SEC Petition Evaluation Report
Petition SEC-00058

Report Rev # 0 Report Submittal Date 09-01-2006

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Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition B Qualification Date	DOE/AWE Facility Name
SEC-00058	83.13	August 9, 2006	Blockson Chemical

Petitioner Class Definition

All Atomic Weapons Employer employees, contractors, and subcontractors, who worked in Building 55 at the Blockson Chemical Company (also known as Olin Mathieson) from January 1, 1951 to December 31, 1962.

Proposed Class Definition

All Atomic Weapons Employer personnel who worked on uranium recovery pilot studies and/or in Building 55 of the Blockson Chemical Company, Joliet, Illinois, from January 1, 1951 through December 31, 1962.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00045	83.13	Blockson Chemical	Under evaluation

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
NONE	

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Evaluation Report Summary: SEC-00058, Blockson Chemical

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-00058, qualified on August 9, 2006 requested that NIOSH consider the following class: All Atomic Weapons Employer employees, contractors, and subcontractors, who worked in Building 55 at the Blockson Chemical Company (also known as Olin Mathieson) from January 1, 1951 to December 31, 1962. Another petition (SEC-00045) on behalf of a subset of the above-requested class of workers was qualified and merged into SEC-00058.

NIOSH-Proposed Class Definition

Based on its research, NIOSH modified the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employer personnel who worked on uranium recovery pilot studies and/or in Building 55 of the Blockson Chemical Company, Joliet, Illinois, from January 1, 1951 through December 31, 1962. The work activity definition was modified because Building 55 was not completed for uranium recovery production until 1952; however, uranium recovery pilot studies occurred in 1951.

Feasibility of Dose Reconstruction

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

Health Endangerment Determination

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

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SEC Petition Evaluation Report for SEC-00058

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all Atomic Weapons Employer personnel who worked on uranium recovery pilot studies and/or in Building 55 of the Blockson Chemical Company, Joliet, Illinois, from January 1, 1951 through December 31, 1962. 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 provide 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 make the final determination as to whether or not the proposed class will be added to the SEC (see Section 2.0).

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

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether or not it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.[1]

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine whether or not 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] 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 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 other SEC classes (excluding aggregate work day requirements).

NIOSH is required to document its evaluation in a report, and in doing so, relies upon both its own dose reconstruction expertise as well as technical support from Oak Ridge Associated Universities (ORAU). Once completed, the report is provided to the petitioners and to the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decisions, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 Petitioner Requested Class/Basis and NIOSH Proposed Class/Basis

Petition SEC-00058, qualified on August 9, 2006, requested that NIOSH consider the following class: All Atomic Weapons Employer employees, contractors, and subcontractors, who worked in Building 55 at the Blockson Chemical Company (also known as Olin Mathieson) from January 1, 1951 to December 31, 1962.

The petitioner for SEC-00058 stated his belief that accurate dose reconstruction over time is impossible because no monitoring was performed. Based on further research, NIOSH deemed the petitioner's submission sufficient to qualify SEC-00058 for evaluation and further consideration by NIOSH, the Board, and HHS. Detail regarding the SEC-00058 petition basis is presented below in Section 7.4.

Another petition, SEC-00045, on behalf of a subset of the above-requested class of workers was qualified on March 6, 2006 and later merged into SEC-00058. The petitioner for SEC-00045 provided information and affidavit statements to support his/her belief that accurate dose reconstruction over time is impossible. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00045 for evaluation:

> The petitioner submitted twelve affidavits (from one former Atomic Weapons Employee and eleven survivors) to support his/her position that neither the government nor Blockson Chemical ever monitored Atomic Weapons Employee exposures to radioactive materials, or monitored the workplace for radiation levels.

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

The information and statements provided by the petitioner for SEC-00045 qualified the petition for further consideration by NIOSH, the Board, and HHS. SEC-00045 was subsequently merged with SEC-00058. Details on the SEC-00045 petition basis are included in the discussion in Section 7.4.

Based on its research, NIOSH modified the petitioner-requested class for SEC-00058 to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class thus includes all Atomic Weapons Employer personnel who worked on uranium recovery pilot studies and/or in Building 55 of the Blockson Chemical Company, Joliet, Illinois, from January 1, 1951 through December 31, 1962. The work activity definition was modified because Building 55 was not completed for uranium recovery production until 1952; however, uranium recovery pilot studies occurred in 1951.

4.0 Data Sources Reviewed by NIOSH

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

4.1 Technical Basis Document (TBD)

A Technical Basis Document (TBD) provides specific information concerning the documentation of historical practices at the specified site. A dose reconstructor can use the TBD to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to serve as a supplement to, or substitute for, individual monitoring data. A TBD provides process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. As part of NIOSH's evaluation, it examined information in the following TBDs for insights into Blockson operations or related topics/operations at other sites:

- *Basis for Development of an Exposure Matrix for Blockson Chemical Company, Joliet, Illinois; Period of Operation: March 1, 1951 through March 31, 1962,* ORAUT-TKBS-0002, Rev. 01; June 29, 2004

- *Technical Basis Document for Atomic Energy Operations at Blockson Chemical, Joliet, Illinois,* OCAS-TKBS-0002; Rev. 00-B; July 19, 2006 (Draft)

- *Y-12 National Security Complex – Occupational Internal Dose,* ORAUT-TKBS-0014-5, Rev. 01, PC-3, February 14, 2006

- *Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,* ORAUT-TKBS-0017-5, Rev. 00; May 28, 2004

- *Technical Basis Document: Basis for the Development of an Exposure Matrix for Chapman Valve Manufacturing, Indian Orchard, Massachusetts, Period of Operation: January 4, 1948 through April 30, 1949,* ORAUT-TKBS-0033, Rev. 00; February 22, 2005

4.2 ORAU Technical Information Bulletin (OTIB)

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

- *OTIB: Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities,* ORAUT-OTIB-0004; Rev. 3 PC-1; November 18, 2005

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures,* ORAUT-OTIB-0006; Rev. 3 PC-1; December 21, 2005

- *OTIB: Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds,* ORAUT-OTIB-0024; Rev. 00; April 7, 2005

- *OTIB: Characterization of Occupational Exposure to Radium and Radon Progeny During Recovery of Uranium from Phosphate Materials,* ORAUT-OTIB-0043; Rev. 00; January 6, 2006

4.3 Facility Employees and Experts

Telephone interviews were conducted with five former Blockson Chemical Co. employees to gain additional information and insight into the operations associated with uranium processing in Building 55. The information gained from these interviews has been compiled in NIOSH's SEC Information System (SECIS). These communications are documented under SEC-00058, Non-Submitter Communications, SECIS IDs 83 through 87. The primary interview questions were:

- How many people worked in Building 55?
- Was uranium extraction work confined to Building 55?
- Did work crews remain constant?
- How were the drums filled?
- Was there any localized ventilation used during drum filling?
- Was the work area cleaned regularly, and how was that done?
- Were there incidents or spills?
- Were there any implemented radiological controls?
- Do you recall any details regarding a uranium urinalysis program?

