking devices minimized the potential for personnel exposures (ORAUT-TKBS-0012-2, Section 2.3.5).

Table 5-1 summarizes the BSD facilities at Y-12 and provides related radioactive source information.

Table 5-1: BSD Facilities at Y-12

Buildings/Rooms	Radioactive Sources	Quantity (Ci)	Dose Rate (rad/hr at 1 m)	Radiation Type
Bldg 9207/ Room 403A	cesium-137 cesium -137	1,300 65	430 21.5	Gamma Gamma
Bldg 9207/ Room 4040	cesium -137	0.83	0.3	Gamma
Bldg 9210/ Room 341	cesium -137	2.5	0.8	Gamma
Bldg 9779-2	cesium -137	80	26.5	Gamma
Bldg 9207/ Room 127	cobalt-60	3.75	5	Gamma
Building 9983-17/ Trailer	californium-252	3.91	0.8	Gamma and Neutrons

5.2 Radiological Exposure Sources from BSD Operations at Y-12

Radiological exposure sources used in BSD experiments were gamma-emitting sealed sources used for direct irradiation experiments. Although the specific procedural documentation is not available, the basic radiological protection requirement for such sources across the AEC complex was to maintain the sources within source storage wells and mechanically raise them out of the well during the experimental exposure period. NIOSH has not located any records indicating that any of the sealed sources at BSD had ruptured (ORAUT-TKBS-0014-2).

5.2.1 Alpha Particle Emissions

Other than residual uranium contamination (in work locations that previously had been used for uranium operations), californium-252 was the only alpha-emitting source associated with BSD activities. However, because the uranium exposure is associated with potential residual contamination

and the BSD sources were sealed (as previously discussed), it is not expected that alpha particles would be a significant exposure concern or contributor to the internal dose for the worker class evaluated in this report.

5.2.2 Beta Radiation Fields

The potential source of beta radiation for BSD personnel would have been associated primarily with any residual uranium in BSD locations. As a result, it is not expected that beta radiation would be a significant exposure concern or contributor to the personnel dose for the worker class evaluated in this report.

5.2.3 Neutron Exposures

The only potential source of neutron exposure identified for this class was the sealed californium-252 capsules, which were used within a trailer associated with Building 9983-17. Although NIOSH does not have a definitive time period for this source, to ensure that this potential dose is accounted for in this evaluation, NIOSH included the consideration of neutron exposures from the sealed californium-252 capsules. Historical information lists the source with an activity of 3.75 Ci and an unshielded dose rate at one meter of 0.8 rad/hour (ORAUT-TKBS-0012-2). However, NIOSH has not identified any specific information indicating whether the californium-252 sealed source was present during the period relevant to the class covered by this evaluation.

5.2.4 Photon Exposures

The sealed sources used for BSD activities during the period of concern, which included cesium-137 and cobalt-60, produced photon emissions. Table 5-2 provides the primary photon emissions for cesium-137 and cobalt-60.

Table 5-2 summarizes default photon energies for BSD materials at Y-12.

Table 5-2: Default Photon Energies for BSD Materials at Y-12

Radionuclide	Photon Energy	Photon Intensity
Cesium-137	662 keV	85%
Cobalt-60	1173 keV	~100 %
	1332 keV	~100 %

5.2.5 Radiological Incident

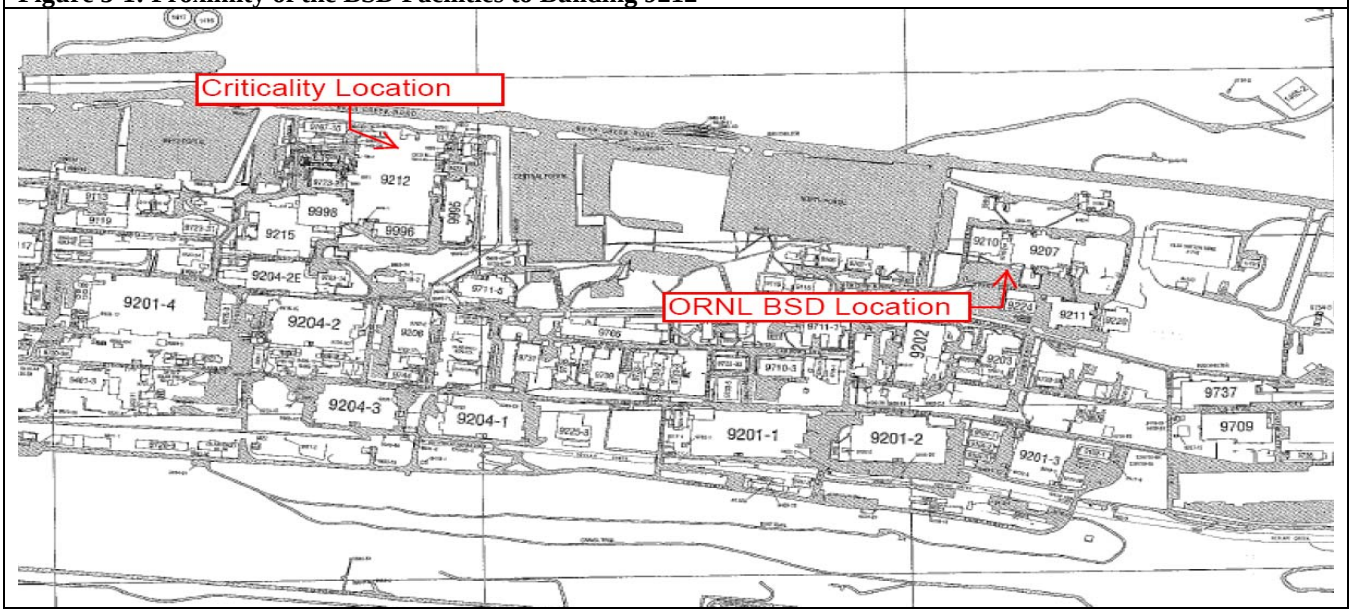
A search of the Y-12 Delta View Imaging System identified five exposure investigations of possible exposure incidents that took place between October 1, 1957 and March 19, 1959. The reports included only one acute exposure incident (an incident that occurred on November 4, 1957), which involved a spill of enriched uranium nitrate (Fish, 1958). The uranium nitrate spill resulted in one individual receiving a suspected internal exposure, but the incident was not associated with ORNL

