SEC Petition Evaluation Report
Petition SEC-00066

Report Rev #:_0_____ Report Submittal Date___12/04/06__________

Subject Expert(s):	Cindy W. Bloom, James Mahathy, Janet L. Westbrook, Kenneth Fleming, and Michael Kubiak
Site Expert(s):	Not Applicable

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00066	83.14	July 24, 2006	Harshaw Chemical Company
Proposed Class Definition			
All Atomic Weapons Employer (AWE) employees who were monitored or should have been monitored while working at the Harshaw Harvard-Denison Plant located at 1000 Harvard Avenue in Cleveland, Ohio for a number of work days aggregating at least 250 work days from August 14, 1942 through November 30, 1949, 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			

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
None	None

ORAU Lead Technical Evaluator:	**ORAU Review Completed By:**
James M. Mahathy	Michael S. Kubiak

Peer Review Completed By:	[Signature on file] *LaVon Rutherford*	12/05/2006 Date
SEC Petition Evaluation Reviewed By:	[Signature on file] *Jim Neton*	12/05/2006 Date
SEC Evaluation Approved By:	[Signature on file] *Larry Elliott*	12/05/2006 Date

This page intentionally blank

Evaluation Report Summary: SEC-00066, Harshaw Chemical Company

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*.

NIOSH-Proposed Class Definition

The NIOSH-proposed class includes all Atomic Weapons Employer (AWE) employees who were monitored or should have been monitored while working at the Harshaw Harvard-Denison Plant located at 1000 Harvard Avenue in Cleveland, Ohio for a number of work days aggregating at least 250 work days from August 14, 1942 through November 30, 1949, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.14(b), NIOSH has established that it does not have sufficient information to complete dose reconstructions for individual members of the class with sufficient accuracy.

Health Endangerment Determination

NIOSH's evaluation did not identify evidence from the petitioners or from other sources that would establish the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures, such as nuclear criticality incidents or other events involving similarly high levels of exposure. However, the evidence reviewed in this evaluation suggests that some workers in the class may have accumulated chronic radiation exposures through intake of radionuclides and from direct exposure to radioactive materials. Consequently, in accordance with 42 C.F.R. § 83.13(c)(3)(ii), NIOSH has determined that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

This page intentionally blank

Table of Contents

Table

This page intentionally left blank

SEC Petition Evaluation Report for SEC-00066

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for employees who worked at specific facilities during a specified time. It provides information and analysis 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, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC (see Section 2.0). This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

This evaluation, in which NIOSH provides its findings on both the feasibility of estimating radiation doses of members of this class with sufficient accuracy and on health endangerment, was conducted in accordance with the requirements of EEOICPA and 42 C.F.R. § 83.14.

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting the Department of Health and Human Services to 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 proposed class of employees through NIOSH dose reconstructions.[1]

NIOSH is required to document its evaluation in a report. In doing so, NIOSH relies on its own dose reconstruction expertise as well as technical support from Oak Ridge Associated Universities (ORAU). Upon completion, the report is provided to both the petitioners and to the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, to make recommendations to the Secretary of HHS on whether 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 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, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

[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.
[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.

3.0 NIOSH-Proposed Class Definition and Petition Basis

This NIOSH report summarizes the methods and findings of the NIOSH SEC evaluation for all AWE employees who were monitored or should have been monitored while working at the Harshaw Harvard-Denison Plant located at 1000 Harvard Avenue in Cleveland, Ohio from August 14, 1942 through November 30, 1949.

The evaluation responds to Petition SEC-00066, which was submitted by an EEOICPA claimant who was employed as a chemical mixer at the facility during this period, and whose dose reconstruction could not be completed by NIOSH because of a lack of sufficient dosimetry-related information. The NIOSH determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at the Harshaw Chemical Company during the period of AWE operations from August 1942 to September 1955, and the information available to NIOSH to characterize particular processes and radioactive source materials. During this period, employees at Harshaw were involved with research and production activities using multiple forms of uranium, including uranium tetrachloride, uranium tetrafluoride, uranium hexafluoride, uranium dioxide, uranium trioxide, and uranyl nitrate hexahydrate. From available resources, 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.

4.1 Harshaw Chemical Company Plant and Process Description

The Harshaw Chemical Company site in Cleveland, Ohio received uranium in a variety of forms including milled ore or black oxide (U_3O_8), sodium diuranate (soda salt), and uranyl nitrate hexahydrate. The milled uranium feed products were further processed by various chemical and extraction methods from 1942 to 1955 under contract to the U.S. government. The site also did business under the name Harshaw Filtrol Partners, but this appears to have occurred after 1955 (when radiological operations had ceased).

Uranium production operations for the Manhattan Engineer District (MED) war effort began in August 1942 when Harshaw produced laboratory quantities of uranium tetrachloride. This work would have been done using ore material. Harshaw Chemical Company also produced uranium tetrachloride for the National Bureau of Standards. After 1943, other research contracts followed, including a contract to research methods of improving uranium capture and recovery (Harshaw, 1945).

