SEC Petition Evaluation Report
Petition SEC-00182

Report Rev #: 0 Report Submittal Date: July 14, 2011

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Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00182	83.13	December 21, 2010	February 17, 2011	W.R. Grace and Company (Maryland)

Petitioner-Requested Class Definition

Chemical operators, bar mill operators, and pot operators who worked with or on rotary dryers, pill machines, nauta mixes (sieves), hydroxide dryer, blenders #1 and #3, Reactor 906 and 902 material, Red Dog and Vanadium material at the Specialty, Monasito [sic], LDI Plants, Tech Center, Buildings 109, 193, 194, and 224 at W.R. Grace and Company, Curtis Bay, Maryland, from 1955 through 2009.

Class Evaluated by NIOSH

All Atomic Weapons Employees who worked at W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from January 1, 1955 through December 31, 1958 and the residual radiation period from January 1, 1959 through October 31, 2009.

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

All Atomic Weapons Employees who worked at any building or area at the facility owned by W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from May 1, 1956 through January 31, 1958, 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 Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
N/A	N/A	N/A	N/A

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
N/A	N/A

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Evaluation Report Summary: SEC-00182, W.R. Grace and 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*.

Petitioner-Requested Class Definition

Petition SEC-00182 was received on December 21, 2010, and qualified on February 17, 2011. The petitioner requested that NIOSH consider the following class: *Chemical operators, bar mill operators, and pot operators who worked with or on rotary dryers, pill machines, nauta mixes (sieves), hydroxide dryer, blenders #1 and #3, Reactor 906 and 902 material, Red Dog and Vanadium material at the Specialty, Monasito* [sic], *LDI Plants, Tech Center, Buildings 109, 193, 194, and 224 at W.R. Grace and Company, Curtis Bay, Maryland, from 1955 through 2009.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH evaluated the following class: All Atomic Weapons Employees who worked at W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from January 1, 1955 through December 31, 1958 and the residual radiation period from January 1, 1959 through October 31, 2009. Note: The DOE defines the dates for the operational period as "1955-1958," and the dates for the residual period as "1959-October 2009." NIOSH has applied the earliest logical start dates and latest logical end dates for defining the periods to be evaluated.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employees who worked at any building or area at the facility owned by W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from May 1, 1956 through January 31, 1958, 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 Special Exposure Cohort. The class under evaluation was modified (see Section 3.0 below). The time period was reduced to correspond to the duration of the monazite sand and thorium work. The job titles were expanded to include all workers because, although all thorium-refining work was completed within Building 23, all workers may have had unlimited access to the building. The period before May 1, 1956 is not included in the proposed SEC class because NIOSH has determined that AEC-related operations involving radioactive materials did not start at the Curtis Bay, Maryland site until May 1956 with the completion of site construction. Based on this information, that period will not be included in the radiological dose assessment included in this evaluation. The period from February 1, 1958 through December 31, 1958 is not included in the proposed SEC class because NIOSH has determined that

AEC-related operations had ceased at the site by the end of January 1958. Therefore, these eleven months along with the period from January 1, 1959 through October 31, 2009 are considered the residual radiation period. The residual radiation period is not included in the NIOSH-proposed SEC class because dose reconstruction has been determined to be feasible.

Feasibility of Dose Reconstruction

NIOSH finds it is not feasible to estimate internal or external exposures with sufficient accuracy for all workers at the site for the operational period from May 1, 1956 through January 31, 1958. Internal monitoring data, work area radiological monitoring data, and source term data are not available. Furthermore, NIOSH has not identified any external monitoring records or personal dosimetry data associated with the thorium processing that occurred during the operational period under evaluation. NIOSH also has not been able to identify any radiological surveys or area monitoring data conducted or gathered during the operational period.

For the residual radiation period, per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses more precisely than an estimate of maximum dose. Information available from additional resources for other site performing similar work is sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the residual radioactivity period from February 1, 1958 through October 31, 2009.

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

- Principal sources of internal radiation for members of the proposed class included exposures to uranium, thorium, and their progeny present in the monazite sands during milling and extraction operations. The modes of exposure were inhalation and ingestion of dust generated during the various processes associated with monazite sand. Isotopic components of monazite sand include U-238 and Th-232 and their decay progeny. Depending on their geographical source, monazite sands contain approximately 2.5% to 8 % thorium oxides.

- Thorium was the only radionuclide refined during the operational period; internal exposure was primarily a concern during this process. NIOSH finds that it lacks sufficient personnel or area monitoring data, source term data, and operational information to support assessing internal dose with sufficient accuracy during the operational period from May 1, 1956 through January 31, 1958, which encompasses the period that AEC-related radiological operations were performed on site.

- During the residual period, workers had a potential for internal exposure due to re-suspended surface contamination. NIOSH finds that it has access to sufficient area monitoring data and surrogate site information to support assessing internal dose with sufficient accuracy during the residual radioactivity period from February 1, 1958 through October 31, 2009.

- Principal sources of external radiation for members of the proposed class included exposures to uranium, thorium, and their progeny present in the monazite sands during milling and extraction operations. NIOSH finds that it lacks sufficient personnel or area monitoring data, source term data, and operational information to support assessing external dose with sufficient accuracy during the operational period from May 1, 1956 through January 31, 1958, which encompasses the period that AEC-related radiological operations were performed on site.

- During the residual period, workers were potentially exposed to external radiation from residual surface contamination. NIOSH finds that it has access to sufficient area monitoring data and surrogate site information to support assessing external dose with sufficient accuracy during the residual radioactivity period from February 1, 1958 through October 31, 2009.

- Based on its research, NIOSH has concluded that physical examinations with X-rays were not performed at the site. Therefore, medical X-ray dose is not a consideration for W.R. Grace and Company-Maryland workers.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) 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 (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

- Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at W.R. Grace and Company in Curtis Bay, Maryland during the period from May 1, 1956 through January 31, 1958, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

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 during the operational period from May 1, 1956 through January 31, 1958.

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 thorium and uranium, 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 this employment or in combination with work days within the parameters established for other SEC classes.

For the residual radioactivity period from February 1, 1958 through October 31, 2009, a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the evaluated class.

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SEC Petition Evaluation Report for SEC-00182

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: Ray Clark, Oak Ridge Associated Universities. 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 Atomic Weapons Employees who worked at W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from January 1, 1955 through December 31, 1958 and the residual radiation period from January 1, 1959 through October 31, 2009. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

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

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

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

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioner(s) and the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.[3]

3.0 SEC-00182, W.R. Grace and Company (Maryland) Class Definitions

The following subsections address the evolution of the class definition for SEC-00182, W.R. Grace and Company, located in Curtis Bay, Maryland. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00182 was received on December 21, 2010, and qualified on February 17, 2011. The petitioner requested that NIOSH consider the following class: *Chemical operators, bar mill operators, and pot operators who worked with or on rotary dryers, pill machines, nauta mixes (sieves), hydroxide dryer, blenders #1 and #3, Reactor 906 and 902 material, Red Dog and Vanadium material at the Specialty, Monasito* [sic], *LDI Plants, Tech Center, Buildings 109, 193, 194, and 224 at W.R. Grace and Company, Curtis Bay, Maryland, from 1955 through 2009.*

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

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the W.R. Grace and Company (Maryland) workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00182 for evaluation:

> The petitioner submitted an individual dose reconstruction report indicating that individual monitoring records do not exist for the W.R. Grace and Company (Maryland) for the operational and residual periods.
>
> *On page 5 of the NIOSH dose reconstruction report:* [NIOSH ID and DOL Case Number Redacted] *it clearly states that no records were found to indicate any monitoring was done for the period from 1955 through 1989.*

Based on its W.R. Grace and Company (Maryland) research and data capture efforts, NIOSH determined that it has access to contracts, amendments, and process records for W.R. Grace and Company (Maryland) workers during the time period under evaluation. However, NIOSH also determined that monitoring records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal and external radiation exposures and radiation doses were not adequately monitored at W.R. Grace and Company (Maryland), either through personal monitoring or area monitoring. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. The time period was divided into an operational period and a residual radiation period. The worker specifications were expanded to include all workers because it was unclear whether exposures could be limited to certain buildings/areas and job titles. Therefore, NIOSH defined the following class for further evaluation: All Atomic Weapons Employees who worked at W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from January 1, 1955 through December 31, 1958 and the residual radiation period from January 1, 1959 through October 31, 2009. Note: DOE defines the dates for operations as "1955-1958," and the dates for the residual period as "1959-October 2009." NIOSH has applied the earliest logical start dates and latest logical end dates for defining the periods to be evaluated.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employees who worked at any building or area at the facility owned by W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from May 1, 1956 through January 31, 1958, 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 Special Exposure Cohort.

The period before May 1, 1956 is not included in the proposed SEC class because NIOSH has determined that AEC-related operations involving radioactive materials did not start at the Curtis Bay, Maryland site until May 1956 with the completion of site construction. Based on this information, this period will not be included in the radiological dose assessment included in this evaluation. The period from February 1, 1958 through December 31, 1958 is not included in the proposed SEC class because NIOSH has determined that AEC-related operations had ceased at the site by the end of January 1958. Therefore, these eleven months along with the period from January 1, 1959 through October 31, 2009 are considered the residual radiation period. The residual radiation period is not included in the NIOSH-proposed SEC class because dose reconstruction has been determined to be feasible.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding W.R. Grace and Company. 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. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment 1 contains a summary of W.R. Grace and Company documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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

4.1 Site Profile Technical Basis Documents (TBDs)

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

- *Site Profiles for Atomic Weapons Employers that Worked Uranium and Thorium Metals*, Battelle-TBD-6000, PNWD-3738, Rev 0; Battelle; December 13, 2006; SRDB Ref ID: 30671

4.2 Technical Information Bulletins

A Technical Information Bulletin is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following Technical Information Bulletins as part of its evaluation:

- *Estimation of Ingestion Intakes*, OCAS-TIB-009, Rev. 0; National Institute for Occupational Safety and Health (NIOSH); April 13, 2004; SRDB Ref ID: 22397

- *Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, ORAUT-OTIB-0004, Rev. 03 PC-2; Oak Ridge Associated Universities; December 6, 2006; SRDB Ref ID: 29949

- *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, ORAUT-OTIB-0070, Rev. 00; Oak Ridge Associated Universities; March 10, 2008; SRDB Ref ID: 41603

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed an SEC petitioner representative and a former W.R. Grace and Company (Maryland) employee.

