SEC Petition Evaluation Report
Petition SEC-00136

Report Rev #: 0 Report Submittal Date: July 21, 2009

Subject Expert(s):	D. S. Mantooth, D. Watkins, R. Halsey
Site Expert(s):	N/A

Petition Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition Qualification Date	DOE/AWE Facility Name
SEC-00136	83.13	March 12, 2009	Electro-Metallurgical Corporation

Petitioner Class Definition
All workers who worked in any area at the Electro-Metallurgical Corporation facility, for the period from August 13, 1942 through December 31, 1953.

Class Evaluated by NIOSH
All workers who worked in any area at the Electro-Metallurgical Corporation for the period from April 1, 1943 through June 30, 1953.

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
SEC-00132	83.13	Electro-Metallurgical Corporation	Merged into SEC-00136

Related Evaluation Report Information	
Report Title	DOE/AWE Facility Name
N/A	N/A

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Evaluation Report Summary: SEC-00136, Electro-Metallurgical Corporation

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

Petitioner-Requested Class Definition

Petition SEC-00136, qualified on March 12, 2009, requested that NIOSH consider the following class: *All workers who worked in any area at the Electro-Metallurgical Corporation facility, for the period from August 13, 1942 through December 31, 1953.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class because actual uranium processing did not begin until April 1943, and the contract with the Atomic Energy Commission expired on June 30, 1953. NIOSH evaluated the following class: All workers who worked in any area at the Electro-Metallurgical Corporation for the period from April 1, 1943 through June 30, 1953.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has obtained internal and external dosimetry and air sampling data. 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-00136

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all workers who worked in any area at the Electro-Metallurgical Corporation (also known as Electro-Met) facility for the period from April 1, 1943 through June 30, 1953. 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-00136, Electro-Metallurgical Corporation Class Definitions

The following subsections address the evolution of the class definition for SEC-00136, Electro-Metallurgical Corporation. 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-proposed class. If some portion of the petitioner-proposed 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.

A separate petition for Electro-Metallurgical Corporation, SEC-00132, was also submitted. On review, NIOSH found that the proposed class for SEC-00132 was encompassed by that of SEC-00136; NIOSH then merged the two petitions.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00136, qualified on March 12, 2009, requested that NIOSH consider the following class for addition to the SEC: *All workers who worked in any area at the Electro-Metallurgical Corporation facility, for the period from August 13, 1942 through December 31, 1953.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Electro-Met workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00136 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.

In support of his claim, the SEC-00136 petitioner claimed that radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored, either through personal monitoring or through area monitoring.

The petitioner provided a typed statement (non-affidavit) stating that:

Records within the files of the Department of Labor, and the Department of Energy demonstrate that at the ElectroMet radiation doses were either not monitored or there was very little monitoring done. There is also evidence that the U.S. government deliberately misled workers about the health and safety issures [sic] *by concealing the facts of very poor working conditions from them and by failing to undertake the needed level of radiation dose surveillance including frequent and widespread urine sampling that was warranted.*

The petitioner provided a hand-written statement (non-affidavit) in the Form B petition stating that:

Uranium production (metal) was occurring [sic] *in the late 1940s at ElectroMet. Only limited data on the range of air concentrations found in working areas, as well as air concentrations weighted over the working day are available in the detail needed to make even an approximate dose calculation. See USA article attached.*

In support of this basis, the petitioner also provided a report appearing in the August 16, 2000 edition of *USA Today*, which evaluated potential internal radiation dose from inhaled uranium at three AWEs, including Electro-Metallurgical Corporation.

The petitioner for SEC-00132 (which has been merged with SEC-00136), provided a statement by affidavit stating:

I, [name of petitioner], *wife of* [Electro-Metallurgical Corporation Employee], *know for sure that my husband never wore a dosimetry badge at any time in his career with Union Carbide.*

The petitioner's affidavit further states:

I also know that my husband was never told his life may be in danger due to past or present chemicals or radiation he had been unknowingly exposed to.

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

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-proposed class because NIOSH located information indicating that the contract to construct the building and install equipment used for the uranium refining process was issued in November 1942 (DOE, 1986; NYOO, 1951, p. 38). Actual uranium processing did not begin until April of 1943, which would indicate that radioactive materials were not present until that time. Also the contract with the Atomic Energy Commission expired on June 30, 1953 (DOE, 1986), ending its involvement with the site. Therefore, NIOSH defined the following class for further evaluation: All workers who worked in any area at the Electro-Metallurgical Corporation for the period from April 1, 1943 through June 30, 1953.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research, NIOSH has obtained internal and external dosimetry and air sampling data. 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 Electro-Met. 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 Electro-Met 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 Electro-Met operations or related topics/operations at other sites:

- *An Exposure Matrix for Linde Ceramics Plant (Including Tonawanda Laboratory)*, ORAUT-TKBS-0025; Rev. 01; November 4, 2008; SRDB Ref ID: 53205

- *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

- *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 C, Electro Metallurgical Company*, Battelle-TBD-6001 Appendix C, Rev. 0; December 21, 2007; SRDB Ref ID: 41362

4.2 ORAU Technical Information Bulletins (OTIBs)

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

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

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

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed two former Electro-Met employees. NIOSH also attempted to contact a third individual; however, multiple attempts to contact the third individual were unsuccessful.