The respondents' answers are summarized as follows:

- All respondents described the work crews in Building 55 as small (2 to 6 people) and constant. They also confirmed that uranium extraction activities were confined to Building 55.

- An access security clearance requirement and access control by posted guard was confirmed by all but one individual (who had no information regarding clearances or guards).

- Three out of five respondents had seen uranium drum loading. One thought that there had been a loading hopper, while two were certain that the drums were filled by hand-shoveling.

- Only one individual was certain that there was no localized ventilation in the drum loading area, while the other four were unsure. One of those four mentioned a "dust collector," but could not remember where it had been or how it had been used.

- Three stated that the work area was cleaned regularly (one said each shift), and two of those three recalled that the area was swept first, and then washed down using a water hose.

- None of the five recalled any uranium urinalysis program or any radiological controls program.

- One individual thought that there had been medical X-rays administered, while the other four did not know.

- Two of the five recalled small, occasional spills which required clean-up. One described spills as occurring when he had been involved in changing out cloth screens on the "Kelly Filters." Some of the uranium would fall off of the screens onto the floor and they would have to clean it up. He stated that the material was wet at that point in the process.

- When asked later if there was anything else the respondents thought was important, the individual who mentioned the Kelly Filters stated that when changing out the cloth screens, the screens were difficult to hold while wearing gloves, so they had to grab them with their bare hands.

4.4 Previous Dose Reconstructions

NIOSH reviewed its dose reconstruction database, NIOSH OCAS Claims Tracking System (NOCTS), to locate dose reconstructions under EEOICPA that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review for the period of January 1, 1951 through December 31, 1962. (Data available as of August 28, 2006)

Table 4-1: No. of Blockson Chemical Co. Claims Submitted Under the Dose Reconstruction Rule
(January 1, 1951, through December 31, 1962)

Description	Totals
Total number of claims submitted for energy employees who meet the proposed class definition criteria	113
Number of dose reconstructions completed for energy employees who were employed during the years identified in the proposed class definition	68
Number of claims for which internal dosimetry records were obtained for the identified years in the proposed class definition	0*
Number of claims for which external dosimetry records were obtained for the identified years in the proposed class definition	0

* Data capture efforts identified internal monitoring data for three claimants that match the employment time frame (one based on last name and first initial, and two based on last name only).

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. At the time that dose reconstructions were performed, NIOSH was not able to obtain personnel dosimetry records for any employee represented in an individual claim submitted for dose reconstruction under EEOICPA for the time period of January 1, 1951 through December 31, 1962. However, data capture efforts did locate internal monitoring data for 25 former Blockson Chemical employees who were monitored by urinalysis. This is discussed in greater detail in Section 7.2.1. Computer Assisted Telephone Interviews (CATIs) were also conducted to obtain additional information relevant to the individual claim, such as work locations, hours, job titles, and other information.

As part of the dose reconstruction process, the CATI summaries were carefully reviewed for relevant information. Particular attention was given to the interviews of former employees. To the extent that they related to the individual claims reviewed for this evaluation, the interviews provided some information, such as hours worked, that could be useful for future dose reconstructions. In addition, three of the energy employees interviewed indicated that some air monitoring was performed, and two other former employees stated there was some sort of external radiation dosimetry monitoring performed. However, no record of air or external dosimetry radiation monitoring was found. Most interviewees reported that no monitoring of any sort was performed.

4.5 NIOSH Site Research Database

The NIOSH site research database was reviewed to locate documents to support the evaluation of the proposed class. Sixteen documents were identified as pertaining to Blockson Chemical. These documents were evaluated for their relevance to this petition. The documents include historical background on site processes; proposals and contracts with the USAEC; uranium yellowcake production totals; FUSRAP activities; and general background documents. The only documents containing monitoring data of any kind are several pages of urine sample results for 25 employees between the years 1954 and 1958.

4.6 Documentation and/or Affidavits Provided by Petitioners

In qualifying and evaluating petitions SEC-00058 and SEC-00045, NIOSH reviewed the following documents submitted by the petitioners:

- (SEC-00058) Petition Form B and supporting information, received May 13, 2006; SECIS document ID: 9722

- (SEC-00045) Petition Form B and supporting information, received January 26, 2006; SECIS document ID: 9475

- (SEC-00045) Twelve affidavits by petitioners, received January 26, 2006; SECIS document ID: 9477

The twelve affidavits in support of SEC-00045 and one affidavit in support of SEC00058 were provided by two former Atomic Weapons Employee and eleven survivors. Each party provided general employee information such as dates and location of employment, and nearly identical statements regarding the lack of personnel or area monitoring, and lack of protective gear provided to the employee.

5.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at Blockson Chemical Company from January 1, 1951 through December 31, 1962 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 the process through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

5.1 Blockson Chemical Plant and Process Descriptions

The Blockson Chemical Company produced technical grades of sodium phosphate compounds, such as disodium and trisodium phosphate, from phosphate rock obtained mainly from Florida sources. The naturally-occurring uranium content of the phosphate rock averaged about 0.014% U_3O_8. 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 (Stoltz, 1958).

In March 1951, Blockson and the AEC entered into Letter Contract AT (49-1)-606 to build a pilot plant to further test and refine the process. In May 1951, Blockson started preliminary experimentation to determine the feasibility of this process. Blockson determined that it was economically feasible to make the uranium recovery a by-product process designed to fit into their normal production of phosphates (Stoltz, 1958).

From both a process and economic standpoint, using chlorine as an oxidizing agent and then adding sodium hydrosulfite to cause precipitation was determined to be the best option (Stoltz, 1953). Based on existing production, uranium production capacity was estimated to be 50,000 pounds per year of basis uranium oxide (yellowcake) containing 50% to 60% U_3O_8 (Lopker).

