

## SEC Petition Evaluation Report

### Petition SEC-00177

Report Rev #: 0

Report Submittal Date: February 4, 2011

| Subject Expert(s):   |   | Monica Harrison-Maples, Mike Mahathy                 |  |                                  |
|--|---|--|--|----------------------------------|
| Site Expert(s):  |   | N/A  |  |                                  |
| Petition Administrative Summary  |   |  |  |                                  |
| Petition Under Evaluation  |   |  |  |                                  |
| Petition #   | Petition Type                               | Petition Receipt Date                                | Qualification Date   | DOE/AWE Facility Name            |
| SEC-00177  | 83.13                                       | July 14, 2010  | September 9, 2010  | Vitro Manufacturing (Canonsburg) |
| Petitioner Class Definition  |   |  |  |                                  |
| All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through April 30, 1960.  |   |  |  |                                  |
| Class Evaluated by NIOSH   |   |  |  |                                  |
| All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through December 31, 1959.   |   |  |  |                                  |
| NIOSH-Proposed Class to be Added to the SEC  |   |  |  |                                  |
| All Atomic Weapons Employer employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania, from January 1, 1958 through December 31, 1959, 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  |                                  |
| SEC-00134  | 83.14                                       | Vitro Manufacturing (Canonsburg)                     | Class added to the SEC for Aug. 13, 1942 through Dec. 31, 1957 |                                  |
| Related Evaluation Report Information  |   |  |  |                                  |
| Report Title   |   |  | DOE/AWE Facility Name  |                                  |
| SEC Petition Evaluation Report for Petition SEC-00134  |   |  | Vitro Manufacturing (Canonsburg)                               |                                  |
| <b>ORAU Lead Technical Evaluator:</b> Monica Harrison-Maples   |   | <b>ORAU Peer Review Completed By:</b> Michael Kubiak |  |                                  |
| <b>Peer Review Completed By:</b>   | [Signature on file]                         | 2/4/2011   |  |                                  |
|  | <i>Gregory Macievic</i>                     | <i>Date</i>  |  |                                  |
| <b>SEC Petition Evaluation Reviewed By:</b>  | [Signature on file]                         | 2/4/2011   |  |                                  |
|  | <i>J. W. Neton</i>                          | <i>Date</i>  |  |                                  |
| <b>SEC Evaluation Approved By:</b>   | [Signature on file]                         | 2/4/2011   |  |                                  |
|  | <i>David Sundin for Stuart L. Hinnefeld</i> | <i>Date</i>  |  |                                  |

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## Evaluation Report Summary: SEC-00177, Vitro Manufacturing

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-00177 was received on July 14, 2010, and qualified on September 9, 2010. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through April 30, 1960.*

### Class Evaluated by NIOSH

Based on its preliminary research, NIOSH divided the petitioner-requested class into two periods to be separately evaluated. The first period, evaluated herein, is from January 1, 1958 through December 31, 1959, the period for which NIOSH was able to locate evidence of continuing operations on behalf of the Atomic Energy Commission (AEC), extending the site's Atomic Weapons Employer (AWE) operations period through December 31, 1959. The other period, beginning on January 1, 1960, extends into the residual radiation period. NIOSH has documentation stating that the facility ceased operations and that personnel were no longer working at the site after May 1960, but further evaluation is required. In the interest of timeliness, NIOSH has reserved the feasibility evaluation for the residual radiation period beginning in January 1960.

NIOSH evaluated the following class: All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through December 31, 1959.

### 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 Employer employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania, from January 1, 1958 through December 31, 1959, 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 recommended for inclusion in the SEC (see Section 3.0 below) because NIOSH lacks personnel monitoring data, air monitoring information, sufficient process information, and radiological source term information for the period under evaluation to allow it to estimate, with sufficient accuracy, the potential occupational exposures to uranium products and uranium progeny during processing at Vitro Manufacturing during the proposed SEC period.

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| <b>Peer Review Completed By:</b>   | [Signature on file]                         | 2/4/2011   |  |                                  |
|  | <i>Gregory Macievic</i>                     | <i>Date</i>  |  |                                  |
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## Evaluation Report Summary: SEC-00177, Vitro Manufacturing

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-00177 was received on July 14, 2010, and qualified on September 9, 2010. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through April 30, 1960.*

### Class Evaluated by NIOSH

Based on its preliminary research, NIOSH divided the petitioner-requested class into two periods to be separately evaluated. The first period, evaluated herein, is from January 1, 1958 through December 31, 1959, the period for which NIOSH was able to locate evidence of continuing operations on behalf of the Atomic Energy Commission (AEC), extending the site's Atomic Weapons Employer (AWE) operations period through December 31, 1959. The other period, beginning on January 1, 1960, extends into the residual radiation period. NIOSH has documentation stating that the facility ceased operations and that personnel were no longer working at the site after May 1960, but further evaluation is required. In the interest of timeliness, NIOSH has reserved the feasibility evaluation for the residual radiation period beginning in January 1960.

NIOSH evaluated the following class: All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through December 31, 1959.

### 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 Employer employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania, from January 1, 1958 through December 31, 1959, 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 recommended for inclusion in the SEC (see Section 3.0 below) because NIOSH lacks personnel monitoring data, air monitoring information, sufficient process information, and radiological source term information for the period under evaluation to allow it to estimate, with sufficient accuracy, the potential occupational exposures to uranium products and uranium progeny during processing at Vitro Manufacturing during the proposed SEC period.

### Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it does not have access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of maximum dose. Information available from additional resources is not sufficient to document or estimate the maximum internal and external potential exposure to members of the proposed class under plausible circumstances during the specified period.

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

- NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Vitro Manufacturing workers with sufficient accuracy.
- Principal sources of internal and external radiation for members of the proposed class included exposures to site contamination and residue piles containing uranium and uranium progeny, including radon.
- There is currently a class of Vitro Manufacturing (Canonsburg) workers associated with the previous NIOSH evaluation of SEC petition SEC-00134 for a portion of the site's Atomic Weapons Employer operations period (August 13, 1942 through December 31, 1957). The Secretary of the Department of Health and Human Services has designated the following class for inclusion in the Special Exposure Cohort:

*All AWE employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania from August 13, 1942 through December 31, 1957, 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 currently being evaluated, January 1, 1958 through December 31, 1959, follows immediately after the already-designated SEC period for Vitro Manufacturing. NIOSH has determined that Vitro Manufacturing continued to process scrap and residues that could have resulted in the generation of airborne dust, surface contamination, and direct contact with bulk materials. The potential for unmonitored exposures continued at Vitro Manufacturing until site AWE operations concluded in 1959.
- NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored internal and external exposures for Vitro Manufacturing workers during the period from January 1, 1958 through December 31, 1959.
- 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 Vitro Manufacturing (Canonsburg) during the period from January 1, 1958 through December 31, 1959, 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.

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma and beta 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 one or more other SEC classes.

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## SEC Petition Evaluation Report for SEC-00177

*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: Monica Harrison-Maples, 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 employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through December 31, 1959. 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.<sup>1</sup>

### 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.<sup>2</sup>

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of

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<sup>1</sup> DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).

<sup>2</sup> 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>.

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

### **3.0 SEC-00177, Vitro Manufacturing Class Definitions**

The following subsections address the evolution of the class definition for SEC-00177, Vitro Manufacturing in Canonsburg, Pennsylvania (sometimes referred to as ‘Vitro’ throughout this report). 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.

Per the DOE Office of Health, Safety and Security, the time period associated with AWE operations at the Vitro Manufacturing Canonsburg site is 1942 through 1959. However, prior to this petition evaluation, the period associated with AWE operations was defined as 1942 through 1957, with a residual radiation period designated for 1958 through 1985 (DOL, 2011a; DOL, 2011b). There is currently a class of Vitro Manufacturing workers associated with the previous NIOSH evaluation of SEC petition SEC-00134 for the site’s previously-designated AWE operations period (1942 through 1957). The Secretary of the Department of Health and Human Services (DHHS) has designated the following class for inclusion in the Special Exposure Cohort:

*All AWE employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania from August 13, 1942 through December 31, 1957, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work*

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<sup>3</sup> 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>.