- Personal Communication, 2009a, *Personal Communication with a Former Chemist at Electro-Metallurgical Corporation*; Telephone Interview by ORAU Team; May 29, 2009; SRDB Ref ID: 69862

- Personal Communication, 2009b, *Personal Communication with a Former Production Area Worker at Electro-Metallurgical Corporation*; Telephone Interview by ORAU Team; May 29, 2009; SRDB Ref ID: 69863

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 June 12, 2009)

Table 4-1: No. of Electro-Met Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	96
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (April 1, 1943 through June 30, 1953)	94
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).	88
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	1
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	1

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employees. Based on its review of the dose reconstructions completed for employees at Electro-Met and the available documentation for the site, NIOSH has identified a limited quantity of personnel and area monitoring data for the Electro-Met site. NIOSH's detailed review and assessment of the available records/documentation, and the process and air monitoring data, is provided in Sections 6.0 and 7.0 of this report.

4.5 NIOSH Site Research Database

NIOSH examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Two hundred fifty six documents in this database were identified as pertaining to Electro-Met. These documents were evaluated for their relevance to this petition. The documents include historical background on Electro-Met processes and radiological monitoring data (e.g., dust sampling, air monitoring, urinalysis data, radiological control program, medical monitoring, process materials, and process description). Based on its review, NIOSH was able to locate monitoring records for a limited number of the individuals comprising the evaluated class. NIOSH has also located air sampling and contamination data that pertain to the operational periods at Electro-Met, when uranium refining processes were ongoing.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Form B for SEC-00132*; OSA Ref ID: 107378 (Form B-SEC00132)
- *Form B for SEC-00136*; OSA Ref ID: 107806, pp. 8-20 (Form B-SEC00136)

- *Non-Standard Form B for SEC-00136*; December 2, 2008; OSA Ref ID: 107873, pp. 1-7 & OSA REF ID: 107806, pp. 1-7 (Non-Standard Form B)

- *Affidavit from Survivor for SEC-00132*; December 28, 2009; OSA Ref ID: 107789, p. 5 (Affidavit, 2009)

- *SEC-00132 Consult Call Response*; January 7, 2009; OSA REF ID: 107789, pp. 1-4 (Consult Call Response, 2009)

- *Preliminary Partial Dose Estimates from the Processing of Nuclear Materials at Three Plants During the 1940s and* 1950s; *USA Today* article; OSA Ref ID: 107873, pp. 8-23 & OSA Ref ID: 107806, pp. 21-36 (Makhijani, 2006)

- *Poisoned Workers and Poisoned Places*, Chapter Two; *USA Today* article; OSA Ref ID: 107873, pp. 24-27 (Eisler, 2000)

- *Statement of the Honorable John N. Hostettler Chairman of the Subcommittee on Immigration, Border Security, and Claims for the December 5, 2006 Oversight Hearing on EEOICIPA*; OSA Ref ID: 107873, pp. 28-38 (Statement, 2006)

- *New Study Finds Multiple Myeloma Linked to Radiation Exposures of Nuclear Workers*; Bio-Medicine Website; OSA Ref ID: 107789, pp. 6-9 (Williamson, 2000)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the Electro-Met site from April 1, 1943 through June 30, 1953, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Electro-Metallurgical Plant and Process Descriptions

ATTRIBUTION: Section 5.1 was completed by D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The Electro-Metallurgical Company entered into a contract with the Manhattan Engineering District (Contract No. W-7405-Eng.14) to design, engineer, construct, and operate a plant/facilities that transformed metal salt into metal. A letter of intent was written on November 14, 1942, with construction starting on December 29, 1942. The plant, known as the Area Plant, was located in the manufacturing section of the city of Niagara Falls, New York (south of Pine Avenue and east of its

intersection with Packard Road) and was situated within a fenced area on land owned by the Electro-Metallurgical Corporation. The plant was a one-story cinder block and wood structure, which measured approximately 50 feet by 219 feet, and housed all operations associated with the contract—operating equipment, restrooms, locker rooms, laboratory, and offices. The Area Plant utilities and rail spur requirements were serviced by existing utilities and tracks within the Electro-Metallurgical Plant proper. In addition to the Area Plant, there was also an addition known as the Magnesium Room, measuring 77 feet by 19 feet. Equipment installation was performed by Electro-Met personnel, who made numerous minor changes after operations had started, but before the plant was reported 100% complete. As a result, the actual completion date for the construction (June 15, 1943) was reported after operations had started (ElectroMet, 1946a).

Electro-Met, a subsidiary of Union Carbide and Cargon Corporation, received uranium tetrafluoride from Union Carbide's Linde Air Products Division plant at Tonawanda, New York, and converted it into uranium metal. The uranium metal products were primarily shipped to Hanford Engineer Works, but were also shipped to Argonne National Laboratory or DuPont's Chambers Works for testing. The uranium metal products were shipped to Simonds Saw and Steel, Vulcan Crucible Steel Company, Revere Copper and Brass Company, or Joslyn Manufacturing and Supply Company for rolling. Process residues were shipped to other sites, including Lake Ontario Ordnance Works, Mallinckrodt Chemical Company, Vitro Manufacturing, DuPont Chambers Works, and Hooker Electrochemical, for uranium recovery, storage, or disposal. In addition to uranium-metal production from green salt, Electro-Met also recast scrap metal from Simonds Saw and Steel, Chapman Valve Manufacturing Company, and American Rolling Mill Company. Electro-Met's contract also contained a provision for conducting research and development (DOE, 1986).