A second contract, replacing the original contract, was signed October 18, 1951. Under this second contract, Blockson constructed a facility (Building 55) at its plant in Joliet, Illinois, capable of recovering uranium. This facility was built at Blockson's expense, with the AEC providing and installing the uranium recovery equipment. Blockson was also responsible for both the health and safety of workers at the site and for conforming to AEC health and safety regulations (AEC Letter Contract AT (49-1)-611).

Uranium recovery production began August 15, 1952 (Stoltz, 1953). By the end of December 1955, Blockson had produced 121,400 pounds of uranium oxide (AEC, 1955).

In 1955, the Blockson Chemical Company was sold to the Olin Mathieson Chemical Corporation which assumed the liabilities and obligations under all Blockson contracts. The contract was amended in 1958, primarily to change the pricing structure for uranium. Production was also limited by this amendment to no more than 50,000 pounds of uranium concentrate per year starting in 1958 (DOE, 1985). The 1958 contract also removed the provision that made Blockson responsible for the health and safety of the workers. In March 1962, the uranium extraction work ended when the contract expired (DOE, 1985).

Table 5-1 summarizes Blockson site development.

Table 5-1: Blockson Chemical Company Development Chronology

Years	Buildings	Comments
1951-1952	Pilot Plant, Building 55	• Pilot Plant constructed and used to evaluate and refine the process. • Construction of Building 55, a one-story brick building of approximately 18,900 ft^2. • Production begins in Building 55 on August 15, 1952.
1955	Building 55	• Contract amended; contract work transferred from Blockson Chemical Company to Olin Mathieson Chemical Corporation.
1958	Building 55	• Contract amended which: (1) limited production to 50,000 lbs uranium concentrate per year; and (2) deleted Olin Matheison's AEC health and safety enforcement responsibilities.
1962	Building 55	• Contract ends; production ceases.

5.2 Blockson Chemical Company Functional Areas

Blockson Chemical operations included the following main functional areas:

- Recovery of uranium from phosphoric acid
- Packaging of uranium concentrate (yellowcake) into drums for shipment to the AEC

5.2.1 Recovery of Uranium from Phosphoric Rock

The initial phases of the uranium recovery process at Blockson were identical to normal phosphate production. To recover uranium, phosphate rock is first calcined to remove organic matter, then pulverized to a fine material and reacted with sulfuric acid to produce phosphoric acid and phosphogypsum. The phosphoric acid (which retains around 70-90% of the uranium) is separated for uranium extraction, and the phosphogypsum (which contains most of the radium) is left behind. The phosphoric acid is then converted into monosodium phosphate and other phosphorus derivatives. The uranium by-product is precipitated from the monosodium phosphate stream. The monosodium phosphate liquor is heated and clarified, and then sodium hydrosulfite ($Na_2S_2O_4$) is added to precipitate the uranium. The liquor is filtered and the filtrate is returned to the phosphate processing plant. The precipitate, containing about 5% U_3O_8 is slurried in water in which the uranium is re-dissolved. The uranium is then re-precipitated as sodium uranous phosphate. The slurry is filtered and the precipitate, known as yellowcake, contains 40 to 60% U_3O_8.

5.2.2 Packaging of Uranium Concentrate for Shipment to the USAEC

In the final packing areas, the essentially-pure uranium compound is dried and packaged in drums for shipping, resulting in a potentially-dusty operation (OCAS-TKBS-0002). Follow-up interviews were conducted with five former Blockson Chemical employees who were asked to describe the drum-loading process. Two described the loading process as that of hand-shoveling the product into drums.

One mentioned the use of a hopper, but could not be certain of his recollection. The method used for packing the drums is unclear; it may have included manual loading and/or the use of a hopper system.

5.3 Radiological Exposure Sources from Blockson Chemical Operations

The primary source of radiological exposure from operations performed at Blockson Chemical Company from January 1, 1951 through December 31, 1962 was natural uranium in the form of yellowcake, of which 40-60% was U_3O_8. Potential exposure pathways to be considered include:

- Internal exposure through inhalation and ingestion of airborne uranium dust
- Internal exposure from radon and radon progeny
- External photon dose from drums of uranium yellowcake
- External photon dose from radium
- External beta dose from direct exposure to yellowcake material and from uranium skin contamination
- External neutron dose from drums of yellowcake

5.3.1 Alpha Particle Emissions

Alpha particle emissions from the radioactive materials handled at Blockson Chemical present the greatest potential for exposure through internal deposition via inhalation and ingestion (alpha particles do not present an external exposure hazard). The principal alpha-emitting radioactive materials associated with Blockson operations were natural uranium in the form of yellowcake which contained 40 to 60% uranium oxide (U_3O_8). Natural uranium consists of approximately equal activities of uranium-238 (4.20 MeV and 4.15 MeV alpha particles) and uranium-234 (4.77 MeV and 4.72 MeV alpha particles). There are smaller amounts of uranium-235 (approximately 1/20 of the activity levels of uranium-238 or uranium-234) with alpha particles of 4.40 MeV and 4.36 MeV (Radiological Health, 1970).

Uranium-238 and Ra-226 are essentially in radioactive equilibrium in phosphate rock. During the process in which the phosphate rock is pulverized, mixed with sulfuric acid, and separated into phosphogypsum and phosphoric acid streams, uranium and radium are chemically separated such that the radium is concentrated in the phosphogypsum while the uranium is concentrated in the phosphoric acid. The Ra/U activity ratio found in phosphogypsum was about 75, whereas the Ra/U activity ratio in the phosphoric acid was only about 0.01 (Roessler, C. E., et al, 1979). It is the phosphoric acid stream which was used in the uranium recovery process and that was diverted to Building 55 for uranium extraction. Therefore, personnel performing uranium extraction activities at Blockson would not have been exposed to the concentrations of radium associated with phosphogypsum.

5.3.2 Beta Radiation Fields

The beta dose rate on the surface of yellowcake just after separation is negligible, but rises steadily thereafter due to the build-up of uranium-238 decay products protactinium-234 and thorium-234. A few months after chemical separation, when equilibrium is reached, the beta dose rate from yellowcake is approximately 150 mrad/hr.

Former workers describe very dusty workplace conditions and direct handling of yellowcake with no protective clothing. Therefore, beta skin dose from skin contamination should also be evaluated.