*days within the parameters established for one or more other classes of employees in the Special Exposure Cohort (DHHS, 2009).*

### **3.1 Petitioner-Requested Class Definition and Basis**

Petition SEC-00177 was received on July 14, 2010, and qualified on September 9, 2010. The petitioner requested that NIOSH consider the following class: *All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through April 30, 1960.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Vitro Manufacturing workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00177 for evaluation:

The petitioner submitted an affidavit (Affidavit, 2010) stating that radiation exposures and therefore radiation doses potentially incurred by members of the proposed class were not monitored, either through personal or area monitoring. The petitioner also included information (Form B, 2010) on the Vitro Manufacturing site published by the United States Energy Information Administration and by NIOSH. The petitioner submitted two memoranda (Petition Supplement, 2010) in which the petitioner questioned the 1957 end date for the previously-designated SEC class, and indicated that the same radiological conditions that had resulted in the inability to reconstruct doses for the previously-designated AWE operations period continued to exist after 1957.

Based on its Vitro Manufacturing research and data capture efforts, NIOSH determined that it has access to only limited process information and area surveys that occurred well beyond the time period requested for evaluation. NIOSH also determined that there are no personnel monitoring data available to NIOSH for the period requested for evaluation. NIOSH concluded that there is sufficient documentation to support the petition basis that internal and external radiation exposures and radiation doses may not have been adequately monitored at Vitro Manufacturing during the period for which the petition was submitted, 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 divided the petitioner-requested class into two periods (the period from January 1, 1958 through December 31, 1959, and the post-1959 residual radiation period) because preliminary indications showed that the radiological activities during the period from 1958 through 1959 were unmonitored and the potential for unmonitored occupational exposure did exist. The operations during 1958 and 1959 were consistent with the operations during the previously-defined AWE operational period (1942-1957). Documentation located during NIOSH's research provided evidence that the ongoing work also qualified as AWE operations. NIOSH presented this evidence to the Department of Labor (DOL) and DOL concurred that the period from 1958 through 1959 should be reclassified as a period of AWE operations (DOL, 2011b).

Following the completion of the AEC contract, operations were directed toward shutdown activities. During NIOSH's initial review of Vitro documentation, it became clear that additional research into the operations and conditions during 1960 and beyond was necessary to understand the potential for exposure that may have existed. While the petition specified April 30, 1960, as an end date for the evaluation, NIOSH located references to later dates in 1960 as the end of operations. References were made to the end of May (Inspection Responses, 1963, pdf p. 3) and a reference was made to July 1960 (Zugschwerdt, 1981, pdf p. 12). Therefore, NIOSH is reserving the evaluation of operations at Vitro Manufacturing starting in 1960 in order to proceed with its evaluation of January 1, 1958 through December 31, 1959 in a timely manner.

NIOSH defined the following class associated with this evaluation: All employees who worked in any area at the Vitro Manufacturing facility in Canonsburg, Pennsylvania, during the time period from January 1, 1958 through December 31, 1959.

### **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 Employer employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania, from January 1, 1958 through December 31, 1959, 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.

## **4.0 Data Sources Reviewed by NIOSH to Evaluate the Class**

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding Vitro Manufacturing. 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 One contains a summary of Vitro Manufacturing 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. In the case of Vitro Manufacturing, a Site Profile document has not been written.

## 4.2 ORAU Technical Information Bulletins (OTIBs)

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

- *OTIB: Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, ORAUT-OTIB-0004, Rev. 03 PC-2; December 6, 2006; SRDB Ref ID: 36191
- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 03 PC-1; December 21, 2005; SRDB Ref ID: 20220
- *OTIB: Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site*, ORAUT-OTIB-0079; January 3, 2011; SRDB Ref ID: 89563

## 4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed seven former Vitro Manufacturing employees. NIOSH selected individuals based on their known experience and likelihood that they would be knowledgeable about the operations and/or radiation monitoring practices at the Vitro site. All interviews were conducted by phone for the purpose of gaining additional information about any differences in work processes or health and safety procedures between the defined Atomic Energy Commission (AEC) operational period and the period under evaluation.

- Personal Communication, 2010a, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; October 19, 2010, 9:30 a.m.; SRDB Ref ID: 90804
- Personal Communication, 2010b, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; October 25, 2010, 10:00 a.m.; SRDB Ref ID: 90806
- Personal Communication, 2010c, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; October 25, 2010, 11:00 a.m.; SRDB Ref ID: 90808
- Personal Communication, 2010d, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; October 26, 2010, 3:00 p.m.; SRDB Ref ID: 90810

- Personal Communication, 2010e, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; October 27, 2010, 10:00 a.m.; SRDB Ref ID: 90812
- Personal Communication, 2010f, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; November 2, 2010, 9:50 a.m.; SRDB Ref ID: 90814
- Personal Communication, 2010g, *Personal Communication with Former Vitro Employee*; Telephone Interview by ORAU Team; November 2, 2010, 1:00 p.m.; SRDB Ref ID: 90813

#### 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 January 24, 2011)

| <b>Table 4-1: No. of Vitro Manufacturing Claims Submitted Under the Dose Reconstruction Rule</b>   |               |
|--|---------------|
| <b>Description</b>   | <b>Totals</b> |
| Total number of claims submitted for dose reconstruction   | 27            |
| Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1958 through December 31, 1959)  | 14            |
| 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) | 9             |
| Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition   | 0             |
| Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition   | 0             |

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for each claimant. Based on the claim and information reviews performed to date, NIOSH has not located any internal or external monitoring data associated with Vitro Manufacturing energy employees within the time period of this evaluation.

#### 4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Seven hundred twenty-eight documents in this database were identified as pertaining to Vitro Manufacturing in Canonsburg, Pennsylvania. These documents were evaluated for their relevance to this petition. The documents include personnel data, historical background on Vitro operations and materials, contractual information, maps and surveys from the residual radiation period, and air monitoring information (although limited).

## 4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Petition Form B for SEC-00177 with attached site summary documents*; received on July 14, 2010; OSA Ref ID: 112176, pdf pp. 2-9, 11-13 (Form B, 2010)
- *Affidavit from Laboratory Technician*; July 2, 2002; OSA Ref ID: 112176, pdf p. 10 (Affidavit, 2002)
- *Affidavit from Laboratory Technician*; July 6, 2010; OSA Ref ID: 112176, pdf p. 1 (Affidavit, 2010)
- *Supplemental Information for SEC-00177 Petition*; August 14, 2010; OSA Ref ID: 112455 (Petition Supplement, 2010)

## 5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize radiological operations at Vitro Manufacturing that may have had a radiological impact on the facility during the AWE operational period, and which would have contributed to worker exposure potential during the period under evaluation from January 1, 1958 through December 31, 1959. From available sources, NIOSH has gathered process and source descriptions, information regarding the identity and quantities shipments of source materials of concern (to and from the site), inventory records, accountability surveys, contractual information, waste removal plans and reports, 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 Vitro Manufacturing Plant and Process Descriptions

Vitro Manufacturing was located on an 18-acre site on Strabane Avenue in Canonsburg, Pennsylvania. The plant was built by the Standard Chemical Company. The facility had a total of 22 buildings, including a guardhouse, and three chemical storage sheds. NIOSH lacks clear documentation specifying the size of the workforce during the period evaluated. However, NIOSH does have workforce information for 1943 through 1953. The size of the workforce ranged from 50 to 82 employees. In 1952 and 1953 there were approximately 80 workers at the site (Klevin, 1952a, pdf p. 7; Klevin, 1952b, pdf p. 13; Klevin, 1953, pdf. p. 12; AEC, 1953, pdf p. 12).

#### Processing and Recovery

Domestic ores, African pitchblende, recoverable scrap materials, and Canadian residues were processed onsite throughout the history of Vitro. Because the feed materials were variable, there were many manual processes that would have resulted in high exposure potential.

