SEC Petition Evaluation Report
Petition SEC-00225

Report Rev Number:	0
Report Submittal Date:	September 8, 2015
Subject Expert(s):	Roger Halsey, Mutty Sharfi
Site Expert(s):	N/A

Petition Administrative Summary
Petition Under Evaluation

Petition Number:	SEC-00225
Petition Type:	83.13
Petition Receipt Date:	February 24, 2015
Qualification Date:	May 5, 2015
DOE/AWE Facility Name:	Blockson Chemical Co. (Building 55 and related activities)

Petition Class

Petitioner-Requested Class Definition:	All maintenance and operations personnel who worked in any area at Blockson Chemical Co. in Joliet, Illinois, from July 1, 1960 through December 31, 1991.
Class Evaluated by NIOSH:	All employees who worked in any area at the Blockson Chemical Co. site in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991.
NIOSH-Proposed Class(es) to be Added to the SEC:	None

Related Petition Summary Information

SEC Petition Tracking Number(s):	SEC-00045 SEC-00058
Petition Type:	83.13
DOE/AWE Facility Name:	Blockson Chemical
Petition Status:	SEC-00045: Merged into SEC-00058 SEC-00058: Class added to the SEC for March 1, 1951 through June 30, 1960

Related Evaluation Report Information

Report Title:	SEC Petition Evaluation Report for Petition SEC-00058
DOE/AWE Facility Name:	Blockson Chemical

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Evaluation Report Summary: SEC-00225, Blockson Chemical Co.

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-00225 was received on February 24, 2015, and qualified for evaluation on May 5, 2015. The petitioners requested that NIOSH consider the following class: *All maintenance and operations personnel who worked in any area at Blockson Chemical Co. in Joliet, Illinois, from July 1, 1960 through December 31, 1991*.

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class to include all employees. NIOSH evaluated the following class: All employees who worked in any area at the Blockson Chemical Co. site in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has obtained personnel bioassay monitoring data from the production period prior to the period under evaluation, and workplace radiological survey data, airborne particulate data, and radon data from the period under evaluation. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of maximum dose. 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 evaluated class under plausible circumstances during the specified period.

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

- NIOSH finds that it is not applicable to reconstruct occupational medical dose for Blockson Chemical Co. during the period under evaluation. Medical X-rays are not required to be considered during a residual radiation period.

- Principal sources of internal radiation for members of the proposed class included exposures to natural uranium and thorium (and their progeny) through inhalation or ingestion of surface or airborne contamination.

- NIOSH has obtained personnel bioassay monitoring data from the production period prior to the period under evaluation, and workplace and air monitoring data from the period under evaluation to allow it to reconstruct with sufficient accuracy the internal doses from natural uranium and thorium and their progeny, for Blockson Chemical Co. workers during the period from July 1, 1960 through December 31, 1991.

- Principal sources of external radiation for members of the proposed class included exposures to surfaces contaminated with natural uranium and thorium (and their progeny) and submersion in re-suspended surface contamination.

- NIOSH has found no external personnel monitoring data for the period under evaluation. NIOSH has obtained workplace radiological survey data and site source-term information to allow it to reconstruct with sufficient accuracy the external doses from natural uranium and thorium and their progeny, for Blockson Chemical Co. workers during the period from July 1, 1960 through December 31, 1991.

Health Endangerment Determination

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

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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: Roger Halsey, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any area at the Blockson Chemical Co. site (also referred to as Blockson) in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.[2]

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

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

[1] DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).
[2] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at http://www.cdc.gov/niosh/ocas.

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 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 the petitioner(s) and the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[3]

3.0 SEC-00225, Blockson Chemical Co. Class Definitions

The following subsections address the evolution of the class definition for SEC-00225, Blockson Chemical Co. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

NIOSH previously evaluated a class of employees for the facility under petition SEC-00058, which included: All Atomic Weapons Employer employees who worked at the Blockson Chemical Company (also known as Olin Mathieson) in Joliet, Illinois, from January 1, 1951 to December 31, 1962 (NIOSH, 2007). The Evaluation Report for SEC-00058 was issued in July 2007. That evaluation was based on uranium production at Blockson ending in March 1962. However, in March 2010, based on additional information regarding the Blockson uranium production and contract periods, the facility listing for Blockson was changed by the Department of Labor (DOL) to an AWE period of 1951 through June 1960. Subsequently, the residual radiation period was changed by NIOSH to July 1960 through March 1, 2011. Thus, this evaluation of SEC-00225 is based on the residual radiation period starting on July 1, 1960 rather than the date of April 1, 1962, as was used in the evaluation of SEC-00058.

In the evaluation of SEC-00058, NIOSH recommended that no SEC class be added. However, the Board disagreed with the NIOSH recommendation and recommended an SEC class be added for all Blockson Chemical Company workers from 1951 through June 30, 1960. The Board's recommendation was based on potential worker exposures to radon in Building 40 during digestion of

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

phosphate rock (ABRWH Transcript, 2010, PDF p. 10). The Secretary of Health and Human Services agreed with the Board's recommendation and the class was added (HHS, 2010).

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00225 was received on February 24, 2015, and qualified on May 5, 2015. The petitioners initially requested that NIOSH consider a class including: *All maintenance and operations personnel who worked in any area at Blockson Chemical Co. in Joliet, Illinois, during the periods 1952 through 1962 and from 1962 through 1991*. The periods initially petitioned included a period of time previously evaluated for SEC-00058. Petition SEC-00225 does not provide new exposure information for the time period already considered in the SEC-00058 evaluation. After NIOSH consultation with the petitioners, they requested that NIOSH consider the following class: *All maintenance and operations personnel who worked in any area at Blockson Chemical Co. in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991*.

The petitioners provided information and affidavit statements in support of the petitioners' belief that accurate dose reconstruction over time is impossible for the Blockson Chemical Co. workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00225 for evaluation:

> *1962-1991: Equipment and production buildings were still on site and workers were still not monitored. There was also a report by Argonne indicating excessive radiation still present in their 1978-1979 study. A 1996 Environmental Protection Agency report to Olin stated radioactive yellow powder, assumed to be yellowcake, was still onsite* (Form B, 2015, PDF p. 8).
>
> (F.1) Basis: NIOSH understands that workers at Blockson Chemical Co. were potentially exposed to phosphate ores containing natural uranium, uranium oxides produced as a result of separations from the phosphate ores, phosphogypsum (waste from acid production that contained small amounts of uranium, radium, and other progeny), and associated radon gas. NIOSH's review of available documentation indicates periods for which NIOSH lacks comprehensive personnel or workplace monitoring data for potential exposures to the residual uranium-related radionuclides.

Based on its Blockson Chemical Co. research and data capture efforts, NIOSH determined that it has access to limited radon, contamination, photon, and alpha and beta measurements for Blockson Chemical Co. workers during the time period under evaluation. However, NIOSH also determined that survey and monitoring records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal and external radiation exposures and radiation doses were not adequately monitored at Blockson Chemical Co., either through personal monitoring or area monitoring. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research for petition SEC-00225, NIOSH modified the petitioner-requested class to include all employees. Therefore, NIOSH defined the following class for further evaluation:

All employees who worked in any area at the Blockson Chemical Co. site in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991.

3.3 NIOSH-Proposed Class to be Added to the SEC

NIOSH has obtained monitoring records, survey data, process descriptions, and source term data. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding Blockson Chemical Co. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of Blockson Chemical Co. documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document. As part of NIOSH's evaluation detailed herein, it examined the following TBD for insights into Blockson Chemical Co. operations:

- *Technical Basis Document for Atomic Energy Operations at Blockson Chemical Company, Joliet, Illinois*, DCAS-TKBS-0002, Rev. 04; May 19, 2014; SRDB Ref ID: 143289

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 as part of its evaluation:

- *TIB: Lung Dose Conversion Factor for Thoron WLM*; DCAS-TIB-0011, Rev. 4; May 1, 2013; SRDB Ref ID: 126391
- *TIB: Estimation of Ingestion Intakes*; OCAS-TIB-009, Rev. 0; April 13, 2004; SRDB Ref ID: 22397
- *OTIB: Characterization of Occupational Exposures to Radium and Radon Progeny During Recovery of Uranium from Phosphate Materials*; ORAUT-OTIB-0043, Rev. 00; January 6, 2006; SRDB Ref ID: 22596
- *OTIB: Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*; ORAUT-OTIB-0070, Rev. 01; March 5, 2012; SRDB Ref ID: 108851
- *OTIB: Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium* Compounds; ORAUT-OTIB-0024, Rev. 00; April 7, 2005; SRDB Ref ID: 19445

4.3 Facility Employees and Experts

To obtain additional information in support of its 2007 evaluation of petition SEC-00058, NIOSH interviewed five former Blockson Chemical Co. employees and participated in Worker Outreach meetings on January 24-25, 2007 (Worker Outreach, 2007a,b) and a Town Hall meeting on September 12, 2007 (Worker Outreach, 2007c). Details regarding these interviews can be found in the SEC-00058 Blockson Chemical Co. evaluation report (NIOSH, 2007). Additional interviews for the specific purpose of supporting this SEC-00225 evaluation were not considered likely to produce new information for the period under evaluation. Additional interviews were therefore not conducted.

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 August 19, 2015)

Table 4-1: No. of Blockson Chemical Co. Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	143
Total number of claims submitted for energy employees who worked during the period under evaluation (July 1, 1960 through December 31, 1991)	130
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 DOL for final approval).	127
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	0

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. NIOSH has obtained no personnel external monitoring data for any Blockson Chemical Co. claimants. NIOSH has no internal personal monitoring data for the period under evaluation. However, uranium bioassay data are available for a number of workers from 1954 through 1958.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. There were 1,141 documents and sub-documents in this database in 285 separate files that were identified as pertaining to Blockson Chemical Co. These documents were evaluated for their relevance to this petition. The documents include historical background on the contracts held with the AEC, the chemistry of the phosphate process at Blockson and of phosphate production in general, data on phosphogypsum piles produced from Florida phosphate ores, statements from former workers on conditions and processes, and exposure conditions pertaining to the production of phosphates. In addition, some documents contained survey data at Blockson during the residual period in 1978, 1983, 1993, and 1997-1998.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Form B-83.13 with Attachments*; received February 24, 2015; DSA Ref ID: 120775
- Various correspondence from members of Congress; November and December 2014; DSA Ref ID: 120778, PDF pp. 1-3
- Select sections (as provided by petitioners) of SCA-SEC-TASK5-0063 document; July 18, 2008; DSA Ref ID: 120778, PDF pp. 4-6
- *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*; NIOSH; August 2011; DSA Ref ID: 120778, PDF pp. 7-16
- *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*; NIOSH; December 2006; DSA Ref ID: 120778, PDF pp. 17-25
- *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*; NIOSH; 2009; DSA Ref ID: 120778, PDF pp. 26-33
- Select pages from larger untitled documents; both recognized as from the routinely issued NIOSH *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*, one page from the 2008 report (NIOSH, Oct2008, PDF p. 65) and one page from the 2011 report (NIOSH, 2011, PDF p. 60); DSA Ref ID: 120778, PDF pp. 34-36
- Untitled document; January 10, 2014; DSA Ref ID: 120778, PDF p. 37

- Correspondence to Congressman regarding EEOICPA claim; date not provided; DSA Ref ID: 120778, PDF pp. 38-42

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at Blockson Chemical Co. from July 1, 1960 through December 31, 1991 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 the available information.

