

SEC Petition Evaluation Report

Petition SEC-00089

Report Rev #: 0

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Subject Expert(s):	Joe Guido
Site Expert(s):	NA

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Qualification Date	DOE/AWE Facility Name
SEC-00089	83.13	January 4, 2008	Spencer Chemical Company/Jayhawk Works

Petitioner Class Definition

All workers who worked in all areas at Spencer Chemical Company/Jayhawk Works from 1958 through 1963.

Class Evaluated by NIOSH

All workers who worked in any area at Spencer Chemical Company/Jayhawk Works from January 1, 1956 through December 31, 1961.

NIOSH-Proposed Class(es) to be Added to the SEC

All Atomic Weapons Employer employees who worked in any area at Spencer Chemical Company/Jayhawk Works near Pittsburg, Kansas, from January 1, 1956 through December 31, 1961, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
None	NA	NA	NA

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
NA	NA

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Evaluation Report Summary: SEC-00089, Spencer Chemical Company/Jayhawk Works

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-00089, qualified on January 4, 2008, requested that NIOSH consider the following class: *All workers who worked in all areas at Spencer Chemical Company/Jayhawk Works from 1958 through 1963*. The period of employment defined in the original petition was based on the covered period for the site as listed by the Department of Energy (DOE) Office of Health, Safety and Security at the time the petition was submitted.

Class Evaluated by NIOSH

NIOSH modified the petitioner-requested class timeframe based on concurrence and direction from the Department of Labor (DOL). The NIOSH-evaluated class includes *all workers who worked in any area at Spencer Chemical Company/Jayhawk Works from January 1, 1956 through December 31, 1961*.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research, NIOSH defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes *all Atomic Weapons Employer employees who worked in any area at Spencer Chemical Company/Jayhawk Works near Pittsburg, Kansas, from January 1, 1956 through December 31, 1961, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC*. The class was broadly defined because NIOSH has little insight into Spencer Chemical Company/Jayhawk Works control of radioactive materials being transported between work areas during the covered period. Without such information, NIOSH is not able to rule out cross-contamination of work areas. Therefore, NIOSH is unable to limit the SEC class based on work location. Consequently, all Spencer Chemical Company/Jayhawk Works areas are included in the proposed SEC class.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it does not have 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 from available resources is not sufficient to document or

estimate the maximum internal and external potential exposures 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 required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the proposed class.

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation. Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under their employment or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

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SEC Petition Evaluation Report for SEC-00089

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: Karin Jessen, ORAU. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any area at Spencer Chemical Company/Jayhawk Works from January 1, 1956 through December 31, 1961. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, 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

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

during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

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

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

Petition SEC-00089, qualified on January 4, 2008, requested that NIOSH consider the following class for addition to the SEC: *All workers who worked in all areas at Spencer Chemical Company/Jayhawk Works from 1958 through 1963.* The period of employment defined in the original petition was based on the covered period for the site as listed by the DOE Office of Health, Safety and Security at the time the petition was submitted.

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Spencer Chemical Company/Jayhawk Works employees in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00089 for evaluation:

In support of the petition, the SEC-00089 petitioner provided numerous Spencer Chemical Company/Jayhawk Works memos and partial Atomic Energy Commission (AEC) reports. The petitioner claims that radiation monitoring records for members of the proposed class cannot be found. The petitioner also states that workers were continuously exposed to high concentrations of highly enriched uranium dust and powder. In addition, safe handling practices were not used, as workers were not adequately trained nor were they adequately protected as evidenced by dusty respirators. Finally, there is a lack of survey documentation, potentially indicating that workers were not aware of potential radiation hazards.

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

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.

NIOSH modified the petitioner-requested class timeframe based on concurrence and direction from the DOL (Turcic, 2008) and evaluated its ability to estimate radiation doses with sufficient accuracy for the proposed worker class. The class evaluated by NIOSH includes *all workers who worked in any area at Spencer Chemical Company/Jayhawk Works from January 1, 1956 through December 31, 1961.*

Based on the research and reviews performed as part of this evaluation, NIOSH has defined a single class of employees for which it cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes *all Atomic Weapons Employer employees who worked in any area at Spencer Chemical Company/Jayhawk Works near Pittsburg, Kansas, from January 1, 1956 through December 31, 1961, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.* The class was accepted as a result of the feasibility evaluation documented in Section 7.0.

4.0 Data Sources Reviewed by NIOSH

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

Spencer Chemical Company/Jayhawk Works utilized several different companies for the purpose of internal and/or external monitoring between 1956 and 1961. One company, Landauer, specifically stated that they did not have records identifying Spencer Chemical Company/Jayhawk Works as a customer (Jessen, 2008). Another company, Nuclear Science and Engineering, no longer exists. Although contact was made with successor companies, no records were found regarding Spencer Chemical Company/Jayhawk Works. Another company, National Spectrographic Laboratory could not be located.

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. Although there are no Site Profile TBDs written specifically for Spencer Chemical Company, as part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights:

- *Site Profiles for Atomic Weapons Employers that Worked Uranium and Thorium*, Battelle-TBD-6000; PDWD-3738 Rev. F0; December 13, 2006; SRDB Ref ID: 30671
- *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001; Rev. F0; December 13, 2006; SRDB Ref ID: 30673

4.2 Technical Information Bulletins (TIBs) and Procedures

A Technical Information Bulletin (TIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. A 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 TIBs and procedures as part of its evaluation:

- *TIB: Dose Reconstruction from Occupationally Related X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 03 PC-1; December 21, 2005; SRDB Ref ID: 20220
- *TIB: 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
- *TIB: Default Assumptions and Methods for Atomic Weapons Employer Dose Reconstructions*, Battelle-TIB-5000, Rev. 00; April 7, 2007, SRDB Ref ID: 32016
- *Procedure: Occupational X-Ray Dose Reconstruction for DOE Sites*, ORAUT-PROC-0061, Rev 00; July 21, 2006; SRDB Ref ID: 29987

4.3 Facility Employees and Experts

To obtain additional information, NIOSH researched its NIOSH OCAS Claims Tracking System (NOCTS) database and located nine former employees who worked at Spencer between 1956 and 1961. Of those nine employees, three employees were willing to be interviewed. During the interview process, one additional person (a non-claimant) was identified and willing to be interviewed. None of the people interviewed worked in the “nuclear” buildings, as the buildings were referred to. However, one interviewee did go into the “nuclear” buildings for Safety and Health Inspections and clean-up activities.