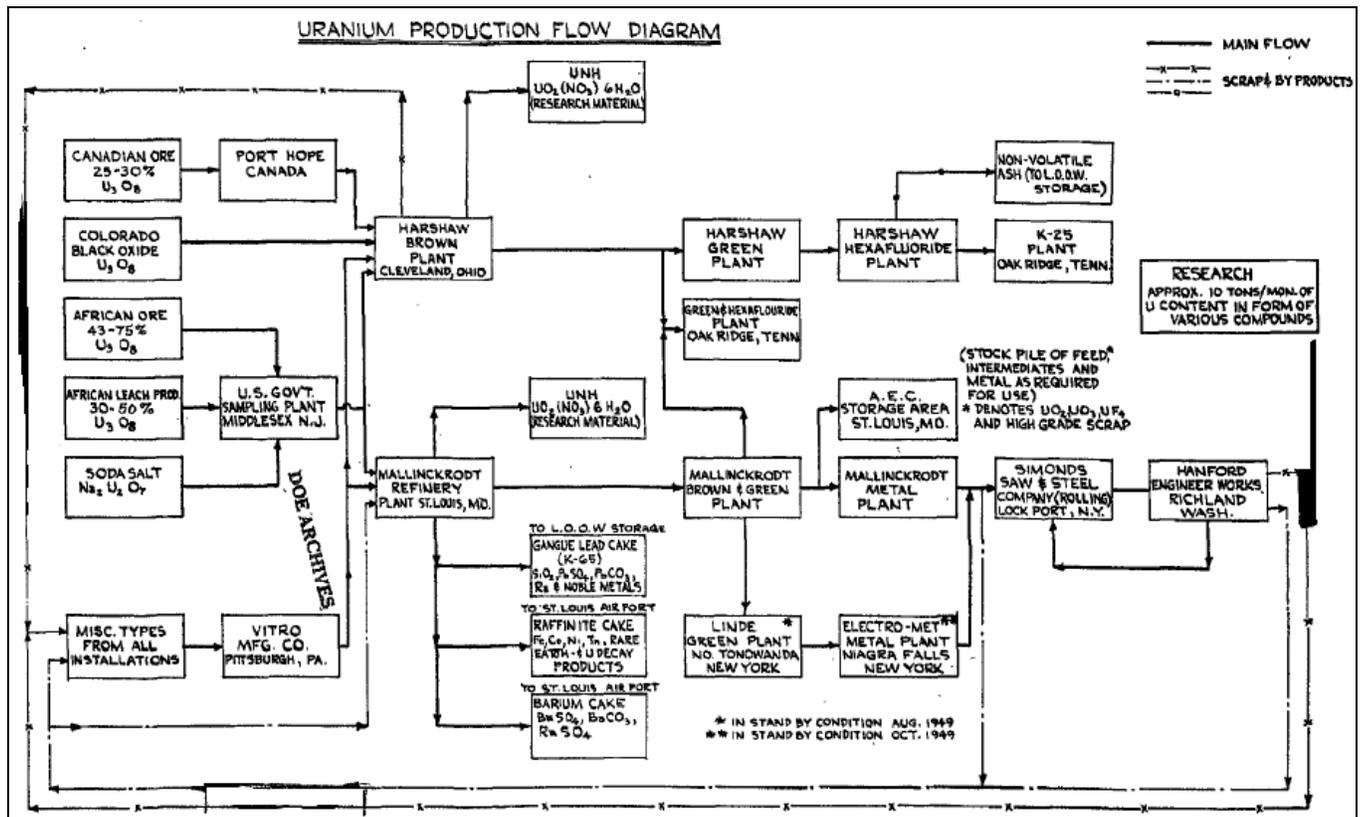
From 1930 to 1942, the site was operated by Vitro Manufacturing and extracted radium and uranium salts from carnotite ore and residues for commercial purposes (Zugschwerdt, 1981, pdf pp. 10-13), resulting in contaminated site buildings even before AEC operations started (Snapp, 1951, pdf p. 53).

Beginning in 1942, Vitro Manufacturing had begun processing African uranium ores and uranium concentrates for the Manhattan Engineer District (MED), the predecessor agency of AEC, to produce a feed concentrate in the form of  $U_3O_8$  (Whitman, 1978).

In November 1947, Vitro's contract with AEC was supplemented to include processing uranium-bearing residues containing significant quantities of  $U_3O_8$  that had been generated at other sites. Vitro Manufacturing assumed responsibility from the DuPont scrap recovery plant for processing these scrap and uranium-bearing residues from other AEC contractor sites (Snapp, 1951, pdf pp. 12, 42; Strod, Jan1949, pdf p. 30).

By 1948, Vitro was receiving miscellaneous uranium scrap materials from AEC installations throughout the uranium production complex under Contract No. At-30-1-GEN-253 (Snapp, 1951, pdf p. 85). In 1948, Vitro processed 60 diverse lots of scrap and produced 23 lots with an overall recovery rate of 98.7%.

Figure 5-1 provides examples of the material flow to and from various AEC sites.



Source: Snapp, 1951, pdf p. 85

Figure 5-1: Uranium Production Flow Diagram

On November 1, 1953, the AEC and Vitro contracted (contracts AT-(30-1)-1683 and AT-(30-1)-1241) to process government-owned materials at the Vitro site, thus obligating Vitro to store scrap materials and residues from those processes.

In 1955, the AEC issued Vitro a series of source material licenses to import milling by-product residue material containing  $U_3O_8$  from Canada (Zugschwerdt, 1981, pdf p. 10). Three shipments of these "Port Hope Wastes" were imported, with the first two for testing and the third for the fulfillment of AEC contract No. AT(49-6)-1158, which called for Vitro to extract the  $U_3O_8$  from the material and sell it to the AEC. This contract was terminated in 1959. While under this contract, Vitro produced and sold 820 pounds of uranium in 1957; 54,951 pounds of uranium in 1958; and 144 pounds of uranium in 1959 (DOE, post-1962).

In 1956, the AEC and Vitro planned the removal of the waste piles (some 10,000 "running tons") to the Blairsville, Pennsylvania disposal site (Zugschwerdt, 1981, pdf pp. 10-13). This was clearly a major loading operation. Vitro was to erect a wooden loading ramp (if necessary), construct temporary roads into the storage areas (i.e., to the waste piles), retrieve the materials from the waste piles, transport the wastes to the onsite rail spur, load the wastes into gondola cars, and weigh and transfer the wastes to the Pennsylvania railroad. Vitro was to supervise the entire operation in accordance with AEC instructions (Zugschwerdt, 1981, pdf pp. 10-13).

## Research

In addition to the processing and recovery efforts that occurred throughout the years, there were personnel who worked in laboratory facilities and were involved with process control, research, development, and accountability. Vitro personnel performed various research and laboratory operations to find processes suitable for uranium recovery from the various scrap feed forms received at the site. They also worked to adapt extraction and recovery processes developed at other facilities. Before processing activities began, preliminary sampling and analysis determined the treatment or processing that would be used before the materials were introduced into the final refining stage (Vitro, 1952). The pre-processing steps could have included burning, screening, grinding, and handpicking (Vitro, 1952), all of which had to be performed at the laboratory and pilot level first.

At the end of December 1949, Vitro began performing assays of Mallinckrodt Chemical Works material lots under contract with the AEC. Vitro personnel performed research studies into methods for refining Mallinckrodt Chemical Works materials (C-Scrap and C-Liner), and worked on the development of a process for recovery of uranium from the Tonawanda wastes and the St. Louis wastes. During the course of the program, Vitro investigated twelve different wastes (Zugschwerdt, 1981).