BSD activities. The remaining four investigations reported apparent film badge overexposures for four individuals (Stewart, 1959a; Stewart, 1959b; Sanders, 1959). Three of these cases, all of which occurred outside of the evaluated time period, were determined to be a result of improper badge storage. Badges were stored together with uranium parts inside tool boxes, desks, or bundled in a contaminated lab coat. The remaining case of possible overexposure occurred during the week ending February 2, 1958, but the investigation concluded that the high badge reading was the result of over-darkening of film from a light leak in the film packaging. In addition to the laboratory confirming light damage to the badge, the employee was sent to the dispensary for a medical evaluation that confirmed that there was no evidence of an overexposure (West, 1958). The specific work location for this employee was not mentioned in the investigation report.

In addition to the one exposure incident discussed above, a documented criticality accident occurred in Building 9212 on June 16, 1958 (ORAUT-TKBS-0014-2). NIOSH evaluated the potential impact of this criticality incident to BSD workers. Geographically, Building 9212 is located approximately 2,000 feet (600 meters) from the closest BSD facility—Building 9210 (see Figure 5-1) . The evaluation of potential exposures to workers outside the immediate vicinity of the criticality is provided in *External Radiation Dose Estimates for Individuals Near the 1958 Criticality Accident at the Oak Ridge Y-12 Plant*, ORAUT-OTIB-0057. ORAUT-OTIB-0057 provides external gamma dose as a function of distance from the criticality. At a distance of 450 feet, calculated gamma exposures were estimated to have decreased to less than 200 mrad. Further extrapolation of the exposure curve to the distance represented by the closest BSD building would result in potential exposures to this group of workers being well below the 200 mrad level. Such an exposure level would not have resulted in complete film darkening, which has a typical range of 40 mR to 500 R.

The information used to develop these exposure scenarios was based on the results of Y-12 employee film badges. Badges were collected from all employees at the end of the day and processed. The net result was the identification of 31 workers who had received exposures from the criticality. The data from these 31 workers were used in the evaluation and construction of the gamma exposure plot as a function of distance. Figure 5-1 shows the proximity of the ORNL BSD facilities to Building 9212.

Figure 5-1: Proximity of the BSD Facilities to Building 9212



The review of ORNL and Y-12 Incident/Investigation reports covering the period evaluated in this report did not contain any reports of incidents to ORNL workers at the Y-12 facilities.

6.0 Summary of Available Monitoring Data for the Proposed Class

The primary data review for this evaluation focused on external monitoring data, as the petition basis was a discrete radiological incident. External dosimetry and monitoring records prior to and after the period of this evaluation are indicative of an acute whole-body irradiation from either a photon, or combined photon and neutron field, and not a chronic internal or external exposure.

6.1 BSD Operations (at Y-12) Internal Monitoring Data

ORNL workers assigned to BSD operations at Y-12 were monitored by the ORNL Internal Monitoring program detailed in the *Technical Basis Document for Oak Ridge National Laboratory-Occupational Internal Dose*, ORAUT-TKBS-0012-5. Potential internal intakes from Y-12 operations are considered in the *Technical Basis Document for the Y-12 National Security Complex-Occupational Environmental Dose*, ORAUT-TKBS-0014-4. Both documents provide details regarding the various analyses used and the associated minimum detectable activities, or in the case of ORAUT-TKBS-0014-4, provide calculated uranium intakes that include the years covered in this evaluation.