- Personal Communication, 2011a, *Personal Communication with Petitioner Representative*; Telephone Interview by ORAU Team; May 5, 2011; SRDB Ref ID: 96226

- Personal Communication, 2011b, *Personal Communication with former W.R. Grace and Company (Maryland) Supervisor;* Telephone Interview by ORAU Team; May 11, 2011; SRDB Ref ID: 96224

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of June 15, 2011)

Table 4-1: No. of W.R. Grace & Co. (MD) Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	1
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1955 through December 31, 1958 [operational period]; January 1, 1959 through October 31, 2009 [residual radiation period])	1
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	1
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 the one claim submitted for dose reconstruction to determine whether internal and/or external personal monitoring records could be obtained for the employee. This claim did not contain any exposure data.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. One hundred thirty-two documents in this database were identified as pertaining to W.R. Grace and Company (Maryland) (as of June 13, 2011). These documents were evaluated for their relevance to this petition. The documents include contracts, amendments, and process records.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *SEC Petition Form B for SEC-00182, W.R. Grace and Company (Maryland); [Name redacted]*; December 21, 2010; OSA Ref ID: 112871, pdf pp. 1-10

- *NIOSH Report of Dose Reconstruction under the Energy Employees Occupational Illness Compensation Program (EEOICPA)*; [Case No. redacted]; July 1, 2009; OSA Ref ID: 112871, pdf pp. 13-31

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at W.R. Grace and Company from January 1, 1955 through December 31, 1958 (operational period), and January 1, 1959 through October 31, 2009 (residual radiation period) and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 W.R. Grace and Company (Maryland) Plant and Process Descriptions

W.R. Grace and Company (as it is currently named) is located in Curtis Bay, Maryland. The site (currently 109 acres; originally 260 acres) is partially covered with chemical plant facilities in the northwest section and spoils ponds and a disposal area in the northeast section (Remedial Investigation, 2000, pdf p. 3). Atomic Energy Commission (AEC) contract work was carried out in the southwest section of one building, Building 23, within an area measuring 100 feet east/west by 200 feet north/south and five levels in height (60-70 feet) (Trip Report, 1985, pdf p.7). For the period evaluated by NIOSH, the W.R. Grace and Company (Maryland) workforce consisted of 25-30 workers (Personal Communication, 2011b).

In 1909, the Davison Chemical Corporation purchased the Curtis Bay Works location, then known as "Chairs Farm." By the early 1940s, Davison Chemical Corporation was producing several agricultural and industrial chemicals (mainly fertilizers). In 1954, W.R. Grace, a Connecticut corporation, acquired Davison Chemical Corporation. The Curtis Bay Works location became known as the Davison Chemical Division of W.R. Grace and Company (Remedial Investigation, 2000).

Rare Earths, Inc. entered into contract AT (49-6)-993 with the AEC on July 18, 1955, to process 7,900 tons of monazite sands at the Curtis Bay Facility and at the Pompton Plains Facility in Wayne, New Jersey (Remedial Investigation, 2000, pdf p. 4). Rare Earths obtained a license under the Atomic Energy Act of 1954 to possess, transfer, and use the radioactive material thorium, which is defined by

the U. S. Code as a "source material" (Contracts and Amendments, 1950s, pdf p. 2). This license was transferred to W.R. Grace and Company (Maryland) in late 1956 or early 1957. W.R. Grace and Company (the sole shareholder in Rare Earths) became a party to contract AT (49-6)-993 on November 30, 1956, with the dissolution of Rare Earths, Inc. The contract called for W.R. Grace and Company to process the AEC-owned monazite ore at a plant in New Jersey and/or one to be constructed in Curtis Bay, Maryland. Various documents indicate that the Curtis Bay, Maryland plant was completed and placed in operation sometime between May and June 1956 (Johnson, 1958, pdf p. 3, FUSRAP documents, various dates). The Curtis Bay facility did most of the processing of the AEC ore for this contract (Designation Summary, date unknown, pdf p. 2).

Thorium was shipped to the Davison Chemical Division as a component of monazite sand obtained from India and other foreign and domestic sources (e.g., Brazil, Asia, and Idaho). The average thorium content was about 6 percent thorium dioxide. The title to the monazite and the thorium remained with the government during the performance of the contract work. According to the contract terms, at least 95% of the thorium and rare earths in the ore were to be returned to the AEC (Designation Summary, date unknown).

The monazite gangue (i.e., unreacted material) consisted primarily of silica, calcium sulfate, diatomaceous earth, and unreacted monazite including certain thorium and uranium compounds and compounds of their progeny. The gangue was said to not contain more than 5% of the original thorium content. At the direction of the AEC, the gangue was retained by W. R. Grace for non-commercial disposition (Designation Summary, date unknown, pdf p. 2).

Building 23 and the Monazite Sand Thorium-Recovery Process

AEC contract work was carried out in one building, Building 23. The southwest section of Building 23 is the only portion of any site building where monazite sands processing was conducted. The southwest section of Building 23 measures 100 feet east/west by 200 feet north/south and has a height of five levels (60-70 feet). The building is a steel frame structure with 8-feet deep steel roof trusses with corrugated metal siding. An elevator shaft is present which was used for transport of the monazite sands. An enclosed (brick) electrical substation is present at the southwest corner of the building. The ground floor level has concrete slab floor with piping floor chases. Intermediate floor levels are concrete slab and metal decking supported by steel beam frames. Typical equipment includes pumps, tanks, piping, dust hoppers, and a rotary kiln. Some corrosion to steel columns and beams was noted. Access to the roof was available and several exhaust ducts and stacks were present (Trip Report, 1985, pdf p. 7).

Monazite sand was ground through 200 mesh in a Hardinge ball mill and transferred to the reactors, which were jacketed Dopp kettles. There, the ground sand was reacted with concentrated sulfuric acid for approximately four hours. The viscous mass was then dropped into large crystallizer tanks made up of diluted recycled thorium-bearing acid. The crystallizer slurry was pumped into a Dorr rake classifier where a crude separation of rare earth sulfate crystals from the thorium-bearing acid solution was accomplished. The thorium-bearing solution was then filtered on a large Dorr-Oliver rotary drum vacuum pre-coat filter. The thorium-bearing solution was separated from unreacted gangue and further processed by precipitation with concentrated hydrofluoric acid, forming thorium fluoride. The thorium fluoride was reacted with 50% caustic soda, forming sodium fluoride that was washed free of

the insoluble thorium hydrate. The thorium hydrate was twin-drum dried and packaged for shipment to the Curtis Bay Government Storage Depot (Monazite Process, date unknown, pdf p. 12). The aforementioned gangue, made up of various forms of calcium sulfate, calcium silicate, iron sulfate, and unreacted monazite, was retained on the pre-coat (diatomaceous earth) of the filter and uniformly cut off by a doctor blade, collected in Dempster Dumpster-type tubs and removed from the plant by the yard crew truck. The Dempster Dumpsters were emptied into the designated area of the Curtis Bay dump (Monazite Process, date unknown, pdf p. 12). The radioactive gangue was buried at various depths up to about nine feet. Other contaminated materials such as filter cloths and miscellaneous equipment were disposed of in the same manner (Designation Summary, date unknown, pdf p. 2). The landfill-type area covers about four acres. It is a few hundred feet south of the bay and is bordered on the south and west by a Baltimore and Ohio Railroad spur running over the W.R. Grace and Company property. The surrounding areas are industrial, and the nearest residence is about one-half mile away. The facility is still owned by W.R. Grace and Company. The site is fenced and has been patrolled by W.R. Grace guards since 1976 (Designation Summary, date unknown, pdf p. 3).

The facility at Curtis Bay was developmental and the workforce was small. A former W.R. Grace (Maryland) supervisor estimates that there were only 20-30 employees during the 1950-1960 period (Personal Communication, 2011b). It had serious problems in handling the AEC monazite and was never fully completed. It operated for about one year from May 1956 through late spring 1957. As a result of the processing problems and other considerations, AEC and W.R. Grace and Company mutually agreed to terminate the contract, effective January 31, 1958 (FUSRAP documents, various dates). In line with this agreement, effective January 31, 1958, the total quantity of ore required to be processed under the contract was reduced, through Amendment 3, to 997.6l tons, the total amount processed to that date (Designation Summary, date unknown, pdf p. 3).

A review of the contract file and discussions with individuals with peripheral knowledge of Company matters dating back to the late 1950s lead to the conclusion that the failure of the commercial facility and the termination of the AEC contract caused W.R. Grace and Company to dismiss the entire project as concluded. The plant facility was shut down in 1957, the assets were disposed of, and the project abandoned (Shaw, 1978, pdf p. 13). The northwest section of the property contains the plant buildings, including Building 23, whose southwest part was used for thorium processing and is the only potentially radiologically-contaminated building (Trip Report, 1985, pdf p. 3). NIOSH found indications that work with radioactive materials may have continued after the contract was cancelled. The work involved uranium and was done in the 1970s in support of operations of the W.R. Grace site in Erwin, TN. This work is currently outside the Atomic Weapons Employer operations period as defined by DOE.

Radioactive Waste Disposal Area (RWDA)

From May 1956 through late spring 1957, radioactive gangue from processing operations at Curtis Bay was reportedly buried on plant property in a landfill area east of Herring Pond (encompassing the RWDA). Approximately 26,000 cubic yards of residue were buried with other miscellaneous equipment, rare earth double salt, filter cloths, and mechanical scrap. General waste, including rock, refuse (glass, paper, wood, and metal) and dredged soil was also disposed of in this area. Waste is believed to be buried at various depths up to 9 feet, but may be as deep as 25 feet (RWDA Remedial Investigation Vol. 1, 2001).

The RWDA lies in the central, undeveloped portion of the Curtis Bay Facility; however, the exact RWDA boundary is unknown. A radiological surface survey in 1978 identified an area covering approximately 4 acres containing radioactive contamination (Shaw, 1978). At the time of the 1978 survey, the area was not fenced; however, the 1978 report states:

> *Since early May, 1978, the four acre site has been observed by each guard shift without entry on to the site. The site is unoccupied and untraversed, remote, and within the fenced enclosure surrounding the entire plant property, but not separately fenced or marked.*

In 1995, a fence was installed around the area. During fence installation, the fence line was radiologically surveyed by RSO, Inc. (a W.R. Grace subcontractor). RSO personnel were accompanied by the W.R. Grace Radiation Safety Officer to ensure that areas of elevated radioactivity were enclosed by the fence. Based on survey results and site conditions (i.e., heavy vegetation and trees on the east side of Herring Pond), no fencing was placed along the western border of the RWDA (along Herring Pond). Instead, the fence was run down to the Herring Pond water line on the northeast and southeast corners of the pond. The area encompassed by the fence is approximately 7.2 acres (RWDA Remedial Investigation Vol. 1, 2001).

5.2 Radiological Exposure Sources from W.R. Grace & Co. (MD) Operations

The following subsections provide an overview of the internal and external exposure sources for the W.R. Grace and Company class under evaluation.

5.2.1 Internal Radiological Exposure Sources - W.R. Grace & Co. (MD) Operations

W.R. Grace and Company (Maryland), under contract with AEC, processed monazite sands for thorium extraction. Depending on the geographical source, monazite sands contain (by weight) approximately 2.5% to 8% thorium, and about 0.15% to 0.5% uranium (Monazite Process, 1951, pdf p. 4; Monazite, 1949, pdf p. 2). The monazite processes likely resulted in worker internal exposures to uranium, thorium, and their respective decay products. Tables 5-1 and 5-2 list the respective decay products.