## Waste Piles

The waste residues were all stored in bulk (i.e., undrummed) in the open without protection from the elements (Dowling, 1956). Vitro estimated that about five acres were being used for the storage of carb cake residues (Powell, 1955), while AEC stated that about 10 acres were being used for storage of all the waste piles (Wolf, 1948), apparently referring to the size of the plots of land the piles were on, and not to the sum of the areas of ground covered by the piles. The waste piles were surveyed by AEC on July 6, 1953 (Harris, 1953; Neumann, 1955). The results of this survey showed approximately 3,300 tons of the material were below the AEC-NYOO established disposal criterion of

0.2 mr/hr. NIOSH has not determined how much material, if any, was added to the residue piles after this survey, but the amount could have been considerable since Vitro was processing material from Hanford, Mallinckrodt, and Port Hope after July 1953. While the large older piles or parts of piles were likely mostly below the disposal criterion level, the newer material might not have been, as was suggested by one source (Harris, 1953).

Table 5-1 provides a summary of Vitro milestones regarding processing, research, and the waste piles.

| <b>Table 5-1: Summary of Vitro Manufacturing (Canonsburg) Milestones</b> |  |                    |
|--|--|--------------------|
| <i>Table 5-1 spans two pages.</i>  |  |                    |
| <b>Date</b>  | <b>Activity</b>  | <b>SRDB Ref ID</b> |
| 1911-1922  | The facility was run by Standard Chemical Co. to extract radium from carnotite ores (commercial).  | 16418              |
| 1922   | The facility was bought by Vitro Manufacturing Co.   | 16418              |
| 1930-1942  | Radium and uranium salts were extracted from pitchblende ores (commercial).  | 16418              |
| 1942-1957  | Under contract to the AEC, there were ongoing operations to recover uranium from residues and scraps.  | 16418<br>16071     |
| Prior to April 1949  | Residues from any high-grade Belgian Congo ores refined at Vitro were returned to African Metals Corp. and were not stored in the U.S. Lower-grade residues were stored at Lake Ontario Ordnance Works.  | 61040              |
| 1956-1957  | AEC approved the disposal of 11,610 tons of low-content uranium tailings at Pennsylvania Railroad Co. (Blairsville, Pennsylvania) industrial dump.   | 79085              |
| 05/07/1956   | All recovered product and plant clean-up materials had been shipped to National Lead of Ohio by this time.   | 79021              |
| 1957   | The primary contract with AEC (AT-(30-1)-1683) ended.  | 16418              |
| Jan. 1957  | The removal of low-content uranium tailing residues was completed.   | 79021              |
| May 1959   | The contract with AEC (AT(49-6)-1158) for the processing of the Port Hope residues was, by mutual agreement, terminated before all residues were processed.  | 78537              |
| 1957-1966  | The Vitro site and contamination were controlled under an AEC source material license. (License was terminated on Feb. 14, 1966.)  | 16418              |
| Jun 1960   | Documentation states that Vitro personnel were no longer onsite after May 1960, but tailings were still present.   | 79085              |
| Dec. 1962  | The initial license-release inspection and survey of the site began.   | 78537              |
| 12/31/1962   | The site was sold to private investors under the agreement that the piles of uranium-bearing residues stored on the premises were to remain the property of Vitro.   | 79085              |
| 05/16/1963   | The State Division of Sanitary Engineering suggested that Vitro withdraw their request for removal of piles to Blairsville, Pennsylvania because they had received information that the Pennsylvania Railroad Co. would not accept the waste material for disposal at the dump site. | 79805              |
| 07/24/1963   | Vitro hired Allied-Crossroads Nuclear Corp. to survey the site.  | 79805              |
| 08/14/1963   | AEC approved an interim solution for "storage and decontamination" at the site.  | 79805              |
| 10/14/1963   | The new owners gave permission to perform "storage and decommission" activities.   | 79805              |
| 11/07/1963   | The state approved a "storage and decontamination" interim solution.   | 79805              |
| 11/18/1963   | Allied-Crossroads Nuclear Corp. began to implement the interim solution.   | 79805              |
| Aug. 1965  | Allied-Crossroads Nuclear Corp. began remediation under contract to Vitro.   | 78537              |
| Nov. 1965  | AEC conducted the final release inspection and survey.   | 78537              |
| Feb. 1966  | AEC terminated the license and released the site.  | 78537              |
| 1967   | Canon Development Co. bought the property and leased it to tenant companies for light industrial use.  | 16418              |

## 5.2 Radiological Exposure Sources from Vitro Manufacturing Operations

The following subsections provide an overview of the internal and external exposure sources for the Vitro Manufacturing class under evaluation.

### 5.2.1 Internal Radiological Exposure Sources from Vitro Manufacturing

Sources of internal exposure included potential intakes of uranium and uranium decay chain radionuclides. Operations involved processing uranium ores to separate and concentrate the uranium into primarily  $U_3O_8$  oxide, performing chemical sampling of materials and products, and storing and removing ore residues. These processing activities involved uranium and decay chain radionuclides being chemically separated from each other and re-concentrated so that they were frequently not in equilibrium (the degree of disequilibrium is not identifiable from site records).

#### 5.2.1.1 Natural Uranium

The principal source of internal exposure to natural uranium at Vitro Manufacturing was from the inhalation of dust and/or fumes generated during the processing of uranium residues and during the storage of ore and metal residues. Vitro Manufacturing employees were exposed to wastes and residues from processed scrap and uranium-bearing residues that had been received during the operations period (Strod, Jan1949, pdf p. 30). During the operations period, Vitro received uranium materials from Department of Energy (DOE) sites including, but not limited to, Hanford, Mallinckrodt, Massachusetts Institute of Technology, Middlesex, Tyson Valley Powder Farm, Y-12, and Oak Ridge National Laboratory. Some of the waste residues were removed from the Vitro site starting in 1956, but some residues remained through December 31, 1959, and were handled by Vitro Manufacturing workers (Inspection Responses, 1963). During operations at Vitro, uranium ores and wastes that were loaded and unloaded on railcars were weighed, sampled, agglomerated, crushed, and chemically processed. Each of these activities potentially generated airborne dust that could have been inhaled or ingested. Additional wastes that resulted from processing ore residues were also handled and stored by Vitro workers. Thus, workers were potentially exposed to airborne dust from re-suspension of uranium contamination and from direct contact with bulk materials. NIOSH does not have enough information to accurately quantify the volume of natural uranium at Vitro.

#### 5.2.1.2 Uranium Progeny

Since Vitro Manufacturing handled and processed uranium ore materials and residues, company workers were also potentially exposed to uranium progeny, which included thorium-230, thorium-232, thorium-238, radium-226, protactinium-231, actinium-227, and radon daughters. African ores containing significant radium concentrations were also processed at Vitro Manufacturing Canonsburg (NIOSH, 2008). NIOSH does not have enough information to quantify the uranium progeny.

### 5.2.2 External Radiological Exposure Sources from Vitro Manufacturing

Based on a review of the documented activities and potential exposures to source materials, NIOSH believes there was the potential for occupational radiological exposures to photons and beta particles from radionuclides in the uranium decay chain at Vitro. There are no indications that Vitro personnel had any potential for significant exposure to neutrons.

### 5.2.2.1 Photon

Photons from uranium are primarily from the thorium-234 daughter of uranium-238 and are in the energy range of 30-250 KeV (ORAUT-OTIB-0004). There are higher-energy photons, up to 1.00 MeV, from another uranium-238 daughter, protactinium-234m, but the abundance of these photons is less than 1% (Rad Handbook, 1970).

### 5.2.2.2 Beta

The majority of the beta exposures at Vitro Manufacturing would have resulted from exposure to uranium and its decay products. For processed natural uranium, the dominant beta radiation was likely due to uranium-238 decay products. In the uranium-series decay scheme, beginning with uranium-238, the short-lived isotope protactinium-234 emits the most energetic beta particle (2.28 MeV). It is this beta particle that accounts for the shallow-dose hazard associated with handling uranium scrap and uranium residues.

### 5.2.2.3 Neutron

Neutrons result from alpha-neutron reactions where the reactant is fluorine (which occurs during the production of UF<sub>4</sub> and UF<sub>6</sub>) or oxygen that is present in uranium oxides. No indication of the use of fluorine as a reactant at Vitro was expected, nor has been discovered. While there is a possibility of neutrons resulting from spontaneous fission by uranium, NIOSH believes there would not be significant neutron exposures at the site. When necessary, NIOSH utilizes ORAUT-OTIB-0024, which provides information normally associated with the expected neutron dose rates from various forms of uranium compounds.