From March 1942 and continuing until 1951, Harshaw produced uranium hexafluoride (DOE, 1997, Stefanec, 1951). In 1944, under contract to MED, Harshaw built and operated a full-scale uranium hexafluoride pilot plant (Harshaw, 1945).

In May 1949, the Atomic Energy Commission (AEC) contracted with Harshaw to convert uranium concentrate to uranium trioxide and then to uranium oxide (NYOO Medical Division, 1949 and Mayer, 1949). In 1951 AEC discontinued conversion of uranium trioxide to uranium dioxide and production of uranium dioxide ceased. At that point, Harshaw began to produce uranium trioxide only from milled ore (DOE, 1997). Production of uranium trioxide continued until about September 1955 when the plant was shut down. Decontamination and decommissioning (D&D) activities were conducted under AEC supervision starting in November 1951.

The entire Harshaw Chemical Company operational area for AEC work was referred to as “Plant C,” or “Area C” (Velten, 1949). Plant C included all of the individual production operations using radiological materials (uranium dioxide-to-uranium tetrafluoride, uranium tetrafluoride-to-uranium hexafluoride plus distillation, and ore-to-uranium dioxide or -uranium trioxide). The locations where these three individual production operations were performed were also referred to as “plants.” The common usage of the time may have referred to the ore-to-uranium dioxide operations as the "brown plant" or "new brown plant" and to the rest of the operations as “Plant C.”

4.1.1 Uranium Tetrachloride Production

Harshaw shipped its first order of uranium tetrachloride to the National Bureau of Standards in March 1942. Harshaw began larger-scale laboratory production of uranium tetrachloride in November 1942; by April 1943, Harshaw was producing up to 100 pounds of uranium tetrachloride daily (Harshaw, 1945). Harshaw set up a new production area in October 1944. This new production area was initially used to process up to one ton per day of uranium tetrachloride, with the production rate continuing to increase monthly thereafter (Harshaw, 1945; Ferry, 1944; and MED, 1945). In January 1945, MED ordered an additional amount of 65,000 pounds of uranium tetrachloride. This was the final order of the material (Simmons, 1945). Harshaw stopped production of uranium tetrachloride in February 1945 and dismantled the uranium tetrachloride production area. Parts were shipped to Oak Ridge, Tennessee (Harshaw, 1945).

4.1.2 Uranium Hexafluoride Production

In February 1942, Harshaw Chemical Company first produced uranium hexafluoride and maintained a production rate of five (5) pounds per day throughout 1942. By 1943, Harshaw was producing as much as fifty (50) pounds of uranium hexafluoride per day in a pilot plant. Harshaw operated the pilot plant until February 1944, producing a total of 9,000 pounds of uranium hexafluoride (Harshaw, 1945).

In 1944, Harshaw built a new uranium hexafluoride production facility containing three units. Harshaw erected electrolytic cells to obtain the fluorine that was used to produce uranium hexafluoride (Quigley, 1951). By July 1944, Harshaw was producing as much as 3,300 pounds of uranium hexafluoride per day, and as much as 4,500 pounds per day of uranium hexafluoride by April 1945 (AEC, 1951 and Harshaw, 1945). Still, further increases in production were requested and achieved. Although not produced on a regular monthly basis, by December 1947 Harshaw was producing up to 46,000 pounds of uranium hexafluoride per month. In December 1951, Harshaw Chemical Company stopped producing uranium hexafluoride.

4.1.3 Uranium Tetrafluoride Production

In 1942, at the request of Standard Oil, Harshaw Chemical Company began to produce uranium tetrafluoride from uranium dioxide. The first uranium dioxide material processed at Harshaw was supplied by Westinghouse Electric and Manufacturing Company (Medical History of Harshaw Chemical Company). In July 1942, MED asked Harshaw to produce 1,200 pounds of uranium tetrafluoride per day from uranium dioxide produced and supplied by DuPont and Mallinckrodt (Harshaw, 1945).

In September 1942, Harshaw implemented large-scale production using a new facility with a production capacity of 50,000 pounds (25 tons) of uranium tetrafluoride per month (Medical History of Harshaw Chemical Company and AEC, 1951). By December 1943, continued improvements in the conversion process increased the production level to 60 tons per month (Harshaw, 1945 and AEC, 1951).

In December 1944, Harshaw moved production of uranium tetrafluoride to Building G-1 where the production rate was about 3,000 pounds daily (Medical History of Harshaw Chemical Company). In February 1946, anticipating a later full production of 28,000 pounds (14 tons) per week, MED authorized an increase to 15,000 pounds per week.

Although discrepancies in production quantities exist and are likely due to the reporting of theoretical capacity versus actual production, the final full production level for uranium tetrafluoride (in February 1948) appears to have been 81 tons per month (AEC, 1951). In October 1951, Harshaw stopped producing uranium tetrafluoride (DOE, 1997).