The primary internal exposure pathways for workers were likely to include:

- Inhalation and ingestion of dust generated during the processes employed for thorium extraction, particularly during dry-product-handling evolutions
- Inhalation and ingestion of re-suspended particulates from the build-up of contamination in work areas and on equipment
- Ingestion of particulates by workers who ate or drank in areas where a buildup of contamination had occurred (e.g., lunch rooms, locker rooms, etc.)
- Inhalation of radon (Rn-222) and thoron (Rn-220) and the associated progeny

5.2.1.1 Uranium

The principal source of internal exposure to uranium radionuclides at the site was from the inhalation of dust or fumes generated during the refining process. Isotopic components of monazite sand include U-238 and its decay progeny. The decay progeny of U-238 (i.e., Th-230, Ra-226, etc.) in the raw monazite sand would also be expected to have a similar concentration ratio in relation to Th-232 (Feasibility Study, 2003, pdf p. 3). During the refining processes, there was the possibility of airborne dust or fumes that potentially contained uranium.

5.2.1.2 Thorium

Thorium was the only radionuclide refined during the operational period; exposure was primarily during this process. Monazite sands, depending on the geographical source, contain approximately 2.5% to 8 % thorium oxides. By typical methods, thorium extraction processes are capable of collecting greater than 90% of the thorium fraction. This could have resulted in significant amounts of thorium concentrates, resulting in potential internal exposures to personnel who were handling those concentrates at the various stages in the process. However, total amounts cannot be determined from currently available information.

5.2.1.3 Radon/Thoron and Progeny

Thoron (Rn-220) is the second decay product of Th-228, and would be in equilibrium with the parent Th-228 within monazite sands. Similarly, radon (Rn-222) would be in equilibrium with the uranium that might be present with the sands. Potential exposures to radon/radon progeny and thoron/thoron progeny could have occurred in the areas that handled and/or processed the monazite sand during the operational period.

5.2.2 External Radiological Exposure Sources - W.R. Grace & Co. (MD) Operations

The principal source of external exposure during the operational period was the direct exposure to uranium, thorium, and their progeny present in the monazite sands during milling and extraction operations.

5.2.2.1 Photon

Thorium has a significant number of higher-energy photons in the Th-232 decay chain. Based on the half-lives of the progeny, only a partial equilibrium is possible; therefore, it is conservative to state that equilibrium would be reached in this decay chain. It has been assumed that Ra-228 and Th-228 progeny were in equilibrium with Th-232. Therefore, air concentrations were assumed equal for all progeny. Under this assumption, the progeny are the major source of both penetrating and non-penetrating external exposure.

Table 5-1 shows the primary isotopes and photon energies associated with thorium and its progeny.

Table 5-1: Principal Radiation Emissions from Th-232 and its Short-Lived Decay Products

Radionuclide	Half-life	Beta Energy (MeV Max)	Photon (x or γ) Energy (MeV)
Th-232	1.405 x 10^{10} years	None	0.059 (0.19%)
			0.126 (0.04%)
Ra-228	5.71 years	0.389 (100%)	0.0067 (6 x 10^{-5}%)
Ac-228	6.25 hours	0.983 (7%)	0.338 (11.4%)
		1.014 (6.6%)	0.911 (27.7%)
		1.115 (3.4%)	0.969 (16.6%)
		1.17 (32%)	1.588 (3.5%)
		1.74 (12%)	---
		2.08 (8%)	---
		(+33 more βs)	---
Th-228	1.9116 years	None	0.084 (1.19%)
			0.132 (0.11%)
			0.166 0.08%)
			0.216 (0.27%)
Bi-212	60.55 minutes	1.59 (8%)	0.040 (1%)
		2.246 (48.4%)	0.727 (11.8$)
		---	1.620 (2.75%)
Tl-208	3.1 minutes	1.28 (25%)	0.277 (6%)
		1.52 (21%)	0.5108 (21.6%)
		1.80(50%)	0.583 (85.8%)
		---	0.860 (12%)
		---	2.614 (100%)

Source: *Handbook of Health Physics and Radiological Health* (Rad Handbook, 1998). Intensities refer to the percentage of disintegrations of the nuclide itself, not to original parent of series. Gamma percents are given in terms of observable emissions, not transitions.

Table 5-2 shows the primary isotopes and photon energies associated with uranium.

Table 5-2: Principal Radiation Emissions from Natural Uranium and Its Short-lived Decay Products

Radionuclide	Half-life	Beta Energy (MeV Max)	Photon (x or γ) Energy (MeV)
U-238	4.468 x 10^9 years	None	x: 0.013 (8.8%)
Th-234	24.1 days	0.096 (25%)	x: 0.013 (9.6%)
		0.189 (73%)	γ: 0.063 (3.8%)
			γ: 0.093 (5.4%)
Pa-234m	1.17 minutes	2.28 (98.6%)	γ: 0.765 (0.2%)
		~1.4 (1.4%)	γ: 01.001 (0.6%)
U-235	7.038 x 10^9 years	None	x: 0.013 (31%)
			x: 0.090-0.105 (9.3%)
			γ: 0.144 (10.5%)
			γ: 0.163 (4.7%)
			γ: 0.186 (54%)
			γ: 0.205 (4.7%)
Th-231	25.5 hours	0.206 (15%)	x: 0.013 (71%)
		0.288 (49%)	γ: 0.026 (14.7%)
		0.305 (35%)	γ: 0.084 (6.4%)
U-234	244,500 years	None	x: 0.013 (10.5%)
			γ: 0.053 (0.2%)

Source: *Handbook of Health Physics and Radiological Health* (Rad Handbook, 1998). Intensities refer to the percentage of disintegrations of the nuclide itself, not to original parent of series. Gamma percents are given in terms of observable emissions, not transitions.

5.2.2.2 Beta

Tables 5-1 and 5-2 show the principal beta emitters and their energies for the thorium and uranium present in monazite sands. As indicated in these tables, there are a significant number of high-energy beta radiations that represent a shallow dose exposure concern for site workers. Workers who handled monazite and the refined thorium could have received shallow dose exposures. The primary exposure areas would have been the hands and forearms, the neck and face, and other areas of the body that might not have been covered.

5.2.2.3 Neutron

Neutrons were not measured at W.R. Grace (Maryland) and were not expected to be an exposure source for the class under evaluation. However, neutrons could arise from the α-n reaction with light elements, interactions with the oxides, and through spontaneous fission. According to Battelle-TBD-6000, uranium oxides would be the most common generators of (α,n) reactions. Spontaneous fission yields and (α,n) yields in oxides are provided in Table 3.5 of Battelle-TBD-6000. Based on its analysis, NIOSH concludes that none of these sources would be sufficient to result in a significant neutron exposure and, therefore, are not further assessed in this evaluation.

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

The following subsections provide an overview of the state of the available internal and external monitoring data for the W.R. Grace and Company (Maryland) class under evaluation.

6.1 Available W.R. Grace and Company (Maryland) Internal Monitoring Data

Internal monitoring data are not available for workers at W.R. Grace and Company (Maryland). Process radiological monitoring data and source term data are also not available for the operational period from January 1, 1955 through December 31, 1958.

For the residual period, site characterization data from the Curtis Bay site are available starting in 1986, collected under the Formerly Utilized Sites Remedial Action Program (FUSRAP). In addition, air monitoring data are available for monazite ore-processing operations at the Rare Earths / W.R. Grace monazite-processing facility located in Wayne, New Jersey. These datasets are summarized below.

6.1.1 Bldg. 23 - Site Characterization Data from W.R. Grace, Curtis Bay - 1986

The W.R. Grace site at Curtis Bay was slated for further investigation as a result of a 1979 aerial survey conducted by the Department of Energy (Aerial Survey, 1979). The subsequent characterization survey was performed in October and December of 1986 by the Health and Safety Research Division (HASRD) of the Oak Ridge National Laboratory (ORNL) under the FUSRAP program (Cottrell, 1989). A summary of surface contamination (both direct and removable), airborne radioactivity, and dust sample measurements found in Building 23 are contained in Tables 6-1, 6-2, 6-3, and 6-4 below.

Table 6-1: Summary of Direct and Removable Alpha Surface Contamination Data – Curtis Bay
(collected in Building 23 by ORNL HASRD in Oct. and Dec. 1986)

Location	Count	Total Surface Activity (gross alpha, dpm/100 cm^2)			Removable Surface Activity (gross alpha, dpm/100 cm^2)		
		Min	Max	Average	Min	Max	Average
1st floor	4	7	120	49.75	ND	ND	ND
2nd floor	2	140	840	490	3	3	3
3rd floor	2	42	690	366	7	7	7
4th floor	12	39	7800 (200,000)[a]	842[a]	10	10	10
5th floor	9	30	39,000	11,739	3	10	6.8

Source: Cottrell, 1989

[a] A measurement of 200,000 dpm/100 cm^2 was collected inside ductwork and was not included in the calculated average. The next highest value was 7800 dpm/100 cm^2.

Table 6-2: Summary of Rn-220 and Rn-222 Air Activity Data – Curtis Bay
(collected in Building 23 by ORNL HASRD in Oct. and Dec. 1986)

Location	Count	Rn220 (pCi/L)			Rn222 (WL)		
		Min	Max	Average	Min	Max	Average
1st floor	2	0.01	0.03	0.02	<0.001	<0.001	<0.001
2nd floor	3	0.03	0.05	0.04	<0.001	<0.001	<0.001
3rd floor	6	0.06	1.6	0.75	<0.001	<0.001	<0.001
4th floor	3	0.04	0.2	0.1	<0.001	<0.001	<0.001
5th floor	6	0.02	12	3.668	<0.001	<0.001	<0.001

Source: Cottrell, 1989

Table 6-3: Summary of Th-232 Air Activity Data – Curtis Bay
(collected in Building 23 by ORNL HASRD in Oct. and Dec. 1986)

Location	Count	Th-232 (mCi/ml)		
		Min	Max	Average
4th floor	2	5.00E-14	1.1E-13	8.00E-14
5th floor	2	1E-13	1E-13	1E-13

Source: Cottrell, 1989

Table 6-4: Summary of Th-232 and U-238 Concentration Data in Building Dust – Curtis Bay
(collected in Building 23 by ORNL HASRD in Oct. and Dec. 1986)

Location	Count	Th-232 (pCi/g)			U-238 (pCi/g)			% Th-232
		Min	Max	Average	Min	Max	Average	
1st floor	1	5.4	5.4	5.4	2	2	2	73%
4th floor	4	1.8	26	9.9	0.64	2	0.89	92%
5th floor	3	1.2	11	6.5	0.41	1.8	1.27	84%

Source: Cottrell, 1989

FUSRAP Data for W.R. Grace and Company in Curtis Bay, MD - 2000-2001

A second set of characterization data was collected during a site remedial investigation conducted by the U.S. Army Corps of Engineers under FUSRAP from June 2000 through May 2001 (Army Corps, 2002). This investigation included more than 1.9 million measurements using a surface contamination monitor (SCM) system, 2520 beta/gamma exposure measurements, 44 in situ gamma spectroscopy measurements, 84 supplemental alpha/beta measurements, and 543 surface wipes. A total of 24 cores were collected in Building 23, 19 of which were collected from the floor slabs and five on the asphalt roof. For the purpose of the survey, the building was broken into 11 Areas of Concern (AOC). Table 6-5 provides a summary of the surface contamination data reported for AOCs 1-9. Surface contamination measurements were not performed in AOC 10 and 11.