## **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 Vitro Manufacturing facility. Although all of these results occur outside the evaluated period, NIOSH believes it is pertinent to show the data that are available.

### **6.1 Available Vitro Manufacturing Internal Monitoring Data**

NIOSH has not obtained bioassay data or air monitoring data collected during the period under evaluation, January 1, 1958 through December 31, 1959. NIOSH has obtained bioassay urinalysis results for the period between 1950 and 1954 (AEC, Feb-Jun 1950; AEC, 1949-1958; AEC, 1950-1954; AEC, Jun-Nov 1950; AEC, 1950-1951). These samples were analyzed for uranium by fluorimetry, which yielded the total amount of uranium (by mass) in urine. Some records could not be correlated to individuals or specific time periods due to illegibility.

NIOSH has not obtained air monitoring results collected during the period under evaluation. The air monitoring results (daily weighted area and breathing zone air sampling) that NIOSH has obtained were for monitoring conducted at approximately semiannual intervals for 1949 through 1953 (Unknown, 1952; AEC, 1949-1952; AEC, 1949-1958; Klevin, 1949a; Klevin, 1951a; Klevin, 1952a;

Klevin, 1952b; Klevin, 1953; AEC, 1953; Vitro, 1951; Klevin, 1949b; Vitro, unknown date; Vitro, 1953a; Klevin, 1951b).

NIOSH has not obtained radon data for the period under evaluation, but NIOSH has obtained documentation of radon monitoring performed by Oak Ridge National Laboratory in 1977 (Haywood, 1977) and in 1978 and 1979 by the Environmental Measurements Laboratory (Radon Results, 1979-1980).

## **6.2 Available Vitro Manufacturing External Monitoring Data**

There are no external whole-body dosimetry data available for the Vitro period under evaluation, January 1, 1958 through December 31, 1959. Comprehensive whole-body dosimetry records end for Vitro workers in 1954. This date appears to coincide with the discontinuation of the film reading service provided to the AWE sites by the Health and Safety Laboratory. However, there is correspondence between the AEC and Vitro regarding private firms competent to handle film badge supply and service. NIOSH has located a December 1955 National Lead of Ohio personnel monitoring report for Vitro's Canonsburg site with results for November 10-24, 1955.

NIOSH has not obtained radiation survey data for the period under evaluation, January 1, 1958 through December 31, 1959. The radiation survey data that NIOSH has obtained were for some Vitro processes measured in 1950 (Piccot, 1950; Klevin, 1951b) and 1953 (Peterson, 1953; Vitro, 1953b). NIOSH has obtained radiological survey data of equipment measured in 1954 and 1955, during and after decontamination (Klevin, 1955). Additionally, NIOSH has access to various survey results performed after the facility closed in 1960, including the 1965 "close-out" survey performed by Allied-Crossroads following the removal of the waste piles.

## **7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH**

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

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. This approach is discussed in

DCAS's SEC Petition Evaluation Internal Procedures which are available at <http://www.cdc.gov/niosh/ocas>. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00177 as submitted by the petitioner. (Section 7.4)

## **7.1 Pedigree of Vitro Manufacturing Data**

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

### **7.1.1 Internal Monitoring Data Pedigree Review**

NIOSH has been unable to locate internal monitoring data for Vitro Manufacturing workers for the period of this evaluation, January 1, 1958 through December 31, 1959. Neither bioassay monitoring results nor contamination survey results are available for Vitro during the evaluated period; therefore, an internal data sufficiency and pedigree evaluation is not possible for this data type.

### **7.1.2 External Monitoring Data Pedigree Review**

NIOSH has been unable to locate personnel external monitoring records for Vitro Manufacturing workers for the period of this evaluation, January 1, 1958 through December 31, 1959. Neither film badge results nor area monitoring results are available for Vitro during the evaluated period; therefore, an external data sufficiency and pedigree evaluation is not possible for this data type.

## **7.2 Evaluation of Bounding Internal Radiation Doses at Vitro Manufacturing**

The principal sources of internal radiation doses for members of the class under evaluation were from contamination due to uranium and uranium progeny. The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

### **7.2.1 Evaluation of Bounding Internal Doses**

During the period under evaluation, many work activities were very similar to those in the previously-designated AWE operational years for which a class has already been included in the SEC (e.g., recovery of uranium from ore residues, sampling, and analysis of the source materials and the product) (DHHS, 2009). Other non-routine activities just as likely to generate airborne radioactivity

were ongoing from 1958 through 1959, such as removal of equipment from process areas and teardown operations. Vitro workers were potentially exposed to uranium contamination, re-suspended uranium dust, and uranium progeny.

NIOSH has found no indications that bioassay measurements were collected for the period under evaluation. Air monitoring and contamination survey data are also not available for the 1958 through 1959 period. While NIOSH has obtained area air sampling results for the time period from 1949 through 1953, those results were found to be inadequate to bound internal intakes from uranium progeny through the end of 1957 (NIOSH, 2008) and are likewise found to be inadequate to bound internal intakes from uranium progeny during the period currently under evaluation, January 1, 1958 through December 31, 1959. Those samples were analyzed for gross alpha activity only and the data are highly variable with insufficient information available to allow NIOSH to apply the general area air concentrations to specific individual breathing zones.

Measurements of radon exposure in working levels were made in 1977 by Oak Ridge National Laboratory (Haywood, 1977) and in 1978 and 1979 by the Environmental Measurements Laboratory (Radon Results, 1979-1980). While an analysis of these radon data could be used to derive a concentration of radon, NIOSH cannot assume that some ore materials were not removed from Vitro Manufacturing during the period under review or after December 31, 1959, and therefore cannot verify that radon concentrations could not have been higher during the period under review.

NIOSH has not identified sufficient documentation to define and quantify the total internal source term for Vitro Manufacturing during the period under evaluation, January 1, 1958 through December 31, 1959. Without additional documentation, NIOSH cannot make assumptions about the relative amounts of materials that would have been encountered at the site during the evaluated period. Therefore, there is insufficient source term information available to NIOSH to bound internal exposures for the period from January 1, 1958 through December 31, 1959.

### **7.2.2 Methods for Bounding Internal Dose at Vitro Manufacturing**

NIOSH has determined that it lacks sufficient bioassay, workplace monitoring, and source term data needed to bound internal doses that Vitro workers potentially received from natural uranium and uranium progeny. Therefore, NIOSH has not identified a method for bounding internal doses at Vitro Manufacturing for the period from January 1, 1958 through December 31, 1959.

### **7.2.3 Internal Dose Reconstruction Feasibility Conclusion**

NIOSH has established that it does not have access to sufficient information to bound internal doses that Vitro Manufacturing workers potentially received during the period from January 1, 1958 through December 31, 1959.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from January 1, 1958 through December 31, 1959, 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 Vitro Manufacturing (Canonsburg) during the period from January 1, 1958 through December 31, 1959, 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 Vitro Manufacturing**

The principal sources of external radiation doses for members of the evaluated class were uranium and uranium progeny found in the uranium materials and wastes located on the property. Domestic ores, African pitchblende, recoverable scrap materials, and Canadian residues were processed onsite. Radium and its progeny would produce gamma radiation. Contaminated facilities and equipment would pose an external exposure hazard inside the buildings, while exposure to the waste storage piles and the contaminated soil would contribute to direct radiation exposure outside the buildings.

The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

#### **7.3.1 Evaluation of Bounding External Doses**

While the supporting documentation available to NIOSH states that external monitoring was performed for a number of operational years at Vitro, NIOSH has been unable to locate any individual external monitoring data for the period evaluated in this report, January 1, 1958 through December 31, 1959. NIOSH has access to a limited amount of general process and radiological source term information associated with uranium recovery work, but no specific information regarding the work at Vitro during the period under evaluation. NIOSH has been unable to locate any records of radiological surveys done following building cleanup at Vitro or of radiological surveys done following the removal of any waste pile material.