5.1 Blockson Chemical Co. Plant and Process Descriptions

The Blockson Chemical Company is a chemical plant that occupied approximately 1,000 acres adjacent to the Des Plaines River in Joliet Township, Illinois (EPA, 1993). The plant produced technical grades of sodium phosphate compounds, such as disodium and trisodium phosphate, from phosphate rock obtained from Florida sources. The naturally-occurring uranium content of the phosphate rock averaged about 0.014% U_3O_8 (Stoltz, 1958). For the period evaluated by NIOSH, the Blockson workforce consisted of approximately 600 workers. A "Seniority List" provided by a former Blockson employee at the January 23, 2007 Worker Outreach meeting, showed 420 employees as of May 1966, not including administrative staff (Seniority List, 1966). During this same meeting another former employee stated the total number of employees as 600 (Worker Outreach, 2007b).

In the early 1950s, the U.S. Atomic Energy Commission (AEC) approached Blockson Chemical Company about the possibility of recovering uranium from the phosphate rock they processed commercially (Stoltz, 1958). On March 6, 1951, the AEC entered into contract with Blockson Chemical Company to develop a process to extract uranium from wet phosphoric acid which was produced as an intermediate step in the commercial production process (Authority Review, no date, PDF p. 80**)**. Blockson then constructed Building 55 to house uranium recovery equipment at the Blockson plant in Joliet, Illinois. On August 15, 1952, Blockson began production and delivery of uranium concentrates to the AEC (Stoltz, 1958). From September 1952 through June 1960, a total of 118.3 tons of U_3O_8 was produced for the AEC (Receipts, 1953-1963). In 1955, Blockson Chemical Company was sold to the Olin Mathieson Chemical Corporation, which assumed the liabilities and obligations under all Blockson contracts.

To implement the AEC contract Blockson modified both the calcining operation and the acid digestion in Building 40 to maximize the amount of uranium that ended up in the material that went to Building 55. The phosphoric acid partitioned about 85% of the uranium while the phosphogypsum partitioned most of the calcium and radium (Block, 1951, PDF p. 9; Stoltz, 1958). "Phosphogypsum" is the name of the solid gypsum byproduct produced during the digestion of the phosphate ores. At Blockson, this was filtered from the liquid phosphoric acid and sent to a 227-acre waste storage area, termed the "phosphogypsum stack" (EPA, 1993).

In the final packing areas within Building 55, the uranium compound was dried and packaged in drums for shipping, resulting in a potentially-dusty operation. Yellowcake concentrations in the product delivered to the AEC was estimated to be 40% - 60% (DCAS-TKBS-0002, PDF p. 31). Former employees describe the drum-loading process as shaking the uranium out of the drying pans into a cone-shaped funnel through which the uranium went down into the drums. They also describe the use of a dust collector over the drumming station and provided a photo of the drumming station with the filtration unit shown (Worker Outreach, 2007a).

After the contract ended in June 1960, Blockson continued to process the Florida phosphate ores for commercial use well into the 1970s. Building 55 was used for processing phosphate products through 1978 (FUSRAP, 1978, PDF p. 6). There is also a reference in a 1983 report indicating the same building housed a disodium phosphate operation (Marseglia, 1983, PDF p. 7). The plant ceased production on June 28, 1991, (EPA, 1993) and Building 55 was demolished in 1996 (Radiation Safety Associates, 1996).

5.2 Radiological Exposure Sources from Blockson Chemical Co. Operations

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

After AEC-related operations ceased in June 1960, Blockson employees may have been exposed, during the site residual radiation period, to residues from the previous AEC work. During the period under evaluation, from July 1, 1960 through December 31, 1991, the primary source of residual radiation exposure was from residues containing naturally-occurring radioactive constituents, primarily uranium and associated progeny. Smaller amounts of natural thorium and thorium progeny were also present.

Residues remaining after outdoor calcining operations would have had the same 0.014% of U_3O_8 as the calcined ore and, due to the small volume of calcining residue, would have contained relatively small amounts of radioactivity when compared to uranium oxide residues that would be expected in Building 55 processing areas. Dose from AEC-related residues in Building 55 is therefore considered bounding.

Materials were also pumped into and out of Building 40 during AEC operations and included an open-to-the-air tank where the ores were digested. During production, radon may have been released from this tank during the acid digestion of the ores, and was an exposure concern during AEC-related operations (NIOSH, 2007). Any radon exposure occurring onsite during the period under evaluation is considered bounded by radon levels over the phosphogypsum pile. The pile contained radon-producing radium as a result of both commercial and AEC-related activities, cumulative over the lifetime of the phosphate plant.

For both the calciner and Building 40, once operations for AEC ceased, materials for commercial operations immediately replaced previous process materials. During the AEC production period, the plant processed an average of about 6,000 tons per week of phosphate ores (DCAS-TKBS-0002, PDF p. 10) and it is assumed that commercial production continued at similar rates. Residues for the AWE period at the calciner and in Building 40 would have been significantly diluted by phosphate processed every week after AEC operations ceased. Additionally, it was plant policy that all buildings were swept and washed down daily (Worker Outreach, 2007a).

A significant issue for the evaluation of employee exposure at Blockson is that commercial operations occurred prior to and after the AEC work, including processing Florida phosphate ores. In 1978, Building 55 was being used for "processing of phosphate products from ground phosphate rock from Florida" (FUSRAP, 1978, PDF p. 6), and in 1983 it housed a disodium phosphate operation (Marseglia, 1983). These commercial operations created increased ambient gamma exposure, radon levels, and airborne radioactivity. These operations generated exposure conditions and contamination that are indistinguishable from residues and conditions arising from the AEC work, with one exception being that Blockson is not known to have concentrated or separated uranium from their process materials other than during the period when they were under contract to the AEC.

Ambient conditions measured at Blockson during the residual radiation period are a result of both commercial and AEC-related activities. For the purposes of this evaluation report, some of the evaluated dose includes measurements taken during the residual radiation period that would have included contributions from both residual AEC-related exposures and exposures from commercial operations.

5.2.1 Internal Radiological Exposure Sources from Blockson Operations

Potential internal exposures at Blockson during the residual radiation period include inhalation and ingestion of resuspended natural uranium and thorium (and their progeny), and associated nuclides from residues in Building 55. The longer-lived nuclides of concern are grouped into categories based on their expected relative activities in the residues.

5.2.1.1 U-238, Th-230, U-234, Pb-210, Po-210

This group contains nuclides that were in equilibrium with U-238 in the original ores. The process operated with an overall yield of 85% for uranium (Block, 1951, PDF p. 9). This would indicate that 85% of all uranium isotopes, including U-238 and U-234, that were present in the ores went to the purified materials that were produced, primarily uranium oxides by mass.

Although some data exist regarding the fate of various elements in a wet-phosphorus process, the actual fraction of each of the progeny that resulted in the final product is not available. A conservative assumption is made that Th-230, Pb-210 and Po-210 went to the material as well at the same yield (DCAS-TKBS-0002). This would give a 1:1 activity ratio for the nuclides in this group when compared to U-238.

5.2.1.2 Th-231, Pa-231, Ac-227

This group contains nuclides expected to be in equilibrium with U-235. U-235 was present relative to U-238 at the naturally occurring activity ratio of 1:0.045. Each of the U-235 progeny was in equilibrium with U-235 in the original ores. A conservative estimate is made that Th-231, Pa-231, and Ac-227 went to the final product at the same yield as U-238. This would give a 1:0.045 activity ratio for these when compared to U-238 in the final product (DCAS-TKBS-0002).

5.2.1.3 Ra-226, Rn-222

Virtually all of the Ra-226 was removed from the phosphoric acid with the phosphogypsum, which was disposed in the phosphogypsum stack. Various publications have reported differing fractions that remain in the phosphoric acid. One publication, *Uranium and Radium-226 in Florida Phosphate Materials*, reported 1% reports to the acid (Roessler, 1979). Other studies have reported virtually no

radium reports to the acid, while some have reported more. *Radiochemistry of Florida Phosphogypsum* reports that 4% of Ra-226 went with the phosphoric acid (Hull, 1995, PDF p. 12).

For this evaluation, a value of 4% is used as the fraction of Ra-226 that results in the final product for an activity ratio of 1:0.04 when compared to U-238. Note that gamma spectroscopy of residue samples collected by Argonne National Laboratory (ANL) during a survey of Building 55 under the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1978 did not detect Ra-226 in samples collected inside Building 55 (FUSRAP, 1978). One sample collected on the roof of Building 55 indicated the presence of Ra-226 (FUSRAP, 1978, PDF pp. 19-20).

Bounding Rn-222 exposures during the residual radiation period at Blockson is presumed to be from Rn-222 released from the phosphogypsum stack, as it contained nearly all of the Ra-226 processed during the lifetime of the plant, including any during AEC production.

5.2.1.4 Th-232, Ra-228, Th-228

Th-232 was present in the Florida phosphate ores at activity concentrations approximately 1:30 compared to U-238 (DCAS-TKBS-0002, PDF p. 15). Although some references show that thorium was present in the phosphoric acid at fractions smaller than uranium (Roessler, 1979), a conservative assumption is made that it was removed at the same rate as uranium. This would result in an activity ratio in the final product of 1:30 when compared to U-238 for these nuclides. All Th-232 decay progeny are assumed to be in equilibrium with Th-232 during the residual radiation period.