4.1.4 Uranium Trioxide (UO_3) and Uranium Dioxide (UO_2) Production

In 1947, Harshaw Chemical Company constructed an ore-to-uranium trioxide-to-uranium dioxide batch production facility for AEC use (Velten, 1949). This facility was constructed so that Harshaw could produce uranium dioxide on-site, alleviating the need to bring in uranium dioxide from other suppliers. “Ore” was typically received as milled ore.

By July 1949, the ore-to-uranium trioxide-to-uranium dioxide batch production facility was operating (AEC, 1951). In 1951, through process modification that included a switch to the use of tributyl phosphate-kerosene rather than ether, uranium dioxide production increased (AEC, 1951). However, the uranium trioxide-to-uranium dioxide portion of the operation was stopped entirely in 1951 although the AEC implies this occurred as of October 1952 (DOE, 1997; Stefanec, 1951; and Termini, 1952).

The uranium trioxide contractual amount was 200,000 pounds per month from October to December of 1952 (Neumann, 1952). Harshaw continued to produce uranium trioxide from ore until August 1953 when uranium trioxide production was placed on standby and the AEC directed Harshaw to end all processing except for a final conversion of all leftover feed materials to uranium trioxide (Neumann, 1953).

4.1.5 Uranyl Nitrate Hexahydrate Production

Throughout the 1950 through 1951 timeframe, uranyl nitrate hexahydrate, which is an intermediate liquid produced in the initial processing of ore and uranium extraction, was reportedly produced as "Research Material" along with $UO_2(NO_3)\cdot 6\ H_2O$. Documentation available to NIOSH does not indicate if the uranyl nitrate hexahydrate was produced for use at Harshaw or elsewhere. Beginning in 1952, Hanford sent uranyl nitrate hexahydrate to Harshaw, sometimes via the Brush Beryllium Company, to be converted into uranium trioxide (Klevin, 1952; Termini, 1952; DOE; 2000). Hanford produced uranyl nitrate hexahydrate using a tributyl phosphate chemical process and transported it in tank cars to Harshaw.

4.1.6 Operations Involving Other Radiological Materials

Between 1943 and 1944, Harshaw Chemical Company manufactured a number of special radiological materials, including uranium oxyfluoride (UO_2F_2), sodium uranate (Na_2UO_7) at 84%, and uranium nitrate ($U(NO_3)_x$) at 56% (presumably the percentages were of U_3O_8 equivalent) (Harshaw, 1945). However, NIOSH has not located documentation describing how Harshaw processed these materials. Between February 1947 and August 1950, Harshaw prepared short-lived thorium-234 (known as UX1) from a residue of the uranium tetrafluoride-to-uranium hexafluoride conversion process (Stefanec, 1951). Thorium-234 (UX1) was produced in a laboratory in bench quantities (Stefanec, 1951)
.

On at least two occasions, Harshaw Chemical Company processed some low-enriched uranium, in the form of uranium hexafluoride, from Hanford (Kelley, 1946). In 1945 and 1946, Harshaw was asked to mix natural uranium hexafluoride with uranium hexafluoride that had been slightly enriched. The resulting slightly enriched uranium hexafluoride, now referred to as low-enriched uranium hexafluoride, appears to have been enriched to less than 1% uranium-235 by weight and was shipped to the Oak Ridge Gaseous Diffusion Plan in Oak Ridge, Tennessee (Kelley, 1946).

4.1.7 Summary of Potential Exposures

Harshaw AWE employees could have received internal and external radiation exposures from uranium and non-uranium contaminants, including radium, thorium, and lead in the milled and composite materials. The uranium content of mined uranium ores varied based upon the quality of the rock being mined. Natural conditions also resulted in varying degrees of disequilibrium between decay series radionuclides within particular ore deposits. A majority of the ^{226}Ra and thorium isotopes would have been removed by the milling processes.

While the activity of the ^{226}Ra and thorium isotopes was reduced, much of the potential for external exposure to AWE workers at Harshaw was likely due to uranium progeny. Radium-226, a gamma emitter, likely produced some of the external whole body dose received by the Harshaw workers. Thorium-234 and ^{234m}Pa, both primarily beta emitters, likely produced whole body skin and extremity dose for workers involved in handling the fluorination ash or decontaminating equipment used to contain or transport the bed ash (ORAUT-TKBS-0044).

Internal exposures would have included alpha radiation resulting from uranium and uranium progeny emissions. Workers involved in the UX-1 operation were potentially exposed to alpha emissions from thorium. AWE workers were also likely exposed to elevated levels of radon. The concentration of radium (and radon) and other daughters present in the ore concentrates, processed uranium, and processing residue at any given time depended on various factors, including: the concentration of uranium in the original ore body; how much uranium progeny remained in the U_3O_8 product received from the mill, the total amount of U_3O_8 product processed, and how long the U_3O_8 was stored prior to use as feed at Harshaw.

5.0 Summary of Available Monitoring Data for the Proposed Class

The primary data used for determining internal exposures are derived from personal monitoring data, such as urinalyses, fecal samples, and whole-body counting results. If these data are unavailable, the air monitoring data from breathing zone and general area monitoring are used to estimate the potential internal exposure. If personal monitoring and breathing zone area monitoring are unavailable, internal exposures can sometimes be estimated using more general area monitoring, process information, and information characterizing and quantifying the source term.