#### **7.3.2 Vitro Manufacturing Occupational X-Ray Examinations**

Occupational medical procedures are generally not noted in the Vitro Manufacturing records; however, documentation indicates that no routine X-ray examinations were performed before 1950, and that a routine program for chest X-rays had been established by May 1950 (Medical Correspondence, 1948-1953). NIOSH has found no indication that medical X-ray procedures were performed off the Vitro Manufacturing site. Without evidence of off-site medical X-ray exams, NIOSH assumes medical X-ray examinations were performed on the site and NIOSH will assign bounding medical doses in accordance with ORAUT-OTIB-0079 and ORAUT-OTIB-0006. NIOSH assumes that workers received an annual PA chest X-ray for each year of AWE employment beginning in 1950. NIOSH therefore concludes that it is likely feasible to reconstruct occupational medical dose for Vitro Manufacturing workers with sufficient accuracy.

#### **7.3.3 Methods for Bounding External Dose at Vitro Manufacturing**

NIOSH has determined that it lacks sufficient personnel monitoring data, area monitoring data, or source term data needed to bound external doses that Vitro workers potentially received from natural uranium and uranium progeny. Therefore, NIOSH has not identified a method for bounding external doses at Vitro Manufacturing for the period from January 1, 1958 through December 31, 1959.

#### **7.3.4 External Dose Reconstruction Feasibility Conclusion**

NIOSH has established that it does not have access to sufficient information to bound external doses that Vitro workers potentially received during the period from January 1, 1958 through December 31, 1959.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses for the period from January 1, 1958 through December 31, 1959, 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 Vitro Manufacturing (Canonsburg) during the period from January 1, 1958 through December 31, 1959, 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-00177**

The following subsections evaluate the assertions made on behalf of petition SEC-00177 for Vitro Manufacturing.

### **7.4.1 Monitoring Inadequacies**

Assertion: The SEC-00177 petitioner stated that radiation exposures and therefore radiation doses potentially incurred by members of the proposed class that relate to this petition were not monitored, either through personal or area monitoring.

Response: Personal monitoring and/or area monitoring results are not always absolutely necessary to develop an exposure model for a given facility. However, if these monitoring data are not available NIOSH must have access to source term information and detailed process information in order to develop a sufficiently accurate exposure model. NIOSH has determined that, to date, it does not have adequate internal or external monitoring data for members of the proposed class, nor does it have enough source term or process information applicable to the class to develop a sufficiently accurate model for the Vitro Manufacturing facility during the evaluated time period from January 1, 1958 through December 31, 1959.

### **7.4.2 Working Conditions After 1957**

Assertion: The SEC-00177 petitioner stated that the same working conditions that resulted in the inability to reconstruct doses for the AWE operations period existed after December 31, 1957.

Response: NIOSH conducted interviews with seven contemporaneous former workers in an attempt to understand the working conditions after 1957 at the Vitro Manufacturing site in Canonsburg, Pennsylvania. While most were unsure of specific contractual details regarding the purpose and scope of the work conducted after 1957, the interviews did present a consistent picture of unchanging operations into the period being evaluated.

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

During the feasibility evaluation for SEC-00177, an issue was identified that needed further analysis and resolution. The issue and its current status are:

- **ISSUE:** The SEC class associated with AWE operations from August 13, 1942 through December 31, 1957 (DHHS, 2009) was based on the lack of monitoring data for non-uranium radionuclides in disequilibrium with uranium. In order to ascertain the disequilibrium conditions at Vitro, NIOSH attempted to determine the disequilibrium ratio associated with other sites (Tyson Valley Powder Farm, Hanford, Mallinckrodt Chemical Works, MIT Middlesex, Y-12, and Oak Ridge National Laboratory) that sent scrap and uranium-bearing residues to Vitro Manufacturing.

**RESPONSE:** NIOSH researched all disequilibrium ratio information available for the sites known to have sent materials to Vitro for uranium recovery. While information was available for some of the sites, there is not a complete inventory of the materials sent to Vitro. Available data include examples of material types and volumes from memos and other contemporary documents. NIOSH was unable to locate enough information to attempt a meaningful derivation of assumed equilibrium ratios at Vitro Manufacturing based on the radionuclide ratios being introduced to the site.

## 7.6 Summary of Feasibility Findings for Petition SEC-00177

This report evaluates the feasibility for completing dose reconstructions for employees at Vitro Manufacturing from January 1, 1958 through December 31, 1959. 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.

Table 7-1 summarizes the results of the feasibility findings at Vitro Manufacturing for each exposure source during the time period January 1958 through April 1960.

| <b>Table 7-1: Summary of Feasibility Findings for SEC-00177</b><br>January 1, 1958 through December 31, 1959 |                                |                                    |
|--|--------------------------------|------------------------------------|
| <b>Source of Exposure</b>  | <b>Reconstruction Feasible</b> | <b>Reconstruction Not Feasible</b> |
| <b>Internal</b>  |                                | <b>X</b>                           |
| - Natural Uranium  |                                | X                                  |
| - Uranium Progeny  |                                | X                                  |
| <b>External</b>  |                                | <b>X</b>                           |
| - Gamma  |                                | X                                  |
| - Beta   |                                | X                                  |
| - Neutron  | N/A                            | N/A                                |
| - Occupational Medical X-ray   | X                              |                                    |

As of January 24, 2011, a total of 14 claims have been submitted to NIOSH for individuals who worked at Vitro Manufacturing and who worked during the period evaluated in this report. Dose

reconstructions have been completed for 9 individuals, 5 claims were pulled because of the SEC designation associated with SEC-00134 (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 Vitro Manufacturing (Canonsburg) during the period from January 1, 1958 through December 31, 1959, 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-00177**

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.

NIOSH lacks personnel monitoring data, air monitoring information, sufficient process information, and radiological source term information for the period to allow a sufficiently accurate estimate of the potential exposures to uranium products and uranium progeny at the Vitro Manufacturing site. The data that are available to NIOSH pre-date the evaluation period by multiple years, making any attempt to model potential internal exposures using those available data highly uncertain. Likewise, the post-operations data were collected multiple years after the cessation of evaluated operations and would not likely be representative of the period of concern. Therefore, NIOSH's evaluation determined that it is not feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Therefore, the resulting NIOSH-proposed SEC class must include a minimum required employment period as a basis for specifying that health was endangered.

## **9.0 Class Conclusion for Petition SEC-00177**

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 Employer employees who worked at Vitro Manufacturing in Canonsburg, Pennsylvania, from January 1, 1958 through

December 31, 1959, 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 is reserving its feasibility evaluation for the Vitro Manufacturing residual radiation period beginning in January 1960.

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-00177. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

## 10.0 References

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## Attachment One: Data Capture Synopsis

| <b>Table A1-1: Summary of Holdings in the SRDB for Vitro Manufacturing (Canonsburg)</b>  |   |                       |                           |
|--|---|-----------------------|---------------------------|
| <b>Data Capture Information</b>  | <b>Data Capture Description</b>   | <b>Date Completed</b> | <b>Uploaded into SRDB</b> |
| <u>Primary Site/Company Name:</u> Vitro Manufacturing<br><br><u>Other Site Names:</u> Vitro Rare Metals Co.<br><br><u>Successor History:</u><br>GEC merged with British Aerospace to form BAE Systems in 1999<br>General Electric Company - 1998<br>Merged with TAS formed Tracor Systems Technologies - 1993<br>Tracor Applied Sciences - 1993<br>Penn Central Corporation - 1981<br>Renamed to GK Technologies - 1978<br>General Cable Corporation - 1978<br>Automation Industries - 1968<br>Vitro Manufacturing Company | BAE Systems, successor company, Legal Counsel confirmed that a search of records and archives had been performed and that no information relating to any Vitro site had been found.<br><br>No relevant data located.  | 02/25/2008            | 0                         |
| State Contacted:<br>PA Office Bureau of Radiation Protection (Contact: Director PA Dept. of Environmental Protection)  | No relevant data identified.  | 02/22/2008            | 0                         |
| Department of Labor/Paragon  | Lake Ontario Ordnance Works (LOOW) reports which identify Vitro residues, FUSRAP briefing material, and Tonawanda Sub-Office reports which discuss Vitro residues.  | 12/30/2008            | 23                        |
| DOE Environmental Measurements Laboratory/Health And Safety Laboratory   | Site visits, annual report, thorium sampling and storage, and symposium V on aerosols.  | 03/08/2005            | 1                         |
| DOE Germantown   | NYOO uranium operations flow chart, monthly field report, radiological surveys, air sampling and radon in breath exposure data, biological effects of radioactivity near plant, reports documenting Vitro as an AEC uranium supplier, miscellaneous letters, memos and lists, and an accident report. | 01/11/2008            | 20                        |
| DOE Hanford  | Scrap shipments to Vitro. No additional relevant records were identified during Hanford's search for Vitro Manufacturing records (Activity 31, initiated, 09/14/2010, search results forwarded to ER Team Lead 12/20/2010).   | 12/27/2010            | 1                         |