- Personal Communication, 2008a, *Personal Communication with Floor Operator*; Telephone Interview by ORAU Team; February 20, 2008; OSA Ref ID: 105337
- Personal Communication, 2008b, *Personal Communication with Laborer*; Telephone Interview by ORAU Team; February 20, 2008; OSA Ref ID: 105334
- Personal Communication, 2008c, *Personal Communication with Laborer and C Operator*; Telephone Interview by ORAU Team; February 22, 2008; OSA Ref ID: 105335

- Personal Communication, 2008d, *Personal Communication with Nitric Acid Department Employee and Former President of the United Chemical Workers Union*; Telephone Interview by ORAU Team; February 22, 2008; OSA Ref ID: 105336

4.4 Previous Dose Reconstructions

NIOSH reviewed 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 June 4, 2008)

Table 4-1: No. of Spencer Chemical Company/Jayhawk Worksite Claims Submitted Under the Dose Reconstruction Rule	
Description	Totals
Total number of claims submitted for dose reconstruction	30
Total number of claims submitted for energy employees who meet the evaluated class definition criteria (January 1, 1956 through December 31, 1961)	30
Number of dose reconstructions completed for energy employees who meet the evaluated class definition criteria	0
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. Thirty claims have been submitted for Spencer Chemical Company; none of the 30 claims have been completed. NIOSH has not located any internal or external monitoring data for individuals that were employed during the period evaluated in this report. Minimal monitoring information is available in several AEC reports, but it is general and not specific for individuals. NIOSH has been unable to find the original monitoring records to corroborate the results reported in the AEC reports.

4.5 NIOSH Site Research Database (SRDB)

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class. One hundred ninety-four documents in this database were identified as pertaining to Spencer Chemical Company/Jayhawk Works. These documents were evaluated for their relevance to this petition. The SRDB contains mostly one- or two-page copies of licenses and permission to ship materials, but generally, these documents do not provide much detail. Very little information has been found regarding dust sampling, internal and external monitoring data, radiological control programs, medical monitoring, and program/site descriptions or incidents/accidents.

4.6 Other Technical Sources

NIOSH completed an extensive database and internet search for information regarding Spencer Chemical Company/Jayhawk Works. 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, the Atomic Energy Technical Report database, and the Hanford Declassified Document Retrieval System. 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, the DOE-National Nuclear Security Administration-Nevada Site Office-search, as well as general internet searches.

4.7 Documentation and/or Affidavits Provided by Petitioners

No affidavits were provided with the petition; however, the petitioner provided several boxes of information, which were used to complete this report and are summarized below. A more detailed analysis of the petitioner-provided documents can be found in Attachment One at the end of this report.

- Letters to OCAS – Jan. – May 2007 (4)
- Durable Power of Attorney March 24, 2002
- Employment Documents – [Name Redacted]
- Correspondence with various agencies for records (17)
- Database Report – Spencer
- Inspection, May 2-5, 1961 – Jayhawk Works
- License Application – Spencer Chemical
- Letters – Spencer Chemical/AEC – 1962 (4)
- Licensing Correspondence – 1959, 1962 (5)
- Purchase Order Correspondence – Various companies
- Compliance Inspection – 1959
- Excerpt Annual Report to Congress – 1963
- Excerpt Atomic Industrial Progress – 1958
- Excerpt Major Activities in Atomic Energy Programs – 1961
- Joplin Globe Article – January 16, 2001
- Medical Records: [Names Redacted]

- Request for Review by Physician Panel
- Kansas Workers Compensation Claim information
- Birth/Death/Marriage Certificates
- College Transcripts
- Last Will and Testament – [Name Redacted]

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize the radiological operations at the Spencer Chemical Company/Jayhawk Works from January 1, 1956 to December 31, 1961, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing both processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Spencer Chemical Company Plant and Process Descriptions

Spencer Chemical Company/Jayhawk Works, formerly known as the Jayhawk Works Site, was originally used as an ordnance plant during World War II. During 1948, the U.S. Government converted the facility into Spencer Chemical Company, Kansas, which was a 1,600 acre site located in the southeastern corner of Kansas (Evans, 2000). Spencer Chemical Company manufactured ammonia, nitric acid, ammonium nitrate, polyethylene, nylon, urea, methanol, and other similar products. Spencer had been operating as a Uranium Oxide Pilot Plant (under license SNM-154) since December 1, 1957 (SCC, 1959, pdf page 6; Callan, 1992).

Since December 1957, Spencer was licensed by U.S. Atomic Energy Commission (AEC) to possess enriched uranium and thorium. The AEC licenses allowed Spencer Chemical Company to receive UF_6 and to process it into enriched uranium oxides and uranium carbides in the physical form of fused ceramic pellets and finely divided powder (Callan, 1992, pdf page 4).

Spencer Chemical Company/Jayhawk Works was issued at least one license as early as 1956; this license is listed below.

- License R-218 was issued on January 20, 1956 and expired on February 1, 1959. This license allowed Spencer Chemical Company/Jayhawk Works to “receive and title to up to 10 kg of normal thorium oxide/uranium oxide mixture for the use in process research (AEC, 1958, pdf 58).”

Spencer Chemical Company/Jayhawk Works was issued at least five AEC licenses between 1956 and 1961 (Evans, 2000).

- License R-218 (Docket 40-2136) was issued on January 20, 1958 and expired on March 31, 1960. The license allowed Spencer Chemical to possess 10 kilograms of thorium oxide-uranium oxide mixture and 1000 kilograms of thorium oxide for research and development (Evans, 2000, pdf page 4).
Note: Various sources include overlapping dates for License R-218; it is possible that the first License R-218 was amended or re-issued. However, NIOSH does not have documentation proving this to be true.
- License SNM-154 (Docket 70-146) was issued on January 1958 and expired on January 31, 1964. This license allowed Spencer Chemical to possess up to 1,200 kilograms of uranium-235 for use in a Uranium Oxide Pilot Plant.
- License SNM-329 (Docket 70-340) was issued on October 1, 1959 and expired on September 30, 1962. This license allowed Spencer Chemical Company to possess up to 100 kilograms of uranium for chemical processing of uranium enriched to 5 percent in uranium-235.
Note: The Material Status Report (AEC-578) for the period ending December 31, 1961, showed that all special nuclear material had been transferred from SNM-329. No special nuclear material was transferred after December 31, 1961 (Greenlee, 1962).
- License C-3571 allowed the company to possess 300 pounds of uranium magnesium fluoride scrap material and 5,000 pounds of uranium metal or compounds for experimental work. The license (amended) was issued on February 28, 1958 and expired on September 1, 1958 (AEC, 1958, pdf page 57).
- License C-4352 was issued to the company, but information about this license could not be located.