Table 6-5: FUSRAP Area of Concern (AOC) Designations – Curtis Bay
(collected in Building 23 by U.S. Army Corps of Engineers during June 2000 through May 2001)

AOC	Floor	Survey Type	Total Area Surveyed (m^2)	Maximum Activity (total) (dpm/100 cm^2)
1	1	Floors	3.2	5795
2	1	Lower Walls	14.3	3269
3	1	Lower Walls	16.1	4975
4	2	Floors	44.4	3339
5	3	Floors	1.1	865
6	3	Floors	59.6	2914
		Lower Walls	9.3	2559
		Upper Walls	5.4	1956
		Ceilings	1.3	26843
7	3	Floors	8.6	6184
		Lower Walls	19.3	2979
		Upper Walls	3.6	3320
8	4	Floors	343	13571
		Lower Walls	6.5	11311
		Ceilings	1.6	16547
		Columns	4.9	3115
9	5	Floors	290.7	52114
		Lower Walls	13.3	1618
		Ceilings	33.7	11496
		Columns	2.9	1464

Source: Army Corps, 2002

6.1.2 Air Monitoring Data from W.R. Grace / Rare Earths in Wayne, NJ

Air monitoring data are available for the W.R. Grace site in Wayne, New Jersey (formerly owned by Rare Earths, Inc.) during the period in which monazite ore was processed there. Two measurements were collected during an AEC inspection in 1959 at the location of the feeder hopper and the ball mill. Results indicated a general area air concentration of 1×10^{-10} μCi/ml and 1.89×10^{-11} μCi/ml, respectively (Inspection, 1961, pdf p. 368). Additional air monitoring data were collected by W.R. Grace in 1961 (Survey, 1961) and are summarized in Table 6-6 below.

Table 6-6: Air Monitoring Data - W.R. Grace, Wayne NJ Facility
(collected by W.R. Grace in 1961)

Location	Result (alpha/100 ft^3 of air) μCi/ml
Shipping Room	3.7×10^{-12}
Pulverizing Room	1.8×10^{-12}
Calcining Furnace	1.6×10^{-12}
Thorium Refining	4.1×10^{-12}
Thorium Crystallizer	1.3×10^{-11}
Process Storage	5.4×10^{-12}
Ball Mill	2.9×10^{-11}
Monazite Storage	1.0×10^{-11}
Lunch Room	1.1×10^{-12}
Kettle Area	2.7×10^{-12}
Control Lab	2.3×10^{-12}

Source: Survey, 1961, pdf p. 378

6.1.3 Radioactive Waste Disposal Area (RWDA) Site Characterization

Soil Sample Data

Limited radiological characterization of the on-site RWDA was conducted starting in 1978; however, results were reported only for Th-232 (Shaw, 1978).

The most extensive site survey, conducted in 1999, was performed as part of the CERCLA Remedial Investigation (Building 23 Remedial Investigation, 2002). A total of 115 soil samples and 38 groundwater samples (including total and dissolved aliquots) were collected for laboratory analysis. The samples were submitted to the laboratory for analysis of Target Compound List (TCL) VOCs, semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), Target Analyte List (TAL) inorganic compounds (metals and cyanide), grain size, rare earth metals, and radiological parameters.

Table 6-7 provides a summary of the average measured concentrations as well as the associated 95% confidence level.

Table 6-7: Soil Concentration Within RWDA		
Radionuclide	**Concentration (pCi/g)**	
	Average	**Avg. at 95% Confidence Level**
Ra-226	10.07	18.63
Ra-228	18.91	34.81
Th-228	7.28	11.73
Th-230	3.13	4.37
Th-232	6.19	10.19
U-233/234	2.74	3.52
U-238	2.66	3.4

Source: RWDA Remedial Investigation Vol. 1, 2001, Table 6-3

Sample analysis included gamma spectroscopy, alpha spectroscopy (isotopic uranium and thorium) as well as Ra-226 and Ra-228 analysis. Results of isotopic analysis for Th-228 and Th-232 are shown in Table 6-8 (only the most elevated samples are shown).

Table 6-8: Th-228 and Th-232 Isotopic Analysis Results		
Sample Location	**Radionuclide Conc. (pCi/g)**	
	Th-228	**Th-232**
B75-SO-SPLIT	5.78	6.52
BO03-SO-02	3.31	3.51
B07-SO-02	17	19.8
B08-SO-02	34.3	47.8
B18-SO-02	7.54	8.64
B24-SO-02	5.45	6.41
B30-SO-02	71.3	73.9
B32-SO-02	26.7	31.9
B36-SO-02	2.37	2.73
B70-SO-04	1.55	1.93
SO-DUP-02	30.1	34
B18-SO-02	5.96	7.56

Source: RWDA Remedial Investigation Vol. 1, 2001, Table 5-5

Air Monitoring Data

Air samples were collected during the performance of site characterization efforts. The results of these samples (based on gross alpha and beta analysis) are summarized in Table 6-9.

Table 6-9: Air Monitoring Data Collected During RWDA Sampling/Site Investigation

Location	Gross Alpha (µCi/ml)[a]			Gross Beta (µCi/ml)		
	Low	High	Average	Low	High	Average
RWDA-Cont. Reduction Zone	1.22E-15	3.63E-15	1.97E-15	1.73E-14	3.74E-14	2.83E-14
EA Trailer	1.76E-15	2.90E-15	2.22E-15	2.50E-14	4.90E-14	3.84E-14
Analytical Lab Room	1.66E-15	2.90E-15	2.18E-15	2.38E-14	4.95E-14	3.61E-14

[a] Statistics shown are for 13 weekly samples collected between July 27, 1999 and October 27, 1999.
Source: RWDA Remedial Investigation Vol. 2, 2001, Appendix D, pdf p. 256

6.2 Available W.R. Grace and Company (Maryland) External Monitoring Data

6.2.1 W.R. Grace, Curtis Bay MD – Building 23

NIOSH has found no external personnel monitoring results (including medical X-ray records) for the W.R. Grace (Maryland) operational period under evaluation (January 1, 1955 through December 31, 1958).

For the residual radiation period under evaluation, site characterization data from the Curtis Bay site (collected under the FUSRAP program) are available starting in 1986 and are summarized in Table 6-10.

Table 6-10: Average Gamma Dose Rates in Work Areas in Building 23
(collected by ORNL HASRD in Oct. and Dec. 1986)

Location	Average Gamma Exposure Rate (µR/hr)	Maximum Gamma Exposure Rate at 1 m / contact (µR/hr)	Maximum Beta/Gamma Dose Rate (mrad/hr)
1st floor	50	54 / 160	0.04
2nd floor	25	27 /81 (120 inside tank)	0.06
3rd floor	29	54 / 110	0.06
4th floor	40	680 / 490 (2200 on overhead duct)	15 (on duct)
5th floor	120	270 / 570 (1600 on duct)	4.7

Source: Cottrell, 1989

6.2.2 W.R. Grace Pompton Plains Facility (Wayne NJ)

Survey data are available for the W.R. Grace, Wayne NJ facility whose operation predated those at the Curtis Bay, MD site. The Wayne facility was involved in thorium extraction operations similar to those at Curtis Bay and operated under the same AEC license as the Curtis Bay facility. Dose rates measured during a 1961 AEC inspection at the Wayne facility are shown in Table 6-11.

Table 6-11: External Dose Survey of Wayne, NJ Facility

Location	Comments
Restricted Area – Thorium Vault	Maximum level: 10 mR/hr Average level: 3-4 mR/hr
Ball Mill Area	General radiation level: 2 mR/hr In contact with drum of yttrium sludge: 7.5 mR/hr At 1 ft. from the drum: 4 mR/hr In contact with drum containing ground monazite: 10 mR/hr At 1 ft. from this drum: 5 mR/hr
Monazite Storage Area	General radiation level: 5 mR/hr At 1 ft. from a bag containing monazite: 12 mR/hr
Locker Room Area	At 3 ft. above floor: 0.04 mR/hr

Source: Inspection, 1961, pdf p. 368

6.2.3 Lindsay Light and Chemical Co., West Chicago, IL

The Lindsay Light and Chemical Co. in West Chicago, IL, processed thorium ores starting in 1931, originally to extract thorium for gas mantles. Lindsay operations related to the processing of monazite ores and also involved the extraction of rare earth elements from these same ores. An extensive assessment of radiological conditions at the facility was conducted in 1953 by the Industrial Hygiene Branch of the AEC (Lindsay Light, 1953). This assessment included extensive external dose measurements within the facility as summarized in Table 6-12.

Table 6-12: Summary of Radiation Measurements at Lindsay Light

Material / Location	Contact Exposure Rate (mR/hr)			
	No. of Measurements	Minimum	Maximum	Average
Inside Plant	127	0.02	43	3.7
Cerox Oxalate	2	0.2	0.2	0.2
Gray Mud	1	20	20	20
Monazite Bags	2	10	10	10
R.E. Carbonate	2	0.7	0.7	0.7
R.E. Flouride	2	0.08	0.08	0.08
R.E. Hydrate	2	0.7	0.7	0.7
Re_2O_3	1	0.5	0.5	0.5
$ThNO_3$	6	15	15	15
ThO_2	2	7	7	7

Source: Lindsay Light, 1953, Table VII, pdf pp. 22-26
Readings reported as “off scale” not included in this summary.

6.2.4 Radioactive Waste Disposal Area (RWDA) Site Characterization

The on-site RWDA was surveyed in 1978 by the Radiation Management Company. The survey consisted of external radiation measurements and surface and subsurface soil samples. External radiation levels were measured; results ranged from background to 17 mR/hr (Shaw 1978).

An external radiation survey was conducted by ORNL in April and October, 1979. External radiation levels up to 50 µR/hr were measured three feet from the ground surface in the area outside the RWDA. External radiation levels inside the RWDA were reported to range upwards of 3 mR/hr (RWDA Remedial Investigation Vol. 1, 2001).

During the characterization survey, a total of 46,407 data readings were collected for each of the survey instruments. The summary statistics resulting from the consolidated radiation survey data are listed in Table 6.13.