5.3.3 Neutron Exposures

Uranium compounds can be a source of neutrons from both spontaneous fission occurring in the isotopes of uranium and from alpha-neutron reactions with low atomic number materials, such as oxides and impurities. Neutron exposures from yellowcake, a natural uranium compound, are considerably lower than the photon exposures and are, therefore, not significant. ORAU Team 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, with no alpha-emitting progeny (Roessler, C. E., et al, 1979).

5.3.4 Photon Exposures

Photon exposure rates are about 1.2 mrad/hr in contact with fresh yellowcake, but during the build-up of the uranium daughters thorium-234 and protactinium-234 in fresh yellowcake, the radiation levels increase somewhat for several months following yellowcake production (NRC, 2002). Photon exposure rates are estimated to be approximately 1.0 mrad/h at 30 centimeters from a drum of aged yellowcake (OCAS-TKBS-0002, Table 4).

Table 5-2 summarizes default photon energies for Blockson materials. Assignment of a 50%-50% distribution of dose from 30-250 keV photons and >250 keV photons is claimant-favorable because only approximately 8% of the total dose comes from photons less than 300 keV (OCAS-TKBS-0002). Overestimating dose in the 30-250 keV range (compared to >250 keV range) results in a higher probability of causation.

Table 5-2: Default Photon Energies for Blockson Materials

Energy	Natural Uranium
<30 keV	0%
30-250 keV	50%
>250 keV	50%

6.0 Summary of Available Monitoring Data for the Proposed Class

By the terms of the October 1951 AEC contract, Blockson was responsible for the health and safety of workers at the site as well as for conforming with AEC health and safety regulations. However, NIOSH has been unable to find evidence of regulatory inspections pertaining to radiological conditions. Although urine sample results are available, no evidence of an external dosimetry or area monitoring program was found.

6.1 Blockson Chemical Company Internal Monitoring Data

As discussed in Section 5.3, the primary source of internal radiation exposure at Blockson Chemical was uranium dust produced from the drying and loading of yellowcake into containers for transfer to the AEC. One hundred twenty-two urine sample results obtained from 25 different employees between the years 1954 and 1958 are available. These samples were requested by Blockson and analyzed by the AEC New York Operations Office, Health and Safety Division (AEC, 1953).

It is meaningful to note that while there are urinalyses results for 25 workers, there are 113 dose reconstruction claims on file. Based on claimant interviews, the dose reconstructions include workers who: (1) did not work in Building 55 during the covered time period; (2) worked in Building 55 on an infrequent basis; (3) never worked in Building 55; or (4) worked in Building 55 during the covered period as uranium process workers. Other documents on file support the conclusion that the urinalysis data include results for workers who had the potential for uranium intakes (see Section 7.2.1).

6.2 Blockson Chemical Company External Monitoring Data

NIOSH discovered no evidence of individual external exposure monitoring or area radiation monitoring at Blockson Chemical.

6.3 Blockson Chemical Company Air Sampling Data

NIOSH discovered no evidence of air sampling during uranium extraction operations at Blockson Chemical Company. Air monitoring was performed in between March and November, 1978, as a part of a characterization survey conducted by Argonne National Laboratory (ANL). Particulate air monitoring was performed and analyzed for both long-lived radionuclides and short-lived particulate radon progeny. The survey report states, “The radon decay-product concentrations in air samples collected at selected locations in the building, including the areas where contamination was found, ranged form 0.0014 to 0.0061 Working Levels (WL), including background……No long-lived radionuclides were detected in any air sample.” (ANL, 1978)

6.4 Blockson Chemical Company Contamination Monitoring Data

The only available contamination/radiation monitoring results are from surveys done by ANL between March and November 1978. The ANL survey was performed throughout Building 55, including plant surfaces, tanks, pipes, and other process equipment. A dose rate was taken at contact and at one meter on all 63 locations where contamination was detected. The dose rates at one meter on seven of the 63 "hot" spots ranged from 0.04 mrad/hr to 0.2 mrad/hr. The other 57 spots had one-meter dose rates indistinguishable from background.

7.0 Feasibility of Dose Reconstruction for the Proposed Class

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

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class (identified in Section 9.0 of this report). If not, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source-term data, which together or individually might allow NIOSH to 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 (summarized in Section 7.6). Previous dose reconstructions estimate dose by determining the maximum feasible dose using claimant-favorable assumptions, and reasonable worst-case scenarios. This approach is discussed in the SEC Petition Evaluation Internal Procedures (OCAS-PR-004) available at www.cdc.gov/niosh/ocas. The next four major subsections 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 petitions SEC-00058 and SEC-00045 as submitted by the petitioners. (Section 7.4)

7.1 Pedigree of Blockson Chemical Company Data

This subsection answers questions that need to be asked before a feasibility evaluation is performed. The topic of 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 internal data consistency. 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 Dose Data Review

NIOSH has records and data from 122 urine samples from 25 different employees collected from April, 1954 to February, 1958 (nineteen employees have multiple samples). Ten records of the urinalyses are available, with results for 10 to 14 workers on each report. Standard photofluorometric methods were used by the AEC New York Operations Office, Health and Safety Division (AEC, 1954-58). Results of the samples ranged from 0 to 17 ug of uranium per liter of urine, and detection thresholds likely ranged between 2 and 3.8 ug of uranium per liter of urine (HASL-58).

The original New York Operations Office (NYOO) documentation is available for review and was used both to develop the Blockson TBD and in this evaluation. The hard-copy data sheets, provided on a standard NYOO form, include the site/plant identification, the individuals sampled, the date(s) of the samples, the type of sample, information on the analysis performed, and the analysis results in ug/L (handwritten). No other source of information (database or otherwise) has been identified as of the time of this evaluation; therefore, a quality check of this data was not possible.

7.1.2 External Dose Data Review

NIOSH has been unable to find any record of external dosimetry monitoring of Blockson uranium workers.

Although using a source term is not the preferred method for estimating external worker doses, in the absence of personal dosimeter or monitoring data, co-worker data, or area monitoring data, a source term with process information may be used to estimate and bound external doses (OCAS-IG-001, Table 1.1). The source term present at Blockson can be derived from the AEC monthly production reports, the design capacity of the uranium extraction process, contract limits on production, and the source term data input into MCNPX (version 2.5.0) for exposure rate calculation from drums of yellowcake (AEC, 1955; Lopker; AEC Letter Contract AT (49-1)-611; OCAS-TKBS-0002). A claimant-favorable assumption of worker occupancy in the vicinity of the source term can be used to bound the external doses.