Spencer Chemical Company ceased operations and disposed of its licensed materials by May 12, 1961. During the decontamination of the site, a process building was decontaminated, dismantled, burned, and buried. Other areas of the site were decontaminated, surveyed, and returned to unrestricted use (Callan, 1992).

A memo dated September 3, 1962 (Woolsey, 1962) indicates that Spencer Chemical Company/Jayhawk Works had been purchased (sometime prior to the date of the memo) by Kerr-McGee and that the operations would be moving to the State of Oklahoma. However, the only official purchase/sale documentation available to NIOSH for this time period provides specific information regarding the sale of Spencer Chemical Company/Jayhawk Works to the Gulf Oil Company on September 24, 1963 (Purchase Agreement, 1963).

5.2 Spencer Chemical Company/Jayhawk Works Operations and Buildings

NIOSH has found only limited Spencer Chemical Company/Jayhawk Works records and documentation; there are inconsistencies within this documentation. In a letter dated May 20, 1964, written by the Assistant Director for Materials, Division of Compliance, it states that a Jayhawk

Works Engineering Manager said that all radioactive material processing was conducted in Buildings 702 and 709; the manager specifically stated that 95 percent of the processing was conducted in Building 702 and the remaining 5 percent was conducted in Building 709 (Dubinski, 1964). After Kerr-McGee removed all the equipment associated with the processes, Building 702 was thoroughly washed down with soap and water and the remaining equipment was transferred to a disposal pit. Building 702 was then dismantled and burned in the disposal pit (Dubinski, 1964).

In the May 1964 letter (described above), the manager states that only two buildings were used for processing. However, a document dated May 2-5, 1961 mentions more than two buildings. According to the 1961 document, the facilities at Spencer Chemical Company included the Technical Area, Building 702, Plant 2, a storehouse next to Plant 2, and the storage vault in Building 703. Plant 1, the original pilot plant and processing plant, was “moth-balled.” NIOSH has not located documentation that specifies when these buildings were in operation.

After Building 709 was thoroughly washed down with soap and water, the building was surveyed for external radiation and contamination using a civil defense Geiger counter. The smears that were collected during the contamination survey were sent to the Kansas State Department of Health for analysis. Available documentation indicates that the survey consisted of taking external radiation readings and smears at six locations on the facility’s floor and two at locations on the facility’s wall, for a total of 38 smears. The direct radiation readings were recorded as ranging from 0.05 mr/hr to 0.3 mr/hr beta/gamma and 0.04 mr/hr to 0.06 mr/hr gamma. The analysis results of the smears ranged from 0 to 271 dpm/100 cm² removable alpha; 15 dpm/100cm² to 874 dpm/100cm² removable beta. All smears were reported as 0 for removable gamma (Dubinski, 1964).

Spencer Chemical Company/Jayhawk Works operations and buildings included the following:

- Uranium Operations
 - Uranium Pilot Plant No. 1
 - Uranium Pilot Plant, Building 709
 - Technical Operation Building (‘T’ House), Building 702
 - Plant 2
 - Storehouse (next to Plant 2)
 - Change Building
 - Building 703, Storage Vault
- Thorium Operations—NIOSH has not been able to establish the specific buildings where thorium was used.

5.2.1 Spencer Chemical Company/Jayhawk Works Uranium Operations

Spencer Chemical Company/Jayhawk Works processed several types of uranium bearing materials for use in the nuclear energy fuel cycle. The purified uranium compounds from the process were used in research and development and used as actual core material for nuclear reactors. The purification was performed by solvent extraction, and the process was designed to produce primarily UO₂ from UF₆ scrap. Although the Uranium Pilot Plant was originally designed to process uranium of any enrichment, the original license from September 17, 1957 was modified on May 16, 1958, which allowed processing material containing up to 5% enrichment (AEC, 1959, pdf page 95). The

maximum design processing rate was 300 pounds of uranium per day, but the processing rate was dependent upon the exact nature of the feed material and upon customer demand. According to the license, the inventory of uranium-235 was not to exceed 1,000 kg.

Spencer Chemical Company/Jayhawk Works installed a small plant (located in a portion of an ammonia plant acquired from the Government) to recover uranium as an oxide from uranium hexafluoride or scrap metal. There were two treatments. One treatment was the dissolution of metal scrap to recover UO_2 . The other consisted of the heat treatment of a cylinder of uranium hexafluoride in a tight container, where gaseous UF_6 flowed from the cylinder to a hydrolyzer through a piping system with remotely operated valves. Solutions from the dissolver or hydrolyzer passed through a two-stage solvent extraction, precipitation, filtration, drying, (and “furnacing”) to produce uranium oxide, which was packaged in a dry box. Processing was continuous from the solvent extraction through the rest of the processes (Author unknown, 1957).

Uranium Pilot Plant No. 1

The only information that NIOSH has located in regards to Pilot Plant No. 1 is that it was the original pilot plant and processing plant and was eventually “mothballed.”

Uranium Pilot Plant, Building 709

The purpose of Building 709, also known as the Uranium Pilot Plant, was to process several types of uranium-bearing materials for use in the nuclear energy fuel cycle. The Uranium Pilot Plant was designed to purify uranium containing products of various enrichments, with the end result being purified solutions or pure compounds. Pure compounds were the main objective of the Pilot Plant, and the ultimate goal was to create a process that would produce these compounds (AEC, 1958, pdf page 59).

The Analytical Laboratory portion of the Uranium Pilot Plant was set up to perform uranium colorimetric analysis on the samples taken from various phases of the Pilot Plant processes and the settling basin. This work was performed on stainless steel trays and/or paper covered benches to protect the area from spills (AEC, 1958, pdf page 62).

Technical Operation Building (‘T’ House), Building 702

Building 702, also known as the Technical Operation Building, (referred to as the “T” house and the Research and Developmental Laboratory) was used to process material for enrichments greater than 5%.³ However, material for experimental work or new processes utilized material with enrichments less than 5%. Building 702 was used to produce feed uranium oxides and carbides. The process area was manned for one or two shifts a day, depending on work load. The ‘T’ House was a long rectangular building with rooms on either side of the building. It included the Pilot Plant, Hydrolysis room, reactor pit, Receiving room, lab analysis, general storage, processing area, laundry, ‘T’ room (which was the only room where 93% material was processed), lunch room, office and change area, and the feed preparation area for the Pilot Plant (AEC, 1961, pdf page 85).