Initial furnace operations for uranium processing began in April 1943 (NYOO, 1951, p. 31). Three shifts per day were run at full operations. The plant produced uranium metal by reducing uranium tetrafluoride with magnesium metal under high temperature. The uranium tetrafluoride (green salt) and magnesium were placed in a closed-metal container called a "bomb," which was then heated in a furnace to initiate the reaction. The reaction was instantaneous and resulted in the formation of a pool of molten uranium in the container, topped with the magnesium fluoride formed as the byproduct of the reaction (NYOO, 1951, p. 9). The metals were cast into 110-135 kilogram ingots. After cooling, the bomb was opened and the uranium metal was removed, any adhering slag was chipped off the metallic agglomerate. Cleaned metal was then melted in a vacuum furnace and cast into billets in preparation for delivery to other facilities (NYOO, 1951, p. 10). With the exception of a standby period from September 1, 1946 through September 30, 1947, production ran from April 1943 until September 1949 (DOE, 1986). In August 1949, as Electro-Met prepared to enter a standby mode at the end of September 1949, the NYOO Health and Safety Division performed occupational exposure assessments that prescribed health and safety improvements associated with the Electro-Met operations (Hayden, 1948; Dust Sample Results, Aug. 1949).

Under separate contracts, Electro-Met also supplied calcium metal to Los Alamos Scientific Laboratory, Iowa State College, and the Atomic Energy Commission's (AEC) Santa Fe Yards. In April 1950, Electro-Met was reactivated for casting zirconium metal sponge into ingots for the Navy Critical Requirement program. The zirconium metal operations did not pose a radiological hazard other than exposure to the residual uranium remaining from the uranium operations that ended in September 1949. Based on contract AT-(40-1)-1090, between Union Carbide and Carbon Research Laboratories, Inc. and the AEC Oak Ridge Operations Office that "…directed Union Carbide to

conduct research and development of methods of forming metal that would minimize unnecessary machining, finishing, and waste," uranium handling from January 1951 through June l951 may have occurred. Although the contract is not specific, the metal involved is presumed to have been uranium (DOE, 1986).

AEC involvement with the Electro-Met site ended when contract W-7405-Eng.14 expired on June 30, 1953 (DOE, 1986). NIOSH has not located any documentation indicating that there were other sources of radiation at Electro-Met during the evaluated period between April 1, 1943 and June 30, 1953.

Design capacity of the plant was approximately 50 tons of uranium metal (as billets) per month. During operations from April 1943 through August of 1946 (when the plant was placed in standby mode) the plant produced approximately 44 tons of metal billets per month. After restarting operations, Electro-Met produced approximately 26 tons of metal billets per month during fiscal year 1948, and approximately 35 tons of metal billets per month during fiscal year 1949 (NYOO, 1951, p. 38). Operational and standby periods are outlined in Table 5-1 below. Time periods in which no uranium work was occurring are defined as “standby,” even though other non-radiological processes were occurring.

Table 5-1: Electro-Metallurgical Corporation Operational Periods

	Start Date	Stop Date
Operations	4/1/1943	8/31/1946
Standby	9/1/1946	9/30/1947
Operations	10/1/1947	9/30/1949
Standby	10/1/1949	1/1/1951
Operations	1/1/1951	6/30/1951
Standby	6/30/1951	6/30/1953

Source: Battelle-TBD-6001 Appendix C, Table C.1

Electro-Met employed 70 men to work on the reduction process (NYOO, 1951, p. 52). The process of reducing uranium tetrafluoride to uranium metal was comprised of several steps performed by different job types. Those with the highest potential for exposure to radiation or radioactive materials are described in Table 5-2, below (Dust Sample Results, Dec. 1947-May 1948). NIOSH did not locate any documentation indicating that the uranium reduction process initiated in April 1943 was modified or altered during the course of operations (i.e., the same process steps were employed during uranium handling operations over the entire history of AEC involvement at the site).

Table 5-2: The Uranium Tetrafluoride to Metal Reduction Process		
Step	**Job Title**	**Description**
1	Green Room Operator	• Moved bombs (lined with dolomite) to the green salt (i.e., uranium tetrafluoride) room • Charged the bomb with a mixture of uranium tetrafluoride and magnesium • Cleaned up the work area
2	Bomb Topper	• Packed and sealed the top of the bomb • Used vise to close top, inserted gasket, sealed and bolted on the cover • Moved the bomb to the next station
3	Head Reaction Operator	• Inspected and placed bomb into gas-fired furnace • Removed bomb from the furnace at the end of heating cycle and placed it into a cooling tank • Removed bomb from cooling tank and trucked to bomb room
4	Bomb Chipper	• Opened bomb • Drilled down bomb liner • Jolted out the uranium derbies • Chipped slag from derbies in chipping booth • Barreled and weighed slag
5	Head Remelt Operator/Furnace Operator	• Operated a high-frequency vacuum furnace to melt and cast uranium • Placed ingot molds and prepared furnace • Weighed and recorded weight of charge and finished ingots
6	Repairman	• Maintained graphite furnace parts • Used reamers, seaters, facers, and other hand tools to shape graphite parts
7	Saw Man	• Set up and operated power hack saw to cut uranium bar stock to length • Stamped identification marks on samples
8	Laboratory Handy-man	• Prepared uranium samples in sample preparation room • Cleaned laboratory table

Source: Information used to create this table is from *Dust Sample Results, Dec. 1947-May 1948.*

Other jobs that did not involve the direct handling of uranium tetrafluoride or metal, but that may have had the potential for exposure to radiation and/or radioactive materials include the following job titles: general foreman, foreman, shift foreman, repair man, store room attendant, storekeeper, janitor, guard, office personnel, technician, and chemist (Dust Sample Results, Dec. 1947-May 1948).