5.2.2 External Radiological Exposure Sources from Blockson Operations

The external exposure sources for the residual radiation period included exposure from surfaces contaminated with natural uranium and thorium (and their progeny), submersion in re-suspended surface contamination, and exposure to stored material and equipment. Residues remained after operations ceased in Building 55. Although the majority of locations measured in 1978 by ANL detected no increased ambient photon or beta radiation, loose material was located in two locations that were confirmed to contain uranium and the short-lived Pa-234m, a nuclide that is found in equilibrium with uranium after separation from decay progeny (FUSRAP, 1978, PDF pp. 42-51). For this evaluation, following the method developed in DCAS-TKBS-0002, an assumption is made that uranium, thorium, and all of their respective decay progeny would have been present in building residues.

5.2.2.1 Photon

Most of the nuclides in the uranium and thorium decay chains emit photons at varying levels of production and at varying energy levels. Radium-226 was a significant source of external exposure to Blockson employees. Other photon-emitting uranium progeny from the uranium and thorium decay chains were present and contributed to the penetrating photon exposure.

5.2.2.2 Beta

There are a significant number of high-energy beta radiations that represent a shallow dose exposure concern for those in close contact with residues. Pa-234m is the primary source of external beta exposure. Other beta-emitting progeny from both the uranium and thorium decay chains were present and contributed to the beta exposure.

5.2.2.3 Neutron

There is no indication that personnel monitoring for neutrons was performed at Blockson. Technical Information Bulletin ORAUT-OTIB-0024 describes the expected neutron dose rates from the various forms of uranium compounds. In Table 5-2 of that document, the listed neutron dose rate at three feet from a source of natural uranium (U_3O_8) is 8.79E-13 R/hr-gram, assuming no presence of alpha-emitting progeny (Roessler, 1979 from SEC-00058). Assuming both that a drum of yellowcake weighs 1000 pounds, and 2000-hour occupancy, the estimated annual neutron dose would be <0.001 rem. Consistent with the findings of NIOSH's 2007 evaluation of SEC-00058, this level of exposure is insignificant for purposes of dose reconstruction, and neutron exposures are not considered for the period under evaluation herein.

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 Blockson Chemical Co. class under evaluation.

6.1 Available Blockson Chemical Co. Internal Monitoring Data

Available internal monitoring data at Blockson Chemical Co. includes employee bioassay data, air sampling data, and removable surface contamination data. Details regarding the various analyses used are presented in DCAS-TKBS-0002.

6.1.1 Employee Bioassay Data

No bioassay data have been located for the period under evaluation during the Blockson residual period. However, as presented in NIOSH's 2007 evaluation of the AWE operations period (NIOSH, 2007), 122 urine sample results from the Blockson Chemical Co. AWE production period, with results ranging from 0 to 17 micrograms of uranium per liter, have been found in reports from the AEC New York Operations Office (NYOO), Health and Safety Division. The urinalysis results were obtained from 25 different employees between the years 1954 and 1958, with the analyses performed by fluorimetry (Monitoring, 1956-1958). Of the 25 employees, 19 employees had multiple bioassay results, with 6 employees having a single sample result reported. Some of the names on the urinalysis reports have been matched with names of employees known to have performed specific jobs during times of uranium recovery work in Building 55. Some of these employees were also interviewed by NIOSH to confirm the work they performed in Building 55 (Worker Outreach, 2007b).

6.1.2 Air Sampling Data

Radon

From March 27, 1978 through November 28, 1978, ANL personnel surveyed Building 55 for possible remediation under the FUSRAP (FUSRAP, 1978). Air samples were collected on the roof of Building 55 and at four locations within the building: two on the first level, one in the lab on the second level, and one above the "Kelly feed tanks" on the third level. The samples were collected on a "200 cm^2 sheet of Hollingsworth-Vose (HV-70-0.23 mm) filter paper" and had a stated efficiency of 99.9% for 0.3 micron particles. Each sample was counted three times in a 2-pi, gas-flow proportional counter, soon after collection finished, again at 100 minutes, and a final count. The timing of the last count

was not stated but was evidently well after the decay of any radon progeny (FUSRAP, 1978, PDF p. 17). No long-lived alpha activity was detected on any of the air samples. Table 6-1 lists radon levels for the five locations.

Table 6-1: Building 55 Radon Results for 1978 Air Samples

Sample Number	Location	pCi/l	Working Level (WL)
1	1st Level	0.26	0.0026
2	3rd Level	0.25	0.0025
3	Roof	0.14	0.0014
4	1st Level	0.61	0.0061
5	2nd Level	0.47	0.0047

Source: FUSRAP, 1978, PDF p. 57

In 1983, Olin Mathieson Chemical Corporation undertook a series of air samples at locations across the Joliette facility (Marseglia, 1983). Personnel breathing zone samples for 11 individuals and one high-volume sample were analyzed for alpha activity. Ten air samples were collected for radon analysis at locations inside and outside of the buildings. Although Building 55 is not listed, NIOSH has information that indicates Building 55 may have also been called Building 60 and contained the disodium phosphate filtration process (Allison, 1998, PDF p. 324). The sample for "60 DSP" may indicate that the sample was collected in Building 55. Three samples had "40" as part of their location and appear to be for building 40. Few details were included in the memo but the analysis included a single count, delayed after collection by times varying between 40 and 86 minutes. One filter, taken at the "STPP" location, gave 18 counts per 5 minutes and was estimated to be 4.2 E-03 working levels (WL) of radon daughters (Marseglia, 1983). All other remaining filter counts were much less.

In 1993, Olin made radon emanation measurements for the Blockson phosphogypsum pile. The weighted mean radon flux for the total stack area was reported to be 4.4 pCi/m^2-s, with the sides of the stack having the highest mean value of 10.1 pCi/m^2-s (DCAS-TKBS-0002, PDF p. 38).

Alpha Activity in Air

As part of ANL's analysis of the air samples used to measure radon daughter levels, the FUSRAP report used a "last count" to assure no long-lived alpha activity interfered with the radon result. No long-lived activity was found on any filter for this last count.

The previously mentioned 1983 Olin surveys reported alpha activity on air filters that were collected from 11 individual breathing zone samplers and from one high-volume area sampler. The sample for Building 55 (Building 60) has a value of less than 1.12E-12 uCi/ml (Marseglia, 1983). All other personal air sample results were reported as "less than" values. The report states that these "less than" values, including the one listed for Building 55, are calculated from the instrument sensitivity and air volume collected; no activity was detected within the sensitivity of the instruments used. The high-volume air sample was reported as 2.75 E-13 uCi/ml. Table 6-2 shows gross alpha results. Note that the operations listed are taken verbatim from the report; although some terms and abbreviations can be readily interpreted such as TSP for trisodium phosphate and MSP for monosodium phosphate, there was no explanation included for the abbreviations used.

Table 6-2: Gross Alpha Sample Results, 1983

Operation	Total Dust Conncentration (mg/m^3)	uCi/ml
91 oper., SSF	1.84	<8.21 E-13
41, oper., Gyp, TRP, etc.	1.12	<1.00 E-12
71 Bin man, TSP	4.04	<9.90 E-13
160-A,Tripoly A	1.21	<8.3 E-13
81, TSP-Cl	6.37	<1.7 E-12
200, SF	1.55	<9.6 E-13
50, MSP	0.99	<9.8 E-13
40, phosphate	2.22	<1.1 E-12
60 DSP	1.57	<1.12 E-12
40, Filtration Platform	1.58	=2.75 E-13
Hygrade	2.12	<9.0 E-13
Hygrade	1.57	<1.0 E-12

Source: Marseglia, 1983, PDF p. 7
Note: "Less than" values are reported based on the analytical sensitivity and different volumes of air collected for each sample. Only one high volume air sample is reported as an actual concentration.

6.1.3 Removable Surface Contamination Data

The 1978 FUSRAP survey found elevated levels of radioactivity at 47 “spots or localized areas” within Building 55, as well as on the roof of Building 55. In addition, 11 general areas were described as “slightly above the determined background” (FUSRAP, 1978, PDF p. 19). Contamination was found on the floors, building support beams, and in process equipment. Smears were taken in 34 locations. Radioactive contamination was detected on 15 smears with levels up to 850 disintegrations per minute per 100 cm^2 for beta contamination and 640 disintegrations per minute per 100 cm^2 for alpha contamination. The instrument background for the counter used to measure the smear contamination was included in the FUSRAP report. The counter used was a “Nuclear Measurements Corporation PC-5 2π Internal Gas-Flow Counter” with an alpha background of 0.2±0.1 counts per minute and a beta background of 40.0±1.4 counts per minute.

Samples of loose material at two locations within Building 55 and one from the exterior roof were analyzed by gamma spectroscopy. One sample was described as a yellow powder. Both samples from inside the building were described as normal uranium, uranium in natural equilibrium without uranium progeny. The sample from the roof included normal uranium and radium. The spectra for these samples were included in the FUSRAP report (FUSRAP, 1978, PDF pp. 41-43).

Outside the scope of this evaluation, NIOSH has also obtained two sets of data from 1996, after the end of the NIOSH-evaluated class. Radiation Safety Associates, Inc., under contract with Olin Mathieson Chemical Corporation, performed radiation surveys in Building 55 (Radiation Safety Associates, 1996). Environment 2000, Inc. reported results to Olin Corporation as part of a plant survey (Monitoring, 1996).

6.2 Available Blockson Chemical Co. External Monitoring Data

Available external monitoring data at Blockson Chemical Co. includes workplace contamination and radiation level survey data. Details regarding the various analyses used are presented in DCAS-TKBS-0002.

6.2.1 Employee Monitoring Data

No personal external monitoring data have been located for Blockson employees during either the AWE production period or during the residual radiation period.

6.2.2 Ambient Photon Measurements

In the 1978 FUSRAP report, results from "a radiological survey of all accessible floors and original interior wall surfaces to a height of 2 m (7 feet)" (FUSRAP, 1978, PDF p. 15) indicated elevated levels of radioactivity at 47 spots or localized areas and 11 general areas at locations throughout Building 55 and on the roof. Ambient photon measurements were made at these locations. Thirty-two of the areas gave Geiger-Mueller (GM) End Window exposure readings at contact ranging from just distinguishable from background to 7 mR/h. Seven GM End Window readings taken at 1 m (3 feet) were distinguishable from background, the highest being 0.2 mR/h (FUSRAP, 1978, PDF p. 6). The 1978 report includes readings for 70 locations, some of which reflect readings for larger areas (FUSRAP, 1978, PDF pp. 44-51).