NIOSH has not located any documentation regarding AEC-required physical examinations for Blockson employees. Nevertheless, several claimants reported that chest X-rays were performed as part of either pre-employment or periodic physicals. One claimant reported that he had received chest X-rays during work in the "HF" building after he had left Building 55. On this basis, NIOSH would assume employees received an annual chest X-ray and use claimant-favorable methods and data to estimate related radiation doses (OCAS-TKBS-0002).

7.2 Internal Radiation Doses at Blockson Chemical Company

During chemical processes through which uranium is concentrated, contamination and dust exposures are minimal. Such wet chemical processes occur in closed tanks and piping systems. The greatest potential for exposure to radioactive materials associated with a uranium recovery process arises in the final packing areas. Here the essentially-pure uranium compound is dried and barreled for shipping, resulting in a potentially-dusty operation (OCAS-TKBS-0002).

At Blockson, it is unclear whether engineering controls (e.g., hood or room ventilation) were used to lower dust levels during the uranium recovery process. Of the dose reconstruction claimants interviewed, one reported that ventilation had been used in Building 55, and one sample analysis technician reported that a ventilation hood was always used for work that he performed. There was a line item for miscellaneous fans in the summary of cost estimate proposed by Blockson for the construction of Building 55; however, details are not available (Lopker). There was no specific line-item in the proposal for local ventilation of the packing operations.

The principal source of internal radiation doses for members of the proposed class was uranium dust produced from the drying and loading of yellowcake into containers for transfer to the AEC (OCAS-TKBS-0002). Other sources of internal dose to be considered are from: (1) residual contamination on building and equipment surfaces; and (2) radon and radon progeny that may have been present on site.

7.2.1 Process-Related Internal Doses at Blockson Chemical Company

The preferred method for estimating internal dose is by urinalysis. Urinalysis results for total uranium are available for 25 Blockson workers from April, 1954 through February, 1958. The results are documented on ten urinalysis reports, with 10 to 14 workers listed on each report. These workers include personnel assumed to be exposed to the highest concentrations present at the site (e.g., process operators) as well as workers unlikely to be regularly exposed to the highest concentrations.

The urinalysis data reports list the individuals either by last name and first initial or by last name only. NIOSH has documentation confirming five individuals as being involved in uranium process work in Building 55. Their job titles were:

- Chemical Operator: Confirmed in NIOSH records as claimant in previous Blockson-related dose reconstruction; confirmed in urinalysis report by first and last name; confirmed by CATI interview; stated that he scraped dried yellowcake out of the drier and shoveled it into drums; stated it was a three-man operation. He said that usually the powder form was processed on day shift and the wet processing occurred on night shift.

- Supervisor: Identified by first and last name by the Chemical Operator listed above as his Supervisor during his uranium process work in Building 55; listed by last name and first initial in multiple urinalysis results.

- Chemical Product Analyst: Confirmed in NIOSH records as claimant in previous Blockson-related dose reconstruction; confirmed in urinalysis report by an uncommon last-name-only match; job title confirmed by CATI interview; stated that he sometimes analyzed uranium samples.

- Control Chemist: Confirmed in NIOSH records as claimant in previous Blockson-related dose reconstruction; confirmed by last name only on two urinalysis sample results; job title confirmed by CATI interview; stated he worked in Building 55 during uranium processing.

- Filter Operator: Initial and last name match from urinalysis results match the middle initial and last name from a former worker providing information in a petition. The former worker stated that he worked in Building 55 as a Filter Operator of a device that filtered out the solids in the uranium-bearing solution.

The information above supports the conclusion that urinalysis sampling was performed on those individuals who had potential for exposure. The plausible duties of the job titles listed above range from those likely have had the most significant exposure (Chemical Operator) to those likely to have had the least (Supervisor). The urinalysis data are considered to be that of actual Building 55 uranium workers, based on the following:

- A letter of request from Blockson Chemical to the AEC for personnel urinalysis for "about 20 workers involved in uranium work" (Barr, 1953)

- Blockson pre-operational labor estimates listing the need for 18 workers with specified job titles. The titles listed included operators, chemists, part time maintenance support, supervisors and clerks. (OCAS-TKBS-0002; Lopker)

- Urinalysis records of 122 samples for 25 workers with five names matching those known to be involved in uranium process work in Building 55

- Three of the workers listed on urinalysis reports having Blockson-related dose reconstructions on file

- One of the three dose reconstruction claimants having performed work that would be considered having the highest potential for exposure (loading yellowcake into drums)

- The assumed workforce size being supported by former Blockson employees' estimates of the Building 55 work force

Based on review of the available data (i.e., production reports, contract limitations), uranium extraction operations performed at Blockson were consistent over the entire operational period. Therefore, NIOSH has assumed that the internal monitoring data that exist are representative of the personnel exposures that occurred over the entire operational period evaluated in the report. Applying this assumption, the sampling that occurred from 1954 through 1958 is representative of the personnel exposures at Blockson over the period from 1951 through 1962.

7.2.2 Ambient Environmental Internal Radiation Doses at Blockson Chemical

Ambient environmental dose is accounted for in the assignment of process-related dose.

7.2.3 Internal Dose Reconstruction

Workers in Building 55 and related activities were potentially exposed to airborne uranium. Thorium (which is assumed to follow the uranium in the Blockson process) and radon are also considered to be present.

7.2.3.1 Uranium Intakes

For dose reconstruction purposes, intake rates that are favorable to claimants are chosen to ensure that the maximally-exposed workers are assigned favorable values in the absence of individual monitoring information for EEOCIPA claimants. Therefore, production workers would be assumed to have been continually exposed at the 95th percentile intake rate of 82 pCi/day, and administrative personnel assumed to have been exposed continually at the median intake rate of 25 pCi/day. These bounding intakes should be entered into the NIOSH Interactive RadioEpidemiological Program (IREP) as constants (OCAS-TKBS-0002). The presence of associated radionuclides that could be present and contribute to significant internal dose is assumed (ORAUT-OTIB-0043). Intakes can be assessed by either the presumption of inhalation or ingestion. Tissues of the gastrointestinal tract receive larger doses from ingestion than from inhalation. Although inhalation is generally considered the most common route of occupational intakes, internal dose to tissues of the gastrointestinal tract can be bounded by assuming all bioassay results are a result of ingestion of uranium. The results of the bioassay analysis are summarized in Table 7-1, based on the presumption of inhalation (OCAS-TKBS-0002).