At the end of the contract, Electro-Met purchased the facility from AEC. The plant and equipment were decontaminated through washing, vacuuming, and in some locations, removing concrete floors and wooden platforms. In 1953, the site was surveyed and released by AEC's Health and Safety Division. Following the termination of the MED/AEC contracts, under New York State Radioactive Material License 950-0139, Electro-Met processed ores containing uranium and thorium for commercial use.

5.2 Radiological Exposure Sources from Electro-Metallurgical Operations

The following subsections provide an overview of the internal and external exposure sources for the Electro-Met class under evaluation.

5.2.1 Internal Radiological Exposure Sources from Electro-Met Operations

ATTRIBUTION: Section 5.2.1 was completed by D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The primary source of internal radiological exposure resulting from Electro-Met operations was inhalation and/or ingestion of uranium metal or uranium tetrafluoride. The hazards represented from uranium-bearing dust in the air were well documented, particularly in the years preceding 1948, with exposures greater than 500 times the tolerance level of the day being routinely measured (Dust Sample Results, Aug. 1949). Ingestion was discussed less commonly, but it can be assumed that, depending upon hygiene controls enforced at the time, as well as each employee's personal habits, that uranium ingestion was highly likely. NIOSH found data indicating that there were significant uranium surface contamination levels, which would have presented an internal exposure hazard due to uranium resuspension during work activities (Smear Results, Dec. 1952-Aug. 1953).

NIOSH found no information pertaining to exposure conditions during the standby periods shown in Table 5-1. However, NIOSH's review of the available information has not revealed any indication that uranium-handling operations occurred during these periods. For this reason, it is assumed that exposures to uranium-bearing dusts during standby periods would have been limited to residual surface contamination present during non-uranium refining operations.

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 Electro-Met was derived solely from naturally occurring ores. This assumption is based on the knowledge that the uranium produced at Electro-Met 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) the 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 also 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[3], which is well into the final standby period at Electro-Met. For this reason, it can be assumed that recycled uranium was not processed at the Electro-Met site.

Other alpha-emitting radionuclides occur naturally as part of the uranium-238 decay process. However, these would have been removed during the processing of uranium feed materials to generate the uranium tetrafluoride provided to Electro-Met for the metal reduction process. Sufficient time

[3] *ATTRIBUTION:* Information provided by Donald Bihl, Pacific Northwest National Laboratory, Site Expert for the *Hanford Site Occupational Internal Dose* Technical Basis Document (ORAUT-TKBS-0006-5).

would not have elapsed to allow in-growth of these progeny to appreciable activities such that an additional hazard would have been posed to Electro-Met personnel.

5.2.2 External Radiological Exposure Sources from Electro-Met Operations

ATTRIBUTION: Section 5.2.2 and its related subsections were completed by R. Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Based on information and documentation available to NIOSH, the potential for external radiation doses from uranium and uranium decay products existed at the Electro-Met 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 metal and uranium tetrafluoride were handled by Electro-Met 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 Electro-Met 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 and uranium tetrafluoride.

5.2.2.3 Neutron

There was a small potential for personnel neutron exposures from the uranium operations at Electro-Met. As described in Section 5.2.1, site personnel received and handled uranium tetrafluoride. Low-atomic-number elements, such as fluorine, emit neutrons of approximately 2 MeV energy when struck by alpha particles (referred to as alpha-neutron ("α-n") reactions). The radiation field emitted by these reactions increases as a function of the enrichment. Since only uranium with a natural isotopic ratio, or having a "natural enrichment", was used at Electro-Met, the radiation field was significantly lower than the gamma component and are not considered a significant exposure concern.

5.2.3 Incidents

In Section E.5 of the Form B for Petition SEC-00136, the petitioner made the following statement with regard to the uranium-metal production process: *The process was typically troublesome involving frequent blow-outs.* However, the petitioner provided no specific description for a "blow-out" event,

nor was other supporting information provided that indicated the frequency, dates, or other relevant data. The only discussion NIOSH found about blowouts at Electro-Met was in the *USA Today* article attached to the Petition, which briefly stated that "Historically, the process was typically troublesome, involving frequent blowouts, especially under conditions of production pressure that characterized the first two decades of the nuclear era" (Makhijani, 2006, p. 16). Like the petition, the article provides no specific description or supporting information regarding the blowouts.

During interviews with former Electro-Met employees, NIOSH asked questions about blowout events. Neither of the interviewees knew of, or had information regarding any blowout events at Electro-Met.

NIOSH is aware of a condition (referred to as a blowout) that may occur during the uranium tetrafluoride reduction process. The condition is identified in information and documentation from Ames Laboratory, Feed Materials Production Center, and Mallinckrodt Chemical Works. Information in Electro-Met construction documentation indicates that the site was aware of the need to carefully control the heating of the reaction bomb. Electro-Met documentation recognized that an uncontrolled reaction could result in an explosion of the bomb (ElectroMet, 1946a, p. 6). During its Electro-Met research and investigation of the documentation available in the SRDB, NIOSH discovered no evidence to support the occurrence of any reduction process blowouts in the associated documentation for the site. Further review of this potential condition is included in Sections 6 and 7 of this report.