As previously stated in Section 6.1, NIOSH has also obtained two sets of data from 1996, after the NIOSH-evaluated class (Radiation Safety Associates, 1996; Monitoring, 1996). These surveys also contain radiation level survey data outside the scope of this evaluation.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the class of employees under evaluation in this report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to estimate the maximum radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class, or to estimate the radiation doses to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00225 as submitted by the petitioners. (Section 7.4)

7.1 Pedigree of Blockson Chemical Co. Data

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

7.1.1 Internal Monitoring Data Pedigree Review

7.1.1.1 Bioassay Data

As presented in Section 6.1.1 above, the site obtained one hundred twenty-two uranium fluorimetry urine sample results from 25 different employees between the years 1954 and 1958 (Monitoring, 1956-1958), with the results ranging from 0 to 17 micrograms of uranium per liter. These samples were requested by Blockson and analyzed by the AEC NYOO (Barr, 1953).

Of the 25 employees, 19 employees had multiple bioassay results, with 6 employees having a single sample result reported. Some of the names on the urinalysis reports have been matched with names of employees known to have performed specific jobs during times of uranium recovery work in Building 55. Some of these employees were also interviewed by NIOSH to confirm the work they performed in Building 55 (Worker Outreach, 2007b).

7.1.1.2 Radon Data

Blockson site radon data for the period under evaluation have been obtained for the Building 55 processing area, and for the byproduct phosphogypsum stack.

Building 55 and Operations Area Data

From March 27, 1978 through November 28, 1978, ANL personnel surveyed Building 55 for possible remediation under the FUSRAP (FUSRAP, 1978). Air samples were collected on the roof of Building 55 and at four locations within the building: two on the first level, one in the lab on the second level, and one above the "Kelly feed tanks" on the third level. The samples were collected on a "200 cm^2 sheet of Hollingsworth-Vose (HV-70-0.23 mm) filter paper" and had a stated efficiency of 99.9% for 0.3 micron particles. Each sample was counted three times in a 2-pi, gas-flow proportional counter, soon after collection finished, again at 100 minutes, and a final count. The timing of the last count was not stated but was evidently well after the decay of any radon progeny (FUSRAP, 1978, PDF p. 17).

The 1978 report for Building 55 includes the original meter readings used in calculations along with the locations. Maps are included in the report showing the locations of data collected. An instrument section is also included in the report that lists the models, technical specifications, background levels, calibration data, and specific inventory numbers of each instrument (FUSRAP, 1978, PDF p. 64). Conversion factors are included for the survey results to calculate area contamination in consistent units of 100 cm^2 based on probe areas and efficiencies (FUSRAP, 1978, PDF p. 56). Calculations used to derive radon concentrations are included along with a sample calculation for one location (FUSRAP, 1978, PDF p. 70).

Olin Mathieson Chemical Corporation also had radon progeny measurements taken at Blockson in 1983 during plant operations (Marseglia, 1983, PDF p. 6). The highest radon value during that survey was reported to be 0.0042 WL from an active work area. Only one measurement was taken from the phosphogypsum area, and it was lower. Measurements were made with a portable Ludlum Model 2000 Scaler with a Model 43-9 detector, calibrated with radium (Marseglia, 1983, PDF p. 9). Data include the sample volume, elapsed sample draw time, and detector counts per unit time.

Phosphogypsum Pile Data

As stated above, Olin Mathieson Chemical Corporation's 1983 radon survey included one measurement at the phosphogypsum pile, with a reading less than the maximum 0.0042 WL value obtained (Marseglia, 1983, PDF p. 9). The measurement was performed with the Ludlum instrumentation noted above.

In September 1993, Olin Mathieson Chemical Corporation also had radon flux measurements taken to demonstrate compliance with the EPA's (40 CFR Part 61) 20 pCi/m2-s radon flux limits for inactive phosphogypsum stacks (Monitoring, 1993). Three hundred flux measurements were taken from the phosphogypsum stacks at Blockson during varying weather conditions and at different locations. The weighted mean radon flux for the total stack area was reported to be 4.4 pCi/m2-s, with the sides of the stack having the highest mean value of 10.1 pCi/m2-s. The pile radon flux data were obtained from charcoal canisters exposed for approximately 24 hours. Quality control duplicate and blank samples are included in the dataset. Sample locations are correlated to specific detectors, and sample chains of custody forms are presented.

Texas City Phosphogypsum Pile as a Surrogate for Blockson Phosphogypsum Pile

For correlation with available Blockson radon data, NIOSH has obtained measurements (performed February 1983 through September 1984) of the inactive phosphogypsum stack at the Texas City Chemicals plant (Findings of Fact, 1988). In a 1988 court case, radon data collected at the phosphogypsum pile at the Texas City Chemicals site were presented. The 1983 and 1984 data included a weighted average radon air concentration over the pile, and radon flux emanation rates (Findings of Fact, 1988).

To support correlation of Texas City and Blockson radon flux data, these data were evaluated against OCAS-IG-0004, *The Use of Data from Other Facilities in the Completion of Dose Reconstructions Under the Energy Employees Occupational Illness Compensation Act* (OCAS-IG-004). Section 3 of this procedure lists several criteria that are to be followed when using data from other facilities.

- Source Term

- The phosphogypsum pile at Texas City was produced as a byproduct of wet-process acid digestion of Florida phosphate ore. The phosphogypsum pile at Blockson was also produced as a byproduct from wet-process acid digestion of Florida phosphate ore. The two piles, produced by similar methods and starting from the same ores, may be assumed to have similar concentrations and distributions of radon-producing radium in similar physical and chemical matrices.

- Facility and Process Similarities
  - The Texas City phosphogypsum pile is described in the court records as covering 35 acres and standing 30-feet tall, where Blockson's pile was described by the EPA as covering 227 acres and standing 90-feet tall.

- Temporal Considerations
  - The dates of the Texas City data were 1983 and 1984. The survey of Blockson that provides the comparable emanation parameters was performed in 1993. The Blockson pile had been inactive for two years when the measurements were taken. The Texas City pile had been inactive since 1970 (Findings of Fact, 1988, PDF p. 40). For the periods measured, the Texas City emanation values bound the Blockson Chemical Co. values, and thus the temporal consideration is not an issue for the radon emanation rate.

- Data Evaluation
  - Measurements taken at Blockson were submitted to the EPA to assess compliance with their radon emanation standard for phosphogypsum piles. The Texas City data were collected by EAL Corporation, described in the court documents as "certified by the U. S. Environmental Protection Agency" (Findings of Fact, 1988, PDF p. 5). The methods to measure radon along with the definitions of the values presented and terminology used may be assumed to be similar or identical.

- Review of Bounding Exposure Methods
  - The use of the residue depletion calculation provides realistic and bounding values for radon. The value predicted from the bounding method compares closely to measured data in 1978 and 1983, as described in Section 7.2.2, below.

The available internal monitoring data are sufficient in quantity and quality to adequately represent the class under evaluation.

7.1.2 External Monitoring Data Pedigree Review

NIOSH has not identified any external personnel monitoring data for Blockson employees. There are limited ambient survey data collected by ANL in the form of a FUSRAP Report.

As presented in the radon section above, in 1978 ANL personnel surveyed Building 55 for possible remediation under the FUSRAP (FUSRAP, 1978). The report includes the original meter readings along with maps showing the locations of data collected. Instrument information lists the models, technical specifications, background levels, calibration data, and specific inventory numbers of each

instrument (FUSRAP, 1978, PDF p. 64). Conversion factors are included for the survey results to calculate area contamination in consistent units of 100 cm^2 based on probe areas and efficiencies (FUSRAP, 1978, PDF p. 56). Also in the report is a description of the modified GM probe that was used with a short discussion of the beta response (FUSRAP, 1978, PDF p. 64).

The available external monitoring data are sufficient in quantity and quality to adequately represent the class under evaluation.

7.2 Evaluation of Bounding Internal Radiation Doses at Blockson Chemical Co.

The principal source of internal radiation doses for members of the class under evaluation was exposure to natural uranium and thorium, and their decay progeny (DCAS-TKBS-0002). 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 Residual Period Internal Doses

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

7.2.1.1 Urinalysis Information and Available Data

While no bioassay data have been located for the portion of the residual radiation period under evaluation, 122 urine sample results from the Blockson Chemical Co. AWE production period, with results ranging from 0 to 17 micrograms of uranium per liter, have been found in reports from the AEC NYOO. The uranium fluorimetry urinalysis results were obtained from 25 different employees between the years 1954 and 1958 (Monitoring, 1956-1958). See Section 6.1.1 above for more information. The use of these data for reconstruction of Blockson AWE period exposures is outlined in DCAS-TKBS-0002 and NIOSH's 2007 evaluation of SEC-00058 (NIOSH, 2007).

For the current evaluation of residual radiation period doses from resuspension of production residues, these NYOO data are sufficient to provide a bounding estimate of the initial conditions (daily intake rates) as of July, 1, 1960, immediately after the production period ended. The estimates of initial intake conditions are considered bounding because they are derived using AWE operation period exposure data, representing operational intakes from both AEC-related and commercial operations. The derivation of the initial daily intake rates is presented in Section 7.2.2 below.

7.2.1.2 Particulate

As presented in Section 6.1.3 above, the 1978 FUSRAP survey found elevated levels of radioactivity within Building 55, and contamination was found on the floors, building support beams, and in process equipment (FUSRAP, 1978, PDF p. 19). See Section 6.1.3 for more information.

These data are sufficient to provide an estimate of the radioactivity in air from resuspended loose contamination for 1978, eighteen years into the residual radiation period under evaluation. These data are used in accordance with the methods of DCAS-TKBS-0002 and were found to be favorable when evaluated against the methods described in ORAUT-OTIB-0070, *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, to derive annual intake rate values for the period under evaluation. The estimates of 1978 intake conditions derived from these data are considered bounding because they represent possible resuspension of not only AEC-related

residual contamination, but also residual contamination as a result of Blockson's commercial operations, before, during, and after the site's AWE operational period. The derivation of 1978 daily intake rates is presented in Section 7.2.2 below.

7.2.1.3 Radon

The phosphogypsum stack at Blockson contained the greatest source of radium-226 on site. During Blockson's chemical processes, radium-226 was primarily partitioned to the phosphogypsum and pumped to the byproduct stack for the entire phosphate production period at the plant. Consequently, the phosphogypsum pile at Blockson contained the AEC-related radium disposed between 1951 and June 1960 during AWE operations, as well as all of the commercially-related radium disposed through the life of the site's phosphate operations through 1991. Only doses received from AEC-related residues are required to be assessed during the period under evaluation, starting July 1, 1960. Therefore, radon measurements made directly over the stack are considered to be conservative estimates of contemporary radon conditions anywhere on the site. Additionally, as radon resulting from AEC residues is indistinguishable from radon produced from commercial operations, measurements in later years are considered to indicate radon resulting from AEC operations.