Table 7-1: Uranium Inhalation Intake Rates for Blockson Workers

Worker category	Intake rate [1]	Distribution
Administrative	25 pCi/day total U	Constant value
Administrative	0.35 pCi/day Th-232 and Th-228 [2]	Constant value
Production workers	82 pCi/day total U	Constant value
Production workers	1.1 pCi/day Th-232 and Th-228 [2]	Constant value

1. Intake rates are normalized to units of calendar days.
2. Thorium intake rates are derived from ratios in ORAUT-OTIB-0043.

7.2.3.2 Radon and Radon Progeny

Significant radon levels have been known to exist during uranium extraction operations due to the resultant radium concentrations generated during some processes. However, at Blockson, the phosphoric acid used for uranium extraction was a by-product of commercial work already being conducted. As described in Section 5.1.1, the separation process results in essentially no radium being left in the phosphoric acid. Because the acid was the source of the monosodium phosphate being pumped to Building 55, there would be no significant levels of radon in Building 55 from the uranium operations. However, radon could have been present due to dispersion from other areas (outside of Building 55).

Radon exposures to workers at phosphate plants have been evaluated for the NIOSH EEOICPA dose reconstruction project (ORAUT-OTIB-0043). Because no radon monitoring data are available for the period of Blockson uranium operations, the appropriate default values will be assigned. Therefore, for reconstructing lung doses, all Blockson workers are to be assigned an exposure of 0.036 WLM (working level month) per year due to radon progeny (see Table 7-2).

Table 7-2: Radon Exposures for Blockson Workers

Dose component	Annual dose/exposure [1]	Distribution
Radon progeny	0.036 WLM (lungs only)	Lognormal, GSD=2.0
Radon progeny	75 rem alpha (ET1 only) [2]	Lognormal, GSD=2.0
Radon progeny	0.30 rem alpha (ET2 only) [2]	Lognormal, GSD=2.0
Radon gas	0.002 rem alpha (non-respiratory tract tissues only)	Constant value

1. Exposure and dose values are from ORAUT-OTIB-0043.
2. ET1 and ET2 dose conversion factors are from OCAS-TIB-0011.

7.2.3.3 Residual Radioactivity

Internal dose from residual contamination is addressed in the Blockson TBD (OCAS-TKBS-0002), but is outside the bounds of the timeframe specified in the SEC class definition, and is not addressed in this evaluation report.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

This evaluation concludes that dose reconstruction for members of the proposed class is feasible, based on: (1) the availability of representative personnel internal monitoring data; and (2) the application of 95th percentile doses that are bounding or more accurate than bounding.

7.3 External Radiation Doses at Blockson Chemical Company

The principal sources of external radiation doses for members of the proposed class were (OCAS-TKBS-0002):

- Drums of yellowcake
- Medical x-rays

7.3.1 Process-related External Radiation Doses at Blockson Chemical

External dosimetry data are not known to exist for Blockson workers, and data capture efforts for the EEOICPA dose reconstruction project have not found any direct radiation survey results from the Blockson facility. Therefore, source term information has been used to estimate external doses. Blockson's uranium recovery process was a by-product process designed to fit into the existing phosphate process (Stoltz, 1958). The primary radionuclides of interest for potential external exposure in Building 55 are U-238 and daughter radionuclides Th-234 and Pa-234m.

7.3.2 Ambient Environmental External Radiation Doses at Blockson Chemical

Ambient environmental dose is accounted for in the assigning of process-related dose.

7.3.3 Blockson Chemical Occupational X-Ray Examinations

Dose from occupationally-required medical X-rays have also been considered and assumed to have occurred.

7.3.4 External Dose Reconstruction

By the end of August 2006, 113 EEOICPA claims from Blockson Chemical workers had been submitted to NIOSH. Of those 113 claims, NIOSH has completed dose reconstructions for 68 claims. These claims cover the entire range of operations at Blockson Chemical; however, no indication of personnel external radiation exposure monitoring was found.

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

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

7.3.4.1 Photon Dose

The primary source of photon dose to Blockson workers was from drums of uranium yellowcake. Other sources to be considered are photon dose from residual contamination, and from radium.

Photon Dose from Drummed Yellowcake

The Blockson TBD (OCAS-TKBS-0002) discusses evaluation of photon dose from drums of yellowcake. It states: "MCNPX (version 2.5.0) was used to determine the dose rate per curie of ^{238}U regardless of the actual activity in the drum. This was later adjusted for actual source activity to compare actual dose rates. All radionuclides were ratioed with respect to ^{238}U to determine the number of photons and electrons per decay of ^{238}U. Anderson and Hertel showed that the short lived nuclides (^{234}Th, ^{234m}Pa, ^{234}Pa, and ^{231}Th) are very close to equilibrium (adjusted for branching ratios) at 100 days. For the purposes of this evaluation, branching ratio adjusted equilibrium was assumed." ICRP Publication 74 (Table A.1) was used to convert the photon flux to units of air kerma using the conversion factors in shown Table 7-3 below. (ICRP 74; OCAS-TKBS-0002)

The dose rate was determined at 77.9 cm above the ground, and 30 cm from the edge of the drum for both the photon and beta emissions of natural uranium and its progeny. Results are provided in Table 7-3.

Table 7-3: Uranium dose rates from drums of yellowcake

Density of U_3O_8 (g/cm^{-3})	Activity of U in drum (Ci)	Photon emission dose (rad/hr)	Bremsstrahlung dose (rad/hr)	Total dose rate at 30 cm (rad/hr)
0.5 *	3.121E-02	3.96E-04	3.20E-04	7.16E-04
1	6.242E-02	5.00E-04	3.60E-04	8.60E-04
2	1.248E-01	5.54E-04	3.76E-04	9.30E-04
4	2.497E-01	5.84E-04	3.84E-04	9.69E-04
6	3.745E-01	5.84E-04	3.64E-04	9.48E-04
6.7	4.182E-01	5.81E-04	3.74E-04	9.56E-04

* The drum begins to noticeably impact the dose rates at low material concentration

The air kerma dose rates were converted to annual organ doses by assuming a worker's exposure time was lognormally distributed. The median exposure time was determined by assuming all workers were working eight hours per day, one day per week at a distance of one foot from the drum. This was normalized to 400 hours per work year. The 95th percentile exposure time was determined by assuming the worker spent a standard 2000-hour work year at a distance of one foot from the drum. This results in a kerma dose distribution with a median value of 0.387 rad per year with a geometric standard deviation of 2.7. The dose distribution was assumed to be 50% from photons 30-250 keV and 50 % from photons >250 keV.