The same hierarchy is used to determine the external exposures. Personal monitoring data from film badges or thermoluminescent dosimeters (TLD) are the primary data used for determining external exposures. If there are no personal monitoring data, exposure rate surveys, process, and source term modeling can sometimes be used to reconstruct the potential external exposure.

A more detailed discussion of the information required for dose reconstruction can be found in OCAS-IG-001, *Internal Dose Reconstruction Implementation Guide* and OCAS-IG-002, *External Dose Reconstruction Implementation Guide*. These documents are available at: http://www.cdc.gov/niosh/ocas/ocasdose.html.

5.1 Harshaw Chemical Company Internal Personnel Monitoring Data

Radiological uranium urinalysis at Harshaw appears to have first occurred in 1944 as part of a screening experiment conducted at several MED sites (Ferry, 1944). Urinalysis samples were sent to the University of Rochester for processing. However, by January 1946, this screening program was abandoned (Medical History of Harshaw Chemical Company; Mears 1946).

In August 1947, AEC asked Harshaw to implement a routine urinalysis program for uranium and fluorine (Kelley, 1947). Some results are available for August 1947, June 1948, December 1948, and July 1949. However, all samples taken in 1947 were reportedly contaminated. More frequent results were found for the period from December 1949 through 1953. NIOSH has not identified any results for dates after 1953 (AEC, 1958). A document titled *Harshaw Chemical Co.—Occupational Exposure to Radioactive Dust in Green to Hex Plant*, states that 200 workers were subject to urinalysis, which appears to have included workers at all three major areas of Plant C (Klevin, 1950). In 1951, Harshaw estimated that several hundred terminated employees had potentially been exposed to uranium for more than a year and that these employees were unlikely to have been monitored.

NIOSH has obtained results of Harshaw employee urinalyses and blood analyses. One hundred twenty-five (125) results are for the period prior to December 1949. There are 5,898 results for the period from December 1949 through December 1953. NIOSH has identified results of 1950 and 1951 blood analyses analyzed for uranium for sixteen people including one AEC worker (Tabershaw, 1951).

5.2 Harshaw Chemical Company External Personnel Monitoring Data

NIOSH has identified film badge results for 187 workers for the time period of August 1944 through March 1948. These worker results were part of a weekly badge exchange program initiated by MED in 1945. The early film badge results are summaries, by worker, of the total beta dose, gamma dose, and total weeks exposed (Mears, 1946). Documentation available to NIOSH showed that Harshaw maintained a routine film badge program from 1948 through 1953. No specific descriptions of the film badge, quality assurance measures, or reading process used for this dosimetry have been identified. Because the University of Rochester, and later AEC's Health and Safety Laboratory (HASL), processed the film badges, the film badge design was likely similar to the film badge used at other AEC sites.

In 1948, some badges were stored near cylinders of low-enriched uranium hexafluoride that added a spurious gamma dose. In 1949, the AEC reviewed some gamma badge results from various sites (Blatz, 1949). The review showed that although Harshaw generally had no measurable gamma exposures, occasionally all badges for a particular week would range from 50 to 100 mR. The AEC believed this was due to poor handling rather than real dose indication (Blatz, 1949). At one point, Harshaw reported that the seal holding the clip to the back of the film badge frequently failed, allowing the badge to fall onto the floor and other places. As a result, films were potentially ruined.

Extremity monitoring was performed infrequently. In 1946, a MED Sergeant was monitored for a four-day period while he worked as a temporary low-enriched uranium hexafluoride tray loader and ash handler. Some information on the potential for extremity exposure was gathered, but some of the films were unreadable due to a heat problem caused by perspiration (Engel, 1946). Ink fingerprinting and photographic fingerprinting were used in an AEC study to determine if changes to workers' skin ridges could be related to radiation exposure, but the results of these studies have not been located.

Neutron exposure at Harshaw was not monitored. The forms of uranium that would produce neutrons at the highest rates would have been uranium tetrafluoride and uranium hexafluoride; however, uranium oxide (yellow cake), U_3O_8, and the soda salt from $Na_2U_2O_7$ would also have potentially generated neutron reactions from alpha-neutron reactions.

Uranium processing workers at Harshaw were given pre-employment physicals that included a chest X-ray (AEC, 1958). These workers also were given annual physicals that included a chest X-ray and a pelvic X-ray (Ferry 1944; Kelley, 1947; and Quigley, 1951). The rationale for the pelvic X-ray was to detect bone effects due to fluoride exposure; thus, it is likely that only the workers in the uranium tetrafluoride-to-uranium hexafluoride process area received pelvic examinations.

5.3 Harshaw Chemical Company Workplace Monitoring Data

Workplace monitoring data have been identified and reviewed by NIOSH for the purposes of assessing the exposure hazards and potential for exposure, and to determine if these data can be used to reconstruct internal and external doses with sufficient accuracy.

