SEC Petition Evaluation Report
Petition SEC-00141

Report Rev #: 0 Report Submittal Date: May 3, 2010

Subject Expert(s):	Tim Adler, Joe Guido
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00141	83.13	March 6, 2009	October 16, 2009	Hooker Electrochemical

Petitioner Class Definition

All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and residual period from January 1, 1949 to December 31, 1976.

Class Evaluated by NIOSH

All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and during the residual period from January 1, 1949 to December 31, 1976.

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

None

Related Petition Summary Information

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

Related Evaluation Report Information

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

ORAU Lead Technical Evaluator: Tim Adler

ORAU Peer Review Completed By: Daniel Stempfley

Peer Review Completed By:	[Signature on file] *Dave Allen*	5/3/2010 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on file] *J. W. Neton*	5/3/2010 *Date*
SEC Evaluation Approved By:	[Signature on file] *Stuart L. Hinnefeld*	5/3/2010 *Date*

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Evaluation Report Summary: SEC-00141, Hooker Electrochemical

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

The petitioner initially requested that the class be limited to all laborer/furnace processors. On September 26, 2009 NIOSH received a letter from the petitioner requesting that the petitioner-requested class include "all employees, all locations" instead of limiting the class to all laborers/furnace operators. NIOSH has decided to modify the original petition to incorporate this class change in lieu of requesting the petitioner to initiate an entirely new petition.

Petition SEC-00141 was received on March 6, 2009, and qualified on October 16, 2009. The petitioner requested that NIOSH consider the following class: *All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and residual period from January 1, 1949 to December 31, 1976.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class. NIOSH evaluated the following class: All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and during the residual period from January 1, 1949 to December 31, 1976.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has obtained applicable monitoring data from other sites that performed similar work. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, 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 the site profile and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period.

Health Endangerment Determination

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

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SEC Petition Evaluation Report for SEC-00141

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and during the residual period from January 1, 1949 to December 31, 1976. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

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

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

class or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

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

3.0 SEC-00141, Hooker Electrochemical Class Definitions

The following subsections address the evolution of the class definition for SEC-00141, Hooker Electrochemical. 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 petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

The petitioner initially requested that the class be limited to all laborer/furnace processors. On September 26, 2009 NIOSH received a letter from the petitioner requesting that the petitioner-requested class include "all employees, all locations" instead of limiting the class to all laborers/furnace operators (Name1, 2009d). NIOSH has decided to modify the original petition to incorporate this class change in lieu of requesting the petitioner to initiate an entirely new petition.

Petition SEC-00141 was received on March 6, 2009, and qualified on October 16, 2009. The petitioner requested that NIOSH consider the following class: *All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and residual period from January 1, 1949 to December 31, 1976.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Hooker Electrochemical workers in question. NIOSH deemed the following affidavit statement sufficient to qualify SEC-00141 for evaluation:

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

To the best of my knowledge, there is no internal or external monitoring for Hooker Electrochemical Corp.

Based on its Hooker Electrochemical research and data capture efforts, NIOSH determined that it does not have access to any site-specific internal, external, or area monitoring for Hooker Electrochemical workers that were involved with radiological work or potentially exposed to residual radiation during the time period under evaluation. NIOSH concluded that there is sufficient documentation to support the petition basis that internal and external radiation exposures and radiation doses were not monitored at Hooker Electrochemical, 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 accepted the petitioner-requested class. Therefore, NIOSH defined the following class for further evaluation: All employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and during the residual period from January 1, 1949 to December 31, 1976.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research, NIOSH has obtained applicable monitoring data from other sites that performed similar work. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

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 Hooker Electrochemical. 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 Hooker Electrochemical documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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

4.1 Site Profile Technical Basis Documents (TBDs)

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

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

- *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium-Appendix AA-Hooker Electrochemical Company*, Battelle-TBD-6001 Appendix AA; Rev. 0; June 15, 2007; SRDB Ref ID: 74577

- *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium-Appendix C-Electro Metallurgical Company*, Battelle-TBD-6001 Appendix C; Rev. 0; December 21, 2007; SRDB Ref ID: 41362

- *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium-Appendix B-DuPont Deepwater Works*, Battelle-TBD-6001 Appendix B; Rev. 1; January 3, 2008; SRDB Ref ID: 41363

- *Basis for Development of an Exposure Matrix for the Mallinckrodt Chemical Company St. Louis Downtown Site and the St. Louis Airport Site, St. Louis, Missouri*, ORAUT-TKBS-0005; Rev. 02 PC-1; May 25, 2009; SRDB Ref ID: 67979

4.2 Technical Information Bulletins (TIBs)

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

- *TIB: Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds*, ORAUT-OTIB-0024; Rev. 00; April 7, 2005; SRDB Ref ID: 19445

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

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

- *TIB: Estimation of Ingestion Intakes*, OCAS-TIB-009; Rev. 0; April 13, 2004; SRDB Ref ID: 22397

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed three former Hooker Electrochemical employees regarding their knowledge about Hooker workplace radiation fields, radionuclide intakes, and potential exposures during the time period being evaluated in this report.

- Personal Communication, 2009a, *Personal Communication with Former Hooker Electrochemical "Yard Gang" Employee*; Telephone Interview by ORAU Team; December 12, 2009, 10:30 AM EST; SRDB Ref ID: 77828

- Personal Communication, 2009b, *Personal Communication with Former Hooker Electrochemical Chemical Engineer/Operator*; Telephone Interview by ORAU Team; December 12, 2009, 11:15 AM; SRDB Ref ID: 77827

- Personal Communication, 2009c, *Personal Communication with Former Hooker Electrochemical Chemical Operator*; Telephone Interview by ORAU Team; December 19, 2009, 11:00 AM EST; SRDB Ref ID: 77826

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH OCAS Claims Tracking System (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 December 28, 2009.)

Table 4-1: No. of Hooker Electrochemical Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	110
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (January 1, 1943 through December 31, 1976)	110
Number of dose reconstructions completed for energy employees who meet the definition criteria for the class under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	93
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	0

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Based on its review of the dose reconstructions completed for employees at Hooker Electrochemical and the available documentation for the site, NIOSH has identified no personnel or area monitoring data for the Hooker Electrochemical

Corporation site. NIOSH's detailed review and assessment of the available records/documentation, process information, and air monitoring data (from other sites performing similar work), is provided in Sections 6.0 and 7.0 of this report.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. One hundred eighty-three documents in this database were identified as pertaining to the Hooker Electrochemical site. These documents were evaluated for their relevance to this petition. The documents include historical background on the site's Manhattan Engineer District activities, including process descriptions and radioactive source materials.

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 with Affidavit*; Received March 6, 2009; OSA Ref ID: 108367 (Form B, 2009)
- *SEC-00141 Consult Call Response;* April 22, 2009; OSA Ref ID: 108663 (Name1, 2009a)
- *Petitioner's Response to the Proposed Finding Letter*; June 12, 2009; OSA Ref ID: 109045 (Name1, 2009b)
- *Petitioner's Request for Administrative Review of the NIOSH Proposed Finding*; September 10, 2009; OSA Ref ID: 109775 (Name1, 2009c)
- *Email from Survivor Requesting Change in Proposed Class;* September 26, 2009; OSA Ref ID: 109856 (Name1, 2009d)
- *Affidavit from Survivor*, no internal or external monitoring; September 28, 2009; OSA Ref ID: 109892 (Affidavit, 2009)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the Hooker Electrochemical site from January 1943 through December 1976 and the information available to NIOSH to characterize particular processes and radioactive source materials. From sites that performed work similar to the work that was performed at the Hooker Electrochemical site, NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Hooker Electrochemical Plant and Process Descriptions

ATTRIBUTION AND ANNOTATION: Section 5.1 was completed by Tim Adler, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

Hooker Electrochemical Company was located in Niagara Falls, New York. From January 1943 until June 1948, Hooker Electrochemical manufactured various organic chemicals including xylene hexafluoride (P-45), xylene hexachloride, and Miller's Fluoro Lubricant (MFL) while under Contract No. W-7405 eng-28 with the Manhattan Engineer District (MED). Although these processes in themselves did not involve radioactive materials, during part of this period hydrochloric acid (a byproduct of the P-45 process) was used to concentrate uranium-bearing C-2 slag that was sent from the Electro-Metallurgical Corporation to the Hooker Electrochemical site (ORNL, unknown date). The portion of the Hooker Electrochemical site used under the MED program was the "D" Area, 5.5 acres located on the north bank of the Niagara River in Niagara Falls, New York, about two miles east of the falls. Five buildings on this site, D-5, D-6, D-7, D-8 and D-9 were used under the contract with MED from 1943 through 1948 for organic chemical processing work; apparently none of these buildings were used for the uranium recovery operation (Olotka, 1979). As described below, evidence exists that a single (un-named) building was built near this area for the purpose of housing a portion of the uranium recovery operations.