³ It was difficult to decipher where the greater than 5% enrichment took place. The licenses changed, but not reference was made to the buildings. If we were to make assumptions, we could assume that they could process up to 5% in the Pilot Plant, and then used the “T” Room for enrichment greater than 5%. However, this is just an assumption.

As previously mentioned, the 93% enriched material was processed in a special area in the 'T' House where the feed product (UF_6) was converted into either ammonium diuranate (one of the oxides of uranium) or insoluble UF_4 . The insoluble uranium was removed from the reactor stream by means of a filter, and the unused reactant was returned to the Reaction room. The material was treated in a high-temperature furnace for conversion into the desired product; the final product was packaged in a hood (AEC, 1961, pdf pages 75-76).

Plant 2, Building 1011

Plant 2, also referred to as Building 1011, was used to process uranium materials having less than 5% enrichment. This plant processed various uranium feed types and forms (including but not limited to UF_6 , scrap metal, and/or yellow cake) for the Nuclear Fuels Section of the Spencer Chemical Company/Jayhawk Works. The final product was either normal (enrichment levels equivalent to that of normal uranium – a.k.a natural uranium) or enriched (less than 5%) uranium oxide (AEC, 1961, pdf pages 72-74).

Storehouse next to Plant 2

The small storehouse next to Plant 2 was used for preparing material for shipping and storing material ready for shipping. This material could have been enriched, normal/natural, or depleted uranium.

Change Building

The Change Building was in a building separate from the Uranium Pilot Plant, located south of the Pilot Plant. The building had shower and laundry facilities; when the workers left the Pilot Plant for the day, they were required to clean and survey themselves prior to going home.

Storage Vault, Building 703

The Storage Vault was used to store source and special nuclear material. Although the area was not posted as a Radiological Area, the Storage Vault contained material that resulted in a dose rate of 10 mr/hour. This dose rate was in excess of the 5 mrem/hour set for a radiation area (AEC, 1958, pdf page 58). This area was noted as the location of the bird cages (safe geometry storage locations/devices used to secure radioactive material).

5.2.2 Spencer Chemical Company/Jayhawk Works Thorium Operations

License R-218 (1/20/56 – 2/1/59) allowed Spencer Chemical Company/Jayhawk Works to receive up to 10 kg of natural thorium oxide-uranium oxide mixture for use in process research (AEC, 1958, pdf 58). However, no information was found regarding the thorium research that might have been conducted at Spencer Chemical Company/Jayhawk Works. There were six incidents involving thorium and air samples were collected that showed elevated levels where the material was being used (Lambertus, 1962). These air samples were apparently taken in 1962 and corrective measures were implemented to eliminate the high airborne dust around the equipment (Lambertus, 1962). NIOSH found no other information regarding thorium operations.

5.2.3 Summary of Spencer Chemical Company/Jayhawk Works Facilities

Table 5-1 summarizes Spencer Chemical Company/Jayhawk Works processes as well as the buildings and dates of operations.

Table 5-1: Spencer Chemical Company/Jayhawk Works Development Chronology		
Dates¹	Building	Comments²
1956 ³ -1958	Uranium Pilot Plant No. 1	Mothballed in 1958. No other data are available.
1956 ³ -1961	Technical Area Building 702 (referred to as 'T' house or the Advanced Materials Plant)	Used to process material for enrichments greater than 5%. However, material for experimental work or new processes may have utilized material with enrichment less than 5%. This area was used to produce uranium oxides and carbides, uranium fluoride, uranium chloride compounds, and other enriched uranium.
1956 ³ -August 1, 1959	Plant 2	Started processing uranium materials having less than 5% enrichment. The feed for this plant may have been various forms/types of uranium product or scrap. The final products were either normal/natural uranium or enriched (less than 5%) uranium oxide.
1956 ³ -1961	Storehouse next to Plant 2	This small storage building was used to prepare material for shipping; it was also used for storing material ready for shipping. Material in the storehouse could have included enriched, normal/natural, or depleted uranium.
1958-1961	Building 703, storage vault	Spencer began using Building 703 as an analytical laboratory and storage vault in July 1958; it was used to store source and special nuclear material. This area was marked as the location of the bird cages so that the cylinders would be in criticality safe positions.
1957-1961	Building 709, Uranium Pilot Plant	In February 1957, Spencer installed equipment in the Pilot Plant to study "reprocessing of nuclear fuels" (scrap recovery – no indication of operations until 1958). Spencer began commercial operation of the Pilot Plant in July 1958. Building 709 processed several types of uranium bearing materials for use in the nuclear energy fuel cycle.

Notes:

Information for this table is from AEC, 1961; Barnes, 1982.

¹ These dates are all best estimates.

² NIOSH found no data to support defining the exact locations of any thorium-related work at Spencer Chemical Company/Jayhawk Works.

³ No documentation was found indicating start dates for the Uranium Pilot Plant, Plant 2, Building 702, or the Storehouse next to Plant 2.

5.3 Radiological Exposure Sources from Spencer Chemical Company/Jayhawk Works Operations

Spencer Chemical Company/Jayhawk Works was involved in the processing of enriched uranium hexafluoride into uranium oxides and uranium carbides in the physical form of fused ceramic pellets and finely divided powder. Although it is well known that Spencer Chemical Company/Jayhawk

Works was involved with uranium scrap recovery, some documentation indicates that uranium extrusion, rolling, and forging may have also been performed; all of these operations could have resulted in alpha, beta, and gamma radiation exposures. For example, the extrusion method had the potential to release uranium oxide into the air, the rolling method was capable of releasing large quantities of uranium dust into the air, the hot press forging produced relatively low air concentrations, and hammer forging produced higher air concentrations. With uranium scrap recovery, during the pressing of the briquette, heat was generated inside the pressing machine. When the briquette was unloaded, uranium oxide fumes could be released into the air. Sources of radiological exposures in the buildings resulted from surface, airborne, and re-suspended dust particles, depending on what operation may have been taking place.

5.3.1 Internal Radiological Exposure Sources from Spencer Chemical Company/Jayhawk Works Operations

Based on extensive data capture efforts and review of the limited information available regarding the processes at Spencer Chemical Company/Jayhawk Works, NIOSH has concluded that Spencer Chemical Company/Jayhawk Works employees had the potential for internal radiological exposures while working at the site, as discussed below.