The evidence provided in support of the submission basis is indicative of an external whole-body exposure. Based on the fact that BSD operations primarily involved only sealed, gamma emitting sources, the potential for undetected internal intakes (of the magnitude required to result in blood changes) is not considered feasible. Therefore, this information precludes the necessity to further review internal monitoring data, specifically for the sealed radionuclides used by the BSD, for the worker class evaluated in this report.

6.2 BSD Operations (at Y-12) External Monitoring Data

Although BSD activities were conducted at the Y-12 Plant, ORNL assigned and evaluated external monitoring dosimetry. ORNL monitored employees on a quarterly basis during the time covered by this evaluation. External monitoring data for the ORNL worker are available to NIOSH for dose reconstruction.

A film dosimeter designated ORNL Model I was introduced in the late 1950s. The dosimeter employed filters consisting of an open window, plastic, aluminum, and cadmium. Gold foils were included in the cadmium element for use in the event of an accident-level neutron exposure (Hart, 1966). External monitoring results were reported quarterly and are available to NIOSH. Details regarding the various analyses used and the associated minimum detectable activities are presented in the *Technical Basis Document for the ORNL—Occupational External Dose*, ORAU-TKBS-0012-6.

ORAUT-TKBS-0014-4 discusses the data that are available for reconstructing environmental occupational doses for Y-12 and provides the results of aerial surveys conducted during the 1970s, 1980s, and 1990s, as well as the results of land-based radiological scoping surveys. Because onsite environmental monitoring stations were not available until after 1983, ORAUT-TKBS-0014-4

recommends estimating external exposures for the years 1948 to 2002 by applying data collected from the 1987 outdoor scoping survey. These data would then be applicable to the first-half of 1958. Environmental external exposures from building "shine" or contaminated grounds would have been accounted for in overall quarterly dosimetry readings of monitored workers. As such, the co-worker data used in modeling external exposure data for unmonitored workers would include the environmental external exposure component to total dose (ORAUT-OTIB-0015). Although Y-12 worker external exposure data have been evaluated for application to unmonitored worker dose reconstruction, the need to use Y-12 worker external exposure data is unlikely to be necessary for accounting for external exposures for ORNL workers located at the Y-12 facility because ORNL workers were monitored during the time period covered in this evaluation. These ORNL external monitoring data are available to NIOSH for dose reconstructions. The Y-12 TBDs would be applicable to any environmental exposures for ORNL and Y-12 employees assigned to BSD operations at Y-12.

6.3 Air Sampling Data Associated with BSD Operations at Y-12

The air sampling data applicable to this evaluation include air concentrations for the Y-12 facility calculated from environmental monitoring. The specific issues associated with available air sampling data and the methods developed for estimating environmental air concentrations are detailed in ORAUT-TKBS-0014-4. Because the basis for this petition is a discrete radiological incident and BSD activities involved only sealed photon-emitting sources, no additional evaluation of air monitoring data was performed.

7.0 Feasibility of Dose Reconstruction for the Proposed Class

The feasibility determination for the proposed class of employees covered by this evaluation 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 was 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 (discussed in Section 9.0 of this report). If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.6. This approach is discussed in OCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- the sufficiency and reliability of the available data. (Section 7.1)

- the feasibility of reconstructing internal radiation doses. (Section 7.2)
- the feasibility of reconstructing external radiation doses. (Section 7.3)
- the bases for petition SEC-00039 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of BSD Operations (at Y-12) Data

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

7.1.1 Internal Data Review

The basis for petition SEC-0039 is a discrete radiological incident. Since the primary radionuclide of concern at Y-12 was uranium and the sources used for ORNL-BSD activities were sealed and no incident reports or other documentation was identified that would support a history of leaking, a detailed review of the records associated with internal exposures for the proposed worker class was not performed in this evaluation (ORAUT-TKBS-0012-2; Section 2.3.5). Both claims provided in Table 4-1 had internal monitoring data beginning in the 1960s. For the ORNL employee, the data were unrelated to Y-12 activities because the employee had transferred to the ORNL site. Therefore, co-worker and environmental data would be used to assign internal intakes from Y-12 processes for the period that these workers were not internally monitored. Relevant information regarding the availability of internal data and the acceptability of these data for co-worker applications are detailed in *Occupational Environmental Dose*, ORAUT-TKBS-0014-4 and *Internal Dosimetry Coworker Data for Y-12*, ORAUT-OTIB-0029.

7.1.2 External Data Review

Because the original ORNL external dosimetry reports have been provided to NIOSH, extensive data pedigree research for the ORNL external dosimetry data is not necessary. In addition to the ORNL external data reviews and to ensure that all applicable dosimetry data was considered for this evaluation, NIOSH reviewed the Y-12 Site's electronic files of worker data in the Center for Epidemiologic Research, which was used as a resource for the Health and Mortality Studies conducted for the Department of Energy (DOE) and its predecessor agencies. The Y-12 database records contain all data elements received from the original Y-12 files unaltered, including first, middle, and last name, plant badge number, social security number, year of record, quarter of record, quarterly summations of dose readings for the monitoring period (weekly, monthly, or quarterly), and other work history, processing, and demographic data. This database includes 2, 879 external monitoring records for 1958.