The C-2 slag material was primarily from reduction bomb (dolomite) liners with an approximate composition of 90% magnesium fluoride and 10% calcium oxide. (The term bomb, as used here, refers to a device used to contain a particular chemical process.) The slag reportedly contained approximately one pound of uranium per 500 pounds of slag (Howland, 1944, pp. 29-30). Process descriptions indicate the C-2 slag uranium concentration process was sufficient to take care of the excess hydrochloric acid from the Hooker P-45 process. Slag was received in barrels containing approximately 500 pounds of material. The barrels were opened and the material was dumped through a sizing screen onto a conveyor belt that carried the slag into one of three digest tanks. Forty barrels of slag were added to each tank. Waste hydrochloric acid from the P-45 Plant was passed into the digest tank and the pH was adjusted to 4.0 (via the addition of water). After the tank was filled, the contents were agitated for 20 hours. About once in two days a tank was emptied, which was sufficient to take care of the waste hydrochloric acid. At the completion of the digest, the slurry was neutralized by dumping 100-pound bags of lime into the tanks from an overhead platform, pumped into a plate and frame press, and filtered. The filtrate was passed off into the sewer. The precipitate was washed several times and re-barreled. Slag was concentrated from about one pound of uranium to 5 or 10 pounds of uranium by weight (Howland, 1944, pp. 29-30).

Information from various site-related documents and interviews conducted during this evaluation indicates that the uranium concentration/recovery operation occurred partially indoors and partially outdoors. Some documents imply that the operation occurred entirely outdoors. However, during an interview with a former Hooker Electrochemical employee who was involved with the initial processing of the slag, NIOSH was told that raw material (presumably C-2 slag, based on the description, work area, and work dates) was initially delivered in whiskey-type barrels, opened, sorted for size, and then dumped onto a conveyor inside a block building that was apparently built for this specific activity (Personal Communication, 2009a). This interviewed employee noted that he worked with three other men. He also described how barrels of material (presumably C-2 slag) were delivered at night, as they were always waiting in the building when he and his co-workers arrived at work each

morning. They would open the barrels, get the material through a sizing screen and onto a conveyor which exited the building, carrying the sorted material outside to a location unknown to him. This employee also remembered that initially he and three other men received and processed approximately 25 barrels/shipment (approximately 5 tons). The work later increased to approximately 40 barrels/shipment (approximately 10 tons). Another former Hooker Electrochemical employee who worked nearby on the (non-radioactive) P-45 process noted that although he had no knowledge of where the C-2 slag material was initially dropped off and sorted, he remembered that the acid concentration and subsequent processes were all performed outside (Personal Communication, 2009b). Documentation further describing the outdoor activities includes the MED Process Hazard evaluation, which lists ventilation as "outdoors" (Howland, 1944, p. 29), and 1944 notes from a MED Industrial Hygienist which made reference to potential worker exposure during uranium operations due to the wind direction (Ferry, 1944).

Documentation further describing the amount of C-2 processed includes the aforementioned MED Process Hazard evaluation, in which the MED document states that the "actual quantity or monthly rate" was 10 tons per month (Howland, 1944, p. 29). A War Department memo dated March 8, 1946, indicates that a total of 152 tons of slag were processed through this system and that the slag-treatment process operated from July 1944 through January 15, 1946 (Mears, 1946). At 10 tons per month, this timeframe would equal 180 tons, which appears to be consistent with the former employee who indicated that the process rate started slower, but then increased. Taken together, these sources indicate that the barrels were emptied approximately one day per month. These sources also imply that after approximately every two days, only the liquid contents were decanted off and replaced with additional hydrochloric acid.

As mentioned above and established by a War Department memo dated March 8, 1946, the period of operational radiation exposure work at the Hooker Electrochemical site was from July 1944 through January 15, 1946; the P-45 process ended on January 15, 1946 (Mears, 1946). It is possible that the slag-processing occurred for an even shorter period since some start-up time would be expected. For the purposes assessing the ability to bound dose for the evaluated class, this evaluation assumes a period of residual radioactivity exposure from January 16, 1946 to October 11, 1976, the date when measurements for radiation and radioactivity onsite were made, and it was concluded that there were no elevated levels of radioactivity on the Hooker Electrochemical site (DOE, 1977, p. 11). Because no additional radioactive material was brought to the site in the final quarter of 1976, conclusions regarding the feasibility of dose reconstruction for the assumed residual period stated above can be applied through December 31, 1976, as requested in the SEC-00141 petition.

Subsequent to the shutdown of the Hooker facility, Electro-Metallurgical Corporation continued to operate, sending the waste slag material to the Lake Ontario Ordnance Works site (Unknown, 1949, p. 192). The material at Lake Ontario Ordnance Works was eventually shipped to the Y-12 site for uranium recovery (Keller, 1958). However, some amount of the material remained on the ground surface at Lake Ontario Ordnance Works (Anderson, 1981a, p. 72; Unknown, 1971, p. 61).

5.2 Radiological Exposure Sources from Hooker Electrochemical Operations

ATTRIBUTION AND ANNOTATION: Section 5.2 and its related subsections were completed by Joe Guido, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

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

5.2.1 Internal Radiological Exposure Sources from Hooker Electrochemical Operations

Considering that the Electro-Metallurgical Corporation sent uranium-bearing C-2 slag to the Hooker site, the primary source of internal radiological exposure resulting from Hooker Electrochemical operations was inhalation and/or ingestion of uranium metal present in magnesium-fluoride residues obtained from the uranium-tetrafluoride reduction process utilized at the Electro-Metallurgical Corporation. The radiological hazard presented by uranium metal or compounds results primarily from alpha particles emitted by uranium-238 (4.15 MeV and 4.20 MeV) and its isotopes uranium-235 (4.37 MeV, 4.40 MeV, and 4.58 MeV) and uranium-234 (4.72 MeV and 4.77 MeV). Naturally occurring uranium is 0.71% (w/w) uranium-235 and 0.0055% (w/w) uranium-234. NIOSH assumes that uranium tetrafluoride received at the Electro-Metallurgical Corporation was derived solely from naturally occurring ores. This assumption is based on the knowledge that the uranium produced at the Electro-Metallurgical Corporation was fabricated into fuel for use in the production reactors at Hanford, which only used uranium of natural enrichments. On an activity basis (i.e., dpm/gram) uranium-235 will be present in negligible amounts at these enrichment levels, but the uranium-234 activity will be at a level that is essentially equal to uranium-238, due to its much shorter half-life (2.46E05 years for uranium-234 and 4.47E09 years for uranium-238, respectively).

It is known that some facilities were involved in processing uranium recovered from spent nuclear fuel. This material contained trace amounts of transuranic radionuclides, which could have been concentrated during the refining process, thereby presenting an internal dose hazard. However, the use of recycled uranium did not commence until 1952, which is well into the final standby period at the Electro-Metallurgical Corporation. For this reason, it can be assumed that recycled uranium was not processed at the Electro-Metallurgical Corporation site, and hence not present at the Hooker Electrochemical site.

5.2.1.1 Uranium

The work performed at Hooker Electrochemical involved concentrating C-2 slag material (received from the Electro-Metallurgical Corporation) using hydrochloric acid. The uranium concentration in the C-2 slag was below what was normally considered economically feasible for recovery. As deduced from a MED Industrial Hazard Rating Data Sheet, the slag contained about one pound of uranium in a 500 pound barrel, or about 0.2% uranium by mass and was concentrated to a level between 5 and 10 pounds per 500 pound barrel (1 – 2% uranium by mass) (Howland, 1944, p. 29).

Given that the same process was used at both the Mallinckrodt and Electro-Metallurgical facilities, a similar material was produced at the Uranium Metal Plant operated by Mallinckrodt in St. Louis, Missouri (NYOO, 1949, p. 128). A 1945 document termed the dolomite liner material as C-2 (Simons, 1945) and a 1965 document describing waste from the period 1946 to 1953, termed the

material as C-liner (Unknown, 1959). Prior to 1946, the material was shipped to the DuPont Deepwater Works facility (Simons, 1945), and later it was shipped to the St. Louis Airport Storage site where it was deposited on the ground (Unknown, 1959). This material was still present during a 1965 survey of the St. Louis Airport Storage site (Miller, 1965). This same report indicates that as of 1965, half the material had been shipped to the Fernald plant for uranium recovery. The material appears to have been subsequently moved off the St. Louis Airport Storage site with the other raffinate materials that ended up at the St. Louis Latty Avenue site (Sapirie, 1966). The Mallinckrodt material is described as having a uranium content of <2% (Unknown, 1959). Based on inventory data from the St. Louis Airport Storage site (49 tons uranium in a 4,000 ton pile), the uranium content can be calculated as 1.2% (Miller, 1965). The only definitive account of the uranium content of the Mallinckrodt material is contained in a 1949 memo, in which it is listed as having a uranium content of 0.3% (Lynch, 1949).