Alpha particle emissions from the radioactive materials handled at Spencer Chemical Company/Jayhawk Works 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 Spencer Chemical Company/Jayhawk Works operations were uranium and thorium (and associated progeny). Processed 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) (Radiological Health, 1970). 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. Enriched uranium also existed at Spencer Chemical Company/Jayhawk Works and posed a potential internal exposure hazard (uranium with a higher percentage of uranium-235 by weight). The specific activity of uranium increases with enrichment primarily because of the increase in the amount of uranium-234 present, rather than the increase in uranium-235 (for enrichment associated with gaseous diffusion). The determination of the enriched uranium specific activity (alpha - for internal exposure evaluation purposes) can be calculated and accounted for using standard methods if enrichment levels are known for the associated work areas (DOE, 2000).

Thorium-232 emits alpha particles of 4.01 MeV and 3.95 MeV, and the natural thorium decay series includes six daughter products that also emit alpha particles, with energies ranging from 5.34 MeV to 8.78 MeV. The abundance of these daughter product emissions depends on the state of equilibrium with the thorium-232 parent. Thorium-232 decays into radium-228, emitting two primary alpha particles of 3.95 MeV (24%) and 4.01 MeV (76%). The decay series contains several other progeny, most of which decay by alpha particle emission, but each has a half-life of less than 12 hours. Other thorium isotopes—including thorium-228 (5.52 MeV) and thorium-230 (4.62 MeV and 4.69 MeV)—likely existed at Spencer Chemical Company/Jayhawk Works and could be considered contributors to the thorium dose at the site.

5.3.2 External Radiological Exposure Sources from Spencer Chemical Company/Jayhawk Works Operations

Based on extensive data capture efforts and review of the limited information regarding the processes at Spencer Chemical Company/Jayhawk Works, NIOSH has concluded that workers at Spencer Chemical Company/Jayhawk Works had the potential for external radiological exposures while working at the site, as discussed below.

5.3.2.1 Beta

As with the alpha emitters, the majority of the beta exposures at Spencer Chemical Company/Jayhawk Works could have resulted from exposure to natural thorium and its progeny, or uranium and its decay products. For processed natural uranium, the dominant beta radiation was likely from uranium-238 decay products. The most energetic of these beta particles is 2.29 MeV from protactinium-234m.

Thorium processes potentially involved unshielded contact with sources of beta radiation. While thorium-232 itself does not emit beta particles, five of the daughter radionuclides in the natural thorium decay series do have beta emissions, ranging in energy up to a maximum of 2.26 MeV (Radiological Health, 1970). The abundance of these daughter product emissions depends on the state of equilibrium with the thorium-232 parent.

5.3.2.2 Neutron

There are two sources of neutrons. First, neutrons result from alpha-neutron reactions where the reactant is fluorine (which occurs during the production of UF₄ and UF₆) or oxygen that is present in uranium oxides. Second, there is a small amount of spontaneous fission by uranium. Although specific information associated with neutron radiation fields has not been discovered for Spencer Chemical Company/Jayhawk Works, ORAUT-OTIB-0024 provides information associated with the expected neutron dose rates from various forms of uranium compounds.

5.3.2.3 Photon

Photons from uranium are primarily from the thorium-234 daughter of uranium-238 and are in the energy range of 30 - 250 KeV. There are higher-energy photons, up to 1.00 MeV, from another uranium-238 daughter, protactinium-234m, but the abundance of these photons is less than 1%. Thorium-232 itself has no photons; however, many of the daughter radionuclides in the natural thorium decay series do emit photons. These photons have an energy range up to a maximum of 2.61 MeV (Radiological Health, 1970).

5.3.3 Incidents

No documented discrete radiological incidents or accidents that resulted in exceptionally high personnel exposures or overexposures (such as a criticality event) at Spencer Chemical Company/Jayhawk Works were identified or discovered by NIOSH during the data research and investigations performed in support of this SEC evaluation. NIOSH did discover several documented instances of elevated airborne radioactivity conditions (involving both thorium and uranium) at the site. All instances of documented elevated airborne concentrations were based on air monitoring at

the working locations, including time-occupancy studies to assess the potential personnel exposures associated with the exposures to the associated airborne concentrations. Corrective measures were taken to eliminate the high airborne dust around the equipment (Lambertus, 1962).

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

NIOSH has found only a limited amount of monitoring information (Author unknown, 2000). The information found pertaining to any type of monitoring data was from AEC Inspector Reports; no individual monitoring data was found. The subsections below describe the limited Spencer Chemical Company/Jayhawk Works information.

6.1 Spencer Chemical Company/Jayhawk Works Internal Monitoring Data

The section below describes Spencer Chemical Company/Jayhawk Works internal monitoring data. At this time, NIOSH has not been able to locate any individual monitoring records. The monitoring data that NIOSH has available are from AEC survey reports.

Published AEC survey reports indicate that a urine bioassay program existed at Spencer Chemical Company/Jayhawk Works, but no individual monitoring records have been found. Approximately six weeks prior to a May 1961 inspection (because of problems associated with processing the 93% enriched uranium), Spencer's urinalysis program changed from requiring monthly urine samples for Nuclear Fuels Section employees to requiring urine samples every two weeks. During this time period, the urinalysis service was provided by the National Spectrographic Laboratories in Mialasah, Florida (NIOSH also found indication that in 1958, monthly urinalysis service was provided by Nuclear Science and Engineering Corporation in Pittsburg) (SCC, unknown date). If a urinalysis result of greater than the established action limit was returned, the employee with this result was withdrawn from the product area until succeeding urinalysis results dropped below the action limit (AEC, 1961, pdf page 77).

To date, NIOSH has not discovered or been able to gain access to the actual records associated with the personnel monitoring performed at Spencer Chemical Company/Jayhawk Works. NIOSH has exhausted its research trying to track down urinalysis records; this includes NIOSH research and follow-up with bioassay and dosimetry contractors Landauer, Nuclear Science and Engineering, National Spectrographic Laboratories, as well as the Kansas Department of Health (AEC, 1961, pdf pages 79-80).

6.1.1 Spencer Chemical Company Air Sampling Data

Radiological air sampling and smear surveys were conducted by Spencer Chemical Company/Jayhawk Works to determine compliance with 10 CFR 20.201, 20.103 and 20.105(b). The air sampling and contamination survey programs were the responsibility of a senior supervisor, and the actions taken for high air samples depended on the circumstances (i.e. the operation, sample result, and working conditions).