7.2 Internal Radiation Doses for BSD Operations

A review of BSD work activities at Y-12 indicates a small potential for internal exposures from class-related work activities. The methods for accounting for such operational and environmental intakes

during the dose reconstruction process have been provided in the associated technical basis documents, technical information bulletins, and programmatic procedures.

7.2.1 Process-Related Internal Doses for BSD Operations at Y-12

Available data support NIOSH's ability to reconstruct internal doses (including bioassay data, air monitoring data, and co-worker data) and support NIOSH's ability to establish a bounding exposure scenario for the proposed worker class evaluated in this report. Because the basis of the SEC petition is that an unrecorded exposure incident occurred, specifically focusing on the issue of external dose recording and reconstruction, NIOSH did not perform an analysis of the Y-12 or X-10 data (beyond that already included in existing dose reconstruction documents for those sites). The Evaluation Report for Y-12 Petition SEC-00028 determined that internal doses could be reconstructed for uranium intakes through December 1957.

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

7.2.1.1 Urinalysis Information and Available Data

Specific methods for using bioassay data to perform dose reconstructions have been developed for both Y-12 workers and X-10 (ORNL) workers and include provisions for missed doses (ORAUT-TKBS-0014-5 and ORAUT-TKBS-0012-5). NIOSH can establish a bounding internal exposure scenario for environmental uranium intakes from Y-12 operations based on the available co-worker bioassay results for the proposed worker class evaluated in this report (ORAUT-TKBS-0014-5 and ORAUT-TKBS-0012-5).

7.2.1.2 Lung Counting Information and Available Data

Whole-body counting was not routinely practiced at Y-12. Chest counting was the primary *in vivo* detection method. The Y-*12 in vivo* chest-counting facility was developed in the late 1950s but was not put into routine use until 1961. Similarly, ORNL did not begin whole-body or lung counting until 1959, which is after the period covered by this evaluation (ORAUT-TKBS-0012-5 and ORAUT-TKBS-0014-5). This information corroborates the point that lung or whole-body counting data are not available for the proposed worker class evaluated in this report. Therefore, there is no specific need for further analysis of *in vivo* monitoring data in the development of a feasibility determination for the proposed worker class evaluated in this report.

7.2.1.3 Airborne Levels

For the time period evaluated in this report, an air monitoring program was in place for both Y-12 and X-10 (ORNL). The air monitoring program emphasized sample collection in process areas with high potential for airborne contamination. In addition to general area airborne concentration levels, data from job-specific breathing zone air sampling events are available. The availability of air monitoring data support the ability to establish a bounding exposure scenario, based on an assumed isotopic uranium (enriched uranium, natural uranium, and depleted uranium) source term and available process data for the proposed worker class evaluated in this report (ORAUT-TKBS-0014-5 and ORAUT-TKBS-0012-5).

7.2.1.4 Application of Co-Worker Data for Internal Dose Reconstruction

ORAUT-OTIB-0029 and ORAUT-OTIB-0034 provide the necessary data and modeling for assigning intakes to workers who were not monitored for potential internal intakes. The availability of co-worker data supports NIOSH's ability to establish a bounding internal exposure scenario for the proposed worker class evaluated in this report.

7.2.2 Ambient Environmental Internal Radiation Doses

Specific methods for reconstructing the ambient internal dose for members of the proposed worker class are described in the *Onsite Ambient Dose Reconstruction Procedure*, ORAUT-PROC-0060. The available ambient environmental data support NIOSH's ability to establish a bounding ambient environmental exposure scenario for the proposed worker class evaluated in this report (ORAUT-TKBS-0012-4 and ORAUT-TKBS-0014-4).

7.2.3 Internal Dose Reconstruction Feasibility Conclusion

Based on the availability of data to support the reconstruction of internal dose, NIOSH concludes that contributions to internal dose from Y-12 or BSD operations can be bounded (reconstructed with sufficient accuracy) for all members of the proposed worker class evaluated in this report.

7.3 External Radiation Doses from BSD Operations at Y-12

Sealed gamma-emitting experimental exposures were the principal source of external radiation dose for members of the proposed class. Additional external exposures may have occurred from residual radioactivity at the Y-12 locations occupied by the ORNL-BSD workers. All ORNL employee dosimeters were exchanged/counted on a quarterly basis during the period covered by this evaluation. The process-related information regarding the potential external exposure environment and historical information regarding monitoring practices and records are discussed below.