| <b>Table A1-1: Summary of Holdings in the SRDB for Vitro Manufacturing (Canonsburg)</b> |   |                       |                           |
|---|---|-----------------------|---------------------------|
| <b>Data Capture Information</b>   | <b>Data Capture Description</b>   | <b>Date Completed</b> | <b>Uploaded into SRDB</b> |
| DOE Legacy Management - Grand Junction Office   | Tonawanda area Sub-Office and Niagara Frontier Atomic Weapons Employer reports which discuss Vitro residues and scrap, shipments of scrap to Vitro, residue and scrap processing at Vitro, site visits, dose rate surveys, film badge results, air sample results, contract documents, process descriptions, radiological environmental surveys, Canonsburg litigation documents, radon monitoring, Cleveland area Vitro reports, 1953 site decontamination, monthly production reports, engineering assessments, vicinity property surveys, FUSRAP documents, radon mitigation, UMTRA reports, US NRC comments and reviews of remediation plans and reports, draft environmental impact statement and comments, public and project meeting notes, contract flow charts, documentation of uranium produced for sale to Britain, and remedial action plan documents. | 11/17/2010            | 326                       |
| DOE Legacy Management - Morgantown  | 1951 summary of uranium production, LOOW surveys which mention ore received from Vitro, and summary lists of uranium production sites.  | 06/30/2010            | 5                         |
| DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)   | Radon monitoring plan and results, film badge correspondence, HP and operating procedures, Th-230 air samples, environmental TLD's, urinalysis results, radiological survey of the former Vitro Rare Metals Plant, NYOO health and safety field activities reports, production of uranium feed materials, project management plan for remedial action, designation of vicinity properties, and an annual report.  | 05/13/2010            | 27                        |
| DOE Oak Ridge Operations, Records Holdings Task Group Vault                             | Uranium dust exposure information, 1944-1945 work reports with exposure monitoring data, and the report of a 2002 NIOSH reconnaissance.   | 12/10/2010            | 3                         |
| DOE Oak Ridge Operations, Records Holdings Task Group Vault/SC&A                        | Film badge results, 1952  | 12/08/2004            | 1                         |
| DOE Savannah River Site   | 1962 and 1963 thorium reports which discuss thorium metal received from Vitro.  | 08/06/2008            | 2                         |
| [Name Redacted] via NIOSH   | A 1984 list of documents produced for litigation regarding Vitro.   | 01/24/2010            | 1                         |
| Federal Records Center - Kansas City  | Weekly Manhattan Engineer District reports, late 1942 and 1946.   | 08/11/2008            | 1                         |
| Internet - Amazon.com   | 1st of a Kind WMD's, ETC, a history of Vitro and Kellex.  | 11/23/2010            | 1                         |
| Internet - Comprehensive Epidemiologic Data Resource (CEDR)                             | No relevant data identified.  | 03/27/2008            | 0                         |
| Internet - Division of Compensation Analysis and Support                                | Department of Health and Human Services notice documenting the addition of a class of Vitro workers to the Special Exposure Cohort.   | 11/19/2010            | 1                         |
| Internet - DOE Hanford Declassified Document Retrieval System (DDRS)                    | Trip report on uranium scrap processing at the Vitro Manufacturing Co., Canonsburg, PA.   | 01/09/2004            | 1                         |
| Internet - DOE Health Safety and Security Worker Advocacy Site                          | Site description.   | 01/16/2008            | 1                         |

| <b>Table A1-1: Summary of Holdings in the SRDB for Vitro Manufacturing (Canonsburg)</b>    |  |                       |                           |
|--|--|-----------------------|---------------------------|
| <b>Data Capture Information</b>  | <b>Data Capture Description</b>  | <b>Date Completed</b> | <b>Uploaded into SRDB</b> |
| Internet - DOE Legacy Management Considered Sites  | Canonsburg disposal site fact sheet, long-term site surveillance plans, and a Tonawanda area progress report which documents the shipment of a ball mill and dust collector to Vitro.  | 10/05/2010            | 4                         |
| Internet - DOE OpenNet   | 1949 NYOO monthly status and progress reports, the Manhattan District History, Book I, Volume 7, and Linking Legacies Appendix B.  | 12/31/2007            | 5                         |
| Internet - DOE OSTI Energy Citations   | A 1949 Hanford monthly report that documents the shipment of 19 tons of uranium oxide to Vitro, a report on uranium extraction with organic solvents, and a report on the problems of leaching uraniferous slag.   | 02/17/2010            | 3                         |
| Internet - DOE OSTI Information Bridge   | Monthly report, UMTRA Project water sampling plan, engineering feasibility analysis for in-situ stabilization of residues, proceedings of a decontamination conference, UMTRA annual reports to stakeholders, a risk assessment of ground water contamination, reports on the problems of leaching uraniferous slag and refining uraniferous residues. | 12/02/2010            | 40                        |
| Internet - Google  | Poisoned workers and places: part 2/3, Canonsburg site descriptions and histories, an epidemiological study, news stories, and analysis of institutional responsibilities for the long-term management of contaminant isolation facilities.  | 10/05/2010            | 22                        |
| Internet - HP Journal  | No relevant data identified.   | 10/04/2010            | 0                         |
| Internet - Journal of Occupational and Environmental Health                                | No relevant data identified.   | 10/04/2010            | 0                         |
| Internet - National Academies Press (NAP)  | No relevant data identified.   | 03/09/2008            | 0                         |
| Internet - National Archives   | No relevant data identified.   | 01/03/2008            | 0                         |
| Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office            | No relevant data identified.   | 03/14/2008            | 0                         |
| Internet - NRC Agencywide Document Access and Management (ADAMS)                           | Canonsburg ground water concentrations, request for NRC approval to delete institutional controls, precicensing and annual inspections, data validation packages, proposals for erosion control and stream bank stabilization, long term surveillance plans, ground water contaminant concentrations, and a radiological release survey plan.          | 09/28/2010            | 41                        |
| Internet - NRC Agencywide Document Access and Management (ADAMS) Public Library            | A 1994 report which discusses the removal of residues, NRC comments on an erosion control plan, and notice of the issuance of a license for long-term care of the Canonsburg site.   | 10/04/2010            | 3                         |
| Internet - Washington State University (United States Transuranium and Uranium Registries) | No relevant data identified.   | 03/27/2008            | 0                         |
| Missouri Department of Natural Resources   | Historical storage of radioactive material, and a final environmental impact statement.  | 10/03/2008            | 4                         |