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

The following subsections provide an overview of the state of the available internal and external monitoring data for the Electro-Met class under evaluation.

6.1 Available Electro-Metallurgical Internal Monitoring Data

ATTRIBUTION: Section 6.1 was completed by D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

As shown in Table 6-1 below, NIOSH located a total of 111 urinalysis results (67 from July through September, 1944 and 44 from October through December, 1949) (Urinalysis Results, July 1944-Sept. 1944; Urinalysis Results, Oct. 1949-Dec. 1949). The urinalysis data are comprised of data from 48 different employees (5 employees were sampled during both periods) with approximately half of the results being recorded as zero. The 1949 data include employee job categories, but the 1944 data do not include job categories. It appears that the employees sampled represent primarily those with the highest potential for exposure.

The 1944 results are listed in what appears to be a summary report, as opposed to a laboratory data sheet, and are reported in units Mg/L of either Ion F or Ion X. It can be assumed that Ion X is uranium because an air sample report in the same reference (Dust Sample Results, April 1944) reports results in "X-Dust micrograms per cubic meter." Also, recommendations for urinalysis samples (Belmore, 1947) indicated that monitoring for uranium and fluorine should have been performed. It

would be logical to assume that "Ion F" is fluorine while "Ion X" is uranium. The exact meaning of the units Mg/L is uncertain, but likely represents milligrams per liter of urine. This assumption is consistent with the 1949 results reports, as well as those from other uranium refining operations during this time period (ORAUT-TKBS- 0025; ORAUT-TKBS-0005). The laboratory performing the analyses is not indicated, but it is reasonable to assume that it was the University of Rochester, as some of the earliest uranium analyses were performed there (ORAUT-TKBS-0025, p. 33). For similar reasons, the analysis method was most likely fusion photofluorimetry (ORAUT-TKBS-0025, p. 31). The capabilities and sensitivity of this technique are well documented (Wilson, 1958).

Though limited in number, the 1949 data are better presented than the 1944 data in that: (1) the job category for each sample is identified; (2) the results are clearly for the analysis of uranium in urine; (3) the method is clearly identified (i.e., fluorimetric); and (4) the units identified, mg/L, are consistent with those reported for other sites (ORAUT-TKBS-0005; ORAUT-TKBS-0025). The assumption that the method is fusion photofluorimetry is supported because the uranium fusion photofluorimetry urinalyses performed by the University of Rochester and the AEC NYOO were similar to those preformed at other AEC facilities.

Air sampling data were located for the years 1944, 1947, 1948, and 1949 (Dust Sample Results, July 1944; Dust Sample Results, Dec. 1947-May 1948; Dust Sample Results, Aug. 1949), with the bulk generated in 1948 and 1949. Approximately 50% of the air sampling data can be associated with specific job categories (the remaining air sampling data are legible, but the specific job categories are illegible). As with the bioassay results, these appear to be job categories with the highest potential for exposure. It is worth noting that no bioassay data and only 11 air sampling results were located for the standby periods discussed in Section 5.0. With the exception of the 11 results from 1953 (during the last standby period), 135 air samples were collected during Electro-Met operational periods. The operational data represent a total of about 19 sampling days, while the 11 standby period results were collected in a single day. As with the urinalysis data, NIOSH has found no indication of radiological operations during the evaluated class period, other than the uranium metal reduction process. NIOSH also found no information in air monitoring documentation or other reports that supports the occurrence of blowouts related to the uranium tetrafluoride reduction operations (which are discussed in Section 5.2.3), or similar incidents/situations/conditions at Electro-Met.

Contamination survey data were collected in December 1952 and August 1953 (Smear Results, Dec. 1952-Aug. 1953). The December smear sample results include those labeled "before wipe" and "after wipe." According to a separate report containing this same data (Belmore, 1953), a crude cleaning was performed to determine the ease of subsequent decontamination efforts to release the facility. Since the "after wipe" results reflect small areas that were cleaned, they will be of limited usefulness in establishing general radiological surface contamination conditions. Based on information in a 1951 report, the "entire" area was cleaned before October 1, 1949, by washing and vacuuming prior to going into standby (NYOO, 1951) status.

Table 6-1 provides a summary of data found in the SRDB that will assist in calculating bounding internal doses.

Table 6-1: Available Data to Support a Bounding Internal Dose Estimate

Year	Facility Status[1]	Bioassay		Air Samples	Contamination Surveys
		No. Monitored	No. Samples	No. Samples	No. Surveys
1943	N/A	0	0	0	0
1944	Operational	24	67	5	0
1945	N/A	0	0	0	0
1946	N/A	0	0	0	0
1947	Operational	0	0	7	0
1948	Operational	0	0	29	0
1949	Operational	24	44	82	0
1950	N/A	0	0	0	0
1951	N/A	0	0	0	0
1952	Standby	0	0	0	177
1953	Standby	0	0	11	28

Notes:
[1]Indicates facility status when the data was collected.