Table 6-13: Radiation Measurements Collected in the RWDA			
Minimum (μR/hr)	**Maximum (μR/hr)**	**Mean (μR/hr)**	**Std. Dev**
3.1	2292	48.3	104.9

Source: RWDA Remedial Investigation Vol. 2, 2001, Appendix I, pdf p. 707

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determinations for the class of employees under evaluation in this report are 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 ensure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.5. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00182 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of W.R. Grace and Company (Maryland) Data

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

As described in Section 6.0, NIOSH was unable to locate any data directly from W.R. Grace and Company. Air sample data from a very similar process occurring at the W.R. Grace facility in Wayne, NJ are available and have been used in this evaluation. The data were evaluated against OCAS-IG-004, "The Use of Data from Other Facilities in the Completion of Dose Reconstructions under the Energy Employees Occupational Illness Compensation Program Act" (OCAS-IG-004).

The work performed at W.R. Grace and Company was very similar to the work performed at the W.R. Grace facility in New Jersey and the two facilities shared a single AEC contract and received the same materials from the AEC to process. The data have been determined to be appropriate for the purposes of bounding W.R. Grace and Company internal radiation exposures for the beginning of the residual period. Similarly the data pedigree (i.e., the background, history, origin, etc.) of the surrogate data sources used for this evaluation have been determined to be adequate to support the use of the methodology outlined in ORAUT-OTIB-0070 for the residual period.

7.1.1 Internal Monitoring Data Pedigree Review

Operational Period

NIOSH did not locate any internal monitoring data for the operational period under evaluation (January 1, 1955 through December 31, 1958). Therefore, a data sufficiency and pedigree evaluation is not possible for this data type for this period.

Residual Period

NIOSH has determined that it has sufficient internal data of high pedigree for the residual radioactivity period. Radiological survey data collected by AEC representatives and the plant health physicist are available from the operational period at facilities with operations similar to Curtis Bay. In addition, data collected under the FUSRAP program are available, which include isotopic analysis results for sampling and surveys performed during the residual period. The data sources are copies of original reports and are, therefore, primary data sources. The data collection by AEC representatives would have been performed in accordance with standard practices using state-of-the-art methods of the day; furthermore, the FUSRAP program has a rigorous Quality Assurance program governing its methodologies.

7.1.2 External Monitoring Data Pedigree Review

Operational Period

NIOSH did not locate any external monitoring data for the operational period under evaluation (January 1, 1955 through December 31, 1958). Therefore, a data sufficiency and pedigree evaluation is not possible for this data type for this period.

Residual Period

NIOSH has determined that it has sufficient external data of high pedigree for the residual radioactivity period. Radiological survey data collected by AEC representatives are available for the period preceding the end of the operational period. In addition, data collected under the FUSRAP program are available, which include isotopic analysis results for sampling and surveys performed during the residual period. The data sources are copies of original reports and are, therefore, primary data sources. The data collected by AEC representatives would have been performed in accordance with standard practices using state-of-the-art methods of the day; furthermore, the FUSRAP program has a rigorous Quality Assurance program governing its methodologies.

7.2 Evaluation of Bounding Internal Radiation Doses at W.R. Grace (MD)

The principal source of internal radiation doses for members of the class under evaluation was inhalation and ingestion of uranium- and thorium-laden dust generated during the processes employed for thorium extraction, particularly during dry product-handling evolutions.

7.2.1 Evaluation of Bounding Process-Related Internal Doses

Internal monitoring data, work area radiological monitoring data, and source term data are not available to support the assessment of internal dose at the W.R. Grace (Maryland) site. NIOSH has determined there were no potential internal radiological exposures at the Curtis Bay site before construction completion on May 1, 1956. NIOSH has also determined that AEC-related operations had ceased by the end of January 1958; work performed after this date is included in the residual radiation period assessment. Therefore, NIOSH finds that internal doses to personnel during the operational period from May 1, 1956 through January 31, 1958 cannot be bounded, and therefore, accurately reconstructed.

7.2.2 Evaluation of Bounding Residual Period Internal Doses

During the effective residual period workers were potentially exposed to re-suspended surface contamination. Bounding residual period air concentrations can be based on measurements of air concentrations at similar facilities and knowledge of surface contamination levels within Building 23 at Curtis Bay during the post-operations period. Internal exposure during work in the RWDA can be bounded using soil concentration data collected during site remedial investigation activities along with an estimate of the particulate concentration in the air. NIOSH has determined that this information can be used to bound internal dose during the effective residual period, which includes (1) the post-operational, technical residual period from February 1, 1958 through December 31, 1958; and (2) the original DOE-defined residual period from January 1, 1959 through October 31, 2009.

7.2.3 Methods for Bounding Internal Dose at W.R. Grace and Company (Maryland)

7.2.3.1 Methods for Bounding Operational Period Internal Dose

Internal monitoring data, work area radiological monitoring data, and source term data are not available. Therefore, NIOSH finds that internal doses to personnel during the operational period from May 1, 1956 through January 31, 1958 cannot be bounded, and therefore, accurately reconstructed.

7.2.3.2 Methods for Bounding Residual Period Internal Dose

Building 23

Internal exposure during the residual period can be bounded using the methodology in ORAUT-OTIB-0070. In this methodology, air concentrations at the beginning and end of a time period are used with an assumption of an exponential relationship to calculate exposure rates for intervening time periods.

The general area air sample results reported at the W.R. Grace, Wayne NJ facility (Table 6-6) during air monitoring studies conducted in 1961 were used as an estimate of the air concentration at the start of the residual period. In order to do this, the data in Table 6-6 were fit to a lognormal distribution and the geometric mean and standard deviation were calculated. The resultant distribution had a geometric mean of 4.14×10^{-12} μCi/ml with a GSD of 2.70. This air concentration (4.14×10^{-12} μCi/ml), which corresponds to an intake rate of 27 pCi/calendar day, would represent an upper bound of the level of airborne contamination present at the cessation of operations, which corresponds to the beginning of the residual period.

Surface concentration values calculated for the Curtis Bay facility (Table 6-5) can be used to establish a bounding estimate of the air activity at the time of these measurements (i.e., 2000). The weighted average of the maximum reported floor surface activity of 27,000 dpm/100cm^{2,} can be used to represent the bounding surface contamination present within the facility for the purpose of performing these re-suspension calculations. Using a re-suspension factor of 1×10^{-6}, a predicted air concentration of 1.2×10^{-12} μCi/ml is equivalent to an intake rate of 8 pCi/calendar day, which would correspond to the 27,000 dpm/100 cm^2 surface contamination level. The 1×10^{-6} re-suspension factor is bounding given the fact that (1) the measured surface contamination levels represent total activity and the amount of removable contamination is a very small fraction of that value; and (2) the predicted air concentration (1.2×10^{-12} μCi/ml) is greater than the maximum measured air concentration measured during the 1986 survey (see Table 6-3).

The intake rates indicated above were used to calculate an exponential rate constant relating the two values, separated by a time period of 42 years (1958 to 2000). The decay constant is calculated as 0.029 yr^{-1} and is used to adjust the intake rates in Table 7-1 to account for the reduction in the intake rate over time.

Consideration of exposure to uranium, which is also present in monazite sands, could be included based on the relative fraction of thorium within the process material. Based on data collected during the remedial investigation (Table 6-4), the average Th-232 component is 83% of the total gross activity (based on Th-232 and U-238). This activity fraction (0.83) is used to calculate the thorium

intakes shown in Table 7-1. Internal exposure from ingestion would be bounded based on the calculated inhalation intake using the methodology in OCAS-TIB-009.

Internal exposure to radon (Rn-222) and thoron (Rn-220) can be bounded using data collected during the 1986 building survey. The average thoron concentration (based on the 20 samples collected) was 1.15 pCi/l and the radon concentration was consistently < 0.001 WL. Exposure to thoron and radon can be bounded using air concentrations of 1.15 pCi/L and 0.001 WL, respectively, as the basis for the 1986 intake, and by applying the depletion relationship detailed above to determine intakes in prior years. Since these values are based on average concentrations, they may be assigned as the median value of a lognormal distribution with a GSD of 5.

Table 7-1: Residual Period Inhalation and Ingestion Intakes – Bldg. 23
(This table spans two pages)

Year	Uranium (pCi/calendar day)		Thorium (pCi/calendar day)		Thoron (pCi/L)	Radon (WL)
	Inhalation	Ingestion	Inhalation	Ingestion		
1958	4.6E+00	9.6E-02	2.3E+01	4.7E-01	2.6E+00	2.3E-03
1959	4.5E+00	9.4E-02	2.2E+01	4.6E-01	2.5E+00	2.2E-03
1960	4.4E+00	9.1E-02	2.1E+01	4.4E-01	2.5E+00	2.1E-03
1961	4.2E+00	8.8E-02	2.1E+01	4.3E-01	2.4E+00	2.1E-03
1962	4.1E+00	8.6E-02	2.0E+01	4.2E-01	2.3E+00	2.0E-03
1963	4.0E+00	8.3E-02	2.0E+01	4.1E-01	2.3E+00	2.0E-03
1964	3.9E+00	8.1E-02	1.9E+01	3.9E-01	2.2E+00	1.9E-03
1965	3.8E+00	7.9E-02	1.8E+01	3.8E-01	2.1E+00	1.8E-03
1966	3.7E+00	7.6E-02	1.8E+01	3.7E-01	2.1E+00	1.8E-03
1967	3.6E+00	7.4E-02	1.7E+01	3.6E-01	2.0E+00	1.7E-03
1968	3.5E+00	7.2E-02	1.7E+01	3.5E-01	1.9E+00	1.7E-03
1969	3.4E+00	7.0E-02	1.6E+01	3.4E-01	1.9E+00	1.6E-03
1970	3.3E+00	6.8E-02	1.6E+01	3.3E-01	1.8E+00	1.6E-03
1971	3.2E+00	6.6E-02	1.5E+01	3.2E-01	1.8E+00	1.6E-03
1972	3.1E+00	6.4E-02	1.5E+01	3.1E-01	1.7E+00	1.5E-03
1973	3.0E+00	6.2E-02	1.5E+01	3.0E-01	1.7E+00	1.5E-03
1974	2.9E+00	6.0E-02	1.4E+01	2.9E-01	1.6E+00	1.4E-03
1975	2.8E+00	5.9E-02	1.4E+01	2.9E-01	1.6E+00	1.4E-03
1976	2.7E+00	5.7E-02	1.3E+01	2.8E-01	1.5E+00	1.3E-03
1977	2.7E+00	5.5E-02	1.3E+01	2.7E-01	1.5E+00	1.3E-03
1978	2.6E+00	5.4E-02	1.3E+01	2.6E-01	1.5E+00	1.3E-03
1979	2.5E+00	5.2E-02	1.2E+01	2.5E-01	1.4E+00	1.2E-03
1980	2.4E+00	5.1E-02	1.2E+01	2.5E-01	1.4E+00	1.2E-03
1981	2.4E+00	4.9E-02	1.2E+01	2.4E-01	1.3E+00	1.2E-03
1982	2.3E+00	4.8E-02	1.1E+01	2.3E-01	1.3E+00	1.1E-03
1983	2.2E+00	4.6E-02	1.1E+01	2.3E-01	1.3E+00	1.1E-03
1984	2.2E+00	4.5E-02	1.1E+01	2.2E-01	1.2E+00	1.1E-03
1985	2.1E+00	4.4E-02	1.0E+01	2.1E-01	1.2E+00	1.0E-03
1986	2.1E+00	4.4E-02	1.0E+01	2.1E-01	1.2E+00	1.0E-03
1987	2.0E+00	4.3E-02	1.0E+01	2.1E-01	1.2E+00	1.0E-03
1988	2.0E+00	4.1E-02	9.7E+00	2.0E-01	1.2E+00	1.0E-03
1989	1.9E+00	4.0E-02	9.4E+00	2.0E-01	1.2E+00	1.0E-03
1990	1.9E+00	3.9E-02	9.1E+00	1.9E-01	1.2E+00	1.0E-03
1991	1.8E+00	3.8E-02	8.9E+00	1.8E-01	1.2E+00	1.0E-03
1992	1.8E+00	3.7E-02	8.6E+00	1.8E-01	1.2E+00	1.0E-03