5.3.1 Air Monitoring

The milling of uranium ore at Harshaw was a primary source of airborne dust. Operations involving the loading, grinding, and crushing of uranium tetrafluoride were a routine and sustained source of airborne contamination. Operations involving the production of uranium hexafluoride contributed to concentrations of airborne radioactivity as well. Some controls, including the use of damp filter cakes, were used to reduce the release of airborne radioactivity; these controls had limited success. For example, contaminated dust could become airborne when filter cakes dried.

In addition to the chemical processes that generated airborne radioactivity, other tasks such as sweeping contributed to airborne contamination. Some systems intended to control dust could actually result in increased worker exposure. For example, prior to the installation of the central vacuum system in 1950, the portable vacuum cleaners discharged a considerable amount of unfiltered dust back inside the room in which they were being used (Hunter, 1949 and Stefanec, 1951).

In 1944 and 1945, Harshaw performed some limited air sampling and these data are available to NIOSH (Ferry, 1944 and Tybout, 1945). The mass of uranium in the sample was determined by multiplying the mass of uranium in a standard by the ratio of instrument response measured for the sample to the instrument response measured for the standard, and dividing by the volume of air sampled.

By the latter part of 1949, a permanent air sampling program was implemented (Mayer, 1949 and Wolf, 1949). This permanent program consisted of four general area air samples from each of the 40 sample stations, which were to be taken every month; about 100 breathing zone samples, which were to be taken each month; and four samples, which were to be taken from each of 13 stack locations (Wolf, 1949 and Harris, 1949). This program monitored dusts and emanations. While Harshaw intended to implement the permanent program in September 1949, the air sampling program was not fully operational in September 1949. In December 1949, only 130 samples per month were being collected. Harshaw told the AEC that the sampling manifold did not work properly, that there were pump troubles, and that the lines were too long to permit sufficient volume intake. The AEC inspected the system and found that the manifold was not installed according to the layout provided to Harshaw by the AEC New York Operations Office. As a result, there was a significant increase in the amount of tubing, elbows, and tees, which resulted in pressure losses (Klevin, 1950). These deficiencies were corrected under AEC direction (Sargent, 1950). The air sampling results were reported alpha activity. The alpha activity was equated to uranium activity. Although Harris (1949) reported that the refined ores contained “no radium content,” the refinery operations were not 100% efficient, especially with the early refinery operations. Radon concentrations in air were not formally measured at Harshaw. Uranium and radium progenies were not considered in the airborne monitoring results.

Results of air monitoring at Harshaw are available for the period 1948 through 1953, with most results being for 1950 and thereafter. Some breathing zone results are available from 1950 through 1953.

5.3.2 Dose Rate Measurements

There are records of many dose rate measurements throughout the operational period (Quigley, 1951 and Stefanec, 1951). Gamma dose rates were recorded in mR/hour while beta dose rates were recorded in mrep/hour; Beta plus gamma dose rates were sometimes also recorded in units of mrep/hour (Stefanec, 1951).

5.3.3 Surface Contamination Measurements

Early information regarding specific contamination levels is limited, but the available records indicate that contamination was a major issue at Harshaw. Process areas were not always well-enclosed or well-ventilated. It does not appear that there was any designation between clean and contaminated areas for change rooms and other pass-through areas until at least 1949. There was a considerable loss of uranium dust through stacks, after which the dust could eddy back into the building. A 1946 Harshaw operating manual implies that contamination was being tracked from work areas. In addition, visitors were not issued cover clothing until 1949 (Morgan, 1949).

In order to assess contamination, the University of Rochester performed a general contamination survey at Harshaw in 1947 (Ray, 1947). The survey included smears of surfaces inside the plant, collection of ten soil samples, and one sample each of paint, rust, bark and grass outside the main plant building. The smears were counted at Rochester using an alpha counter. The University of Rochester assumed that the counts represented half of the total alpha disintegrations (ignoring absorption in the sample). No information regarding the total area smeared was available. Results of the University of Rochester survey are presented in Table 5-1.

Table 5-1: University of Rochester Survey Results

Area	Range (alpha dpm)
2nd Floor (UO_2-UF_4)	34–680
Worker shoes, top and bottom	5,840;1,692
Stair landing	938
Floor around cooling rack	382–1,240
Floor around furnaces	314–816
Operator's desk	676
Tube filling rack	1,614
Tray loading bench	2,478
Tray loading bench, floor	1,640–2,602
Paste bench	1,084
Green salt bench	6,504
Green salt bench, floor	1,260
Work bench	8,364
Used trays	2,164
1st floor, receiver area	1,118–1,326
Panel board area	910–1,260
UF_4/ash powder on floor	4,550
Hood, near reactors	1,262–7,082
Floor around cells	160–746
Top of cells	70–92
Cell doorways	150–182
Near cell rooms, floor painted, hosed	30–316
In cell rooms, floor hosed down	16–94