6.2 Available Electro-Metallurgical External Monitoring Data

ATTRIBUTION: Section 6.2 was completed by R. Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Routine film badging of the Electro-Met workers began on June 7, 1948 (Heatherton, 1948). NIOSH has obtained weekly film badge results that cover the period between June 7, 1948 and September 30, 1949 (Dosimetry Results, June 1948-June 1949; Dosimetry Results, Aug.-Dec. 1948; Dosimetry Results, March 1948-Jan. 1949; Dosimetry Results, Jan-Sep. 1949). The results include both gamma and beta exposure results for approximately fifty individuals for each period listed. As one of the employee interviews indicated, roughly thirty to forty foundry workers were on the first shift (Personal Communication, 2009a); this data represents a large portion, if not all, of the exposed foundry workers.

Some dosimetry results are listed by employee name, and other results are listed by employee name and job title. The job titles listed include, but are not limited to the following: bomb topper, handyman, operator (Green Room), head remelt operator/furnace operator, head reaction operator, utility man (bomb chipper), special saw operator (saw man), and repairman. These job titles represent those who worked most closely with the materials (ElectroMet, 1948; Dust Sample Results, Dec. 1947-May 1948) and would be expected to be the maximally exposed portion of the workforce. Other job titles that did not involve the direct handling of uranium tetrafluoride or metal, but that may have had the potential for exposure to radiation and/or radioactive materials include the following: general foreman, foreman, shift foreman, repair man, store room attendant, storekeeper, janitor, guard, office personnel, technician, and chemist (Dust Sample Results, Dec. 1947-May 1948).

There were some ambient beta and gamma measurements taken on process equipment and building surfaces in 1946 (ElectroMet, 1946b), 1947 (Hayden, 1947), and in 1953 (Belmore, 1953, p. 3). For

the results taken in 1946, the highest gamma value was 0.005 r/8 hrs and the highest beta value was 0.22 r/8 hrs. From the 1947 data, the highest surface reading was 12.0 mrep/hr, measured on the floor of the "old burn out area." The data collected in 1953 were in preparation for dismantlement of the building and the highest reading was found on the floor around the cut-off saw, with a reading of 2 mr/hr gamma, and 15 mrep/hr beta. There was no indication of any neutron surveys in any of the documents reviewed by NIOSH.

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-00136 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Electro-Metallurgical Data

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

representativeness, and sufficiency for determining the feasibility of dose reconstruction. The feasibility evaluation presupposes that data pedigree issues have been settled.

7.1.1 Internal Monitoring Data Pedigree Review

ATTRIBUTION: Section 7.1.1 and its related subsections were completed by D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

7.1.1.1 Urinalysis Data

As previously mentioned in Section 6.0, NIOSH has obtained a total of 111 urinalysis results from 48 different employees, collected during 1944 and 1949, with approximately half of the results being recorded as zero. The 1944 results comprise the bulk of the data and are non-specific with regard to employee job category.

The 1949 results consist of 44 measurements from samples collected during October through December of that year. The results are reported on forms with the heading "Atomic Energy Commission, New York Operations Office (NYOO), Medical Division," which leads to the assumption that the analyses were performed by the AEC Health and Safety Laboratory (HASL). In addition, the distribution sheet is from the "Chemistry Laboratory" and includes a prominent scientist who is known to have worked for NYOO at that time.

The urinalysis data, collected by HASL who had the objective to assess exposures at AEC facilities and also performed assessments at many other facilities, are legible and are in original form. The available data can be used to support the evaluation of a reasonable estimate of the internal dose for the employees with whom the data are associated. Although the available data are from a subset of the workforce for only two years out of the ten-year period for the evaluated class, NIOSH has found no information that would indicate operations other than the uranium-metal reduction process, described in Section 5.0, occurred at the Electro-Met site. Thus, the modes of exposure and the exposures represented by the bioassay data would be consistent and representative for all operations and time periods. NIOSH intends to use the available bioassay data, coupled with the available air sample data, to support the assessment of the Battelle-TBD-6001 Appendix C methodology as a bounding internal dose reconstruction approach for the unmonitored workers in the class evaluated in this report.

7.1.1.2 Air Sample Data

There are a total of 135 air sample results from 1944 (Dust Sample Results, July 1944), 1947 (Dust Sample Results, Dec. 1947-May 1948), 1948 (Dust Sample Results, Dec. 1947-May 1948; Dust Sample Results, Nov. 1948-Jan. 1949), 1949 (Dust Sample Results, Aug. 1949), and 1953 (Dust Sample Results, Aug. 1953), with the bulk of the results from 1948 and 1949. The 12 results from 1944 and 1947 appear in an original summary report format and not on a laboratory data sheet. The remaining 122 results are reported on a laboratory data sheet entitled "United States Atomic Energy Commission Office of New York Operations Radiological Laboratory." As in the case of the urinalysis results above, this leads to the conclusion that analysis was performed by HASL. The method indicated on the laboratory data sheets is simply "α counter" and the results are reported in

units of $d/m/m^3$. No detection limit or background count information is provided; however, these parameters may be estimated from the discussions of other sites that utilized HASL for analysis (e.g., the Mallinckrodt site, ORAUT-TKBS-0005) or by analysis of the data itself. Eleven air sample results were located from the standby period in 1953.

The usefulness of the air sample data must be considered within the context of their applicability to every operational period. As with the urinalysis data, NIOSH has found no indication of other operations, during the evaluated class period, other than the uranium metal reduction process. From this standpoint, the data sufficiently represent the operations that were performed over the entire operational period. NIOSH intends to use this information, coupled with the available operational information and bioassay data, to support the assessment of the Battelle-TBD-6001 Appendix C methodology as a bounding internal dose reconstruction approach for the class evaluated in this report.