For the purposes of calculating organ doses for use in the NIOSH Interactive RadioEpidemiological Program (NIOSH-IREP), Monte Carlo methods were used to multiply the whole body doses times the triangular organ dose conversion factors found in the NIOSH External Dose Reconstruction Implementation Guideline (OCAS-IG-001). The results are annual doses that are lognormally distributed. The results are in Table 5 of the Blockson TBD. For skin, the air kerma values were multiplied by 1.0.

Photon Dose from Residual Contamination

Photon dose from residual contamination is addressed in the Blockson TBD (OCAS-TKBS-0002), but is outside the bounds of the timeframe specified in the SEC class definition, and is not addressed in this evaluation report.

Photon Dose from Radium

As stated in Section 5.3.1, the Ra/U activity ratio found in phosphogypsum was about 75, whereas the Ra/U activity ratio in the phosphoric acid was only about 0.01 (Roessler, C. E., et al, 1979). Therefore, photon dose from radium is not addressed in this evaluation.

7.3.4.2 Electron Dose

For accumulations of processed yellowcake dust, the surface beta dose rate from U-238 daughters is negligible just after separation, but rises steadily until Pa-234m and Th-234 reach equilibrium concentrations. After a few months, the beta dose rate is approximately 150 mrem/hr (OCAS-TKBS-0002).

We have assumed that there was a potential for workers to receive a shallow dose from exposure to open drums of yellowcake during drum loading and sealing. The dose rate at one foot from the surface of aged yellowcake is between 1-2 mrem/hour. The production workers are assumed to have spent eight hours per week, 50 weeks per year, at one foot from the surface of aged yellowcake at a dose rate of 2 mrem/hour. This results in a shallow beta dose of 0.8 rem/year. To allow for uncertainty, the time of exposure was assumed to be lognormally distributed with the 95th percentile exposure time assumed to be 40 hours per week, 50 weeks per year. This shallow dose result applicable for dose reconstructions is shown in Table 7-4. The calculated beta dose has not been reduced to allow for doses to areas of the skin that are typically covered by clothing (which results in a reduction of beta dose to the skin).

Table 7-4: Shallow Dose for Building 55 Workers

Dose component	Annual dose/exposure	Distribution
Beta dose, E>15 keV	0.8 rem per year	Lognormal, GSD=2.7

It is also assumed that there was a potential for workers to receive a shallow dose from electrons due to skin contaminated with yellowcake. The amount of skin contamination can be calculated by using the measured deposition velocity of 4-µm particles to skin of 0.012 m/s (Andersson, 2002; Fogh, 1999), assuming that the material was deposited on the skin for an entire 8-hour shift. The estimated amount of skin contamination, combined with electron dose-rate conversion factors for U-238 and daughter radionuclides Th-234 and Pa-234m, results in an estimated dose to skin due to electron exposure of 0.0018 rem. This skin dose is negligible when compared to the shallow dose estimate from exposure to a drum of aged yellowcake discussed in the above paragraph (and shown in Table 7-4).

7.3.4.3 Neutron Dose

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, C. E. et al , 1979). Assuming both that a drum of yellowcake weighs 1000 pounds, and 2000-hour occupancy, the estimated annual neutron dose would be <0.001 rem. This level of exposure is considered insignificant for purposes of dose reconstruction.

7.3.4.4 Unmonitored Individuals Working in Production Areas

Records indicate that no personnel were monitored for photon, electron, or neutron doses at Blockson. Methods for dose reconstruction are discussed in the preceding sections.

7.3.4.5 Medical X-ray

Dose from occupationally-required medical X-rays has also been considered and assumed to have occurred. For the AEC operational period at Blockson, employees are assumed to have received an annual chest X-ray. Organ doses are listed in Table 7-5 and are based on an assumed Posterior-Anterior (PA) exposure with minimal collimation. Dose values are reproduced from *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures* (ORAUT-OTIB-0006, Table 6-5). The annual doses are applied as dose from 30-250 keV photons using the values in Table 7-5 as the mean of a normal distribution with a 30% standard deviation.

Table 7-5: Annual Organ Doses From Medical X-rays

Organ	Annual dose, rem; photon 30-250 keV
Thyroid	3.48E-02
Eye/brain	6.40E-03
Ovaries	2.5E-02
Liver/gall bladder/spleen	9.02E-02
Urinary bladder	2.5E-02
Colon/rectum	2.5E-02
Testes	5.0E-03
Lungs (male)	8.38E-02
Lungs (female)	9.02E-02
Thymus	9.02E-02
Esophagus	9.02E-02
Stomach	9.02E-02
Bone surfaces	9.02E-02
Remainder	9.02E-02
Breast	9.80E-03
Uterus	2.5E-02
Bone marrow (male)	1.84E-02
Bone marrow (female)	1.72E-02
Skin	2.70E-01*

* Skin dose is for skin in the primary beam.

7.3.5 External Dose Reconstruction Feasibility Conclusion

This evaluation concludes that external dose reconstruction for members of the proposed class is feasible. By modeling external dose from source term estimates, and by making reasonable exposure time estimates which are favorable to the claimant, dose estimates are either bounding or more accurate than bounding.

7.4 Evaluation of Petition Basis for SEC-00058

The following assertions were made on behalf of petition SEC-00058 (and SEC-00045, as notated) regarding work at Blockson Chemical Company. Italicized statements are from the specified petition; the comments that follow are from NIOSH.