5.2.2 External Radiological Exposure Sources from Hooker Electrochemical Operations

Based on information and documentation available to NIOSH, the potential for external radiation doses from uranium and uranium decay products existed at the Hooker Electrochemical site. The uranium was solely derived from naturally occurring ores, and thus exhibited a natural isotopic abundance. The following subsections provide an overview of the external exposure sources.

5.2.2.1 Photon

Uranium-bearing materials were handled by Hooker Electrochemical employees. External exposures to photon radiation would have resulted from the immediate daughter radionuclides in the uranium decay chain. The uranium progeny that result in the most significant photon exposures include thorium-234 and protactinium-234m (Radiological Health Handbook, 1970). Note that these isotopes have relatively short half-lives and can be assumed to be in equilibrium with the parent uranium-238. Because of their short half-lives, the exposure potential from these isotopes would travel with the parent and will not be considered separately.

5.2.2.2 Beta

Exposure to beta sources for Hooker Electrochemical employees would have resulted principally from uranium decay products. In the uranium-series decay scheme, beginning with uranium-238, the short-lived isotope protactinium-234m 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.

5.2.2.3 Neutron

Due to the low concentration of uranium in both the feed and output materials, there is no credible source of neutron radiation exposure for Hooker Electrochemical employees. Therefore, further discussion or assessment of potential personnel exposures to neutrons at Hooker Electrochemical is not included in this report.

5.2.3 Incidents

NIOSH did not identify any documented accidents at the Hooker Electrochemical site that resulted in exceptionally high personnel exposure levels (such as a criticality event). Therefore, further

discussion or assessment of potential personnel exposures associated with incidents at Hooker Electrochemical is not included in this report.

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

ATTRIBUTION AND ANNOTATION: Section 6.0 and its related subsections were completed by Joe Guido, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

NIOSH did not locate any data relating to the occupational internal or external doses received during AEC work at Hooker Electrochemical. The origin of the slag material processed at Hooker Electrochemcial was from the Electro-Metallurgical Corporation, with uranium concentration in the C-2 slag below what was normally considered economically feasible for recovery (about 0.2% uranium by mass).

No monitoring or source data are available directly from the Hooker uranium concentration work. Nevertheless, data from similar processes occurring at other facilities are available. Another Uranium Metal Production facility in operation during the Hooker MED operational timeframe was Plant 4 (and later 6E) at Mallinckrodt, Destrehan Street. Electro-Metallurgical Corporation and Mallinckrodt used identical processes in the production of uranium metal (Gates, 1945, p. 21), with the exception that in the later years (post 1954), Mallinckrodt converted from using dolomite material as the refractory lining to using recycled MgF (Unknown, 1959). This change was consistent with general practices within the Uranium Metal Production facilities for this time period (Christofano, 1960).

Electro-Metallurgical Corporation and Mallinckrodt generated scrap dolomite material (sometimes referenced as C-liner, C-2, and C-2 slag) (Unknown, 1959; Simons, 1945, p. 8), while the St. Louis Airport Storage site stored slag material. Facilities that handled and/or processed dolomite material are a potential source of radiological monitoring data. In summary:

- SLAG MATERIAL FROM ELECTRO-METALLURGICAL CORPORATION: After the Hooker Electrochemical site shut down, slag material from Electro-Metallurgical Corporation was sent to the Lake Ontario Ordnance Works site (Walter, 1947; Unknown, 1967, p. 9), where the slag material was disposed of on the ground and where the material remained until the mid 1950s, at which time it is reported to have been shipped to the Y-12 plant for uranium recovery (Sapirie, 1957; Unknown, 1967, p. 9).

- SLAG MATERIAL FROM MALLINCKRODT: Slag material from Mallinckrodt was sent to the Scrap Recovery Plant at the DuPont Deepwater Works site (Simons, 1945, p. 8). Other documentation indicates that the slag material from Mallinckrodt was also sent to the St. Louis Airport Storage site beginning March 10, 1946 until “early in 1953” (Unknown, 1959).

- SLAG MATERIAL STORED AT THE ST. LOUIS AIRPORT STORAGE SITE: The slag material stored at the St. Louis Airport Storage Site was reported to be sent to the Fernald Plant for scrap recovery in 1959 (Unknown, 1959).

Based on the relationships outlined above, Sections 6.1 and 6.2 include internal and external monitoring data, as relevant to the Hooker Electrochemical class under evaluation, from the following sites: Lake Ontario Ordnance Works, Electro-Metallurgical Corporation, Mallinckrodt, St. Louis Airport Storage, and Fernald in sections 6.1 and 6.2, below.

6.1 Available Hooker Electrochemical Internal Monitoring Data

As indicated in Section 6.0, internal monitoring data for the Hooker Electrochemical site has not been located. Relevant data from sites that processed the same material are presented in this section.

Electro-Metallurgical Corporation Data

The Electro-Metallurgical Corporation was the source of the C-2 material that was processed at the Hooker Electrochemical site. A study of dust hazards at the Electro-Metallurgical facility was conducted during the period of December 1947 through May 1948 (Various, 1947-1948), and again in 1949 (Brealia, 1949). Two Electro-Metallurgical job descriptions, one in each of the two reports, would include activities similar to those activities performed at the Hooker Electrochemical site. Table 6-1 presents a summary of the data from the two dust hazard reports.

Table 6-1: Pertinent Air Monitoring Data from Electro-Metallurgical Corporation

Date	Description	Measurement	Reference
December 24, 1947 March 30, 1948 May 14, 1948	Bomb Room, Barrel Slag and weigh	456 dpm/m^3 (average of unknown samples)	SRDB Ref ID: 8917, p7
August 17-19, 1949	Shovels slag into lean and rich drums	398 dpm/m^3 (average of 3 samples)	SRDB Ref ID: 8930, p19

Mallinckrodt Data

Prior to 1953, Mallinckrodt employed the same process as Electro-Metallurgical Corporation for the production of uranium metal, thus, generating the same slag materials (Gates, 1945, p. 21). After 1953, Mallinckrodt switched from the use of dolomite as the refractory material to recycled MgF slag. This change from dolomite is evident in the 1954 HASL air dust study which describes in detail the operations in a newly constructed Slag Processing facility (HASL, 1954). Air monitoring studies conducted at the Mallinckrodt facility were reviewed with attention given to activities and materials similar to those at Hooker Electrochemical. Note that monitoring data from the post-1953 period is presented for consideration, owing to the fact that the uranium concentration in the MgF material is higher because it is recycled.

Starting in 1948 and extending through 1956, air sampling data are available for operations involving slag material at Mallinckrodt. These data are summarized in Table 6-2.

Table 6-2: Summary of Pertinent Air Monitoring Data from the Mallinckrodt Facility			
Date	**Description**	**Measurement**	**Reference**
1948 (Plant 4)	Slag Man (DWA)	2.2 (times tolerance) (154 dpm/m^3)	SRDB Ref ID: 9340, p. 4
1949 (Plant 4)	Slag Man (grinding C-Special)	80 dpm/m^3 (average of 3, high 100, low 70)	SRDB Ref ID: 9340, p. 50
1949	Air concentration posted on building layout—cited as "slag dumpster"	200 dpm/m^3	SRDB Ref ID: 11553
1949	Slag Grinding	245 dpm/m^3 average 194 dpm/m^3 min 288 dpm/m^3 max	SRDB Ref ID: 11553
1949	DWE (slag handling)	1.6 x MAC-AEC Study (112 dpm/m^3) 2.2 x MAC-Mallinckrodt Study (154 dpm/m^3)	SRDB Ref ID: 11553
1950 (Plant 4)	Slag Man (DWA)	1.1 (times tolerance) (77 dpm/m^3)	SRDB Ref ID: 9341, p. 5
1951 (Plant 6E)	Unloaders (removing C-Special drum)	149 dpm/m^3 (average of 2, high 237, low 60.8)	SRDB Ref ID: 9443, p. 19
1952	Changing C-oxide and slag-liner drums	27 dpm/m^3	SRDB Ref ID: 20657
1953	Changing C-oxide and slag-liner drums	81 dpm/m^3	SRDB Ref ID: 20657
1953	Changing C-oxide and slag-liner drums	57 dpm/m^3	SRDB Ref ID: 20657

Fernald Data

Available records indicate that sometime prior to 1965, C-2 material deposited at the St. Louis Airport Storage site between 1946 and 1953 was sent to Fernald for uranium recovery (Unknown, 1959). It is further indicated that half of the material that had been shipped to the St. Louis Airport Storage site had been shipped to Fernald sometime prior to 1965 (Unknown, 1959). Air sample datasheets related to the receipt and processing of this material have been located. These data are summarized in Table 6-3.