Table 7-1: Residual Period Inhalation and Ingestion Intakes – Bldg. 23 (This table spans two pages)						
Year	Uranium (pCi/calendar day)		Thorium (pCi/calendar day)		Thoron (pCi/L)	Radon (WL)
	Inhalation	Ingestion	Inhalation	Ingestion		
1993	1.7E+00	3.6E-02	8.4E+00	1.7E-01	1.2E+00	1.0E-03
1994	1.7E+00	3.5E-02	8.1E+00	1.7E-01	1.2E+00	1.0E-03
1995	1.6E+00	3.4E-02	7.9E+00	1.6E-01	1.2E+00	1.0E-03
1996	1.6E+00	3.3E-02	7.7E+00	1.6E-01	1.2E+00	1.0E-03
1997	1.5E+00	3.2E-02	7.4E+00	1.5E-01	1.2E+00	1.0E-03
1998	1.5E+00	3.1E-02	7.2E+00	1.5E-01	1.2E+00	1.0E-03
1999	1.4E+00	3.0E-02	7.0E+00	1.5E-01	1.2E+00	1.0E-03
2000	1.4E+00	2.9E-02	6.8E+00	1.4E-01	1.2E+00	1.0E-03
2001	1.4E+00	2.8E-02	6.6E+00	1.4E-01	1.2E+00	1.0E-03
2002	1.3E+00	2.7E-02	6.4E+00	1.3E-01	1.2E+00	1.0E-03
2003	1.3E+00	2.7E-02	6.2E+00	1.3E-01	1.2E+00	1.0E-03
2004	1.2E+00	2.6E-02	6.1E+00	1.3E-01	1.2E+00	1.0E-03
2005	1.2E+00	2.5E-02	5.9E+00	1.2E-01	1.2E+00	1.0E-03
2006	1.2E+00	2.4E-02	5.7E+00	1.2E-01	1.2E+00	1.0E-03
2007	1.1E+00	2.4E-02	5.6E+00	1.2E-01	1.2E+00	1.0E-03
2008	1.1E+00	2.3E-02	5.4E+00	1.1E-01	1.2E+00	1.0E-03
2009	1.1E+00	2.2E-02	5.2E+00	1.1E-01	1.2E+00	1.0E-03

[a] Uranium intake should be assigned as 100% U-234.
[b] Thorium intake should be assigned at indicated rate to each of Th-232, Th-228, and Ra-228.
Note: Values should be input as a constant distribution because they are based on 95th percentile values.

Radioactive Waste Disposal Area (RWDA)

A bounding estimate for potential internal exposure within the on-site RWDA during the residual period was developed using the dust-loading methodology described in ORAUT-OTIB-0070, Section 2.1.3. In this methodology, an ambient air dust loading of 100 $\mu g/m^3$ is used along with soil concentration data to determine the potential air concentrations during the residual period. Inhalation intake rates were developed using the 95 percent confidence internal soil concentration data reported in the remedial investigation report (see Table 6-7); the calculation results are shown below in Table 7-2. Intakes due to ingestion may be determined by multiplying by the factor 0.021 (based on the methodology contained in OCAS-TIB-009).

Table 7-2: Inhalation Intake Rates Based on Source Concentration Data	
Radionuclide	Inhalation Intake (pCi/calendar day)
Ra-226	1.2E-02
Ra-228	2.3E-02
Th-228	7.7E-03
Th-230	2.9E-03
Th-232	6.7E-03
Uranium	4.6E-03

Because the disposal area was dormant during the duration of the residual period and the contamination present was due to bulk material (i.e., not surface-deposited), no decrease in the source term inventory was applied. However, because the disposed material was concentrated in Ra-228, and owing to the parent-daughter relationship between Ra-228 and Th-228, it is necessary to make an adjustment to account for the likely presence of a larger concentration of these nuclides at the time of disposal. The general relationship between the parent-daughter concentrations is shown in the following equation:

$$N_2 = \frac{\lambda_1}{\lambda_2 - \lambda_1} N_1^0 \left(e^{-\lambda_1 t} - e^{-\lambda_2 t} \right) + N_2^0 e^{-\lambda_2 t}$$

Where:

- N_1^0 = the number of parent atoms at time t = 0
- N_1 = the number of parent atoms at time t
- N_2 = the number of daughter atoms at time t
- λ_1 = decay constant for the parent nuclide – determined by dividing the natural log of two by the half-life of the isotope
- λ_2 = decay constant for the daughter nuclide - determined by dividing the natural log of two by the half-life of the isotope
- e = Euler's number (a constant) generally approximated to be 2.71828…) [unitless]
- t = time

The above parent-daughter relationship was employed along with the assumption that the excess Th-228 present at the time of the 1999 remedial investigation (i.e., the Th-232 concentration minus the Th-228 concentration) was due entirely to Ra-228 that was present 41 years earlier. This equation was first solved to determine the Ra-228 concentration present in 1958 that would yield a unit activity of Th-228. The calculated Ra-228 concentration was then used to calculate the Th-228 in-growth over time. These relationships were then used to adjust the Th-228 and Ra-228 inhalation intake quantities shown above in Table 7-2. The results of this assessment, shown below in Table 7-3, could be used to bound internal exposure during the residual period. As previously noted, ingestion intakes can be determined by applying a multiplier of 0.21 to the inhalation intake quantity. Note that because RWDA access was restricted starting in 1978, intakes are calculated for the period 1958 to 1978 only. Internal exposure is assumed to be zero after this time due to the restricted access.

However, for most workers at the W.R. Grace and Company facility it will be difficult to determine the exact work location and in such cases, inhalation intakes presented in Table 7-1 should be assigned, since the residual doses from process operations would be bounding.

Table 7-3: Residual Period Inhalation Intakes (RWDA)						
Year	Inhalation Intake (pCi/calendar day)					
	Ra-228	Th-228	Th-230	Th-232	Ra-226	Uranium
1958	1.1E-01	2.3E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1959	1.0E-01	4.6E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1960	9.5E-02	6.0E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1961	8.7E-02	6.7E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1962	8.0E-02	7.0E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1963	7.3E-02	7.0E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1964	6.7E-02	6.8E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1965	6.2E-02	6.6E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1966	5.8E-02	6.3E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1967	5.4E-02	5.9E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1968	5.1E-02	5.6E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1969	4.7E-02	5.3E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1970	4.5E-02	5.0E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1971	4.2E-02	4.7E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1972	4.0E-02	4.5E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1973	3.8E-02	4.2E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1974	3.6E-02	4.0E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1975	3.5E-02	3.8E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1976	3.4E-02	3.7E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1977	3.2E-02	3.5E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03
1978	3.1E-02	3.4E-02	2.9E-03	6.7E-03	1.2E-02	2.3E-03

The air concentration corresponding to the intake quantities calculated in Table 7-2 (5E -15 μCi/ml) is slightly higher than air concentrations measured in 1999 during the remedial investigation (maximum value of 2E -15 μCi/ml), this indicating that the calculated intake is in fact bounding under conditions likely present during general site access.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

Internal monitoring data, work area radiological monitoring data, and source term data are not available. Therefore, NIOSH finds that internal doses to personnel during the operational period from May 1, 1956 through January 31, 1958 cannot be bounded, and therefore, accurately reconstructed.

NIOSH has determined that reconstruction of internal doses is feasible for the residual period using the assumptions and approaches presented within Section 7.2.2 of this report. The effective residual period includes: (1) the period from February 1, 1958 through December 31, 1958, which has been determined to be after the confirmed end of the operational period; and (2) the period from January 1, 1959 through October 31, 2009, which is the residual period originally designated by DOE and for which dose reconstruction has been determined to be feasible.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the operational period from May 1, 1956 through January 31, 1958, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at W.R. Grace and Company during the period from May 1, 1956 through January 31, 1958, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at W.R. Grace (MD)

The principal source of external radiation doses for members of the evaluated class was direct exposure to uranium, thorium, and their progeny present in the monazite sands during milling and extraction operations. During the residual period, workers were potentially exposed to residual surface contamination.

7.3.1 Evaluation of Bounding Process-Related External Doses

NIOSH has not identified any external monitoring records or personal dosimetry data associated with the thorium processing that occurred during the operational period under evaluation. NIOSH has not been able to identify any radiological surveys or area monitoring data conducted during the operational period to support the assessment of external dose at the W.R. Grace (Maryland) site. NIOSH has determined that there were no potential external radiological exposures at the Curtis Bay site before construction completion on May 1, 1956. NIOSH has also determined that AEC-related operations had ceased by the end of January 1958; work performed after this date is included in the residual radiation period assessment. Therefore, NIOSH finds that external doses to personnel during the operational period from May 1, 1956 through January 31, 1958 cannot be bounded and, therefore, accurately reconstructed.

7.3.2 Evaluation of Bounding Residual Period External Doses

During the effective residual period, workers were potentially exposed to external radiation from residual surface contamination. Bounding residual period external dose estimates can be based on measurement of external dose rates at the Curtis Bay facility during the post-operations period. Data collected during the 1999 remedial investigation can be used to bound external exposure within the

RWDA (RWDA Remedial Investigation Vol. 1, 2001; RWDA Remedial Investigation Vol. 2, 2001). The effective residual period includes: (1) the post-operational, technical residual period from February 1, 1958 through December 31, 1958; and (2) the original DOE-defined residual period from January 1, 1959 through October 31, 2009.

7.3.3 W.R. Grace and Company (Maryland) Occupational X-Ray Examinations

No specific references could be found stating that X-rays or physical examinations were required at W.R. Grace and Company site at Curtis Bay. An interviewee stated that there were "no work-related X-rays done at the site" (Personal Communication, 2011a). A former W.R. Grace supervisor stated that physical examinations with X-rays were not begun until much later, possibly in the 1970s or 1980s (Personal Communication, 2011b). Therefore, based on the documented evidence, NIOSH concludes that medical X-ray dose is not a consideration for W.R. Grace and Company (Maryland) workers and will not be discussed further in this evaluation.