7.4.1 No Monitoring of Worker Exposures

SEC-00058: [From petitioner's Form B statement] *"While extracting uranium there was no monitoring of dose received, no safety or protective equipment furnished and inadequate ventilation in the building. No exposure records were ever kept."*

SEC-00045: [From the 12 Affidavits] *"….that neither the government nor Blockson Chemical ever monitored (worker's) exposure to radioactive materials; that neither the government nor Blockson Chemical ever monitored the radiation levels and/or exposure of Building 55 during…" (the proposed class dates relevant to this petition).*

NIOSH obtained results from 122 uranium urine samples collected from 25 different workers between 1954 and 1958. Furthermore, according to a document provided by Blockson to the AEC that estimated a breakdown of labor needs for operating Building 55, about 18 people were employed in Building 55 operations (OCAS-TKBS-0002; Lopker). The results of the urine monitoring do not contain the names of any workers appearing on SEC Petition SEC-00045; however, they do contain an initial and last name that matches the middle initial and last name of the petitioner for SEC-00058. Additionally, as verified in NOCTS, the results include three workers for which a dose reconstruction was performed or initiated. One of the three worked as a Chemical Operator who was involved in drum-loading activities with direct handling of yellowcake material. As explained in Section 7.2.1, the urine data are considered representative of the potential exposures from the uranium operations being performed by Blockson Chemical. It can be concluded that this group of workers was selected because they had jobs with a potential for exposure, and includes those individuals with the highest potential for exposure, as well as those considered to be only intermittently exposed.

No evidence of air monitoring or external radiation monitoring during uranium extraction activities was found; however, knowledge of the source term and processes can provide a means for estimating radiological conditions and external dose for members of the proposed class.

7.4.2 Particle Size Used Is Not Claimant Favorable

SEC-00045: *Numerous studies have determined that a significant portion of dusts less than 5 micron collects in tissue deep in the lungs and can cause significant damage to surrounding tissue. It is not clear that the TBD adequately accounts for the accumulation of material in the lungs other than a "calculated" chronic intake rate of 24 pCi/day using broad assumptions that do not necessarily reflect more recent published research.*

The derived intakes in the Technical Basis Document OCAS-TKBS-0002 are based on the particle size recommendations contained in ICRP Publication 66. Calculations using urinalysis data indicate that the lung dose from inhalation of 1 micron AMAD particles is marginally higher than the dose from inhalation of 5 micron AMAD particles. When derived from bioassay data, the 50-year

committed dose to the lung from the chronic inhalation of 1 micron particles is nominally 15% higher than the 5 micron particle dose. In the absence of specific particle size studies, intakes and dose can be estimated based on the recommendations of the ICRP (ICRP 66).

7.4.3 Ingestion of Radioactive Material In Phlegm Not Considered

SEC-00045: *The TBD also appears to fail to account for radioactive material that can be ingested as phlegm from previously inhaled matter.*

The amount of material transferred to the gastrointestinal tract from inhaled particles (ingestion as phlegm) is included in the ICRP Publication 66 lung model being used for dose reconstructions (ICRP 66). Material that is ingested (not via inhalation) is also addressed in the Technical Basis Document OCAS-TKBS-0002. Ingestion intakes can be bounded by assuming all uranium in urine is the result of eating or ingesting uranium. Therefore, the available bioassay data can be utilized to estimate bounding doses from ingestion.

7.4.4 Uranium Daughter Beta/Gamma Emitters Not Considered

SEC-00045: *The 24 pCi/day value does not appear to address the presence of the beta-emitting isotopes Th-234 and Pa-234(m). These isotopes have short half-lives of 24 days and a few hours respectively.*

Progeny in-growth is addressed in Technical Basis Document OCAS-TKBS-0002 and is assumed to have occurred. The dose calculated from intakes of uranium account for the presence of Th-234 and Pa-234m.

7.5 Other Issues Relevant to the Petition Identified During the Evaluation

During the feasibility evaluation for SEC-00045 (later merged with SEC-00058), one issue was identified that required further analysis and resolution. There was a potential for beta dose to worker hands from the handling of uranium filter screens without gloves. It was determined that the source term information available in the site profile and other sources was sufficient to determine the maximum dose that one could receive from direct contact with the uranium yellowcake material.

7.6 Summary of Feasibility Findings for Petition SEC-00058

This report evaluated the feasibility for completing dose reconstructions for employees at Blockson Chemical Company from January 1, 1951 through December 31, 1962. NIOSH found that the monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the proposed class of employees.

Table 7-6 summarizes the results of the feasibility findings at Blockson Chemical Company for each exposure source for the time period January 1, 1951 through December 31, 1962.

Table 7-6: Summary of Feasibility Findings for SEC-00058
January 1, 1951 through December 31, 1962

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal	X	
- Urinalysis (*in vitro*)	X	
External	X	
- Gamma	X	
- Beta	X	
- Neutron	X	
- Occupational Medical x-ray	X	

As of June 20, 2006 a total of 113 claims have been submitted to NIOSH for individuals who worked at Blockson Chemical. Dose reconstructions are complete for 68 individuals (60%).

8.0 Evaluation of Health Endangerment for Petition SEC-00058

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. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has determined that internal doses can be estimated with sufficient accuracy using the available bioassay data, and maximum external doses can be estimated using knowledge of the source term and processes at Blockson Chemical. Therefore, this evaluation determined that it is feasible to

estimate radiation dose for members of the proposed class with sufficient accuracy based on the sum of information available from available resources. Accordingly, it is not necessary to evaluate health endangerment.

9.0 NIOSH Proposed Class for Petition SEC-00058

Based on its research, NIOSH expanded the petitioner-requested class to define a single class of employees for which NIOSH can estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employer personnel who worked on uranium recovery pilot studies and/or in Building 55 of the Blockson Chemical Company, Joliet, Illinois, from January 1, 1951 through December 31, 1962.

NIOSH has carefully reviewed all material sent in by petitioners for SEC-00058 (and SEC-00045 which was merged with SEC-00058), including the specific assertions stated in the petitions, and has responded to them herein (see Section 7.4). NIOSH has also reviewed the available technical resources, and many other references, including the Site Research Data Base (SRDB) for information relevant to SEC-00058. In addition, NIOSH reviewed its dose reconstruction database, NIOSH OCAS Claims Tracking System (NOCTS), to identify dose reconstructions under EEOICPA 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, it is often feasible to estimate doses by using additional information that might be available, such as area monitoring results, information on the radiological sources and the work processes involving radiological exposures, and monitoring information from comparable operations at other facilities. When using such additional information, radiation estimates typically overestimate, within plausible limits, the likely actual exposures and doses of employees at the facility. NIOSH has attempted to comply with these standards of performance in determining that it would be feasible to reconstruct the dose for the class proposed for this petition.

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, Page 22296; 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

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