Table 6-3: Summary of Pertinent Air Monitoring Data from Fernald *Table 6-3 spans three pages.*			
Date	**Description**	**Measurement**	**Reference**
1956	BZ-dumping can of C-liner into dumping station (respirator worn)	247 dpm/m^3	SRDB Ref ID: 34544
1956	BZ-dumping can of C-liner into dumping station (respirator worn)	191 dpm/m^3	SRDB Ref ID: 34544
1956	BZ-dumping can of C-liner into dumping station (respirator worn)	255 dpm/m^3	SRDB Ref ID: 34544
1956	BZ-dumping can of C-liner into dumping station (respirator worn)	206 dpm/m^3	SRDB Ref ID: 34544
1956	Dumping C-liner at 2nd floor dumping station, dry area	3.21 x MAC (224 dpm/m^3) (average of 4, above)	SRDB Ref ID: 41025

Table 6-3: Summary of Pertinent Air Monitoring Data from Fernald *Table 6-3 spans three pages.*			
Date	**Description**	**Measurement**	**Reference**
1958	BZ-operator chipping magnesium from C-liner and uranium at the outside William Mill (no respirator worn) Note: 3 samples total - samples may run high and low due to the wind change (this was an outside operation)	262 dpm/m^3 659 dpm/m^3 519 dpm/m^3	SRDB Ref ID: 42627
1958	BZ-operator dumping drum of C-liner from the 2nd floor drum dumper Note: 3 samples total	793 dpm/m^3 829 dpm/m^3 424 dpm/m^3	SRDB Ref ID: 42627
1959	Evaluation of emptying gondola loaded with C-liner from Mallinckrodt (material removed from gondola and dropped onto pad) -equipment used: crane with clam -material was moist and damp Note: 29 samples total, all sample results are GA samples downwind of operation	13 dpm/m^3 (average) 3 dpm/m^3 (min) 38 dpm/m^3 (max)	SRDB Ref ID: 42628
1959	Phase III of airport scrap evaluation (cleaning out loose material with push broom) -material was dry and very dusty Note: 12 samples total, all sample results are BZ samples	309 dpm/m^3 (average) 195 dpm/m^3 (min) 627 dpm/m^3 (max)	SRDB Ref ID: 42628

Table 6-3: Summary of Pertinent Air Monitoring Data from Fernald *Table 6-3 spans three pages.*			
Date	**Description**	**Measurement**	**Reference**
1959	Part of evaluation of C-liner in gondola at rail line at east end of Plant 8 (car emptied by crane) Laborer cleaned at angles and bends where the crane could not reach -material was partially moist and dry. In some places, the material was very hard Note: 25 samples total, all sample results are BZ samples	63 dpm/m^3 (average) 15 dpm/m^3 (min) 181 dpm/m^3 (max)	SRDB Ref ID: 42628
1959	Evaluation of handling Mallinckrodt airport scrap (BZ hand shoveling airport scrap into 30 gallon drums) -material was damp and cakey with no visible dust (no respirator worn) Note: 11 samples total, all sample results are BZ samples	59 dpm/m^3 (average) 19 dpm/m^3 (min) 108 dpm/m^3 (max)	SRDB Ref ID: 42628
1959	BZ Operator dumping drum of slag liner into outside crusher dumping station (No respirator worn) Ventilation was said to appear very effective Note: 4 samples total, all sample results are BZ samples	78 dpm/m^3 (average) 32 dpm/m^3 (min) 110 dpm/m^3 (max)	SRDB Ref ID: 42628

6.2 Available Hooker Electrochemical External Monitoring Data

As indicated in Section 6.0, external monitoring data for the Hooker Electrochemical site has not been located. Relevant data from sites that processed the same material are presented in this section.

Lake Ontario Ordnance Works Data

After Hooker Electrochemical quit processing C-2 material, C-2 material was shipped to the Lake Ontario Ordnance Works site and was deposited on the ground south of Building 409 in the Water Treatment Plant Area (Unknown, 1967, p. 9). Although this material was reportedly shipped to the Y-12 site sometime during the 1950s (Unknown, 1967, p. 9), some of the material was still present during the 1981 Lake Ontario Ordnance Works site characterization study (Anderson, 1981a, p. 72). As indicated in this study, "*contamination includes broken crucibles, saw blades, and other*

metallurgical scrap left from 1950 storage on the surface." Surface (1 cm) beta/gamma dose rates ranged from 0.1 to 0.65 mR/hr (Anderson, 1981a, p. 72; Anderson, 1981b, p. 776), and gamma dose rates at 1 meter ranged 0.25 to 1 mR/hr (Anderson, 1981b, p. 777).

St. Louis Airport Storage Site Data

Between 1946 and 1953, C-liner materials from uranium production at Mallinckrodt were deposited in a pile at the St. Louis Airport Storage site (Unknown, 1959). In 1948, Mallinckrodt conducted a radiological survey of the St. Louis Airport Storage site's Waste Storage Area. This survey reported the dose rate as 1.6 mrep/hr gamma and 11.5 mrep/hr beta on "top of pile at waste height" (Caplan, 1949).

The C-liner material was still present during a 1965 survey of the St. Louis Airport Storage site (Miller, 1965). A total of three borings were collected in and around the C-liner pile (Miller, 1965, p. 21). Surface and subsurface radiation measurements were collected at each of the survey locations. The surface results (measured at 1 meter) were reported as ranging from 1000 cpm to 1500 cpm, with the added notation that 4,000 cpm is equivalent to 1 mR/hr. This corresponds to a dose rate ranging from 0.25 to 0.375 mR/hr.

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 OCAS'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-00141 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Hooker Electrochemical Data

ATTRIBUTION AND ANNOTATION: Section 7.1 and its related subsections were completed by Tim Adler, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

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

As described in Section 6.0, NIOSH was unable to locate any data directly from the Hooker Electrochemical uranium concentration work. Nevertheless, data from similar processes occurring at other facilities are available and have been used in this evaluation; these data include air sampling data from Electro-Metallurgical Corporation, Mallinckrodt, and Fernald, as well as external radiation measurements for source materials present at the Lake Ontario Ordnance Works and St. Louis Airport Storage site.

The relationships between materials and work performed at Hooker Electrochemical and other sites have been detailed in Section 6. Specific applications of the data from other sites have been determined to be appropriate for the purposes of bounding Hooker Electrochemical radiation exposures. Similarly the data pedigree (i.e., the background, history, origin, etc.) of the various data sources used for this evaluation have been determined to be adequate to support the assessment of the Battelle-TBD-6001 Appendix AA methodology as a bounding dose reconstruction approach for the class evaluated in this report. Data pedigree parameter details for the aforementioned sites (i.e. Electro-Metallurgical Corporation, Mallinckrodt, Fernald, Lake Ontario Ordnance Works, and St. Louis Airport Storage), are already available in site-specific documents written by NIOSH (Site Profiles, Technical Basis Documents, Evaluation Reports, etc.) and/or in documents captured by NIOSH and maintained in the SRDB. As such, only brief summaries of the sources used are provided below.

7.1.1 Internal Monitoring Data Pedigree Review

Internal monitoring data used in this evaluation came from Electro-Metallurgical, Mallinckrodt Chemical Works, and Fernald. As noted in the Pedigree section of *SEC Petition Evaluation Report for Petition SEC-00136, Electro-Metallurgical Corporation*, the air sampling analyses obtained from the Electro-Metallurgical site were performed by AEC's Health and Safety Laboratory (NIOSH, 2009). NIOSH's previous evaluation of the data determined that the collection and analytical techniques used made it suitable for bounding doses. The data were obtained from within period-specific dust hazard reports eliminating the possibility for transcription errors over time.

Data obtained from Mallinckrodt Chemical Works and Fernald also have pedigree characteristics previously judged acceptable by NIOSH. Both of these sites had extensive, well documented air monitoring programs; details of which are available from period-specific documentation stored in the

SRDB, described in TBDs assembled for each site (ORAUT-TKBS-0005 for Mallinckrodt; ORAUT-TKBS-0017-5 for Fernald), and available in respective evaluation reports.

Considering the limited scope of work performed at Hooker Electrochemical and the applicability and pedigree of information available from other sites performing similar activities, NIOSH considers the data utilized in this evaluation report of sufficient quality and quantity to support the Battelle-TBD-6001 Appendix AA methodology as a bounding dose reconstruction approach for Hooker Electrochemical internal doses.