7.3.1 Process-Related External Doses from BSD Operations

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

7.3.1.1 Radiation Exposure Environment: Photon Characterization

The primary radiation exposure environment for statisticians associated with the BSD would have been from direct photon exposure. The default photon energy distribution associated with the cobalt-60 and cesium-137 sources used would be 100% in the higher-energy classification of > 250 keV.

7.3.1.2 History of Whole-Body External Monitoring

As of November 20, 1951, all regular workers on the ORNL site, regardless of work area, were required to wear a combination security badge and film dosimeter called a photobadge (ORAUT-TKBS-0012-6). The photobadge was a four-element film dosimeter that was exchanged quarterly during the period of this evaluation. This dosimeter had four shields (plastic, copper, lead, and

cadmium). The intent of the design was to enable depth-dose measurements in accordance with National Bureau of Standards (NBS) Handbook 59. However, no serious attempt was made to utilize the full capability of the multi-filter badge until the beginning of the second half of 1956. At that time, four depth-dose quantities were considered: a skin dose, a moderately penetrating dose, a lens-of-the-eye dose, and a penetrating dose. No routine determination of skin dose was made because the element was behind an effective density-thickness of approximately 80 mg/cm^2 (ORAUT-TKBS-0012-5).

A film dosimeter designated ORNL Model I was introduced in the late 1950s (and used during the time period evaluated in this report). This dosimeter employed open-window filters consisting of plastic, aluminum, and cadmium (gold foils were included in the cadmium element for use in the event of an accident-level neutron exposure).

7.3.1.3 Dosimetry Records

The *Technical Basis Document for the Oak Ridge National Laboratory—Occupational External Dose*, ORAUT-TKBS-0012-6, provides information regarding dosimetry records for the period under evaluation. Dosimetry records available to NIOSH include original handwritten annual exposure record cards, divided into quarterly exchange cycles. ORNL consistently differentiated dosimeter results that were less than limits of detection from non-monitored periods through the use of zero readings (or other indication) or by leaving the record field blank, respectively. However, the practice of recording zeros for values less than reporting levels did not necessarily apply to all fields for a given record (e.g., if the open-window reading for a monitoring period was recorded as zero, the S field would typically be blank – zeros were not duplicated across all fields). Based on the availability of personnel monitoring data, NIOSH has concluded that external dose can be reconstructed using individual monitoring data for members of the proposed worker class evaluated in this report.

7.3.1.4 Application of Co-Worker Data for External Dose Reconstruction

There is sufficient co-worker data available from both routine monitoring and from workers who may have been near the June 1958 Y-12 criticality incident. These data are provided in referenced documents and are applicable to perform dose reconstructions for the class (ORAUT-TKBS-0012-6; ORAUT-TKBS-0014-6; ORAUT-OTIB-0020; ORAUT-OTIB-0021; ORAUT-OTIB-0057). The availability of the co-worker data support NIOSH's ability to establish a bounding external exposure scenario for the proposed worker class evaluated in this report.

7.3.2 Ambient Environmental External Doses from BSD Operations at Y-12

Contributions to external dose from ambient environmental radiation would be accounted for in the occupational dose from film badge evaluations. Because all ORNL employees were required to wear external exposure dosimetry, no further evaluation of ambient environmental external radiation dose was performed.

7.3.3 BSD Operations (at Y-12) Occupational X-Ray Examinations

The procedure *Occupational X-ray Dose Reconstruction for DOE Sites*, ORAUT-PROC-0061, provides specific information regarding exposure from pre-placement, annual, and termination X-ray

examinations required as a condition of employment for BSD workers. Based on the availability of data and information associated with occupation medical X-ray examinations, NIOSH has concluded that external occupational medical X-ray dose can be bounded for members of the proposed worker class evaluated in this report.

7.3.4 External Dose Reconstruction

Through March 28, 2007, there have been two EEOICPA claims from ORNL-BSD (at Y-12) workers that have been submitted to NIOSH. Individual dose reconstructions have been completed for both claims.

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

- Photon Dose
- Electron Dose
- Neutron Dose
- Unmonitored Individuals Working in Production Areas
- Medical X-ray

7.3.4.1 Photon Dose

Standard external dose reconstruction practices can be employed for dose reconstruction using individual dosimeter results and by assigning missed dose to each non-positive dosimeter cycle in accordance with applicable TBDs and OTIBs (ORAUT-TKBS-0012-6; ORAUT-OTIB-0004; ORAUT-OTIB-0020; ORAUT-OTIB-0021; ORAUT-OTIB-0057).

7.3.4.2 Electron Dose

As discussed in Section 5.0, although it is not expected that beta radiation would be a significant exposure concern or contributor to the personnel dose for the worker class evaluated in this report, dosimeters used during the time period under evaluation included an open window for assessing shallow dose from electrons. Individual dosimeter results may be used to reconstruct skin dose when applicable (ORAUT-TKBS-0012-6; ORAUT-OTIB-0017).