Table 5-1: University of Rochester Survey Results	
Area	**Range (alpha dpm)**
Reactors	460–2,016
Floor around reactors	266–1,450
Still room floor	392–576
Pipe rack in receiving room	556–952
Doorways in receiving room	460–574
Repair room, walls/windows	24–92
Repair room, floor	116–544
Repair room workbench	302
Receiving room desk	250
Receiving room floor	392
Loading room floor	938
Loading room doorway area	122–382
Guard shack area	100–186
Filter shack	46–288
Inside doorway of Supt's office	440
Floor at filing cabinet, office	420
Other floor areas, office	8–256
Box of pipes outside Supt's office	214
Doorway to Plant Manager's office	8
Mail table floor area, hall	12–18
"Girls'" shower room floor	250
"Girls'" locker room floor	778
"Girls'" lunchroom floor	702
Men's shower room floor	846
Men's locker room floor	1,040–2,083
Men's lunchroom floor	958
Main lunchroom, kitchen	2–26

Survey results are available from the last year of operation. A memo regarding a radiation survey of the Harshaw Refinery reported that after nominal cleaning of contaminated floors, beta readings averaged one (1) mrep/hour in many locations. Some beta results exceeded twenty (20) mrep/hour (McAlduff, 1956). Photon radiation was minimal in all surveyed floor locations, averaging 0.05 mR/hour.

6.0 Feasibility of Dose Reconstruction for the Proposed Class

42 C.F.R. § 83.14(b) states that HHS will consider a NIOSH determination that there was insufficient information to complete a dose reconstruction, as indicated in this present case, to be sufficient, without further consideration, to conclude that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy.

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already determined that a dose reconstruction cannot be completed for an employee at the AWE facility. This NIOSH determination provides the basis for the petition by the affected claimant. NIOSH has further considered defining the extent of the class of employees who are similarly affected, as indicated by the completed research, and hence, as a class of employees, found that dose reconstruction is similarly not feasible.

In accordance with 42 C.F.R. § 83.14(a), NIOSH also considered whether or not the completed research provides a basis for evaluating an additional class at the facility for whom NIOSH may believe that dose reconstruction is unlikely to be feasible. If NIOSH were to identify such a basis, it would undertake a separate SEC evaluation regarding the additional class. This would allow NIOSH, the Board, and HHS to complete, without delay, their consideration of the class including a claimant for whom NIOSH has already determined a dose reconstruction cannot be completed, and whose only possible remedy under EEOICPA would be adding a class of employees to the SEC.

This section of the report summarizes research findings where NIOSH determined that it lacked sufficient information to complete the relevant dose reconstruction and on which basis it has defined the class of employees for which dose reconstruction is not feasible. The determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions.

6.1 Feasibility of Estimating Internal Exposures

As indicated in Section 5.1, prior to initiation of routine bioassay monitoring for uranium in December 1949, results from Harshaw bioassay monitoring have serious deficiencies, and as described previously, the results from 1947 were contaminated. NIOSH has 104 results for 1948 through early 1949, but NIOSH has no documentation regarding the methods used for sample collection and analysis prior to the onset of routine monitoring in December 1949. NIOSH has found no indication that monitoring was performed for exposures to uranium progeny resulting from the processing of milled ores.

NIOSH has obtained general area air monitoring data beginning in 1944. However, as discussed in Section 5.3.1, NIOSH does not have adequate air monitoring program documentation or breathing zone air monitoring data prior to 1950. While the available general area monitoring data are useful in demonstrating airborne radiological conditions, air monitoring data obtained prior to 1950 are not adequate to evaluate worker intakes due to uncertainties in sampling flow rate, sampling duration, sampling locations, and analysis methods. It is not feasible to use available general air monitoring results to adequately support reconstruction of uranium progeny and uranium-specific doses at the Harshaw plant prior to 1950.

Due to the lack of personnel and area monitoring data for uranium progeny, NIOSH concludes that the available workplace and bioassay data do not provide the information necessary to assess with sufficient accuracy the non-uranium intakes at Harshaw Chemical Company prior to December 1949.

NIOSH can likely reconstruct uranium-specific internal doses for monitored AWE workers for the period August 14, 1942 through September 30, 1955 using the uranium bioassay data, known uranium production source term data, and techniques applied to other AEC sites that processed uranium during the same period. NIOSH expects to generate co-worker intake data to reconstruct uranium-specific doses for AWE workers who were not monitored

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor. As noted above, HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy.

However, it is likely that NIOSH could estimate external exposure to electrons and photons for employees in this class. Usable external exposure data, as discussed in Section 5.2, include results of beta and gamma monitoring recorded by film badges and results from work area dose rate measurements. In addition, it is likely that NIOSH could also estimate significant neutron doses using the document titled *Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds* (ORAUT-OTIB-0024). NIOSH considers adequate reconstruction of external dose possible by using individual dosimetry records, claimant-favorable assumptions, and the relevant protocols specified in various complex-wide Technical Information Bulletins (TIBs).

Similarly, NIOSH is able to reconstruct medical doses for Harshaw Chemical Company workers by using claimant-favorable assumptions as well as applicable protocols specified in the document titled *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006).