7.1.2 External Monitoring Data Pedigree Review

External monitoring data utilized in this evaluation came from measurements made of C-2 slag material stored at Lake Ontario Ordnance Works and the St. Louis Airport Storage site. Measurements from the Lake Ontario Ordnance Works site were taken in 1981 and documented in detail in a site characterization report that was written immediately following the measurements being taken (Anderson, 1981a, p. 72; Anderson, 1981b, pp. 776-777). Based on the techniques and equipment used to take the measurements, there is no reason to suspect the readings reported for Lake Ontario Ordnance Works were inaccurate. Measurements made on slag material present at the St. Louis Airport Storage site in 1948 (Caplan, 1949) and from borings in and around this material in 1965 (Miller, 1965, p. 21) are also well documented. Similar to the Lake Ontario Ordnance Works measurements, the documents containing the data were produced immediately after the measurements were made, and based on knowledge of the equipment in use at the time, there is no reason to suspect the resultant data are inaccurate.

Considering the limited scope of work performed at the Hooker Electrochemical site and the applicability and pedigree of information available from other sites performing similar activities, NIOSH considers the data utilized in this evaluation report of sufficient quality and quantity to support the Battelle-TBD-6001 Appendix AA methodology as a bounding dose reconstruction approach for Hooker Electrochemical external doses.

7.2 Evaluation of Bounding Internal Radiation Doses at Hooker Electrochemical

ATTRIBUTION AND ANNOTATION: Section 7.2 and its related subsections were completed by Joe Guido, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

The principal source of internal radiation doses for members of the class under evaluation was inhalation of uranium-bearing dust that was generated during the processing of uranium-bearing slag material (C-2 and C-2 concentrate). As received, the slag material has uranium content between 0.2 and 0.3 percent by weight, and between 1 and 2 percent by weight after processing. 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 Process-Related Internal Dose Data at Hooker Electrochemical

As discussed in Section 6.1, there are no available internal monitoring data from the Hooker Electrochemical site. However, pertinent air monitoring data (during the handling of C-2 slag

material) are available from the Electro-Metallurgical, Mallinckrodt, and Fernald sites. The data are summarized in Table 7-1, with the data grouped by activity. Average values are shown in this table as an indicator of the central tendency of the data, but it should be noted that the data contain both individual measurements and average values, and as such an accurate average could not be calculated.

Table 7-1: Summary of Air Monitoring Data from Related Sites

Site	Activity	Range, Airborne Alpha Activity (dpm/m^3)		
		Min.	Max.	Average
Electro-Metallurgical[a]	Slag handling/barreling and weighing	N/A	N/A	456
	Slag handling/shoveling into drums	N/A	N/A	398
Mallinckrodt	Slag handling (DWE values)	70	288	128
	Slag handling (specific operations)	27	237	122
Fernald	Slag drum unloading/slag handling in plant	78	829	390
	Gondola unloading (outdoors)	3	38	13
	Slag handling (outdoors)	15	181	62

Notes:
[a] No min./max. values are available.

The primary source of airborne activity in Battelle-TBD-6001 Appendix AA is associated with slag barrel unloading. Airborne activity values for slag handling at the Electro-Metallurgical site is similar to the Fernald site and higher than the values observed at the Mallinckrodt plant. By comparison, the actual operational experience at these three sites indicates a lower airborne activity concentration than the value of 822 dpm/m^3 upon which the internal dose assignment from slag barrel unloading in Battelle-TBD-6001 Appendix AA is based. Based on the 0.2 percent uranium concentration in the material at Hooker Electrochemical, the associated airborne dust concentration of 294 mg/m3 would constitute a value that is not likely to be tolerated under continuous occupancy conditions. Considering this information, NIOSH concludes that the Battelle-TBD-6001 Appendix AA values represent a maximum exposure scenario which will support a bounding analysis of internal exposures for the class evaluated in this report. The remaining operations at Hooker Electrochemical involving high moisture content material produce lower airborne activity and are accounted for in Battelle-TBD-6001 Appendix AA.

The intake quantities presented above would apply to individuals directly involved in handling operations. If necessary, this intake quantity could be scaled to account for other exposure conditions using the methodology presented in Battelle-TBD-6001 Appendix AA.

7.2.2 Evaluation of Bounding Residual Period Internal Doses

There are no available data for contamination levels or source term quantities left at the Hooker Electrochemical facility after the cessation of operations. The levels in the environment were determined to be at background levels at the time of an environmental survey in 1976 (DOE, 1977). Battelle-TBD-6001 Appendix AA presents an assessment of internal exposures during the residual period based on the deposition of airborne contamination during one year of operations and the subsequent resuspension of this material, resulting in an inhalation intake estimate of 1 pCi/d.

Ingestion intakes could be calculated by applying the methodology present in *Estimation of Ingestion Intakes*, OCAS-TIB-009.

7.2.3 Methods for Bounding Process-Related and Residual Internal Dose at Hooker Electrochemical

NIOSH reviewed and assessed the available airborne radioactivity and source term data against the methodology provided in Battelle-TBD-6001 Appendix AA. Considering the intake scenarios established in Battelle-TBD-6001 Appendix AA, the calculated airborne uranium concentrations from these intakes was compared to actual data and was found to be bounding in each case (based on the assessment of the dose using the appropriate dose reconstruction approaches and methodologies). For this reason, NIOSH believes that internal dose during both the operational and residual periods can be bounded using the methodology defined in Battelle-TBD-6001 Appendix AA.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

After reviewing extensive information relating to Hooker Electrochemical through its review of related sites, NIOSH has found a significant amount of air sampling data relevant to the materials and processes used at the Hooker Electrochemical site. In addition, the method proposed for establishing a bounding dose for the operational periods in Battelle-TBD-6001 Appendix AA, has been compared to available air monitoring data from related sites and has been found to be bounding in each case (based on the assessment of the dose using the appropriate dose reconstruction approaches and methodologies).

Based on this information and the assessment presented in Section 7.2 of this report, NIOSH has concluded that it is feasible to bound the internal dose (reconstruct dose with sufficient accuracy) for the class evaluated in this report. However, as is the case with all dose reconstructions, NIOSH may choose to review and apply more refined dose reconstruction approaches and methods, evaluated on a case-by-case basis for specific individual dose reconstructions.

7.3 Evaluation of Bounding External Radiation Doses at Hooker Electrochemical

ATTRIBUTION AND ANNOTATION: Section 7.3 and its related subsections were completed by Joe Guido, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

The principal source of external exposure for members of the evaluated class was gamma, and beta radiations associated with handling and working in proximity to uranium-bearing slag material (C-2 and C-2 concentrate).

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 Process-Related External Dose Data at Hooker Electrochemical

As discussed in Section 6.2, there are no available external monitoring data from the Hooker Electrochemical site. However, pertinent external dose monitoring data (during the storage of C-2

slag material) are available from the Lake Ontario Ordinance Works and Saint Louis Airport Storage sites. These data are summarized in Table 7-2.

Table 7-2: External Monitoring Data from Related Sites

Data Source	Shallow	Deep
Lake Ontario Ordnance Works (1981)	-	0.1 - 0.65 mR/hr (contact) 0.25 – 1.0 mR/hr (1 meter)
St. Louis Airport Storage Site (1948)	11.5 mrep/hr	1.6 mrep/hr
St. Louis Airport Storage Site (1965)	-	0.25 – 0.375 mR/hr

Notes:
- Indicates no data.

The exposure rate listed for the Saint Louis Airport Storage site in 1948 is cited as being on top of the slag storage pile. Although the size of this pile is not known, based on the generation rate cited in 1945 (80,000 – 90,000 pounds every month to six weeks) (Simons, 1945), it would easily exceed any quantity of material that would be handled or stored at the Hooker Electrochemical site. Based on these data, a bounding deep and shallow dose can be based on the values measured in 1948 (11.5 mrep/hr beta and 1.6 mrep/hr gamma).

7.3.2 Evaluation of Bounding Residual Period External Doses

There are no available data on contamination levels or source term quantities left at the Hooker Electrochemical facility after the cessation of operations. A bounding assessment of external dose is presented in Battelle-TBD-6001 Appendix AA, based on the assignment of dose from surface contamination present during scrap recovery operations, with no adjustment for cessation of processing activities. That is, the dose assigned is the same as would be from exposure to surface contamination at an operating scrap recovery facility.

7.3.3 Hooker Electrochemical Occupational X-Ray Examinations

A memo reviewing the medical program at Hooker Electrochemical was written by the MED in 1943 (Warren, 1943). The memo recommended pre-employment and annual X-rays. Although it predates the radiological work at the site, there is no reason to believe that this regiment was not in place during C-2 slag processing. Additionally, a 1946 memorandum summarizing the medical monitoring program at the site (Mears, 1946) lists a pre-employment X-ray as one of the components of the medical examination program.

Although no specific information regarding occupational medical dose have been identified specific to Hooker Electrochemical, the dose associated with medical X-ray exams, if required as a condition of employment, can be assessed using the methodology defined in ORAUT-OTIB-0006. NIOSH believes that this methodology supports its ability to bound the occupational medical X-ray doses for the Hooker Electrochemical evaluated class.