7.3.4.3 Neutron Dose

The only source of neutron exposure for BSD workers was a californium-242 source at the ORNL-BSD facility at Y-12. Neutron doses associated with these exposures, applicable to the proposed worker class evaluated in this report, will be evaluated and assigned in accordance with the methodology described in ORAUT-TKBS-0014-6 (ORAUT-TKBS-0014-6; ORAUT-TKBS-0012-6).

7.3.4.4 Unmonitored Individuals Working in Production Areas

If workers were not monitored for external exposures at Y-12, unmonitored dose may readily be assigned based on the approaches described in the applicable document, *Use of Coworker Dosimetry Data for External Dose Assignment* (ORAUT-OTIB-0020). During the time period covered in this

evaluation, ORNL's practice was to monitor all employees for external exposure. Therefore, NIOSH does not expect that unmonitored dose reconstruction approaches will be necessary for the proposed class evaluated in this report.

7.3.4.5 Medical X-ray

Occupational medical dose can be assigned either through information provided in individual records or by assigning dose as a function of the maximum number of diagnostic X-rays that may have been performed as a condition of employment. Methods for assigning occupational medical dose are detailed in the procedure *Occupational X-ray Dose Reconstruction for DOE Sites*, ORAUT-PROC-0061.

7.3.5 External Dose Reconstruction Feasibility Conclusion

Based on the availability of individual monitoring records, combined with co-worker data when required, NIOSH concludes that it can bound (reconstruct with sufficient accuracy) any contributions to external dose from Y-12 or BSD operations for all members of the proposed worker class evaluated in this report.

7.4 Evaluation of Petition Basis for SEC-00039

The following subsections evaluate the assertions made on behalf of petition SEC-00039 for ORNL-BSD workers at Y-12.

7.4.1 Evaluation of Major Topics Detailed in Petition SEC-00039

The basis for petition SEC-0039 is an unrecorded and unmonitored discrete radiological incident occurring during the first quarter of 1958. The petitioner presented evidence of an incident in the form of medical records documenting one of the proposed class worker's history of a depressed white blood cell count (leucopenia) and one of the same worker's quarterly exposure monitoring records (1st quarter of 1958).

The focus of this evaluation is on reviewing historical documentation relating to incidents that occurred during the time period covered in this evaluation and on verifying petitioner-provided evidence to determine whether the evidence is indicative of an incident. The review and verification process included an evaluation of the Site Description Technical Basis documents for Y-12 and ORNL (X-10) as well as incident reviews for both Y-12 and ORNL. Besides reviewing Technical Basis Documents and incident reports, NIOSH requested Y-12 and ORNL personnel exposure incident records for the period October 1, 1957 through June 30, 1958 (although the specific dates of this evaluation are for the first quarter of 1958). Records from both sites were requested to ensure capture of any incidents that occurred at Y-12 but may have impacted ORNL employees working at Y-12 for the BSD. Additionally, NIOSH reviewed ORNL external radiation exposure monitoring film badges and dosimetry records for BSD workers assigned to Y-12.

The following major topics were detailed in petition SEC-00039. Italicized statements are from the petition; the comments that follow are from NIOSH.

7.4.1.1 Medical Record Results

SEC-00039: *The medical records detailed the identification of a depressed white blood cell count (described as leucopenia in the medical records) for one member of the proposed class. The initial medical identification record of the condition was dated August 1958, was confirmed in September 1958, and was further documented as a continuing medical condition for the next several decades.*

The result of this review did not identify any evidence of a discrete radiological incident involving the ORNL BSD at the Y-12 facility. Furthermore, the medical evidence provided by the petitioner is inconsistent with the well-known effects of an acute radiation exposure.

The threshold for blood changes (changes in the peripheral blood count of the various blood cell types) due to radiation exposure is 25 to 50 rad and the threshold for the hemopoeitic syndrome—defined as one of the three classes of an acute whole-body radiation overexposure affects— is typically 100 to 200 rad from an acute dose. Clinical bone marrow depression occurs at 200 rad. In order to receive such a dose while working with the BSD radiation sources, a worker would have had to remain in the exposure room containing the highest exposure rate source (26.5 rad/h) and be in contact with the source for a full eight-hour work day. However, such a scenario is unlikely because the exposure rooms were equipped with interlocks and administrative controls to prevent such an event from occurring. Furthermore, the petition includes documentation for the primary worker associated with this petition stating that he had no known exposures, such as those described above (Author unknown, 1958).

An acute whole-body radiation dose, sufficient to result in the onset of the hemopoeitic syndrome, would have exceeded the threshold for the other classic symptoms of acute whole-body radiation exposures, including nausea, malaise, and epilation. Such symptoms were not included in the petitioner's medical record, nor is there any indication in the medical notes from the local Oak Ridge physicians involved with the patient at the time of initial illness that a radiation exposure was suspected. Although bone marrow aspirations did show the marrow to be abnormal, it cannot be concluded (without additional symptoms) that the abnormal bone marrow was a result of radiation overexposure. Also, previous studies have documented that after the initial decline, the blood cell counts would return to normal levels over time. Thus, the possibility of receiving a radiation dose from an incident during the first quarter of 1958 that was below the threshold of bone marrow depression, but sufficient to have caused a blood change, is not likely.