7.0 Summary of Feasibility Findings for Petition SEC-00066

This report evaluated the feasibility for estimating the dose, with sufficient accuracy, for all AWE employees working at the Harshaw Chemical Company from August 14, 1942 through November 30, 1949. NIOSH determined that it lacks bioassay data and air monitoring results needed to reconstruct internal exposures to uranium progeny at the facility during this time period. Consequently, NIOSH finds that it is not feasible to estimate with sufficient accuracy the radiation doses resulting from internal exposures received by members of this class of employees.

NIOSH has documented herein that it cannot complete the dose reconstruction(s) related to this petition. The basis of NIOSH’s finding is explained in this report, which demonstrates that NIOSH does not have access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate. Members of this class at the Harshaw Chemical Company may have received internal intakes from exposure to uranium and uranium progeny at the plant. NIOSH lacks sufficient information, including biological monitoring data, air monitoring information, and process and radiological source information that would allow it to estimate the potential intake(s) of uranium progeny, and the resulting dose to which the proposed class may have been exposed.

8.0 Evaluation of Health Endangerment for Petition SEC-00066

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. § 83.14(c) and § 83.13(c)(3). Pursuant to these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulations direct 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 members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of radionuclides. Consequently, NIOSH is specifying that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00066

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This NIOSH-proposed class includes all AWE employees who were monitored or should have been monitored while working at the Harshaw Harvard-Denison Plant located at 1000 Harvard Avenue in Cleveland, Ohio for a number of work days aggregating at least 250 work days from August 14, 1942 through November 30, 1949, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

This page intentionally left blank

10.0 References

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000;* Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p 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

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

ORAUT-OTIB-0006, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, Rev. 03 PC-1, Oak Ridge Associated Universities; December 21, 2005; SRDB Ref ID: 20220

ORAUT-OTIB-0024, *Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds*, Oak Ridge Associated Universities; April 7, 2005; SRDB Ref ID: 19445

ORAUT-TKBS-0005, *Technical Basis Document: Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company*, Rev. 00-C, Oak Ridge Associated Universities, March 10, SRDB Ref ID:

AEC, 1947, *Health Program at "Area C". Letter from W. E. Kelley of AEC to K. E. Long of Harshaw*; Atomic Energy Commission (AEC); August 5, 1947; SRDB Ref ID: 12472

AEC, 1951, *The Production of Uranium Feed Materials*; Atomic Energy Commission; May 22, 1951; SRDB Ref ID: 4125

AEC, 1958, *Correlation of Urine Data and Medical Findings with Environmental Exposure to Uranium Compounds*, In: Symposium on Occupational Health Experience and Practices in the Uranium Industry, proceedings of an Atomic Energy Commission Conference; 1958; SRDB Ref ID: 15010

Author unknown, date unknown, *Medical History of Harshaw Chemical Company*; SRDB Ref ID: 10641, page 186

BJC, 2000, *Recycled Uranium Mass Balance Project*, Oak Ridge Gaseous Diffusion Plant Site Report; Bechtel Jacobs Company; June 2000; SRDB Ref ID: 16497

Blatz, 1949, *Review of Gamma Film Badge Readings at Harshaw, Plant Four (MCW), Linde, and Electro Met*, Memorandum to B. S. Wolf from H. Blatz; Atomic Energy Commission; March 25, 1949; SRDB Ref ID: 10641, page 82

DOE 1997, *Linking Legacies: Connecting the Cold War Nuclear Weapons Production Processes to Their Environmental Consequences*, Appendix B; Department of Energy, Office of Environmental Management; January 1997; SRDB Ref ID: 11930

DOE 2000, *Review of Generation and Flow of Recycled Uranium at Hanford*; Department of Energy, Richland Operations Office; June 30, 2000; SRDB Ref ID: 4971

Engel, 1946, *Visit to Harshaw Chemical Company, Cleveland, Ohio*, Memorandum to B. J. Mears from B. Engel; Manhattan Engineer District; February 19, 1946; SRDB Ref ID: 11662

Ferry, 1944, *Progress Report of the Special Materials Division of the Medical Section*, Memorandum to S. L. Warren from J. L. Ferry; Manhattan Engineer District; January 3, 1944; SRDB Ref ID: 14490

Gamertsfelder, date unknown, *Radiation Survey for Harshaw Chemical Co.*, Brief report of survey taken in two uranium processing areas; SRDB Ref ID: 13020

Harris, 1949, *Sampling Program at Harshaw Chemical Company*, Memorandum to E. C. Sargent from W. B. Harris; Atomic Energy Commission; December 29, 1949; SRDB Ref ID: 10641, page 1

Harshaw, 1945, *Brief History of Work on the Manhattan District Project at the Harshaw Chemical Company, Cleveland, Ohio*; W. J. Harshaw, Harshaw Chemical Company; September 17, 1945; SRDB Ref ID: 11882, page 648

Hunter, 1949, Harshaw Recovery System-Hex Plant, Memorandum to Files from D. Hunter; June 3, 1949; SRDB Ref ID: 10641, page 63