7.3.4 Methods for Bounding External Dose at Hooker Electrochemical

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

- Photon Dose

- Beta Dose
- Neutron Dose (not applicable for the Hooker Electrochemical site)
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon Dose

Photon dose during the operational period can be bound using 1948 exposure rate measurements from the St. Louis Airport Storage site. A dose rate of 1.6 mrep/hr would be considered bounding for any exposure that could have resulted from site activities. The methodologies in Battelle-TBD-6001 Appendix AA can be used to prorate this exposure based on the activities conducted. Based on Battelle-TBD-6001 Appendix AA, waste handling activities would constitute one day each month or a total of 96 hours per year. Other adjustments based on the work categories present in Battelle-TBD-6001 Appendix AA may be applied as appropriate.

Beta Dose

Beta dose during the operational period can be bound using 1948 exposure rates measured at the St. Louis Airport Storage site. A dose rate of 11.5 mrep/hr would be considered bounding for any exposure that could result from site activities. The methodologies in Battelle TBD-6001 Appendix AA can be used to prorate this exposure based on the activities conducted. Based on Battelle TBD-6001 Appendix AA, waste handling activities would constitute one day each month, or a total of 120 hours per year. Other adjustments based on work categories presented in the Battelle-TBD-6001 Appendix AA may be applied as appropriate.

Medical X-ray Dose

With the exception of a memo recommending pre-employment X-rays (Warren, 1943), NIOSH has not found any information regarding occupational medical dose. However, the dose associated with X-ray exams can be assessed using the methodology defined in ORAUT-OTIB-0006. NIOSH believes that this methodology supports its ability to bound the occupational medical X-ray doses for the evaluated class.

7.3.4.2 Methods for Bounding Residual Period External Doses

NIOSH reviewed and assessed the available source term and external monitoring data against the methodology provided in Battelle-TBD-6001 Appendix AA. Considering the scenarios established in Battelle-TBD-6001 Appendix AA, NIOSH has determined that the calculated external dose assigned in Battelle-TBD-6001 Appendix AA can be used to bound exposures at the Hooker Electrochemical site during the residual period. With the removal of the source material at the onset of the residual contamination period, the likely exposure scenario during the post-operations period would be consistent with the scenario evaluated in Battelle-TBD-6001 Appendix AA. The likelihood that the material at the Hooker facility had a much lower uranium content than in typical scrap-recovery operations supports this conclusion.

7.3.5 External Dose Reconstruction Feasibility Conclusion

Guidance outlined in Battelle-TBD-6001 Appendix AA, is sufficient to bound external photon and beta doses for the evaluated class. Using ORAUT-OTIB-0006, external occupational X-ray dose can be bound for members of the evaluated class. However, as is the case with all dose reconstructions, NIOSH may choose to review and apply more refined dose reconstruction approaches and methods, evaluated on a case-by-case basis, for specific individual dose reconstructions.

7.4 Evaluation of Petition Basis for SEC-00141

ATTRIBUTION AND ANNOTATION: Section 7.4 and its related subsections were completed by Tim Adler, Oak Ridge Associated Universities (ORAU). The rationales for all conclusions in this document are explained in the associated text.

The following subsections evaluate the assertions made on behalf of petition SEC-00141 for the Hooker Electrochemical site.

7.4.1 Air Quality, Monitoring, Protection, and Medical Assistance for Furnace Room Workers

ISSUE: The petitioner is concerned about the air quality in the furnace room. The petitioner stated that her husband had experienced extreme conditions innumerable times when the air quality was so bad in the furnace room that her husband and fellow employees would gag, choke, and have to run to a window for air. In fact, they had to stand on a bench to reach the window. Her husband said that the room would fill with so much "gas" that they could hardly breathe.

ISSUE: The petitioner is concerned that besides a total lack of monitoring in the furnace room, the air quality incidents in the furnace room were not recorded. In addition, no medical assistance was provided to the petitioner's husband or others.

ISSUE: The petitioner is concerned that there were no warning devices installed to give employees a chance to escape the furnace room. There was also no protective gear, including a mask with or without oxygen.

RESPONSE: While documentation corroborating these statements exists, the work being referenced was associated with the P-45 manufacturing work area. The work that took place in this area is not addressed in this evaluation because that work did not involve radiological sources.

7.4.2 Internal and External Monitoring

ISSUE: Additionally, the petitioner noted in a separate affidavit that to the best of the petitioner's knowledge, there is no internal or external monitoring data for Hooker Electrochemical Corporation.

RESPONSE: NIOSH found that monitoring records were not available for the entire evaluated class period. However, as presented and evaluated in the preceding sections of this evaluation, sufficient results have been found for other sites performing similar work to support bounding the dose (reconstructing internal and external doses with sufficient accuracy) for the class evaluated in this report.

7.5 Summary of Feasibility Findings for Petition SEC-00141

This report evaluates the feasibility for completing dose reconstructions for employees at the Hooker Electrochemical site from January 1, 1943 through December 31, 1976. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-3 summarizes the results of the feasibility findings at Hooker Electrochemical for each exposure source during the time period January 1, 1943 through December 31, 1976.

Table 7-3: Summary of Feasibility Findings for SEC-00141
January 1, 1943 through December 31, 1976

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal[1]	**X**	
- Uranium	X	
External	**X**	
- Gamma	X	
- Beta	X	
- Neutron	X	
- Occupational Medical X-ray	X	

[1] Internal includes an evaluation of urinalysis (in vitro), airborne dust, and lung (in vivo) data, as applicable.

As of December 28, 2009, a total of 110 claims have been submitted to NIOSH for individuals who worked at the Hooker Electrochemical site and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for 93 individuals (~84%).

8.0 Evaluation of Health Endangerment for Petition SEC-00141

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 has determined that although no monitoring data are available specifically from the Hooker Electrochemical Corporation for the evaluated class, applicable data are available from other sites performing similar operations. Thus, NIOSH's evaluation determined that it is 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. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is not required.

9.0 Class Conclusion for Petition SEC-00141

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes all employees who worked in any location at the Hooker Electrochemical Corporation during the operational period from January 1, 1943 through December 31, 1948, and during the residual period from January 1, 1949 to December 31, 1976.

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-00141. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

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10.0 References

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Attachment One: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Hooker Electrochemical			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded into SRDB**
Primary Site/Company Name: Hooker Electrochemical AWE 1943-1948; Residual Radiation 1949-1976 Other Site Names: Hooker Chemical Co. Occidental Chemical Corp. Marc J. Kennedy (Attorney) (972) 404-4982 Occidental Chemical Corp., Specialty Chemical Div. Hooker Chemical and Plastics Corp.	No relevant data identified.	05/16/2008	0
State Contacted: John Mitchell (518) 402-8573	Transportation and storage of uranium turnings.	12/21/2009	1
Cincinnati Library	Radiological survey.	01/19/2004	1
Department of Labor/Paragon	Air sampling and repair work, Boron Metal Plant (BMP) Project, K-65 inventory, burning of wastes, contract documentation for Hooker Electrochemical, contract supplemental agreement, operating manual, memorandum of understanding between AEC, Air Force, and Department of the Navy, radiological surveys, relocation of contaminated materials, waste disposal and storage, sewage plant and railroad facilities, and weekly reports.	01/14/2009	74
DOE Legacy Management - Grand Junction Office	Radiological survey at selected locations in Niagara Falls, New York, accountability procedures, contract AT-(30-1)-1524, collection of historical maps and site photos, contaminated scrap metal transfer, elimination reports, litigation documents, site surveys, soil sampling, radiological clearance documentation, and a summary report.	07/08/2009	51
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Report on hazardous waste disposal In Erie and Niagara Counties and a report accusing the U.S. of waste dumping.	03/08/2007	3
EML Library	Site visits 1953-1954, annual report 1953, thorium sampling and storage, and a 1953 symposium on aerosols.	03/08/2005	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	10/23/2009	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	10/22/2009	0
Internet - DOE OpenNet	Manhattan District History, Book I - General, Volume 7 - Medical Program	10/22/2009	1