Air samples were taken in all parts of the 'T' House and Plant 2, including outside environs. Although these air sample data are not available, NIOSH learned that the air samples were usually taken as breathing zone samples or in the general area. Background samples were taken in non-work areas such as the office, lunch room, change room, or outside the building, away from exhaust ducts. The operations in which the samples were collected included: blending, transferring material between containers, loading in shipping containers within the hood, fusing uranium and thorium compounds, cleaning the mills and other equipment, crushing, grinding, screening, and dissolution (fumes). There were no set frequencies for the air sampling. For example, air samples in the blending operation in Plant 2 may have occurred at a frequency of 30 minutes in a 24-hour period, whereas the blending operations in the 'T' building may have occurred in 10 minute durations, approximately five or six times a day.

Air samples were normally counted the following day, unless immediate results were required. The 24-hour samples were counted for alpha and beta/gamma when they were pulled. Corrective measures were taken when high results were discovered. These corrective measures included re-sealing units to keep the dust confined to the interior of the unit, increasing the exhaust air flow of various hoods and dry box operations, and re-designing faulty equipment (AEC, 1961, pdf page 77).

Stack discharges from the various areas were also sampled. The general air that was discharged by fans (not process air) was sampled and measured several times. These samples averaged less than the maximum permissible limit established by 10 CFR Part 20. One process air discharge sample measured about 0.3 grams of uranium for 14 hours of blower operation during the production of 500 pounds of 2.5% UO₂. Another sample in the same area for 19 hours of operation yielded 0.115 grams of uranium (AEC, 1961, pdf page 78).

Pilot Plant air samples and radiation surveys were all conducted by responsible parties of Spencer Chemical Company/Jayhawk Works. Air and survey samples were processed and analyzed at the Kansas City Laboratory with significant results being forwarded to Spencer Chemical Company/Jayhawk Works. The only record available is a summary of the air sampling results from the Kansas City, Missouri office. It is said that the radiation survey results were not recorded and the maximum reading in the Pilot Plant was ~0.4 mr/hr (AEC, 1958 pdf page 60).

A May 14, 1962 memo indicates that there were elevated thorium airborne radioactivity conditions. In all cases, these counts were 30 minute air samples taken at a position between the worker and the hooded operation where the material was being utilized. This memo goes on to indicate that the air sample results "represent the absolute maximum intake that the worker could have received." Time studies regarding the operation have indicated that the worker was in the operating position for less than 25 minutes during a typical 8-hour shift. During the rest of the shift, the worker was in other parts of the building where the air was consistently 10E-12 microcuries per ml or less. The overall daily exposure would be less than the limits of 10 CFR Part 20, according to the memo (Lambertus, 1962).

The same 1962 memo also states that there were similar events that involved elevated airborne concentrations of normal uranium in excess of 10 CFR Part 20, with all instances occurring at the fusion operation work location. Samples were taken for a 30-minute period at a position approximately head high between the worker and the hood where the material was being utilized. It

was determined that the worker was in this operation position for less than 25 minutes during an 8-hour shift. The worker's overall daily exposure was less than the prescribed limits (Lambertus, 1962).

To date, NIOSH has not discovered the records or associated data, other than the summaries discussed above, for air monitoring performed at Spencer Chemical Company/Jayhawk Works during the period evaluated in this report.

6.2 Spencer Chemical Company/Jayhawk Works External Monitoring Data

A May 1961 report written by the licensee states that Spencer Chemical Company/Jayhawk Works used film badges for personnel monitoring (for approximately 30-60 people, dependent on the work load) and that the badges were sent to R. S. Landauer Jr. and Company on a monthly basis. As a result of some of the film badges being returned contaminated, the site required badges to be covered with a plastic bag while the badge was worn in the work area, thus, preventing contamination. The film badge design included a beta-gamma badge with a strip of indium foil across the top edge (AEC, 1961).

A partial inspection report from the AEC (SCC, unknown date, pdf page 2) states that workers were monitored on a monthly basis with film badges provided by R. S. Landauer Company, Park Forest, Illinois. Records from Landauer, as discussed by the licensee in the report, indicate that records from August 1958 through December 1958 show no monthly exposures except for one employee. This employee received 35 mrem gamma and 880 beta in October and 475 mrem gamma and 7,450 mrem beta in December. Spencer personnel theorized that the employee's doses resulted from the heliarc unit (used for fusing the uranium oxide sample to test the sintering qualities of the material), and the exposures were possibly caused by low energy rays from the heliarc welder. Spencer considered it unlikely that the readings were true beta readings.

To date, NIOSH has not discovered the records or associated data, other than the summaries discussed above, relating to external exposures or dose at Spencer Chemical Company/Jayhawk Works during the period evaluated in this report.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the proposed class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to estimate the maximum radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class, or to estimate the radiation doses to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it 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 the OCAS 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-00089 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Spencer Chemical Company/Jayhawk Works Data

The AEC inspection reports indicate that internal and external monitoring was performed at Spencer Chemical Company/Jayhawk Works. However, NIOSH did not locate any internal or external monitoring records for the period under this evaluation. Therefore, an internal and external data sufficiency and pedigree evaluation is not possible for this data type.

7.2 Internal Radiation Doses at Spencer Chemical Company

Principal sources of internal radiation doses for members of the proposed class included exposures to uranium and thorium. A discussion of the feasibility of internal dose reconstruction for the proposed class is provided below.

Internal exposures during the operational period at Spencer Chemical Company/Jayhawk Works could have resulted from inhalation and ingestion of dust generated by the uranium operations or contaminated dust that was re-suspended by foot traffic. AEC reports indicate that Spencer Chemical Company/Jayhawk Works employees submitted urinalysis samples; however, only limited internal data have been found. Specifically:

- No internal personnel monitoring data are available for any of the Spencer Chemical Company/Jayhawk Works individuals;
- No area monitoring data are available to support evaluating potential Spencer Chemical Company/Jayhawk Works personnel radiological exposures to operations conducted at the site; and
- No source term information has been identified to permit characterizing and evaluating the Spencer Chemical Company/Jayhawk Works thorium operations, and limited data exist for uranium operations.