7.1.1.3 Surface Contamination Data

There are 177 original results for removable surface contamination collected in December 1952 and 28 results collected in August 1953. The surface contamination data are comprised of smear samples collected throughout the Electro-Met facility on floors, equipment, desks, and virtually all other surfaces. Of the 177 smear samples collected in 1952, 56 were labeled as "after wipe" results. The surface contamination data are reported on laboratory data sheets from the US AEC NYOO Health and Safety Division; therefore, the samples were likely analyzed at HASL. The specific analytical method is not indicated, but is reported as "α count" on the data sheets. Although specific instrument counting information regarding the minimum detectable activity, the background counting time, and background counts from which the MDA could be calculated are not available, a value for the MDA could be inferred from the smear data since the activity for several smears is recorded as <1.0 dpm/sample. This information may be used to supplement NIOSH's internal dose-bounding approach for the class evaluated in this report who worked during the standby period after October 1, 1949.

7.1.2 External Monitoring Data Pedigree Review

ATTRIBUTION: Section 7.1.2 was completed by R. Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The film badge results obtained by NIOSH are in original form and represent a large fraction of, if not the entire, foundry workforce for the period monitored from June 7, 1948 through September 30, 1949. The titles associated with the film badge results indicate the jobs with the highest exposure potential (ElectroMet, 1948). As the materials handled and methods used did not change during the covered period, this data may be used to estimate external penetrating exposure for all workers including those who worked at this site prior to and after this monitored period. NIOSH intends to use this information to support its ability to bound external dose for the class evaluated in this report.

7.2 Evaluation of Bounding Internal Radiation Doses at Electro-Metallurgical

ATTRIBUTION: Section 7.2 and its related subsections were completed by D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal source of internal radiation doses for members of the class under evaluation was inhalation of uranium bearing dust generated during the reduction of uranium tetrafluoride to uranium metal. 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 Doses

The following subsections summarize the extent and limitations of information available for reconstructing the process-related internal doses of members of the class under evaluation.

7.2.1.1 Urinalysis Information and Available Data

As discussed in Section 6.1, there were a limited number of bioassay samples taken; bioassay samples were taken for only two years out of the ten-year evaluated period. Because of this limitation, NIOSH does not intend to base its ability to bound the internal dose solely on the available bioassay data. NIOSH does intend to use the bioassay data, coupled with the available air sample data, to assess and corroborate the internal dose estimates calculated using Battelle-TBD-6001 Appendix C methodology as a bounding internal dose reconstruction approach for the unmonitored workers in the class evaluated in this report.

7.2.1.2 Airborne Levels

A substantial quantity of air sample data providing gross alpha analytical results exist for some of the Electro-Met operational periods indicated in Table 5-1. Based on the knowledge of the process conducted, it can be assumed that the alpha activity consists of uranium-238, uranium-234, and uranium-235. However, the bulk of the data are from samples collected in 1948 and 1949, with a few (12) collected in 1944 and 1947. Although no unusual occurrences (such as blowouts) were identified in the available documentation, in the case that potential exposure condition occurred on the frequency identified by the petitioner, the associated exposures and airborne concentrations would be accounted for in the available bioassay and air sample data. Based on the consistency of Electro-Met operations (i.e., only uranium tetrafluoride to metal reduction was performed), and information indicating that major improvements in ventilation and other controls were not implemented until after October 1949, NIOSH believes that the air sample data, coupled with the available bioassay data, are sufficient to support and corroborate the internal dose estimates calculated using Battelle-TBD-6001 Appendix C methodology as a bounding internal dose reconstruction approach for the unmonitored workers in the class evaluated in this report. NIOSH concludes that it can establish a bounding internal dose estimate from airborne particulates containing the isotopes of uranium (i.e., uranium-238, uranium-234, and uranium-235). As discussed in Section 5.0, exposure to radon is not believed to be a significant source of internal exposure due to the age of the source and product materials.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

Ambient environmental internal doses could have resulted from the inhalation of radionuclides in locations outside of the process/operations areas at Electro-Met. NIOSH has identified no specific indication that ambient air particulate levels were monitored at Electro-Met. However, the ambient environmental exposures would be included and accounted for in the occupational monitoring data available for site personnel. Based on this information, and the available data and documentation associated with the Electro-Met operations, NIOSH has concluded that ambient environmental internal doses, associated with ambient environmental airborne exposures, outside the direct vicinity of the Electro-Met process areas, are accounted for and can be bounded by application of operational internal dose assessment methods. Therefore, further analysis and evaluation of the ability to bound (reconstruct dose with sufficient accuracy) ambient environmental external dose is not included in this report.

7.2.3 Methods for Bounding Operational Internal Dose at Electro-Metallurgical

NIOSH intends to use the available bioassay data in applicable cases for which they apply. In the case of unmonitored personnel, NIOSH reviewed and assessed the available bioassay data and air sample data against the methodology provided in Battelle-TBD-6001. Considering the intake scenarios established in Battelle-TBD-6001 Appendix C, the calculated urinary excretion of uranium 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).