| <b>Table A1-1: Summary of Holdings in the SRDB for Vitro Manufacturing (Canonsburg)</b> |  |                       |                           |
|---|--|-----------------------|---------------------------|
| <b>Data Capture Information</b>   | <b>Data Capture Description</b>  | <b>Date Completed</b> | <b>Uploaded into SRDB</b> |
| National Archives and Records Administration - Atlanta                                  | Film badge results, radon breath measurements, air samples and radon data, gamma radiation at Vitro, Vitro contract AT(30-1)-1241 (1951), 1949 and 1950 trip reports, reports and correspondence on uranium ore, receipts of scrap at Vitro, pitchblende processing, and periodic progress reports.  | 02/28/2007            | 48                        |
| National Archives and Records Administration - College Park                             | 1948 weekly film badge report, 1951 Kellex report which discusses recovery of uranium from process residues, 1948 memo regarding the markings on a new film badge design, flow chart of NYOO uranium operations, and a reviewer's notes from a College Park data capture.  | 09/24/2010            | 7                         |
| National Archives and Records Administration - Kansas City                              | Radiation surveys, waste disposal, solid waste treatment, disposal of uranium bearing residues, radiological survey plan, close out survey, survey of buildings #14 and #16, environmental radiation surveys, radon monitoring data, phase II radiological survey, radiological survey of the former Vitro Rare Metals Plant, and an evaluation of radiation exposures.  | 08/14/2008            | 27                        |
| NIOSH   | Department of Labor letters extending the covered period to 1959.  | 01/20/2011            | 2                         |
| NOCTS   | Claim file CATI extracts with: brief job/process description for filter press operator, ore process, Belgium Congo material process, Canadian ore processing description, site date information, list of most hazardous positions, cubic yards of onsite uranium, newspaper clippings and site timeline, DOE radiological survey memo, newspaper clipping with amount of contaminated waste buried onsite, and other claimant documents to support Vitro work post-1957. | 01/17/2008            | 15                        |
| ORAU Team   | Project spreadsheet, monitoring data, and documented communications with process knowledge sources.  | 12/06/2010            | 9                         |
| Unknown   | Air dust samples, film badge reports, medical records, monthly status and progress reports, NYOO Health and Safety Division monthly reports of field activities, radiological survey of the former Vitro Rare Metals Plant in Canonsburg, alpha smears, summary of Manhattan Project, uranium flow sheet, safety evaluations, Vitro correspondence, material transactions with other sites, NYOO Medical Division health hazards report, and urinalysis reports.         | 09/12/2004            | 69                        |
| Unknown/SC&A  | Merits of keeping dosimetry badges on site, film badge reports and correspondence, process and hazard descriptions.  | 06/23/2003            | 12                        |
| US Army Corps of Engineers, Buffalo District  | A 1950 report with limits on unaccounted losses at Vitro and other facilities.   | 06/24/2010            | 1                         |
| US Army Corps of Engineers, St. Louis District  | North County uranium residues historical synopsis, St. Louis, MO, which discusses the history behind Vitro residues in the St. Louis area.   | 03/18/2008            | 1                         |
| <b>Total</b>  |  |                       | <b>728</b>                |

| <b>Table A1-2: Database Searches for Vitro Manufacturing (Canonsburg)</b>  |                 |             |                           |
|--|-----------------|-------------|---------------------------|
| <b>Database/Source</b>   | <b>Keywords</b> | <b>Hits</b> | <b>Uploaded into SRDB</b> |
| NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Data Capture Synopsis for Vitro Manufacturing Canonsburg." |                 |             |                           |
| CEDR<br><a href="http://cedr.lbl.gov/">http://cedr.lbl.gov/</a><br>COMPLETED 03/27/2008  | See note above  | 0           | 0                         |
| DOE Hanford DDRS<br><a href="http://www2.hanford.gov/declass/">http://www2.hanford.gov/declass/</a><br>COMPLETED 09/24/2010  | See note above  | 1           | 1                         |
| DOE Legacy Management Considered Sites<br><a href="http://csd.lm.doe.gov/">http://csd.lm.doe.gov/</a><br>COMPLETED 10/05/2010  | See note above  | 10          | 4                         |
| DOE OpenNet<br><a href="http://www.osti.gov/opennet/advancedsearch.jsp">http://www.osti.gov/opennet/advancedsearch.jsp</a><br>COMPLETED 01/03/2008                             | See note above  | 8           | 5                         |
| DOE Energy Citations<br><a href="http://www.osti.gov/energycitations/">http://www.osti.gov/energycitations/</a><br>COMPLETED 03/28/2008  | See note above  | 26          | 1                         |
| DOE OSTI Information Bridge<br><a href="http://www.osti.gov/bridge/advancedsearch.jsp">http://www.osti.gov/bridge/advancedsearch.jsp</a><br>COMPLETED 10/04/2010               | See note above  | 204         | 20                        |
| Google<br><a href="http://www.google.com">http://www.google.com</a><br>COMPLETED 10/04/2010  | See note above  | 3,529       | 21                        |
| HP Journal<br><a href="http://journals.lww.com/health-physics/pages/default.aspx">http://journals.lww.com/health-physics/pages/default.aspx</a><br>COMPLETED 10/04/2010        | See note above  | 1           | 0                         |
| Journal of Occupational and Environmental Health<br><a href="http://www.ijoeh.com/index.php/ijoeh">http://www.ijoeh.com/index.php/ijoeh</a><br>COMPLETED 10/04/2010            | See note above  | 1           | 0                         |
| National Academies Press<br><a href="http://www.nap.edu/">http://www.nap.edu/</a><br>COMPLETED 03/09/2008  | See note above  | 14          | 0                         |

| <b>Table A1-2: Database Searches for Vitro Manufacturing (Canonsburg)</b>  |                 |             |                           |
|--|-----------------|-------------|---------------------------|
| <b>Database/Source</b>   | <b>Keywords</b> | <b>Hits</b> | <b>Uploaded into SRDB</b> |
| National Archives<br><a href="http://search.archives.gov/query.html">http://search.archives.gov/query.html</a><br>COMPLETE 01/03/2008  | See note above  | 0           | 0                         |
| NNSA - Nevada Site Office<br><a href="http://www.nv.doe.gov/main/search.htm">www.nv.doe.gov/main/search.htm</a><br>COMPLETED 03/14/2008  | See note above  | 0           | 0                         |
| NRC ADAMS Public Legacy Library<br><a href="http://adamspublic.nrc.gov/FNOpenClient/FnLogin.aspx?Library=PL_ADAMS^PBNTAD08&amp;Op=Logon&amp;ReturnURL=%2fFNOpenClient%2fFnBrowsePage.aspx%3fLibrary%3dPL_ADAMS%5ePBNTAD08%26Op%3dBrowse&amp;Error=10001">http://adamspublic.nrc.gov/FNOpenClient/FnLogin.aspx?Library=PL_ADAMS^PBNTAD08&amp;Op=Logon&amp;ReturnURL=%2fFNOpenClient%2fFnBrowsePage.aspx%3fLibrary%3dPL_ADAMS%5ePBNTAD08%26Op%3dBrowse&amp;Error=10001</a><br>COMPLETED 10/04/2010 | See note above  | 17          | 1                         |
| NRC ADAMS Public Library<br><a href="http://adamspublic.nrc.gov/FNOpenClient/FnLogin.aspx?Library=PU_ADAMS^PBNTAD01&amp;Op=Logon&amp;ReturnURL=%2fFNOpenClient%2fFnBrowsePage.aspx%3fLibrary%3dPU_ADAMS%5ePBNTAD01%26Op%3dBrowse&amp;Error=10001">http://adamspublic.nrc.gov/FNOpenClient/FnLogin.aspx?Library=PU_ADAMS^PBNTAD01&amp;Op=Logon&amp;ReturnURL=%2fFNOpenClient%2fFnBrowsePage.aspx%3fLibrary%3dPU_ADAMS%5ePBNTAD01%26Op%3dBrowse&amp;Error=10001</a><br>COMPLETED 10/04/2010        | See note above  | 300         | 2                         |
| NRC ADAMS Reading Room<br><a href="http://www.nrc.gov/reading-rm/adams/web-based.html">http://www.nrc.gov/reading-rm/adams/web-based.html</a><br>COMPLETED 09/24/2010  | See note above  | 564         | 41                        |
| U.S. Transuranium & Uranium Registries<br><a href="http://www.ustur.wsu.edu/">http://www.ustur.wsu.edu/</a><br>COMPLETED 03/27/2008  | See note above  | 0           | 0                         |