As presented in Section 7.1.1 above, in 1993, to demonstrate compliance with the EPA's 20 pCi/m^2-s radon flux limits for inactive phosphogypsum stacks, Olin Corporation conducted 300 radon emanation measurements for the Blockson pile. The weighted mean radon flux for the total stack area was reported to be 4.4 pCi/m^2-s, with the sides of the stack having the highest mean value of 10.1 pCi/m2-s (Monitoring, 1993, PDF p. 14). NIOSH compared the Blockson radon flux values to flux and radon gas measurements reported from a similar phosphogypsum stack at a phosphate plant in Texas. Note that when these measurements were collected, the stack had been inactive for two years and it had been 33 years after the addition of any phosphogypsum generated during the AWE production period.

In testimony before a U.S. District court, radon data for Texas City Chemicals were presented. Data from 1983 and 1984 showed an average flux of 10.5 pCi/m^2-s at a phosphogypsum pile at the Texas City Chemical site (Findings of Fact, 1988, PDF p. 6). This value corresponds well with the highest mean radon flux value of 10.1 pCi/m^2-s for the Blockson inactive pile. Also presented for the Texas City case were a site background radon concentration of 0.14 pCi/l, and an average over the pile of 0.56 pCi/l (Findings of Fact, 1988, PDF p. 9). Subtracting the background from the average radon concentration gives an average radon concentration value of 0.42 pCi/l over the Texas City phosphogypsum pile. The pile had been inactive for 13 years when these measurements were taken. Referenced in the court case was EPA's research that showed that an inactive phosphogypsum pile forms a crust that reduces the radon emanation by a factor of five (EPA, 1988, PDF p. 12).

The 1993 Olin Corporation radon flux data for Blockson's inactive phosphogypsum pile, combined with the Texas City radon flux and radon concentration data, are sufficient to estimate radon conditions at Blockson on July 1, 1960 and in 1993, providing a framework to interpolate radon levels emanating from the active stack in 1960, assumed to all be from AEC-related waste, to a gradually declining concentration attributed to the buried AEC-related waste, to the inactive stack radon levels in 1993. The derivation of bounding radon conditions for the Blockson phosphogypsum pile is presented in Section 7.2.2 below for the period under evaluation.

7.2.2 Methods for Bounding Residual Period Internal Dose at Blockson Chemical Co.

Resuspension of Residues in Building 55

After the production period ended, employees in Building 55 may have received internal exposure through inhalation or ingestion of uranium oxide residues resuspended into the air through normal activities in the building. Residues would have diminished over time through normal removal mechanisms. Interviews with former workers indicate that housekeeping was performed regularly to reduce material buildup on the floors. According to one former employee, they swept and washed down Building 55 daily, a policy for all buildings (Worker Outreach, 2007a).

Following guidance in DCAS-TKBS-0002, the amount of exposure from the residues is estimated by establishing conditions at the start of the residual radiation period under evaluation on July 1, 1960; and by establishing conditions later in the evaluation period in 1978. These points are used to develop a depletion rate constant, representing the rate of removal of uranium residues as the source of exposure. As the exposure is assumed to be directly proportional to the source term, the calculations for this depletion rate constant are in terms of the final exposure to the worker.

For July 1, 1960, worker exposure is based on an analysis of the Blockson 1954-1958 bioassay data collected during AEC operations for employees in Building 55 who directly handled the uranium oxide materials, including drumming and shipping the final product. In DCAS-TKBS-0002, calculations show the median inhalation rate for these workers was 13 pCi/day of U-238.

For 1978, survey data collected by ANL in a FUSRAP report are used to estimate an air concentration of U-238. The highest concentration of removable contamination in the FUSRAP report was 640 dpm/100 cm^2 of alpha activity. Using a resuspension factor of $1 * 10^{-6}$/m provides an air concentration of 0.029 pCi/m^3. Multiplying by an assumed breathing rate of 9.6 m^3/day results in an inhalation of approximately 0.28 pCi/day of alpha activity. The alpha activity is assumed to be equal amounts of U-238, U-234, and Th-230, giving an estimated daily inhalation of 0.092 pCi/day of U-238.

The equation:

$$I_t = I_0 * e^{-\lambda t}$$

where:

I_t = daily intake rate at time t
t = time (days) since July 1, 1960
I_0 = daily intake on July 1, 1960
e = base of the natural logarithms
λ = exponential constant

is used to calculate a depletion rate constant, λ in the above equation, for the daily inhalation of U-238.

Using 6,483 days for t, the time between July 1, 1960, the start of the residual period under evaluation, the start of the residual radiation period, and April 1, 1978, the date of the survey that identified the alpha contamination, along with 13 pCi/day for I_t and 0.029 pCi/day for I_o, the depletion rate constant

λ is calculated to be 0.000764 days^{-1}. This may be used in the equation above to calculate I_t for 1 year, 2 years, 3, years, etc. after 1960 to estimate a daily intake of U-238 for each year between 1960 and 1991. A table of these estimated daily U-238 inhalation intake rates calculated for each year in the residual period is presented in DCAS-TKBS-0002.

By proportioning to the derived U-238 activity, the corresponding daily intake rates for other nuclides of uranium, thorium, and their progeny can be developed. The nuclides described in Section 5.2.1 above are assigned daily intake rates based on the ratios presented in Section 5.2.1. Note that Ra-226, estimated to have a ratio of 1:0.04 in the final product, is included with the group Th-231, Pa-231, and Ac-227, each estimated to have a U-238 ratio of 1:0.045 when compared to U-238. This provides intake estimates that include uranium, thorium, and their decay progeny. Additional information is presented in DCAS-TKBS-0002.

Bounding ingestion intakes can be evaluated using the same 1954-1958 bioassay data to derive a bounding daily ingestion rate for the start of the period on July 1, 1960, based on the assumption that no inhalation occurred (DCAS-TKBS-0002). In DCAS-TKBS-0002, calculations using available 1954-1958 bioassay data indicate a median daily ingestion intake rate of 41 pCi/day for U-238.

The OTIB-0070 equation above is used with the same depletion rate constant, λ of 0.000764 days^{-1}and an initial ingestion rate, I_0 of 41 pCi/day to estimate a daily intake rate of U-238 for each year between 1960 and 1991. A table of the estimated daily U-238 ingestion intake rates is presented in DCAS-TKBS-0002. As with the inhalation rates, daily intake rates are derived for the same three groups of uranium, thorium, and their decay progeny. Additional information is presented in DCAS-TKBS-0002.

For bounding dose reconstruction purposes, the inhalation rate and the ingestion rate are each used to estimate resultant doses to the organ of interest and the method resulting in the higher dose is applied for each claim.

Radon

As presented above in Section 7.2.1.3, the 1993 Blockson weighted mean radon flux for the total phosphogypsum stack area was reported to be 4.4 pCi/m^2-s, with the sides of the stack having the highest mean value of 10.1 pCi/m^2-s (Monitoring, 1993, PDF p. 14). These Blockson flux measurements compare well with the data showing an average radon flux of 10.5 pCi/m^2-s at a phosphogypsum pile at the Texas City Chemical site (Findings of Fact, 1988, PDF p. 6). Texas City Chemicals used a similar process to dissolve Florida Phosphate ores in acid and generated a phosphogypsum waste pile similar to that at the Blockson facility. Details of the Texas City process are described in Petition SEC-00088 (NIOSH, Jan2008).

In addition to radon flux measurements, radon gas concentrations at Texas City Chemicals were also measured on top of the phosphogypsum stack and near the Administration Building some 200 to 300 yards from the stack (DCAS-TKBS-0002) and radon concentrations above background (0.14 pCi/L), were reported to be 0.42 pCi/L and 0.32 pCi/L, respectively. Radon concentrations at other locations on the property were lower. NIOSH uses these radon concentrations to estimate bounding radon exposures at Blockson (DCAS-TKBS-0002). As the highest ground emanation rate at Blockson compares favorably with the average ground emanation rate at Texas City, the radon concentration of 0.42 pCi/l may be taken as a bounding value for the radon concentration above Blockson's inactive phosphogypsum pile in 1993.

EPA research shows that an inactive phosphogypsum pile forms a crust that reduces the radon emanation by a factor of five (EPA, 1988, PDF p. 12). Because the Texas City pile and the Blockson pile were inactive at the time of radon flux and concentration measurements, it is expected that the active piles would have had radon flux and concentration values five times higher when the piles were active. A radon concentration for the active Blockson pile on July 1, 1960, can therefore be derived as 0.42 pCi/l * 5 = 2.1 pCi/l to estimate the radon concentration above the active Blockson pile. This value is bounding for the radon concentration as of July 1, 1960 when the pile was active.

Between July 1960 and 1993, the radium-bearing materials in the Blockson pile would have been covered by increasing amounts of commercially-generated phosphogypsum, further reducing the amount of AEC-related radon being released from the pile. Consequently, the assumed EPA factor of 5 reduction in radon concentration between an active and inactive pile underestimates the true reduction that would have been observed at Blockson relative to the AEC-related radon of concern.

For Blockson residual radon calculations, NIOSH assumes a concentration of 2.1 pCi/L for July 1, 1960 (start of residual radiation period under evaluation), and a concentration of 0.42 pCi/L for September 1993 when the radon flux measurements were taken at the inactive Blockson stacks. As a bounding method, it is assumed that both the 0.42 pCi/L radon estimate for the inactive pile (when flux measurements were made in 1993) and the 2.1 pCi/L concentration as of July 1960 is all attributable to AEC work (DCAS-TKBS-0002).

Following DCAS-TKBS-0002, the July 1960 and 1993 radon concentrations are fitted to an exponential curve to approximate the rate of reduction. The number of days between July 1, 1960 and September 1, 1983 is 12,115 days.