Table A1-1: Data Capture Synopsis for Hooker Electrochemical			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded into SRDB**
Internet - DOE OSTI Energy Citations	Hot semiworks redox studies.	10/22/2009	1
Internet - DOE OSTI Information Bridge	No relevant data identified.	10/22/2009	0
Internet - FUSRAP Considered Sites Database	Contract No. W-7405 eng-28 supplemental agreement No. 3, July 26, 1944.	07/08/2005	1
Internet - Google	Contract supplements, report on the development of the Atomic Bomb under the auspices of the United States Government, environmental cost of victory in WWII and the Cold War, inspection report of former licensee's activities, and information on the poisoned workers and poisoned places regarding the bomb that fell on Niagara.	11/22/2009	9
Internet - National Academies Press (NAP)	No relevant data identified.	10/23/2009	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	10/23/2009	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	No relevant data identified.	10/22/2009	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	10/23/2009	0
NARA Atlanta	Disposition of KAPL wastes and bioassay results, dust, air and breath samples, Madison Square area monthly accountability reports, manufacturing process at Hooker, monthly progress reports, neutron source information, semi-monthly reports, weekly reports, and work reports of Richard Tybout.	06/07/2008	15
NARA Kansas City	Facility decontamination history, historical information, health and safety meeting, radiological survey, U.S. military involvement in the toxic contamination of Love Canal and the Niagara Frontier region, and weekly reports.	08/14/2008	7
ORAU Team	Visit with Berwyn Robinson (Director of Uranium Development), e-mail on chemical processing of uranium contaminated slag, and site profiles for Atomic Weapons Employers that refined uranium and thorium.	10/20/2009	3
ORO Vault	Work reports, dosimetry, and hazardous area information.	10/26/2005	2
Unknown	Unloading K-65, medical requirements and work reports, data analysis results, declassification, decommission and decontamination of Hooker Electrochemical, health and safety precautions, and quarterly film badge data.	04/19/2004	13
TOTAL			**183**

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
DOE CEDR http://cedr.lbl.gov/ COMPLETED 10/23/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." or "Hooker Chemical and Plastics Corp." or "OxyChem"	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 10/22/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." or "Hooker Chemical and Plastics Corp." or "OxyChem"	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 10/22/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." or "Hooker Chemical and Plastics Corp." or "OxyChem"	0	1
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 10/22/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." or "Hooker Chemical and Plastics Corp." or "OxyChem"	63	1
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 10/22/2009	"Hooker Chemical Co." "Occidental Chemical Corp." "Hooker Chemical and Plastics Corp." "OxyChem"	29	0
Google http://www.google.com COMPLETED 11/22/2009	"Hooker Chemical Co." americium, OR Am241, OR Am-241, OR "AM 241", OR 241Am, OR 241-Am, OR "241 Am" "Hooker Chemical" ionium, OR Th230, OR Th-230, OR "Th 230", OR 230Th, OR 230-Th, OR "230 Th" "Hooker Chemical" neptunium, OR Np237, OR Np-237, OR "Np 237", OR 237Np, OR 237-Np, OR "237 Np" "Hooker Chemical" polonium, OR Po210, OR Po-210, OR "Po 210", OR 210Po, OR 210-Po, OR "210 Po" "Hooker Chemical" thorium, OR Th232, OR Th-232, OR "Th 232", OR 232Th, OR 232-Th, OR "232 Th", OR "Z metal", OR myrnalloy, OR "chemical 10-66", OR "chemical 10-12" "Hooker Chemical" ionium, OR UX1, OR UX2, OR Th-230, OR Th230, OR "Th 230", OR 230-Th, OR "230 Th", OR 230Th, OR Th-234, OR Th234, OR "Th 234", OR 234-Th, OR 234Th, OR "234 Th"	444,537	9