7.3.4 Methods for Bounding External Dose at W.R. Grace and Company

7.3.4.1 Methods for Bounding Operational Period External Dose

NIOSH has not identified any external monitoring records or personal dosimetry data associated with the thorium processing conducted during the period under evaluation. Therefore, NIOSH has concluded that external doses for the operational period of May 1, 1956 through January 31, 1958 for W. R. Grace cannot be bounded.

7.3.4.2 Methods for Bounding Residual Period External Doses

Building 23

External radiation survey data first measured in 1986 (as discussed in Section 7.3.2) can be used to bound Building 23 external exposure from both penetrating and non-penetrating radiation. The surveys conducted over the time period under evaluation provide sufficient detail and coverage to be used for this purpose. Based on a review of the 1986 survey data, a penetrating dose rate of 0.6 mR/hour would be bounding. Application of the depletion factor calculated in Section 7.2.3.2 (0.029 yr^{-1}) would predict a penetrating dose rate of 1.4 mR/hr at the beginning of the residual period (i.e., 1958). If needed, a non-penetrating radiation may be assumed to be equal to the penetrating dose rate. This would be a bounding assumption based on the nature of the source term and considering operational experience at other monazite ore facilities such as the Lindsay Light Chemical Co. (Klevin, 1953). This exposure rate compares favorably with external dose rates measured within operational monazite processing facilities, such as the W.R. Grace site in Wayne, NJ and the Lindsay Light site in West Chicago. Data from these sites, shown in Tables 6-11 and 6-12, are comparable, with levels only considerably higher on process equipment and materials that would not be present during the residual period.

Radioactive Waste Disposal Area (RWDA)

External dose rate measurements collected during the 1999 remedial investigation can be used to bound external exposure during the residual period (RWDA Remedial Investigation Vol. 1, 2001; RWDA Remedial Investigation Vol. 2, 2001). As was previously done for internal exposure, an annual adjustment was applied to 1999 data to account for the likely presence of elevated levels of Tl-208 in the RWDA (Tl-208 is in equilibrium with Th-228). The results of this calculation are shown below in Table 7-4. Exposure data are shown only until 1978 because RWDA access was restricted thereafter.

Table 7-4: Adjusted External Dose Rates for the RWDA

Year	Dose Rate (mR/hr)	
	Maximum	Mean
1958	2.0	0.042
1959	8.9	0.188
1960	12.9	0.272
1961	15.0	0.317
1962	15.9	0.335
1963	15.9	0.335
1964	15.5	0.326
1965	14.7	0.310
1966	13.8	0.291
1967	12.9	0.271
1968	11.9	0.251
1969	11.0	0.231
1970	10.1	0.212
1971	9.3	0.195
1972	8.5	0.179
1973	7.8	0.165
1974	7.2	0.151
1975	6.6	0.139
1976	6.1	0.129
1977	5.7	0.119
1978	5.2	0.111

7.3.5 External Dose Reconstruction Feasibility Conclusion

NIOSH has concluded that sufficient data are not available to estimate a bounding external dose from the thorium handling and processing that occurred during the operational period from May 1, 1956 through January 31, 1958. Therefore, NIOSH has determined that reconstruction of external doses for W.R. Grace (Maryland) workers is not feasible for the operational period from May 1, 1956 through January 31, 1958.

NIOSH has determined that reconstruction of external doses is feasible for the residual period using the assumptions and approaches presented within Section 7.3.4.2 of this report. The effective residual period includes: (1) the period from February 1, 1958 through December 31, 1958, which has been determined to be after the confirmed end of the operational period; and (2) the period from January 1, 1959 through October 31, 2009, which is the residual period originally designated by DOE and for which dose reconstruction has been determined to be feasible.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses for the period from May 1, 1956 through January 31, 1958, NIOSH intends to use any external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at W.R. Grace and Company (Maryland) during the period from May 1, 1956 through January 31, 1958, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.4 Evaluation of Petition Basis for SEC-SEC-00182

The following assertion was made on behalf of petition SEC-00182 for the W.R. Grace and Company (Maryland) site.

Monitoring Data Missing or Lost

SEC-00182: *All work performed at the W.R. Grace facility in Curtis Bay, MD, between 1953 – 1990 was conducted without the use of dose monitoring equipment or all monitoring data was destroyed or missing.*

Operational Period

Internal monitoring data are not available for workers at W.R. Grace and Company (Maryland). Process radiological monitoring data and source term data are also not available for the operational period. Therefore, internal doses to personnel during the operational period cannot be bounded, and therefore, accurately reconstructed.

NIOSH has found no external personnel monitoring results for the W.R. Grace operational period. NIOSH has concluded that sufficient data are not available to estimate a bounding external dose from the thorium handling and processing that occurred during the operational period.

Residual Radiation Period

Site characterization data from the Curtis Bay site are available starting in 1986. In addition, air monitoring data are available during monazite ore-processing operations at the Rare Earths / W.R. Grace monazite-processing facility located in Wayne, New Jersey. NIOSH has determined that reconstruction of internal doses is feasible for the residual period using the assumptions and approaches presented within Section 7.2.2 of this report.

Site characterization data from the Curtis Bay site are available starting in 1986. NIOSH has determined that reconstruction of external doses is feasible for the effective residual period using the assumptions and approaches presented within Section 7.3.4.2 of this report. The effective residual period includes: (1) the post-operational, technical residual period from February 1, 1958 through December 31, 1958; and (2) the original DOE-defined residual period from January 1, 1959 through October 31, 2009.

7.5 Summary of Feasibility Findings for Petition SEC-00182

This report evaluates the feasibility for completing dose reconstructions for employees at W.R. Grace and Company from January 1, 1955 through December 31, 1958 (operational period), and from January 1, 1959 through October 31, 2009 (residual radiation period). NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete dose reconstructions for the evaluated class of employees for the operational period. However, for the residual radiation period, NIOSH has determined that reconstruction of internal and external doses is feasible using the assumptions and approaches presented within this report.

Table 7-5 summarizes the results of the feasibility findings at W.R. Grace and Company (Maryland) for each exposure source during the operational period (May 1, 1956 through January 31, 1958) and the effective residual radiation period. The effective residual period includes: (1) the period from February 1, 1958 through December 31, 1958, which has been determined to be after the confirmed end of the operational period; and (2) the period from January 1, 1959 through October 31, 2009, which is the residual period originally designated by DOE and for which dose reconstruction has been determined to be feasible.

Table 7-5: Summary of Feasibility Findings for SEC-00182
May 1, 1956 through January 31, 1958 (operations);
February 1, 1958 through December 31, 1958 (technical residual period)
January 1, 1959 through October 31, 2009 (original residual period)

Source of Exposure	May 1, 1956 through January 31, 1958 (operations)		February 1, 1958 through October 31, 2009 (effective residual period[2])	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal		**X**	**X**	
- Uranium		X	X	
- Thorium		X	X	
- Thoron / Radon		X	X	
External		**X**	**X**	
- Gamma		X	X	
- Beta		X	X	
- Neutron	N/A	N/A	N/A	N/A
- Occupational Medical X-ray[1]	N/A	N/A	N/A	N/A

[1] No medical X-rays were performed on site during the operational period. Medical X-rays are not considered during the residual period.
[2] Effective residual period = technical residual period + original residual period.

As of April 28, 2011, a total of one claim has been submitted to NIOSH for an individual who worked at W.R. Grace and Company during the period under evaluation in this report. A dose reconstruction has been completed for this individual (100%).

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at W.R. Grace and Company (Maryland) during the period from May 1, 1956 through January 31, 1958, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00182

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.

Internal and external monitoring data are not available for the operational period. For the residual radiation period, site characterization data from the Curtis Bay site are available starting in 1986. In addition, air monitoring data are available from monazite ore-processing operations at the Rare Earths / W.R. Grace monazite-processing facility located in Wayne, New Jersey. Based on the sum of information available from available resources, NIOSH's evaluation determined that it is not feasible to estimate radiation dose with sufficient accuracy for members of the NIOSH-evaluated class for the time period from May 1, 1956 through January 31, 1958. Therefore, the resulting NIOSH-proposed SEC class must include a minimum required employment period as a basis for specifying that health was endangered for this time period. NIOSH further determined that it is feasible to estimate radiation dose with sufficient accuracy for members of the NIOSH-evaluated class for the time period from February 1, 1958 through October 31, 2009. Therefore, a health endangerment determination is not required for this time period.

9.0 Class Conclusion for Petition SEC-00182

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employees who worked at any building or area at the facility owned by W.R. Grace and Company in Curtis Bay, Maryland, for the operational period from May 1, 1956 through January 31, 1958, 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 Special Exposure Cohort.

NIOSH has determined that it is feasible to estimate radiation dose with sufficient accuracy for members of the NIOSH-evaluated class for the effective residual radiation period based on available site characterization data and data from sites performing similar work. The effective residual period includes: (1) the period from February 1, 1958 through December 31, 1958, which has been determined to be after the confirmed end of the operational period; and (2) the period from January 1, 1959 through October 31, 2009, which is the residual period originally designated by DOE.

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-00182. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

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10.0 References

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

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

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

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

Aerial Survey, 1979, *An Aerial Radiological Survey of the Curtis Bay Facility of the W.R. Grace Company, Baltimore, Maryland*, L. K. Hilton, The Remote Sensing Laboratory of the U.S. Department of Energy; November 1979; SRDB Ref ID: 7181

Army Corps, 2002, *Draft Final Feasibility Study of Building 23 at the W.R. Grace Curtis Bay Facility, Baltimore, Maryland*; United States Army Corps of Engineers; July 2002; SRDB Ref ID: 43458

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Cottrell, 1989, *Results of the Indoor Radiological Survey at the W.R. Grace Co., Curtis Bay Site, Baltimore, Maryland*, ORNL/TM-10439; W. D. Cottrell, R. D. Foley, and C. A. Johnson, Oak Ridge National Laboratory; issued July 1989; SRDB Ref ID: 7188

DCAS-PR-004, *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, Rev. 1, National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; April 15, 2011; SRDB Ref ID: 94768

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Feasibility Study, 2003, *Final Feasibility Study (FS) of Building 23 at the W.R. Grace Curtis Bay Facility, Baltimore, Maryland*; U.S. Army Corps of Engineers, Baltimore District; February 2003; SRDB Ref ID: 43512

FUSRAP documents, various dates, *Various Documents Related to the Formerly Utilized Sites Remedial Action Project (FUSRAP) Effort at the W.R. Grace Site at Curtis Bay, Maryland*; some documents undated, others in 1970s or 1980s; SRDB Ref ID: 7251

Inspection, 1961, *Part 40 Inspection*; date of inspection was June 29, 1961; SRDB Ref ID: 41327, pdf pp. 366-373

Johnson, 1958, *Thorium Procurement*, office memorandum R. W. Cook from J. C. Johnson (U.S. Atomic Energy Commission); January 23, 1958; SRDB Ref ID: 70389