In the equation:

$$0.42 \text{ pCi/l} = 2.1 \text{ pCi} * e^{-\lambda * 12{,}115 \text{ days}}$$

the value λ becomes the depletion rate constant for radon and is calculated to be 0.000133 days^{-1}. This depletion rate constant may be used with the starting concentration of 2.1 pCi/l to derive a concentration for each year between July 1960 and 1991. A table of the bounding annual radon exposures from residual contamination can be found in DCAS-TKBS-0002. Note that this estimates a value of 0.0035 WL of radon in 1978. ANL measured radon concentrations in Building 55 “from 0.0014 to 0.0061 WL, including background” (FUSRAP, 1978, PDF p. 7). The value estimated in 1983 was 0.0028 WL. The highest radon reading reported by Olin in their 1983 site survey was 0.0042 WL. Although the report stated that the results were adjusted for background when counted, the values appear to indicate ambient radon conditions (Marseglia, 1983, PDF p. 9).

7.2.3 Internal Dose Reconstruction Feasibility Conclusion

NIOSH has determined that it is feasible to reconstruct internal doses from resuspended residual AEC-related uranium and thorium and their progeny using Blockson employee bioassay data and site workplace contamination survey data. These data are used in accordance with the methods used in DCAS-TKBS-0002 to derive daily intake rate values for the period from January 1, 1960 through December 31, 1991.

NIOSH has determined that it is feasible to reconstruct internal doses from residual AEC-related radon using a comparison of Blockson radon emanation (flux) measurements to radon flux and

concentration measurements taken at a similar phosphate production facility. These radon data are used in accordance with the methods used in DCAS-TKBS-0002 to derive annual radon exposure rate values for the period from July 1, 1960 and December 31, 1991.

7.3 Evaluation of Bounding External Radiation Doses at Blockson Chemical Co.

The principal source of external radiation doses for members of the evaluated class was exposure to surfaces contaminated with natural uranium and thorium (and their progeny) and submersion in re-suspended surface contamination. The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

7.3.1 Evaluation of Bounding Residual Period External Doses

Photon

Direct reading radiation results are available from surveys done by ANL from March to November 1978 (FUSRAP, 1978). The ANL survey was performed throughout Building 55, including plant surfaces, tanks, pipes, and other process equipment. Dose rates were taken at contact and at 1-meter on all areas in which contamination was detected. The dose rates at 1-meter on 7 of the "hot" spots ranged from 0.04 mR/hr to 0.2 mR/hr. Of these, one at 0.07 mR/hr was taken inside of a steel pipe and one at 0.15 mR/hr was taken on top of a stainless steel tank, "Kelly-1" and the remaining five were readings taken 1-meter above the concrete floor in the main room. All other remaining spots had 1-meter dose rates indistinguishable from background. The report included 70 dose rate readings taken at 1-meter, some of which are indicative of larger areas (DCAS-TKBS-0002; FUSRAP, 1978). The reported background dose rate on the instrument used was between 0.02 mR/hr and 0.03 mR/hr. The results of the 7 spots with measurable dose rates included the background dose rates. From a NIOSH review of the survey map and results, it is improbable that a worker could be significantly exposed above the background rate of 0.03 mR/hr for significant time. However, to account for variability in potential exposures to the workers, the data are taken as a distribution of possible exposures with the median of 0.03 mR/hr and the 95th percentile at the maximum value reported, 0.2 mR/hr (DCAS-TKBS-0002).

In the absence of individual dosimeter data, to bound Blockson external dose due to residual contamination after AWE operations had ceased, whole-body dose rates can be modeled by assuming workers were exposed to the 1978 upper background dose rate of 0.03 mR/hr for 2,000 hours per year, which results in an annual exposure of 60 mR, or 0.06 R. To allow for uncertainty, this value can be applied as the median of a lognormal distribution. The geometric standard deviation is 3.2, which was determined by assuming that the 95th percentile dose rate is equal to the maximum observed result of 0.2 mR/hr (DCAS-TKBS-0002). The assignment of the derived 60 mR/year overestimates the worker dose from AEC-related residual contamination because the values also include contributions from commercially-generated residues in the Blockson workplace.

In the ANL 1978 survey report, thirty-two of the areas gave GM End Window exposure readings at contact. The contact readings ranged from just distinguishable from background to 7 mR/h (FUSRAP, 1978, PDF p. 6). Individual readings are listed in a table in the report. Slightly over half of the readings taken at contact showed background. Two showed 7 mR/hr: one for a spot of yellow residue on a valve flange and the other on top of a stainless steel tank. The majority of the readings were taken on the concrete floor. The highest of the contact readings on the floor showed 5 mR/hr and was at the same spot that showed the highest reading at 1-meter, 0.2 mR/hr.

Beta

NIOSH has developed a model using measurements by ANL to provide an estimate of exposure from direct, fixed residues and a resuspended submersion field of residues and applying Federal Guidance Report No. 12 (FGR, 1993) exposure factors. Based on the maximum in-place contamination and the maximum removable contamination found by ANL within the building, the FGR-12 modelling results in penetrating photon exposures of 0.0005 rem per year, and beta exposure to the skin of 0.0251 rem per year. These values are much less than the bounding 0.060 rem per year assumed for photon exposure.

Beta dose is bounded within the 0.060 rem per year assigned as photon dose (assigned as 10% dose from 30-250 keV photons and 90% dose from >250 keV photons). Beta dose is not reconstructed separately for the period under evaluation from July 1, 1960 through December 31, 1991.

7.3.2 Blockson Chemical Co. Occupational X-Ray Examinations

The assignment of medical X-ray dose is not required during residual radiation periods for AWE facilities. Consequently, NIOSH concludes that it is not applicable to reconstruct occupational medical dose for Blockson Chemical Co. workers during the period being evaluated from July 1, 1960 through December 31, 1991.

7.3.3 Methods for Bounding Residual Period External Dose at Blockson Chemical Co.

Photon Dose

As presented in Section 7.3.1 above, bounding photon dose can be reconstructed using values measured in Building 55 by ANL in 1978 (DCAS-TKBS-0002). In the absence of individual dosimeter data, whole body dose rates are modeled by a lognormal distribution by assuming a worker was exposed to the 0.03 mR/hr rate for 2,000 hours per year, which results in an annual exposure of 60 mR. To allow for uncertainty, this value is applied as the median of a lognormal distribution. The geometric standard deviation is 3.2, which was determined by assuming that the 95th percentile dose rate is equal to the maximum observed result of 0.2 mR/hr (DCAS-TKBS-0002).

Beta Dose

The instrument used by ANL in the 1978 FUSRAP-related survey to measure ambient photon exposure in Building 55 included an end-window GM probe and was sensitive to beta radiation as well as photon radiation.

As presented in Section 7.3.1, NIOSH used maximum in-place contamination and the maximum removable contamination values, and FGR-12 exposure factors, to provide an estimate of exposure from fixed residues and a resuspended submersion field of residues. Penetrating photon exposure was calculated to be 0.0005 rem per year and beta exposure to the skin was calculated as 0.0251 rem per year. This assumed 2,000 hours per year, standing on the contaminated surface and used a resuspension factor of 10^{-6} per meter, as was applied for calculating resuspension for inhalation. These modeled values show much less exposure than the 0.060 rem per year assumed for photon exposure based on measurements by ANL within the building in 1978. Much of the residues identified by ANL were in relatively remote locations, such as on overhead beams and overhead pipes, which is supported by the statements by former workers that work areas, including those in

Building 55, were washed down daily. As beta exposure is produced by surface or suspended contamination, this indicates that the values measured by ANL and listed in the FUSRAP report were not significantly influenced by beta activity. Smear results were collected at the same spots measured with the GM probe for the 1-meter results. While some spots measured may have indicated beta activity, such as a measurement of a spot of yellow powder on a valve flange, the greatest number of measurements were made over a concrete floor, had background levels listed for the majority of the smear results, and are assumed to have measured primarily photon exposure.

Beta dose contribution is bounded within the 0.060 rem per year assigned as photon dose (assigned as 10% dose from 30-250 keV photons and 90% dose from >250 keV photons). Beta dose is not reconstructed separately for the period under evaluation from July 1, 1960 through December 31, 1991.

7.3.4 External Dose Reconstruction Feasibility Conclusion

NIOSH has determined that it is feasible to reconstruct external doses from AEC-related residues, during the period from July 1, 1960 through December 31, 1991, by applying a bounding annual photon dose of 60 mR/year derived from Blockson facility survey data. The photon dose assignment bounds beta contributions and overestimates the worker dose from AEC-related residual contamination because the values include contributions from background, and from commercially-generated residues in the Blockson workplace.

The assignment of medical X-ray dose is not required during residual radiation periods for AWE facilities. Consequently, NIOSH concludes that it is not applicable to reconstruct occupational medical dose for Blockson Chemical Co. workers during the period being evaluated from July 1, 1960 and December 31, 1991.

7.4 Evaluation of Petition Basis for SEC-00225

The following subsections evaluate the assertions made on behalf of petition SEC-00225 for Blockson Chemical Co.

7.4.1 Equipment and Production Buildings Onsite after Production Ended

Issue: A petitioner stated that after production ended the equipment and production buildings were still onsite.

Response: After the end of the AEC contract, the same equipment was used for commercial operations. Equipment in areas other than Building 55 continued to be used in the same manner and the site continued processing the same materials. It is not known if equipment within Building 55 was used in the same manner as during the AEC contract, but the building housed commercial operations and processed the same materials. For purposes of bounding exposure to AEC-related residues during the period under evaluation, the conservative assumption is made that all radiation measurements made in Building 55 are assumed to indicate levels arising from residual radioactivity remaining from AEC operations.

7.4.2 Yellow Powder Onsite

Issue: A petitioner stated that a yellow powder identified in 1996 by the EPA was found onsite and presumed to be yellowcake.

Response: In a review of EPA's 1993 inspection of the phosphogypsum pile at Blockson, there was no mention of a yellow powder nor was there any indication that Building 55 was involved. However, a 1979 report by ANL located a yellow powder in Building 55; it was sampled and found to be primarily uranium (FUSRAP, 1978, PDF p. 19). The existence of general uranium residue, and the results of the 1978 ANL report, are used as part of the basis of this evaluation.

7.4.3 Lack of Radiation Monitoring

Issue: A petitioner stated that after the production period ended and up until 1962, there is no known employee radiation monitoring.

Response: No monitoring data have been found for the period from July 1, 1960 through 1962. However, NIOSH has demonstrated that radiation dose may be bounded by establishing exposure conditions prior to and after this time.

7.4.4 Production Period End Date

Issue: A petitioner stated that the end date of the production period should be tied to the dates stated in the AEC contract rather than dates of uranium production.