In the text, *Introduction to Health Physics,* author Herman Cember provides a graph that represents a study performed on individuals who were closest to the June 1958 criticality accident at Y-12. The graph shows the hematologic effects of radiation overexposure versus a 65-day time period (Cember, 1983, page 182). In addition, the graph shows the average blood cell count for the workers involved in the accident who had received estimated doses ranging from 236 to 365 rads. The various blood cell counts show a distinct decline, reaching minimum count approximately 30 days post-exposure, then recover to near-normal levels over the following 30 days post-exposure.

NIOSH does not find the medical records provided for this petition indicate the occurrence of a discrete, unrecorded incident. This conclusion is based on several factors. First, the primary worker's medical condition was chronic, the condition appears to have been isolated to a single individual (there were no other unusual exposure record investigations), whereas leucopenia is a temporary, not

chronic, symptom of the hemopoeitic syndrome for radiation doses below the threshold of complete bone marrow ablation (400 to 600 rads). Furthermore, the original recorded penetrating dose of 4.4 rem, which was investigated and resultantly changes to zero by the Y-12 dosimetry program (see further discussion below), was nearly an order of magnitude below the minimum level at which acute physiological effects of radiation exposure occur. Finally, it should be noted that the blood condition documented can be the result of a genetic predisposition and can be caused by non-radiological environmental agents, such as benzene exposure.

NIOSH also reviewed a statement within the CATI files, associated with the petitioner's individual claim, regarding the petitioner's involvement in a March 1958 contamination incident that occurred when the petitioner was returning to Y-12 from X-10. NIOSH requested incident reports from both facilities and found no corroborating evidence to support the occurrence of the incident. Thus, the result of the NIOSH review did not identify any evidence to support the basis of a discrete radiological incident involving the ORNL-BSD proposed worker class at the Y-12 facility.

7.4.1.2 Exposure Record Results

SEC-00039: *The exposure record for the health physics monitoring period ending the 14th week of 1958 showed the initially recorded moderately penetrating eye and penetrating doses of 4,350 mrem. However, each had been crossed-out, initialed, and the dose re-entered as "0" for each.*

Issues with errors in the film badge optical density readouts are well-documented. The most common issues are darkening of the film (fogging) from light leaks in the film packaging and/or from excessive humidity. Incident and investigation reports demonstrate that when a worker's film badge for a given monitoring period showed an anomalous result—such as repeated monitoring period results of less than the detection limit followed by a sudden spike in the reported exposure level— an investigation was performed. These investigations included worker interviews to establish whether the worker may have been in an area where an exposure could have occurred, and also included evaluation of the film itself. Because the film badge in use at the time included filters for differentiating photon energies, exposures beneath the filters may be used to determine whether the fogging was the result of a light leak or radiation exposure. Uniform total darkening is indicative of fogging as a result of light leak, which was a relatively common issue with film badge dosimetry. The follow-up steps that were performed for the employee represented in the petition associated with this report were consistent with steps taken/described in the investigation reports. The suspected fogged dosimeter was investigated to determine if the result could have been due to an exposure. Because the investigation results were negative, a dose of zero for the reporting period was entered. Based on a review of the historical exposure records for the petition employee, NIOSH concluded that the investigation and report findings for this situation were consistent with the processes and reporting methods of that period.

NIOSH further investigated the policies in place for revising a worker's dose of record when an anomalous result was identified. The purpose of this additional investigation was to evaluate the frequency of the notations "evidence of light" or "100% fogging" documented in external dosimetry readings for Y-12 and/or ORNL. As part of its investigation, NIOSH performed SRDB and simple internet document searches related to light contamination, due to light leaks, of film badge monitoring devices. A substantial number of documents are available, via the internet, confirming the well-known problem of light contamination of damaged film badges. Common failures included pinholes, tears, or failed adhesives associated with the light seal. The documents discussed in the following

paragraphs provide strong support that erroneous film badge readings and subsequent adjustments were not an unusual occurrence within the ORNL Dosimetry program and that the program documented abnormalities procedurally.

The 1979 *Analysis of External Personnel Monitoring Devices and Data for Oak Ridge National Laboratory Epidemiological Study* is a 246-page Master's thesis in which the author, Bruce Parrish, analyzes the external dose data of individuals who were monitored while working at ORNL from 1943 through 1978. The analysis was conducted to determine the usability and accuracy of accumulated dose data for an epidemiological study. In writing his thesis, Parrish used many documents and interviews with E. D. Gupton, J. R. Muir, and directors of a Dosimetry Assessment Group.