Klevin, 1953, *Lindsay Chemical Company Industrial Hygiene Survey Part I Occupational Exposure to Thorium Dust and Thoron*; Paul B. Klevin and James Fresco; January 21, 1953; SRDB Ref ID: 9085

Lindsay Light, 1953, *Lindsay Light Company Industrial Hygiene Survey, Part I, Occupational Exposure to Thorium Dust and Thoron*, P.B. Klevin and J. Fresco; U.S. Atomic Energy Commission, New York Operations Office, Health and Safety Division; January 21, 1953; SRDB Ref ID: 9068

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NIOSH, 2009, *NIOSH Report of Dose Reconstruction under the Energy Employees Occupational Illness Compensation Program (EEOICPA)*; [Case No. redacted]; July 1, 2009; OSA Ref ID: 112871, pdf pp. 13-31

OCAS-IG-004, *The Use of Data from Other Facilities in the Completion of Dose Reconstructions under the Energy Employees Occupational Illness Compensation Program Act*, Rev. 0, Office of Compensation Analysis and Support Implementation Guideline, National Institute for Occupational Safety and Health, Cincinnati, Ohio, August 21, 2008, SRDB Ref ID: 49029

OCAS-TIB-009, *Estimation of Ingestion Intakes*, Rev. 00, Office of Compensation Analysis and Support Technical Information Bulletin; National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; April 13, 2004; SRDB Ref ID: 22397

ORAUT-OTIB-0004, *Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, Rev. 03 PC-2; Oak Ridge Associated Universities; December 6, 2006; SRDB Ref ID: 29949

ORAUT-OTIB-0070, *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, Rev. 00; Oak Ridge Associated Universities; March 10, 2008; SRDB Ref ID: 41603

Personal Communication, 2011a, *Personal Communication with Petitioner Representative*; Telephone Interview by ORAU Team; May 5, 2011; SRDB Ref ID: 96226

Personal Communication, 2011b, *Personal Communication with former W.R. Grace and Company (Maryland) Supervisor;* Telephone Interview by ORAU Team; May 11, 2011; SRDB Ref ID: 96224

Petition, 2010, *SEC Petition Form B for SEC-00182, W.R. Grace and Company (Maryland); [Name redacted]*; December 21, 2010; OSA Ref ID: 112871, pdf pp. 1-10

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RWDA Remedial Investigation Vol. 1, 2001, *Revised Final: Remedial Investigation (RI) Report for the Radioactive Waste Disposal Area (RWDA) at the W.R. Grace Curtis Bay Facility, Baltimore, Maryland, Volume 1 of 2*, U.S. Army Corps of Engineers, Baltimore District, July, 2001; SRDB Red ID: 97417

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Shaw, 1978, *Account of Facts Pertaining to the Radioactive Waste Disposal Site on the Property of W.R. Grace at Curtis Bay, Maryland*; with cover letter from F. V. Shaw (W.R. Grace) to D. H. Noren (Maryland State Dept. of Health and Mental Hygiene); October 20, 1978; SRDB Ref ID: 7176

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Trip Report, 1985, *Trip Report on Visit to W.R. Grace, Curtis Bay, Maryland*, M.G. Jones, et al, Bechtel National, Inc.; report on trip by BNI, ANL, and DOE personnel; November 11-12, 1985: SRDB Ref ID: 15303

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for W. R. Grace and Company (Maryland)			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site/Company Name: W.R. Grace AWE 1955-1958; Residual Radiation 1959-1978 Other Site Names: Davison Chemical Corp. Agri-Chemicals Div. Rare Earths, Inc. Physical size of the site: The Curtis Bay site encompasses approximately 260 acres. The waste disposal area occupies approximately 40 acres. Monazite sand processing was performed in Building 23, which has approximately 525,000 square feet under roof, based upon exterior dimensions of 300' by 350' and 5 floors. Monazite processing was performed in an area comprising approximately 1/4 of the total Building 23 floor area. Size of the workforce: No information regarding employment numbers during the operational period has been identified. In 1986, 90 employees worked in Building 23. Of these, 18 worked in the former monazite sand processing area. By 1987, 5 full time employees and 1 half time employee worked in the former monazite sand processing area. In 2009 total employment at the Curtis Bay site was 564; in 2010 it was 530.	[Name redacted], [Title redacted], Public and Regulatory Affairs, confirmed that a company-wide search did not identify any relevant records from either the AWE operational period or the residual radiation period. NOTE: W. R. Grace is working the Curtis Bay clean up.	04/11/2011	0

Table A1-1: Data Capture Synopsis for W. R. Grace and Company (Maryland)			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
State Contacted: Maryland Department of Environment	Maryland state provided FUSRAP documents. Performed data capture at MD Department of Environment, Baltimore, MD. A 1999 incident response, 1982 inspection notes of low level radioactive waste, 1984 site inspection, an aerial view of the plant and surrounding area, Building 23 remedial investigation and feasibility studies, and radioactive waste disposal area remedial investigation.	04/16/2008	16
Nuclear Regulatory Commission (NRC)	OPEN - 28 non publicly available documents are on order.	Ongoing	0
DOE Germantown	References to thorium work at W.R. Grace and descriptions of early thorium processing.	Unknown	2
DOE Hanford	No relevant data identified.	04/11/2011	0
DOE Legacy Management - Grand Junction Office	Oak Ridge National Laboratory survey plans, Rare Earths thorium documents and contracts, source material licenses, thorium shipments and receipts, FUSRAP documents, thorium process description, and building occupancy data.	08/07/2010	36
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Response letter to a request for additional Th02 powder, inventory of thorium nitrate tetrahydrate, evaluation of TNT, and 1974 shipping documents.	04/09/2008	5
Internet	AEC licenses, license application, and a license transfer application.	03/13/2008	6
Internet - Department of Energy (DOE)	No relevant data identified.	01/13/2008	0
Internet - DOE Argonne National Laboratory	No relevant data identified.	01/10/2008	0
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	03/01/2011	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	04/14/2011	0
Internet - DOE Legacy Management Considered Sites	No relevant data identified.	04/14/2011	0
Internet - DOE Oak Ridge National Laboratory (ORNL)	No relevant data identified.	01/13/2008	0
Internet - DOE OpenNet	Linking Legacies Appendix B. Note: This document was added by site association review.	04/14/2011	1
Internet - DOE OSTI Energy Citations	No relevant data identified.	04/14/2011	0
Internet - DOE OSTI Information Bridge	Proceedings of the tenth DOE low-level radioactive waste conference.	04/14/2011	1
Internet - DOE Protecting Human Subjects	No relevant data identified.	01/20/2008	0
Internet - Google	Company history, site summary, site plans, and FUSRAP documents including assessments and studies.	04/14/2011	27

Table A1-1: Data Capture Synopsis for W. R. Grace and Company (Maryland)			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - Health Physics Journal	No relevant data identified.	03/01/2011	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant data identified.	03/01/2011	0
Internet - National Academies Press (NAP)	No relevant data identified.	04/14/2011	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	04/14/2011	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	AEC license amendment application, FOIA request and responses, and a 1958 inspection report.	04/14/2011	7
Internet - U.S. Army Corps of Engineers	No relevant data identified.	04/14/2011	0
Internet - U.S. NRC	No relevant data identified.	01/15/2008	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	04/14/2011	0
Internet - Washington University Libraries - St. Louis	No relevant data identified.	01/15/2008	0
National Archives and Records Administration (NARA) Atlanta	A quotation for W.R. Grace to produce 1000 grams U-233 as U3O8 for Y-12.	05/20/2008	1
National Archives and Records Administration (NARA) Kansas City	History information, survey data, description of site, survey and description of Building 23, and a description of uranium from phosphate contracts.	03/30/2005	9
ORAU Team	A key to 1970s Landauer dosimetry reports and documented communication with a process knowledge expert.	03/20/2007	2
Unknown	Radiation status of site, radiological survey results, a general description of Curtis Bay, former thorium sites investigation, a Rare Earths contract, and a reference to W.R. Grace processing of monazite sand.	N/A	10
Westinghouse Site (United Nuclear), Hematite, MO	Reference to W.R. Grace as a supplier of UO2 pellets including a brief process description.	04/06/2009	1
TOTAL			124

Table A1-2: Databases Searched for W. R. Grace and Company			
Database/Source	**Keywords**	**Hits**	**Uploaded To SRDB**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file "W R Grace Curtis Bay, MD, Rev 01 (83.13) 05-03-11"			
Department of Energy http://www.doe.gov/ COMPLETED 01/13/2008	See Note above	78	0
DOE Argonne National Laboratory http://www.anl.gov/ COMPLETED 01/10/2008	See Note above	0	0
DOE CEDR http://cedr.lbl.gov/ COMPLETED 03/01/2011	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 04/14/2011	See Note above	0	0
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 04/14/2011	See Note above	59	0
DOE Oak Ridge National Laboratory http://www.ornl.gov/ COMPLETED 01/13/2008	See Note above	31	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 04/14/2011	See Note above	89	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 04/14/2011	See Note above	275	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 04/14/2011	See Note above	258	1
DOE Protecting Human Subjects Website http://humansubjects.energy.gov/ COMPLETED 01/20/2008	See Note above	0	0

Table A1-2: Databases Searched for W. R. Grace and Company			
Database/Source	**Keywords**	**Hits**	**Uploaded To SRDB**
Google http://www.google.com COMPLETED 04/14/2011	See Note above	6,282,124	27
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 03/01/2011	See Note above	17	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 03/01/2011	See Note above	14	0
National Academies Press http://www.nap.edu/ COMPLETED 04/14/2011	See Note above	3,938	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 04/14/2011	See Note above	1	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 04/14/2011	See Note above	434	7
USACE http://www.nan.usace.army.mil/ COMPLETED 04/14/2011	See Note above	32	0
U.S. NRC http://www.nrc.gov/site-help/search.html COMPLETED 01/15/2008	See Note above	39	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 04/14/2011	See Note above	1	0
Washington University Libraries - St. Louis http://library.wustl.edu/units/westcampus/govdocs/nukes/index.html COMPLETED 01/15/2008	See Note above	8	0

Table A1-3: OSTI Documents Ordered for W. R. Grace and Company			
Document Number	**Document Title**	**Requested Date**	**Received Date**
ORNL/TM-10439 REF ID: 7188	Results of the Indoor Radiological Survey at the W.R. Grace Co., Curtis Bay Site, Baltimore, Maryland dated 7/1/1989.	10/19/2007	Already in SRDB
PB-90-163544/XAB	Superfund Record of Decision (EPA Region 1): W.R. Grace, Acton, Massachusetts (First Remedial Action), September 1989 dated 9/29/1989.	10/19/2007	Not applicable to the W. R. Grace sites which are covered.
PB-90-260118/XAB	Health Assessment for W.R. Grace and Co., Inc./Wayne Interim Storage Site, Wayne, Passaic County, New Jersey, Region 2. CERCLIS No. NJD891837980, Final Report dated 7/30/1990.	10/19/2007	OSTI doesn't have this document.