Kelley, 1946, *Disposal of Slightly Enriched C-616*, Memorandum to S. L. Brown from W. E. Kelley; February 4, 1946; SRDB Ref ID: 11882

Klevin, 1950, *Harshaw Chemical Co.—Occupational Exposure to Radioactive Dust in Green to Hex Plant, September 13-16, 1949*; Harshaw Chemical Company; February 14, 1950; SRDB Ref ID: 10558

Klevin, 1952, *Harshaw Chemical Company—Visit of October 8, 1952*, Memorandum to W. B. Harris from P. B. Klevin; Atomic Energy Commission; October 29, 1952; SRDB Ref ID: 11131, page 14

Mayer, 1949, *Visit to Harshaw Chemical Company, Cleveland, Ohio, on June 23, 1949-Preliminary Statistical Survey*, Memorandum to F. M. Belmore from C. M. Mayer and F. Proschan; Atomic Energy Commission; June 28, 1949; SRDB Ref ID: 11891, page 128

McAlduff, 1956, Radiation Survey of Harshaw Refinery, Memorandum to F. R. Dowling from H. J. McAlduff; Atomic Energy Commission; November 20, 1956; SRDB Ref ID: 4416, page 6

Mears, 1946, *Badge Monitoring at Harshaw Chemical Company*, Memorandum to the Rochester Area Engineer from B. J. Mears; April 16, 1946; SRDB Ref ID: 7717, page 4

MED, 1945, *Supplemental Agreement Number 1 (to Contract No. W-26-021 eng-4)*, Agreement between the Harshaw Chemical Company and MED: Manhattan Engineer District; January 1, 1945

Morgan, 1949, *Meeting with Harshaw Chemical Company on January 24, 1949*, Memorandum to Files from J. P. Morgan; Atomic Energy Commission; February 24, 1949; SRDB Ref ID: 11891, page 120

Neumann, 1952, Harshaw Contract Feed and Production Schedule for Quarter Beginning October 1, 1952, Letter to G. R. Fernelius from A. W. Neumann; August 1, 1952; SRDB Ref ID: 4125

Neumann, 1953, *Termination of Period of Work Performance*, Letter to G. R. Fernelius from A. W. Neumann; Atomic Energy Commission; August 17, 1953; SRDB Ref ID: 11822, page 993

NYOO Medical Division, 1949, *Health Hazards in NYOO Facilities Producing and Processing Uranium*; April 18, 1949; SRDB Ref ID: 3931

Quigley, 1951, *Visit to Harshaw Chemical Company, Cleveland, Ohio, on June 6, 1951*, Memorandum to M. Eisenbud from J. A. Quigley; Atomic Energy Commission; June 20, 1951; SRDB Ref ID: 11646, page 24

Ray, 1947, *Survey of Harshaw Chemical Company Unit at Cleveland, Ohio, July 9-10, 1947*, Memorandum report to Dr. B. S. Wolf from W. H. Ray; Atomic Energy Commission; July 12, 1947; SRDB Ref ID: 11891, page 22

Sargent, 1950, *Medical Meeting at Harshaw, October 4, 1950*, Memorandum to J. P. Morgan of the Production Division from E. C. Sargent; Atomic Energy Commission; October 5, 1950; SRDB Ref ID: 11895, page 41

Simmons, 1945, *Shipment Security Survey at Mallinckrodt Chemical Works*, Memorandum to the Officer in Charge from F. W. Simmons; Manhattan Engineer District; February 15, 1945; SRDB Ref ID: 7717

Stefanec, 1951, *Health Physics Activities November 15 through December 15, 1951*; A. J. Stefanec; December 21, 1951; SRDB Ref ID: 11137

Tabershaw, 1951, *Contemplated Medical Program at Harshaw Chemical Company*, Memorandum to M. Eisenbud from I. R. Tabershaw; Atomic Energy Commission, November 21, 1951; SRDB Ref ID: 11135

Termini, 1952, *Plant Visit: AEC Operations at Harshaw Chemical Company, Cleveland, Ohio*, Memorandum to Files from J. P. Termini; Atomic Energy Commission; September 16, 1952; SRDB Ref ID: 11882, page 715

Tybout, 1945, *Letter to F. Becker of Harshaw Chemical Company*; March 1, 1945; SRDB Ref ID: 10682

Velten, 1949, *Record of Negotiations for Definitive Supplemental Agreement No. 32 to Contract No. W-7405 eng-276 -- Harshaw Chemical Company,* Memorandum to J. C. Clarke from E. H. Velten; Atomic Energy Commission; February 7, 1949; SRDB Ref ID: 11882, page 683

Wolf, 1948, *Protective Clothing at Harshaw Chemical Company*, Memorandum to W. A. Taussig from B. S. Wolf; Atomic Energy Commission; November 1, 1948; SRDB Ref ID: 10641, page 120

Wolf, 1949, *Visit to Harshaw Chemical Co., Memorandum to F. M. Belmore from B. S. Wolf*; Atomic Energy Commission; August 9, 1949; SRDB Ref ID: 10641, page 45