In the "Record Keeping" section of Parrish's thesis (starting on page 126), he presents information from E. D. Gupton's *Methods and Procedures for External Radiation Dosimetry at ORNL* (revised and reissued many times) and *A Progress Report Dealing with the Derivation of Dose Data from ORNL Personnel Exposure Records Applicable to the Mancuso Study* by J.C. Hart in 1966. A 1981 version of Gupton's procedures is available in the SRDB and is discussed below.

Based on information obtained from these documents Parrish wrote:

> *The records of active ORNL employees* [like those of the employee represented in the petition associated with this evaluation] *were reviewed by Gupton in 1961 and changes were made to the data recorded as "less than 30 mrems." Where a person consistently had a recorded dose of "less than 30 mrems", the assumption was made that the correct dose was approximately zero and the "less than 30 mrems" values were changed to zeros. If a person had many doses of less than 30 mrems recorded, but some higher doses, then some of the "less than 30 mrems" values were changed to zeros and others were left as 30 mrems. It was also noted that certain cases of suspected inaccurate readings were changed. An example would be the case of a person whose dose was consistently zero and then had one very high reading followed by zeros again. The assumption was made that the high reading was inaccurate and due to artifacts in the film. In these cases the high reading might be changed to zero.*

This text indicates that changing an abnormally high reading to zero was not an unusual occurrence unique to the records provided for this petition. In addition, this text indicates that the process of changing an abnormally high reading to zero was documented. Parrish's thesis also provides details for all the codes used to record problems with dosimeters and the Dosimetry program. He notes that records of damaged dosimeters were kept and investigated, which is further evidenced by the "Personnel Exposure Supplement" form described in the thesis.

As part of its follow-up investigation, NIOSH attempted to locate and interview individuals regarding the issue of film badge light leaks/contamination and the associated reporting processes. Dosimetry program research for the timeframe evaluated in this report shows that principal oversight of ORNL Dosimetry during this time period was provided by J. C. Hart and E. D. Gupton, who are both deceased. Thus, two former Y-12 and/or ORNL Health Physicists/Health Physics Division employees were contacted. One of the former employees was hired in 1958 and worked primarily as a field survey health physicist. The other former employee worked on the 86" cyclotron in the 1950s, and in 1957 he left Y-12 and attended the Oak Ridge School of Reactor Technology. When he returned to

work in 1958, he accepted a position in the Health Physics Division at Oak Ridge National Laboratory, though he was not involved with the dosimetry side of the department. Neither of the former employees could provide much information regarding the frequency of badge contamination via light leaks. Both men did agree that E. D. Gupton would have been the most knowledgeable regarding the dosimetry practices of the 1950s and 60s (Personal Communication, 2007a; Personal Communication, 2007b).

7.5 Summary of Feasibility Findings for Petition SEC-00039

This report evaluates the feasibility for completing dose reconstructions for BSD employees at Y-12 from January 1, 1958 through June 30, 1958. NIOSH found that the available monitoring records, process descriptions, and source term data available are sufficient to complete dose reconstructions for the proposed class of employees.

Table 7-1 summarizes the results of the feasibility findings at the Y-12 Plant for each exposure source during the time period January 1, 1958 through June 30, 1958.

Table 7-1: Summary of Feasibility Findings for SEC-00039
January 1, 1958 through June 30, 1958

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal	X	
External	X	
- Gamma	X	
- Beta	X	
- Neutron	X	
- Occupational Medical x-ray	X	

8.0 Evaluation of Health Endangerment for Petition SEC-00039

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. Section 83.13 requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

This evaluation consisted of historical site operations reviews, source and exposure scenario evaluations, exposure monitoring reviews, and determining the applicability of technical basis

documents and technical information bulletins for the purpose of determining the probability of an undocumented radiological incident having occurred. NIOSH's evaluation did not identify any direct or anecdotal evidence that such a discrete radiological incident occurred. NIOSH determined that it is feasible to estimate radiation dose for members of the proposed class with sufficient accuracy based on the sum of information available from available resources. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is not required.

9.0 NIOSH-Proposed Class for Petition SEC-00039

Based on its research, NIOSH reduced the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all statisticians who performed statistical analysis of biological experiments (working within the Oak Ridge National Laboratory Biological Sciences Division) in all locations at the Y-12 Plant in Oak Ridge, Tennessee, who were employed by DOE or its contractors between January 1, 1958 and June 30, 1958. The time period of the class was reduced because of the petition basis that one or more members of the class might have incurred a high level radiation dose from an unmonitored exposure incident in the first or second quarter of 1958.

For the purpose of ensuring that the review associated with this evaluation was adequate to address the affidavit statements that were provided in the petition as evidence of a radiological incident, this evaluation includes the review of Y-12 and ORNL (X-10) incident reports for the period from October 1, 1957 through June 30, 1958.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Data Base (SRDB), for information relevant to SEC-00039. 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 that it would be feasible to reconstruct the dose for the class proposed in this petition.

10.0 References

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