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Hooker Chemical" tritium, H3, H-3, mint, HTO "Hooker Chemical" uranium, OR U233, OR U-233, OR "U 233", OR 233U, OR 233-U, OR "233 U", OR U234, OR "U 234", OR U-234, OR 234U, OR 234-U, OR "234 U" "Hooker Chemical" U235, OR "U 235", OR U-235, OR 235-U, OR 235U, OR "235 U", OR U238, OR "U 238", OR U-238, OR 238-U, OR 238U, OR "238 U" "Hooker Chemical" U308, OR "U 308", OR U-308, OR 308-U, OR 308U, OR "308 U", OR "uranium extraction", OR "black oxide", OR "brown oxide" "Hooker Chemical" green salt, OR "orange oxide", OR "yellow cake", OR UO2, OR UO3, OR UF4, OR UF6, OR C-216, OR C-616, OR C-65, OR C-211, OR U3O8 "Hooker Chemical" plutonium, OR Pu-238, OR Pu238, OR "Pu 238", OR 238Pu, OR 238-Pu, OR "238 Pu", OR Pu-239, OR Pu239, OR "Pu 239", OR 239Pu, OR 239-Pu, OR "239 Pu" "Hooker Chemical" Pu-240, OR Pu240, OR "Pu 240", OR 240Pu, OR 240-Pu, OR "240 Pu", OR Pu-241, OR Pu241, OR "Pu 241", OR 241Pu, OR 241-Pu, OR "241 Pu" "Hooker Chemical" radium, OR Ra-226, OR Ra226, OR "Ra 226", OR 226-Ra, OR 226Ra, OR 226-Ra, OR Ra-228, OR Ra228, OR "Ra 228", OR 228Ra, OR 228-Ra, OR "228 Ra" "Hooker Chemical" radon, OR Rn-222, OR Rn222, OR "Rn 222", OR 222Rn, OR 222-Rn, OR "222 Rn" "Hooker Chemical" thoron, OR Rn-220, OR Rn220, OR "Rn 220", OR 220Rn, OR 220-Rn, OR "220 Rn"		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Hooker Chemical" protactinium, OR Pa-234m, OR Pa234m, OR "Pa 234m", OR 234mPa, OR 234m-Pa, OR "234m Pa" "Hooker Chemical" strontium, OR Sr-90, OR Sr90, OR "Sr 90", OR 90-Sr, OR 90Sr, OR "90 Sr" "Hooker Chemical" oralloy, OR postum, OR tuballoy, OR "uranyl nitrate hexahydrate", OR UNH, OR K-65, OR "sump cake" "Hooker Chemical" uranium dioxide, OR "uranium tetrafluoride", OR "uranium trioxide" "Hooker Chemical" uranium hexafluoride, OR accident, OR "air count" "Hooker Chemical" air dust, OR "air filter", OR "airborne test" "Hooker Chemical" alpha, OR "belgian congo ore", OR bioassay, OR bio-assay "Hooker Chemical" breath, OR "breathing zone", OR BZ, OR calibration, OR columnation "Hooker Chemical" contamination, OR curie, OR denitration, OR "denitration pot" "Hooker Chemical" derby, OR regulus, OR dose, OR dosimeter "Hooker Chemical" dosimetric, OR dosimetry, OR electron, OR environment		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Hooker Chemical" Ether-Water Project, OR exposure, OR "exposure investigation", OR "radiation exposure" "Hooker Chemical" external, OR "F machine", OR fecal, OR "feed material", OR femptocurie, OR film, OR fission, OR fluoroscopy "Hooker Chemical" Formerly Utilized Sites Remedial Action Program, OR FUSRAP, OR gamma-ray, OR "gas proportional", OR "gaseous diffusion" "Hooker Chemical" health, OR "health instrument", OR "health physics", OR "H.I.", OR HI, OR HP, OR "highly enriched uranium", OR HEU "Hooker Chemical" hydrofluorination, OR "in vitro", OR "in vivo", OR incident, OR ingestion, OR inhalation, OR internal "Hooker Chemical" investigation, OR isotope, OR isotopic, OR "isotopic enrichment", OR "JS Project", OR Landauer, OR "liquid scintillation" "Hooker Chemical" log, OR "log sheet", OR "log book", OR "low enriched uranium", OR LEU "Hooker Chemical" maximum permissible concentration, OR MPC, OR metallurgy, OR microcurie, OR millicurie "Hooker Chemical" mixed fission product, OR MFP, OR monitor, OR "air monitoring", OR nanocurie, OR "nasal wipe", OR neutron, OR "nose wipe" "Hooker Chemical" nuclear, OR Chicago-Nuclear, OR "nuclear fuels", OR "nuclear track emulsion", OR "type A"		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Hooker Chemical" NTA, OR "occupational radiation exposure", OR occurrence, OR "ore concentrate", OR "PC Project" "Hooker Chemical" permit, OR "radiation work permit", OR "safe work permit", OR "special work permit", OR RWP, OR SWP "Hooker Chemical" phosphate research, OR photon, OR picocurie, OR pitchblende, OR "pocket ion chamber", OR PIC, OR problem, OR procedure "Hooker Chemical" radeco, OR radiation, OR radioactive, OR radioactivity, OR radiograph, OR radiological "Hooker Chemical" Radiological Survey Data Sheet, OR RSDS, OR radionuclide, OR raffinate, OR reactor "Hooker Chemical" respiratory, OR "retention schedules", OR roentgen "Hooker Chemical" sample, OR "air sample", OR "dust sample", OR "general area air sample" "Hooker Chemical" solvent extraction, OR source, OR "sealed source", OR spectra, OR spectrograph, OR spectroscopy, OR spectrum, OR standard, OR "operating standard", OR "processing standard" "Hooker Chemical" survey, OR "building survey", OR "routine survey", OR "special survey", OR "technical basis" "Hooker Chemical" thermal diffusion, OR "thermoluminescent dosimeter", OR TLD, OR "Tiger Team" "Hooker Chemical" tolerance dose, OR urinalysis, OR urine, OR "whole body count", OR WBC, OR "working level", OR WL, OR X-ray, OR "X ray", OR Xray "Occidental Chemical" OxyChem americium, OR Am241, OR Am-241, OR "AM 241", OR 241Am, OR 241-Am, OR "241 Am"		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Occidental Chemical" OxyChem ionium, OR Th230, OR Th-230, OR "Th 230", OR 230Th, OR 230-Th, OR "230 Th" "Occidental Chemical" OxyChem neptunium, OR Np237, OR Np-237, OR "Np 237", OR 237Np, OR 237-Np, OR "237 Np" "Occidental Chemical" OxyChem polonium, OR Po210, OR Po-210, OR "Po 210", OR 210Po, OR 210-Po, OR "210 Po" "Occidental Chemical" OxyChem thorium, OR Th232, OR Th-232, OR "Th 232", OR 232Th, OR 232-Th, OR "232 Th", OR "Z metal", OR myrnalloy, OR "chemical 10-66", OR "chemical 10-12" "Occidental Chemical" OxyChem ionium, OR UX1, OR UX2, OR Th-230, OR Th230, OR "Th 230", OR 230-Th, OR "230 Th", OR 230Th, OR Th-234, OR Th234, OR "Th 234", OR 234-Th, OR 234Th, OR "234 Th" "Occidental Chemical" OxyChem tritium, H3, H-3, mint, HTO "Occidental Chemical" OxyChem uranium, OR U233, OR U-233, OR "U 233", OR 233U, OR 233-U, OR "233 U", OR U234, OR "U 234", OR U-234, OR 234U, OR 234-U, OR "234 U" "Occidental Chemical" OxyChem U235, OR "U 235", OR U-235, OR 235-U, OR 235U, OR "235 U", OR U238, OR "U 238", OR U-238, OR 238-U, OR 238U, OR "238 U" "Occidental Chemical" OxyChem U308, OR "U 308", OR U-308, OR 308-U, OR 308U, OR "308 U", OR "uranium extraction", OR "black oxide", OR "brown oxide" "Occidental Chemical" OxyChem green salt, OR "orange oxide", OR "yellow cake", OR UO2, OR UO3, OR UF4, OR UF6, OR C-216, OR C-616, OR C-65, OR C-211, OR U3O8		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Occidental Chemical" OxyChem plutonium, OR Pu-238, OR Pu238, OR "Pu 238", OR 238Pu, OR 238-Pu, OR "238 Pu", OR Pu-239, OR Pu239, OR "Pu 239", OR 239Pu, OR 239-Pu, OR "239 Pu" "Occidental Chemical" OxyChem Pu-240, OR Pu240, OR "Pu 240", OR 240Pu, OR 240-Pu, OR "240 Pu", OR Pu-241, OR Pu241, OR "Pu 241", OR 241Pu, OR 241-Pu, OR "241 Pu" "Occidental Chemical" OxyChem radium, OR Ra-226, OR Ra226, OR "Ra 226", OR 226-Ra, OR 226Ra, OR 226-Ra, OR Ra-228, OR Ra228, OR "Ra 228", OR 228Ra, OR 228-Ra, OR "228 Ra" "Occidental Chemical" OxyChem radon, OR Rn-222, OR Rn222, OR "Rn 222", OR 222Rn, OR 222-Rn, OR "222 Rn" "Occidental Chemical" OxyChem thoron, OR Rn-220, OR Rn220, OR "Rn 220", OR 220Rn, OR 220-Rn, OR "220 Rn" "Occidental Chemical" OxyChem protactinium, OR Pa-234m, OR Pa234m, OR "Pa 234m", OR 234mPa, OR 234m-Pa, OR "234m Pa" "Occidental Chemical" OxyChem strontium, OR Sr-90, OR Sr90, OR "Sr 90", OR 90-Sr, OR 90Sr, OR "90 Sr" "Occidental Chemical" OxyChem oralloy, OR postum, OR tuballoy, OR "uranyl nitrate hexahydrate", OR UNH, OR K-65, OR "sump cake" "Occidental Chemical" OxyChem uranium dioxide, OR "uranium tetrafluoride", OR "uranium trioxide" "Occidental Chemical" OxyChem uranium hexafluoride, OR accident, OR "air count"		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Occidental Chemical" OxyChem air dust, OR "air filter", OR "airborne test" "Occidental Chemical" OxyChem alpha, OR "belgian congo ore", OR bioassay, OR bio-assay "Occidental Chemical" OxyChem breath, OR "breathing zone", OR BZ, OR calibration, OR columnation "Occidental Chemical" OxyChem contamination, OR curie, OR denitration, OR "denitration pot" "Occidental Chemical" OxyChem derby, OR regulus, OR dose, OR dosimeter "Occidental Chemical" OxyChem dosimetric, OR dosimetry, OR electron, OR environment "Occidental Chemical" OxyChem log, OR "log sheet", OR "log book", OR "low enriched uranium", OR LEU "Occidental Chemical" OxyChem maximum permissible concentration, OR MPC, OR metallurgy, OR microcurie, OR millicurie "Occidental Chemical" OxyChem Ether-Water Project, OR exposure, OR "exposure investigation", OR "radiation exposure" "Occidental Chemical" OxyChem external, OR "F machine", OR fecal, OR "feed material", OR femptocurie, OR film, OR fission, OR fluoroscopy "Occidental Chemical" OxyChem Formerly Utilized Sites Remedial Action Program, OR FUSRAP, OR gamma-ray, OR "gas proportional", OR "gaseous diffusion"		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Occidental Chemical" OxyChem health, OR "health instrument", OR "health physics", OR "H.I.", OR HI, OR HP, OR "highly enriched uranium", OR HEU "Occidental Chemical" OxyChem hydrofluorination, OR "in vitro", OR "in vivo", OR incident, OR ingestion, OR inhalation, OR internal "Occidental Chemical" OxyChem investigation, OR isotope, OR isotopic, OR "isotopic enrichment", OR "JS Project", OR Landauer, OR "liquid scintillation" "Occidental Chemical" OxyChem mixed fission product, OR MFP, OR monitor, OR "air monitoring", OR nanocurie, OR "nasal wipe", OR neutron, OR "nose wipe" "Occidental Chemical" OxyChem nuclear, OR Chicago-Nuclear, OR "nuclear fuels", OR "nuclear track emulsion", OR "type A" "Occidental Chemical" OxyChem NTA, OR "occupational radiation exposure", OR occurrence, OR "ore concentrate", OR "PC Project" "Occidental Chemical"OxyChem permit, OR "radiation work permit", OR "safe work permit", OR "special work permit", OR RWP, OR SWP "Occidental Chemical" OxyChem phosphate research, OR photon, OR picocurie, OR pitchblende, OR "pocket ion chamber", OR PIC, OR problem, OR procedure "Occidental Chemical" OxyChem radeco, OR radiation, OR radioactive, OR radioactivity, OR radiograph, OR radiological "Occidental Chemical" OxyChem Radiological Survey Data Sheet, OR RSDS, OR radionuclide, OR raffinate, OR reactor "Occidental Chemical" OxyChem respiratory, OR "retention schedules", OR roentgen		

Table A1-2: Database Searches for Hooker Electrochemical			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"Occidental Chemical" OxyChem sample, OR "air sample", OR "dust sample", OR "general area air sample" "Occidental Chemical" OxyChem solvent extraction, OR source, OR "sealed source", OR spectra, OR spectrograph, OR spectroscopy, OR spectrum, OR standard, OR "operating standard", OR "processing standard" "Occidental Chemical"OxyChem survey, OR "building survey", OR "routine survey", OR "special survey", OR "technical basis" "Occidental Chemical" OxyChem thermal diffusion, OR "thermoluminescent dosimeter", OR TLD, OR "Tiger Team" "Occidental Chemical" OxyChem tolerance dose, OR urinalysis, OR urine, OR "whole body count", OR WBC, OR "working level", OR WL, OR X-ray, OR "X ray", OR Xray		
National Academies Press http://www.nap.edu/ COMPLETED 10/23/2009	"Hooker Chemical Co." "Occidental Chemical Corp." "Hooker Chemical and Plastics Corp." "OxyChem"	427	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 10/23/2009	"Hooker Chemical Co." "Occidental Chemical Corp." "Hooker Chemical and Plastics Corp." "OxyChem"	12	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 10/22/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." "Hooker Chemical and Plastics Corp." or "OxyChem"	20	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 10/23/2009	"Hooker Chemical Co." or "Occidental Chemical Corp." or "Hooker Chemical and Plastics Corp." or "OxyChem"	0	0

Table A1-3: OSTI Documents Requested for Hooker Electrochemical			
Document Number	**Document Title**	**Requested**	**Received**
No documents ordered.	N/A	N/A	N/A