Response: NIOSH performs analyses exposure at historical AWE sites using production and residual period locations and dates as defined by the DOE and DOL. The DOL defines the AWE production period at Blockson Chemical Co. as between 1951 and June 1960, with the residual radiation period starting in July 1960 (DOL, 2007). The ending of uranium production and termination of the contract prior to its March 1962 expiration date was consistent with contract provisions. NIOSH has multiple references to verify when production ended and the amounts of uranium produced by Blockson.

7.5 Other Potential SEC Issues Relevant to the Petition Identified During the Evaluation

During the feasibility evaluation for SEC-00225, a number of issues were identified that needed further analysis and resolution. The following subsections discuss the issues and their current status for SEC-00225.

7.5.1 NIOSH-Proposed Bounding Values in SEC-00058

Issue: For SEC-00058, the Board did not accept the NIOSH-proposed bounding values for radon during the production period.

Response: The Board recommended SEC class for March 1, 1951 through June 30, 1960, was based on workers exposed to radon in the acid plant during digestion of phosphate rock and filtration of radium bearing residues in that building. Those activities of processing phosphate rock are not covered during the residual radiation period.

7.5.2 AEC Operations Versus Commercial Operations Radioactivity

Issue: Radioactivity from AEC operations measured in the post-production period is indistinguishable from radioactivity generated during this period for commercial operations.

Response: For all cases where measurements of ambient radiation or radon are used to estimate worker exposure and contributions from AEC work residues cannot be distinguished from contributions from commercial operations, the data are taken to indicate measurements resulting solely from residues from AEC operations.

7.6 Summary of Feasibility Findings for Petition SEC-00225

This report evaluates the feasibility for completing dose reconstructions for employees at Blockson Chemical Co. from July 1, 1960 through December 31, 1991. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-1 summarizes the results of the feasibility findings at Blockson Chemical Co. for each exposure source during the time period from July 1, 1960 through December 31, 1991.

Table 7-1: Summary of Feasibility Findings for SEC-00225
July 1, 1960 through December 31, 1991

Source of Exposure	Reconstruction Feasible (Yes or No)
Internal[1]	**YES**
Residues of natural U and progeny	YES
Residues of natural Th and progeny	YES
External	**YES**
- Gamma	YES
- Beta	YES
- Neutron	N/A
- Occupational Medical X-ray	N/A

[1] Internal includes an evaluation of urinalysis (in vitro), airborne dust, and radon data, as applicable.

As of August 19, 2015, a total of 130 claims have been submitted to NIOSH for individuals who worked at Blockson Chemical Co. during the period under evaluation in this report. Dose reconstructions have been completed for 127 individuals (~98%).

8.0 Evaluation of Health Endangerment for Petition SEC-00225

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

9.0 Class Conclusion for Petition SEC-00225

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes all employees who worked in any area at the Blockson Chemical Co. site in Joliet, Illinois, during the period from July 1, 1960 through December 31, 1991.

NIOSH has carefully reviewed all material sent in by the petitioners, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database (SRDB), for information relevant to SEC-00225. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

These actions are based on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing dose for the class under evaluation.

10.0 References

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000;* Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p. 22,296; May 2, 2002; SRDB Ref ID: 19391

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

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

42 U.S.C. §§ 7384-7385 [EEOICPA], *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended

ABRWH Transcript, 2010, *70th Meeting of the Advisory Board on Radiation and Worker Health Transcript*; Neal R. Gross, Court Reporters and Transcribers; meeting held on July 14, 2010; SRDB Ref ID: 146885

Allison, 1998, *Preliminary Radiation Assessment Report*, correspondence; Cynthia L. Allison; June 25, 1998; SRDB Ref ID: 30623, PDF pp. 323-328

Authority Review, no date, *Authority Review for Former Blockson Chemical Company, Joliet, Illinois*; author not specified; date not specified; SRDB Ref ID: 11587, PDF pp. 80-86

Barr, 1953, *Uranium Urinalyses,* correspondence to Richard Fahrner; James A. Barr; September 14, 1953; SRDB Ref ID: 9728, PDF p. 16

Block, 1951, *Outline of Process for Recovering Uranium from Phosphate Rock*, correspondence to Sheldon Wimpfen; Louis Block; July 31, 1951; SRDB Ref ID: 9558, PDF pp. 6-21

DCAS-PR-004, *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, Rev. 1; Division of Compensation Analysis and Support (DCAS); Cincinnati, Ohio; April 15, 2011; SRDB Ref ID: 94768

DCAS-TIB-0011, *Lung Dose Conversion Factor for Thoron WLM*, Rev. 4; Division of Compensation Analysis and Support (DCAS); Cincinnati, Ohio; May 1, 2013; SRDB Ref ID: 126391

DCAS-TKBS-0002, *Technical Basis Document for Atomic Energy Operations at Blockson Chemical Company, Joliet, Illinois*, Rev. 04; Division of Compensation Analysis and Support (DCAS); Cincinnati, Ohio; May 19, 2014; SRDB Ref ID: 143289

DOL, 2007, *Facility Designation Specifics*, correspondence to NIOSH/OCAS; Department of Labor (DOL); February 12, 2007; SRDB Ref ID: 30222

EPA, 1988, *A Long-Term Study of Radon and Airborne Particulates at Phosphogypsum Stacks in Central Florida*, EPA 520/5-88-021; Environmental Protection Agency (EPA); October 1988; SRDB Ref ID: 145811

EPA, 1993, *Inspection Under the National Emission Standards for Radon Emissions from Phosphogypsum Stacks, 40 CFR 61, Subpart R*; Environmental Protection Agency (EPA); inspection date: September 7, 1993; SRDB Ref ID: 30131, PDF pp. 9-11

FGR, 1993, *Federal Guidance Report No. 12, External Exposure to Radionuclides in Air, Water, and Soil*, EPA-402-R-93-081; Keith F. Eckerman and Jeffrey C. Ryman; September 1993; SRDB Ref ID: 11997

Findings of Fact, 1988, *Findings of Fact and Conclusions of Law*; United States District Court for the Southern District of Texas; July 7, 1988; SRDB Ref ID: 75158, PDF pp. 3-33

Form B, 2015, *Form B-83.13 with Attachments*; received February 24, 2015; DSA Ref ID: 120775

FUSRAP, 1978, *Formerly Utilized MED/AEC Sites Remedial Action Program Radiological Survey of Chemicals Group, Olin Corporation (Formerly Blockson Chemical Company) Joliet, Illinois, March 27-November 28, 1978*; Argonne National Laboratory; May 1983; SRDB Ref ID: 23615

HHS, 2010, *HHS Designation of Additional Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000 Designating a Class of Employees from Blockson Chemical Company, Joliet, Illinois*; Health and Human Services (HHS); September 3, 2010; SRDB Ref ID: 146542

Hull, 1995, *Radiochemistry of Florida Phosphogypsum*, C. D. Hull and W. C. Burnett; August 28, 1995; SRDB Ref ID: 32562

Marseglia, 1983, *Alpha Radiation Survey*, correspondence to M. S. Davenport; L. M. Marseglia; May 20, 1983; SRDB Ref ID: 30623, PDF pp. 6-10

Monitoring, 1956-1958, *Compilation of Urine Sample Results for Individuals at Blockson Chemical Co.*; various dates ranging from January 1956 through February 1958; SRDB Ref ID: 4032

Monitoring, 1993, *Results of Radon Flux Testing*; Scientific Analysis, Inc.; results for September 1993; SRDB Ref ID: 30131, PDF pp. 12-43

Monitoring, 1996, *Radiation Survey Results and Associated Documents*; various dates and authors; cover letter dated September 16, 1996; SRDB Ref ID: 30623, PDF pp. 59-122

NIOSH, 2007, *SEC Petition Evaluation Report for Petition SEC-00058, Blockson Chemical Co.*; National Institute for Occupational Safety and Health (NIOSH); July 2, 2007; SRDB Ref ID: 146624

NIOSH, Jan2008, *SEC Petition Evaluation Report for Petition SEC-00088, Texas City Chemicals Inc.*; National Institute for Occupational Safety and Health (NIOSH); January 18, 2008; SRDB Ref ID: 75146

NIOSH, Oct2008, *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*; National Institute for Occupational Safety and Health (NIOSH); October 2008; SRDB Ref ID: 100990

NIOSH, 2011, *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*; National Institute for Occupational Safety and Health (NIOSH); August 2011; SRDB Ref ID: 106641

OCAS-IG-004, *The Use of Data from Other Facilities in the Completion of Dose Reconstructions Under the Energy Employees Occupational Illness Compensation Program Act,* Rev. 0; Division of Compensation Analysis and Support (DCAS), Formerly Office of Compensation Analysis and Support; Cincinnati, Ohio; August 21, 2008; SRDB Ref ID: 49029

OCAS-TIB-009, *Estimation of Ingestion Intakes,* Rev. 0; Division of Compensation Analysis and Support (DCAS), Formerly Office of Compensation Analysis and Support; Cincinnati, Ohio; April 13, 2004; SRDB Ref ID: 22397

ORAUT-OTIB-0024, *Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium* Compounds, Rev. 00; ORAU Team Dose Reconstruction Project for NIOSH; April 7, 2005; SRDB Ref ID: 19445

ORAUT-OTIB-0043, *Characterization of Occupational Exposures to Radium and Radon Progeny During Recovery of Uranium from Phosphate Materials*, Rev. 00; ORAU Team Dose Reconstruction Project for NIOSH; January 6, 2006; SRDB Ref ID: 22596

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

Radiation Safety Associates, 1996, *Radiological Assessment of Olin Corporation Chemicals Group, Building 55, Joliet, Illinois*; Radiation Safety Associates, Inc.; 1996; SRDB Ref ID: 30623, PDF pp. 12-57

Receipts, 1953-1963, *Spreadsheet of Receipts of U_3O_8 from Phosphate and Other Miscellaneous Domestic Sources*; some contract terms begin in 1951 and the spreadsheet goes through FY 1962; SRDB Ref ID: 40645, PDF p. 2

Roessler, 1979, *Uranium and Radium-226 in Florida Phosphate Materials*; C. E. Roessler, Z. A. Smith, W. E. Bolch, and R. J. Prince; February 13, 1979; SRDB Ref ID: 13364

Seniority List, 1966, *Factory Seniority List as of May 2, 1966*; May 2, 1966; SRDB Ref ID: 30131, PDF pp. 2-5

Stoltz, 1958, *Recovery of Uranium from Phosphate Ores*; E. M. Stoltz, Jr.; July 24, 1958; SRDB Ref ID: 4026

Worker Outreach, 2007a, *NIOSH Dose Reconstruction Project Worker Outreach Meeting with Former Workers from the Blockson Chemical Company*; National Institute for Occupational Safety and Health (NIOSH); meeting date: January 24, 2007; SRDB Ref ID: 77186

Worker Outreach, 2007b, *NIOSH Dose Reconstruction Project Worker Outreach Meeting with Former Workers from the Blockson Chemical Company*; National Institute for Occupational Safety and Health (NIOSH); meeting date: January 25, 2007; SRDB Ref ID: 77187

Worker Outreach, 2007c, *Meeting Minutes of the Town Hall Meeting with Former Employees of the Blockson Chemical Company*; National Institute for Occupational Safety and Health (NIOSH); meeting date: September 12, 2007; SRDB Ref ID: 74837

Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for Blockson Chemical Co.