7.2.1 Internal Dose Reconstruction Feasibility Conclusion

Based on the lack of personnel or area monitoring data, and/or source term information for thorium exposures at Spencer Chemical Company/Jayhawk Works, NIOSH has determined that the thorium internal dose cannot be reconstructed. Therefore, NIOSH has concluded that it cannot bound internal dose (cannot reconstruct internal dose with sufficient accuracy) for the proposed worker class evaluated in this report. Because of NIOSH's internal dose feasibility determination for the proposed worker class, it did not attempt a feasibility determination with respect to uranium internal exposures. Currently, NIOSH has no personal monitoring data for uranium or thorium exposures and has access to only a limited amount of general process and radiological source term information associated with uranium work (such as producing UO₂ from UF₆, uranium recovery and quantities of radioactive materials indicated on material licenses for the site). Given this information, and the internal uranium dose reconstruction assumptions and approaches presented in *Battelle TBD 6000* and *Battelle TBD 6001*, it is possible for NIOSH to estimate internal uranium dose for the purpose of partial dose reconstructions (to be evaluated on a case by case basis). If personnel monitoring data become available for uranium and/or thorium exposures, NIOSH will also evaluate the use of these data for partial dose reconstructions.

7.3 External Radiation Doses at Spencer Chemical Company/Jayhawk Works

Based on five AEC licenses that were active between 1956 and 1961, the potential for external radiation dose from uranium and thorium compounds existed at the Spencer Chemical Company/Jayhawk Works. However, NIOSH does not know the extent of the activities that were performed with the uranium and thorium compounds, nor does NIOSH know the processes involved in the shipping operations. Documentation available to NIOSH does not describe the work processes or exposure conditions associated with Spencer Chemical Company/Jayhawk Works. Specifically, NIOSH has not found information to adequately characterize the uranium-thorium operations, and employee dosimetry records have not been located.

7.3.1 External Dose

The supporting documentation available to NIOSH states that external monitoring was performed during the operational period at Spencer Chemical Company/Jayhawk Works. However, NIOSH has not located any individual external monitoring data for the worker class evaluated in this report. Based on NIOSH's finding regarding internal dose reconstruction (inability to bound internal dose), NIOSH has not performed an exhaustive research effort or evaluation of its ability to bound the external dose (or reconstruct dose with sufficient accuracy) for the proposed worker class evaluated in this report. NIOSH has access to a limited amount of general process and radiological source term information associated with uranium work (such as producing UO₂ from UF₆, uranium recovery, and quantities of radioactive materials indicated on material licenses for the site). Given this information and the external uranium dose reconstruction assumptions and approaches presented in *Battelle TBD 6000* and *Battelle TBD 6001*, it is possible for NIOSH to estimate external dose associated with uranium operations for the purpose of partial dose reconstructions (to be evaluated on a case by case basis). If personnel external monitoring data become available, NIOSH will also evaluate the use of these data for partial dose reconstructions.

7.3.2 Occupational X-Ray Examinations

All personnel working with uranium were required to pass a complete medical examination, including a chest X-ray before starting work at Spencer Chemical Company/Jayhawk Works and annually thereafter (SCC, 1959). A single posterior-anterior (PA) radiographic chest X-ray is assumed to have been required during each pre-employment and annual physical. Although no records have been identified that indicate that occupational medical X-rays were required at termination, for the purpose of partial dose reconstructions during the time period, X-ray exams will be assumed to have been required at termination. This assumption provides a level of conservatism to the dose reconstruction. Organ doses from PA chest X-ray for all time periods are available in *ORAUT-OTIB-0006*. NIOSH believes that by using this methodology, occupational medical X-ray doses can be reconstructed.

7.3.3 External Dose Reconstruction Feasibility Conclusion

NIOSH has established that it can estimate the medical X-ray exposure associated with Spencer Chemical Company/Jayhawk Works employees. NIOSH has concluded that information pertaining to Spencer Chemical Company/Jayhawk Works personnel external exposures is sufficient to support a partial dose estimate for the proposed worker class.

7.4 Evaluation of Petition Basis for SEC-00089

The petition basis provided in SEC-00089 states that it could not be proven that members of the proposed class were monitored because, based on NIOSH's research, individual dosimetry readings and records are not available for any employee at Spencer Chemical Company/Jayhawk Works for the time period beginning January 1, 1956 through December 31, 1961. The following topics were detailed in the petition SEC-00089. Italicized statements are from the petition; the comments that follow are from NIOSH.

- SEC-00089: *Can't prove individuals were monitored without individual dosimetry reading and records on every employee at Spencer Chemical Company.*
- SEC-00089: *Correspondences sent to all Federal Agencies and companies (past and present) to obtain dosimetry records revealed no records sent to claimant.*
- SEC-00089: *Based on various documents submitted with this letter it is evident that workers were exposed to radiation. Since there are no records of internal or external exposure the amount of exposure to workers is unknown.*
- SEC-00089: *The many documented accidents along with radiological operational non-compliances of the site regarding the cavalier implementation of radiological safety procedures has the very high potential of inducing carcinomas in exposed Spencer Chemical Company, Jayhawk Works workers due to long term inhalation and ingestion of alpha radiation in the form of highly enriched powders and dusts from the process handled by the chemists and workers.*
- SEC-00089: *It appears that the workers were exposed to continuous high concentrations of highly enriched uranium dust, alpha radiation exposure over a long period of time which is chronic exposure.*

- *SEC-00089: Since the hoods were not filtered, the hood exhausted to the atmosphere causing high concentrations of the highly enriched uranium dusts to become airborne radioactivity and produce the high risk with a high probability of exposing workers to radiation.*
- *SEC-00089: There was a high probability of workers ingesting radionuclides due to lunch room being in the change room.*
- *SEC-00089: There was a complete lack of records showing any survey reading indicating an absence of worker awareness to work place radiological and contamination hazards.*
- *SEC-00089: Lack of conducting surveys and producing characterization reports and retaining records.*
- *SEC-00089: There is a high probability that the workers were exposed to more radiation than was suspected.*

Personal internal, external monitoring, and/or area monitoring data are not always required to develop an exposure model for a given facility. However, if these monitoring data are not available, NIOSH must have access to source term information and detailed process information in order to develop a sufficiently accurate exposure model. NIOSH has determined that it does not have adequate internal and/or external monitoring data for members of the proposed class, nor does it have enough source term or process information applicable to the class to develop a sufficiently accurate model for dose reconstruction for these exposures during the associated time period. As discussed in Section 5.0, NIOSH has discovered very little information regarding any operations or activities at the Spencer Chemical Company/Jayhawk Works for the time period of January 1, 1956 through December 31, 1961. For the potential uranium and thorium exposures, there appear to be limited site data available from the AEC license and license applications (some airborne radioactivity measurements for the purpose of evaluating personnel exposures). However, based on the evaluation of this report, a bounding dose scenario cannot be established for Spencer Chemical Company/Jayhawk Works.

A letter from the Department of HHS to the petitioner, included in the original petition documentation, stated that no records were found for the claimant. A discussion between representatives of NIOSH and Landauer took place on October 3, 2007. The representative from Landauer stated that Landauer does not have records identifying Spencer Chemical Company/Jayhawk Works as a customer (Jessen, 2008).

Note: Statements specific to an individual claim are not pertinent to the review and evaluation of this SEC proposed worker class and will not be reviewed under this SEC evaluation.

- *SEC-00089: It is evident that the workers were not properly trained to handle the radioactive materials at Jayhawks Works.*
- *SEC-00089: This is evidence of no action being taken by site management to workers obviously working in air with high contamination.*
- *SEC-00089: The workers were not adequately protected as indicated by using dusty respirators.*

- SEC-00089: *Contaminated film badges, thereby indicating that Uranium dust was in the air.*
- SEC-00089: *There is indication of sloppy and unsafe working conditions unacceptable to providing a healthy working environment.*
- SEC-00089: *Various incidents were reported where high air-borne dust samples were observed.*

Appendixes to the license application do state that protective clothing and respirators were required. In addition, the interviews conducted with former workers also stated that some protective clothing was worn and that showers may have been required at the end of the shift. Although plant safety procedures were absent in 1958 (Sapirie, 1959, pdf page 3), by 1959 there is an indication that a Health and Safety program had been implemented. Records were kept for accountability of licensed material and waste disposals. The facilities were found to be posted in compliance with 10 C.F.R 20.

Air sampling was being performed and some air sampling results exist in AEC reports. However, only summaries appear to be available, and not all summaries for all years have been located by NIOSH.

The documentation available to NIOSH did discuss the concern of Landauer and contaminated film badges. Landauer requested that film badges be put in plastic bags. However, these monitoring data are not available.

Although these issues do not impact NIOSH's ability to bound dose for the proposed worker class, further evaluation of these points was not performed by NIOSH. As previously discussed, NIOSH has determined that it does not have adequate internal and/or external monitoring data for members of the proposed class, nor does it have enough source term or process information applicable to the class to develop a sufficiently accurate model for dose reconstruction for these exposures during the associated time period.

7.5 Summary of Feasibility Findings for Petition SEC-00089

This report evaluates the feasibility for completing dose reconstructions for employees at the Spencer Chemical Company/Jayhawk Works from January 1, 1956 through December 31, 1961. NIOSH found that the available monitoring records, process descriptions, and source term data available are not sufficient to complete dose reconstructions for the proposed class of employees.

Table 7-1 summarizes the results of the feasibility findings at Spencer Chemical Company/Jayhawk Works for each exposure source during the time period of January 1, 1956 through December 31, 1961.

Table 7-1: Summary of Feasibility Findings for SEC-00089		
January 1, 1956 through December 31, 1961		
Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal		X¹
- Uranium	X	
- Thorium		X
External		X²
- Gamma		X
- Beta		X
- Neutron		X
- Occupational Medical X-ray	X	

Notes:

¹ The internal uranium dose can be estimated in support of a partial DR for claims with non-presumptive cancers and those with less than 250-days of employment.

² The external dose associated with uranium work could be estimated in support of a partial DR for claims with non-presumptive cancers and those with less than 250-days of employment.

As of March 3, 2008, a total of 30 claims have been submitted to NIOSH for individuals who worked at Spencer Chemical Company/Jayhawk Works and are covered by the proposed class definition evaluated in this report. Dose reconstructions have not been completed for any of these individuals.

8.0 Evaluation of Health Endangerment for Petition SEC-00089

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

Based on lack of available data, little information on source terms and activities, very few available surveys, NIOSH's evaluation determined that it is not feasible to estimate radiation dose for members of the proposed class with sufficient accuracy based on the sum of information available from available resources.

Evidence reviewed in this evaluation indicates that some workers in the class (and covered by this evaluation) may have accumulated chronic radiation exposures through intakes of radionuclides.

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

9.0 NIOSH-Proposed Class for Petition SEC-00089

Based on its research, NIOSH accepted the petitioner-requested class (with a minor date clarification) to define a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employer employees who worked in any area at Spencer Chemical Company/Jayhawk Works near Pittsburg, Kansas, from January 1, 1956 through December 31, 1961, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the. The class was accepted because NIOSH has little insight into Spencer Chemical Company/Jayhawk Works control of radioactive materials being transported between work areas. Without such information, NIOSH is not able to rule out cross-contamination of work areas. Therefore, NIOSH is unable to limit the SEC class based on work location. Consequently, all Spencer Chemical Company/Jayhawk Works areas are included in the proposed SEC class.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database (SRDB), for information relevant to SEC-00089. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

10.0 References

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Attachment One: Documentation Provided by Petitioner

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

- *SEC Petition for [Name One Redacted]*, letter to OCAS, [Name Two Redacted]; May 17, 2007; OSA Ref ID: 103189, pdf pages 1-2
- *Reference: [Name Three Redacted]*, letter to OCAS, [Name Two Redacted]; January 30, 2007; OSA Ref ID: 103189, pdf page 3
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- *Forms A & B*, completed by claimant, [Name Two Redacted]; Unknown date; OSA Ref ID: 103189, pdf pages 8-13
- *Durable Power of Attorney*, for three individuals; March 24, 2002; OSA Ref ID: 103189, pdf pages 14-19
- *Form B Instructions*, includes petitioner notes; Unknown date; OSA Ref ID: 103189, pdf pages 20-23
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- *Transmittal of EEOICPA Information*, misc doc info, Department of Health and Human Services; October 5, 2001; OSA Ref ID: 103189, pdf page 42
- *Response to Request for Personnel or Dosimetry Records*, Department of Energy; March 25, 2002; OSA Ref ID: 103189, pdf page 43
- *FUSRAP Database Report*, report is for Spencer Chemical Company; Unknown date; OSA Ref ID: 103189, pdf page 44
- *Response to Freedom of Information Act Request*, Department of Energy; September 24, 2001; OSA Ref ID: 103189, pdf page 45
- *Form Letter Acknowledging Freedom of Information Act Request*, Department of Health and Human Services; August 16, 2001; OSA Ref ID: 103189, pdf page 46
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- *Information Regarding Inspection on May 2-5, 1961*, Spencer Chemical Company; May 14, 1962; OSA Ref ID: 103189, pdf page 48-50
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