Data Capture Information	Data Capture Description	Completed	No. Uploaded into SRDB
Primary Site/Company Name: Blockson Chemical Company AWE 1951 - June 1960; Residual Radiation July 1960-March 1, 2011 Alternate Site Names: Blockson Chemical Group Olin Mathieson Olin Physical Size of the Site: The entire site encompasses approximately 1,000 acres. The production area of the site comprised approximately 33 acres. The Building 55 footprint was 17,500 square feet. Site Population: There were 418 workers on the seniority list in 1964.	Background documents for the Blockson case and information from the Blockson worker outreach meetings.	02/02/2007	2
State Contacted: Illinois Emergency Management Agency	Discovered records are held by the Illinois Environmental Protection Agency. A review of their online holdings indicated that their earliest records post-dated the demolition of Building 55 by 7 years, and that these records deal primarily with groundwater and soil contamination. No records providing source term information or occupational radiation exposure data were identified.	07/27/2015	0
Cincinnati Public Library	An article on recovering uranium during phosphate processing.	10/04/2007	1
Claimant Provided	The September 1964 seniority list and plant photographs and drawings.	07/16/2008	2
Clemson University	An evaluation of the fate of radionuclides during phosphate processing.	06/05/2007	1
DOE Germantown	A report on uranium recovery from wet process phosphoric acid, a listing of potential remedial action sites including Blockson, material transfer reports, and confirmation that Blockson records are in the DOE Oak Ridge Records Holding Area.	03/07/2011	4

Data Capture Information	Data Capture Description	Completed	No. Uploaded into SRDB
DOE Legacy Management - Grand Junction Office	1954 and 1955 urinalysis results, FUSRAP surveys and documentation, site photographs, the authority review for decontamination of the Blockson site, Building 55 photographs, uranium inventories, amendments to Contract No. AT(49-1)-611, reports on difficulties in uranium recovery, monthly domestic production reports, and a listing of concentrates received from phosphate sources.	06/20/2011	37
DOE Legacy Management - Morgantown	1955 accountability station symbols and FUSRAP proposals and analyses.	06/30/2010	4
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Fernald reports referring to Blockson including air samples taken during processing of Blockson ore, analysis of ore concentrates, weekly progress reports, material transfer and discrepancy reports, sampling and assaying procedures and reports, 1954 accountability station symbols, AEC contractors and contract descriptions, a 1956 meeting on uranium recovery from phosphoric acid production, monthly reports, and dissolution studies of Blockson concentrate.	07/08/2008	56
DOE Oak Ridge Operations Office - Records Holding Task Group (RHTG)	Uranium production statistics for the month ending October 31, 1952.	04/08/2011	1
DOE Office of Scientific and Technical Information (OSTI)	Mallinckrodt test criteria for Blockson concentrates.	09/16/2010	1
DOL - Paragon	DOL determination of which Blockson areas are covered under EEOICPA.	03/06/2007	1
Florida Institute of Phosphate Research	Characterization of radioactive aerosols, dose scaling factors, and the effect of particle size and solubility on inhalation doses.	10/26/2007	6
Hanford	Uranium trioxide production reports from 1953-1954 and the authority to declassify Raw Material Program documents.	03/20/2013	5
Interlibrary Loan	Reports on uranium ore processing.	05/04/2015	2
Internet - Defense Technical Information Center (DTIC)	No relevant data identified.	05/07/2015	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	04/06/2015	0
Internet - DOE Legacy Management	1955 AEC monthly reports on uranium production from phosphates and the 1978 FUSRAP survey of Blockson.	05/31/2006	2
Internet - DOE Legacy Management Considered Sites	A 1985 letter stating that contamination at Blockson exceeds remedial action guidelines and an AEC site summary report on Blockson.	04/16/2015	2
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	05/07/2015	0
Internet - DOE OpenNet	No relevant data identified.	04/02/2015	0
Internet - DOE OSTI Energy Citations	A Dow Chemical report which mentions the implementation of a process improvement at Blockson.	02/17/2010	1
Internet - DOE OSTI Information Bridge	Thorium reports and a 1959 Hanford fuels preparation monthly report.	12/30/2011	3
Internet - DOE OSTI SciTech Connect	A 1980 FUSRAP background report.	04/03/2015	1

Data Capture Information	Data Capture Description	Completed	No. Uploaded into SRDB
Internet - Energy Employees Claimant Assistance Project (EECAP)	No relevant data identified.	05/07/2015	0
Internet - Google	Newspaper reports, lists of contaminated sites, report from the September 2008 DOE HSS/Labor Union meeting, minutes of Advisory Board on Radiation and Worker Health meetings, uranium control in the phosphogypsum industry, the microbiology and radiochemistry of phosphogypsum, dose conversion factors for the phosphate industry, strategies for validating the Blockson radon model, and Blockson Working Group meeting minutes.	04/23/2015	59
Internet - Health Physics Journal	No relevant data identified.	05/07/2015	0
Internet - Journal of Occupational and Environmental Health	No relevant data identified.	05/07/2015	0
Internet - National Academies Press (NAP)	No relevant data identified.	04/06/2015	0
Internet - National Institute for Occupational Safety and Health (NIOSH)	Reports on residual contamination at Atomic Weapons Employer facilities and the technical basis document for Blockson Atomic Energy Operations.	08/31/2011	4
Internet - NEPIS	No relevant data identified.	04/06/2015	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	Staff evaluations of contamination identified in USA Today, a 1980 Blockson survey, Freedom of Information Act (FOIA) requests and responses, and a listing by state of FUSRAP sites.	04/06/2015	11
Internet - USACE/FUSRAP	No relevant data identified.	04/06/2015	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	04/06/2015	0
Karam, P.	Excerpts from The Chemistry of Actinide Elements and Uranium: Mineralogy, Geochemistry, and the Environment.	04/11/2007	2
Massachusetts Department of Public Health	A routine inspection of Nuclear Metals, Inc. which mentions Olin.	04/12/2012	1
National Archives and Records Administration (NARA) - Atlanta	A 1952 conference on the problems of extracting uranium from phosphate rock.	08/12/2004	1
National Archives and Records Administration (NARA) - Kansas City	Excerpts from Blockson's Source Material contract, a description of uranium extraction from phosphate contracts, and a Ryerson Physical Laboratory survey report.	06/24/2005	3
National Institute for Occupational Safety and Health (NIOSH)	Semiannual reports to Congress, telephone interviews with former workers, and Worker Outreach Meeting transcripts, minutes, sign-in sheets, and notices.	10/20/2010	25
National Institute for Occupational Safety and Health (NIOSH) / HERB	A 1956 encyclopedia of industrial hygiene instrumentation and a 1992 discussion on approaches to estimation of inhalation risk by air sampling.	09/08/2003	2
Nuclear Regulatory Commission Non-Public Holdings	Olin's process for packaging and disposal of low-level waste.	06/04/2012	1
Nuclear Regulatory Commission Public Document Room	Source Material License SUB-1138 with related documentation and Byproduct Material License 24-24576-01.	02/17/2012	5

Data Capture Information	Data Capture Description	Completed	No. Uploaded into SRDB
Olin Chemical Company	Detailed site surveys, the Radiation Safety Manual for the demolition of Building 55, and the DOE's authority determination for remediation of the site.	03/07/2007	2
ORAU Team	A Project spreadsheet, technical basis documents, Letter Contract No. AT(49-1)-606 and modification 1, Letter Contract AT(49-1)-611 and modifications, a written exchange with a former Blockson employee, and documented communications.	05/15/2015	16
Public Library	A 1957 report on the recovery of uranium from wet phosphoric acid.	10/16/2007	1
SAIC	A 1960 AEC radiation exposure summary.	09/02/2004	1
S. Cohen & Associates (SC&A)	A report on air leakage of buildings.	08/20/2009	1
Southern Illinois University, Edwardsville, IL	Transcripts from the 56th Advisory Board on Radiation and Worker Health meeting.	10/29/2008	2
Unknown	Reports on the recovery of uranium from phosphates and phosphoric acid, urine data, NYOO correspondence, and FUSRAP reports.	07/22/2003	16
Total	Not applicable		**285**

Table A1-2: Database Searches for Blockson Chemical Co.

Database/Source	Keywords	Hits	Viewable Hits	Uploaded into SRDB
Defense Technical Information Center (DTIC)https://www.dtic.mil/ COMPLETED 05/07/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	791	791	0
DOE Hanford DDRShttp://www2.hanford.gov/declass/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	763	763	0
DOE Legacy Management Considered Sites http://www.lm.doe.gov/considered_Sites/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	0	0	0
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 05/07/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	0	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 04/02/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	14	14	0
DOE OSTI SciTech Connect http://www.osti.gov/scitech COMPLETED 04/03/2015	Database search terms are available in the Excel file called “Blockson Chemical Co Rev 00, (83.13) 07-30-15”	4,913	4,913	2

Database/Source	Keywords	Hits	Viewable Hits	Uploaded into SRDB
Energy Employees Claimant Assistance Project (EECAP) http://www.eecap.org COMPLETED 05/07/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	0	0	0
Google http://www.google.com COMPLETED 04/23/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	10,199,348	27,830	35
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 05/07/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	0	0	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 05/07/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	9	9	0
National Academies Press http://www.nap.edu/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	575	575	0
NEPIS http://nepis.epa.gov/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	267	267	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 04/06/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	1,943	27	6
United States Army Corps of Engineers (USACE) http://www.usace.army.mil/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	0	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 04/06/2015	Database search terms are available in the Excel file called "Blockson Chemical Co Rev 00, (83.13) 07-30-15"	0	0	0