With the exception of two reports of decontamination efforts, little is known about activities that took place during the standby periods. NIOSH has not discovered information indicating that AEC-related radiological operations were performed during the standby periods. Therefore, NIOSH has concluded that, based on the currently available information and documentation, activities occurring during operations would result in internal radiological exposures doses far in excess of those during standby periods. For that reason, the internal dose during standby periods can be bounded using the methodology defined in Battelle-TBD-6001 Appendix C.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH has reviewed extensive information relating to Electro-Met and has found a significant number of urinalysis records and air sampling data. While these data do not reflect every year of Electro-Met operations, the results can be considered representative of all years of operations at the Electro-Met site. In addition, the method proposed for establishing a bounding dose for operational periods in Battelle-TBD-6001 Appendix C, has been compared to actual urinalysis data from the early years of operation 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 as 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 Electro-Metallurgical

ATTRIBUTION: Section 7.3 and its related subsections were completed by R. Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal source of external exposure for members of the evaluated class was gamma, beta, and to a lesser extent, neutron radiations associated with handling and working in proximity to uranium tetrafluoride and uranium metal.

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 Doses

The following subsections summarize the extent and limitations of information available for reconstructing the process-related external doses of members of the class under evaluation.

7.3.1.1 Personnel Dosimetry Data

NIOSH has documentation of film badge results covering a sixteen month period between June 7, 1948 and September 30, 1949 (Dosimetry Results, June 1948-June 1949; Dosimetry Results, Aug.-Dec. 1948; Dosimetry Results, March 1948-Jan. 1949; Dosimetry Results, Jan.-Sep. 1949). The documents include both photon (gamma) and beta exposure results. The data include results for job titles that represent the maximally exposed work population and cover a period of routine plant operations.

As the radiation sources and plant processes are representative of the operational periods, these data may be used to bound exposures during those periods. For the non-operational or standby periods, Battelle-TBD-6001 Appendix C provides guidance that may be used to bound the external photon and beta doses based on the operational period results.

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

Ambient environmental external doses could have resulted from low-level exposures to radioactive materials in locations outside of the process/operations areas at Electro-Met. There is no specific indication that ambient radiation levels were monitored at Electro-Met. However, ambient environmental external doses would be included and accounted for in the occupational monitoring data available for site personnel. In addition, this site managed one radioactive material source, natural abundance uranium, and had no operations involving other radioactive materials prior to the evaluated period. Based on this information, and the available data and documentation associated with the Electro-Met operations, NIOSH has concluded that ambient environmental external doses, associated with exposures outside the direct vicinity of the Electro-Met process areas, are accounted for and can be bounded using operational external dose assessment methods. Therefore, further analysis and evaluation of the ability to bound (reconstruct dose with sufficient accuracy) ambient environmental external dose is not included in this report.

7.3.3 Electro-Metallurgical Occupational X-Ray Examinations

A memo reviewing the medical program at Electro Metallurgical was written by the MED in 1945 (Mears, 1945). The memo recommended pre-employment, annual, and termination X-rays. Although no information regarding occupational medical dose have been identified specific to Electro-Met, 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 Electro-Met evaluated class.

7.3.4 Methods for Bounding External Dose at Electro-Metallurgical

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
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

NIOSH has obtained sufficient personnel dosimetry records to reconstruct occupational photon and beta dose for the covered period. A bounding approach for neutron and medical X-ray dose is outlined below.

Photon Dose

Photon dose may be bound using guidance from Battelle-TBD-6001 Appendix C. To take advantage of all data, including dosimetry results where job titles are not reported, the aggregate of all film badge results, which includes the maximally exposed work group for the site, may be considered to represent a lognormal distribution. These film badge results are documented to cover a range of job types. For the purpose of bounding the dose for the evaluated class, a maximum percentile of the lognormal distribution may be applied. For the purpose of providing a refined dose estimate, that would represent a dose that is more precise than a bounding dose estimate, a lower percentile dose from the distribution may be applied. There were three non-operational or standby periods interspaced within the operational periods. For these times, a minimum percentile of the lognormal distribution may be used to assign dose. This is conservative, as the standby periods were likely to have reduced or zero inventories and little interaction with the processing equipment.

Beta Dose

Beta dose may also be bound using guidance from Battelle-TBD-6001 Appendix C. As in the photon dose, these results may be considered to represent a lognormal distribution. For the purpose of bounding the dose for the evaluated class, a maximum percentile of the lognormal distribution may be applied. For the purpose of providing a refined dose estimate, that would represent a dose that is more precise than a bounding dose estimate, a lower percentile dose from the distribution may be applied. For the non-operational periods, a minimum percentile of the lognormal distribution may be used to

assign dose. This is conservative, as the standby periods were likely to have reduced or zero inventories and little interaction with the processing equipment.

Neutron Dose

NIOSH evaluated several possible methods to bound these potential doses. These methods included consideration of spontaneous fission, uranium compound source terms and quantities used at the site, enrichment levels, neutron yields from alpha-neutron and spontaneous fission reactions, worker stay times under different exposure scenarios, and neutron-to-photon ratios. Due to its low production rate, spontaneous fission can be eliminated as a viable dose contributor. Based on the remaining considerations, NIOSH could provide a bounding estimate of neutron doses using information contained in ORAUT-OTIB-0024.

Medical X-ray Dose

With the exception of a memo recommending pre-employment, annual, and termination X-rays (Mears, 1945), 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.

7.3.5 External Dose Reconstruction Feasibility Conclusion

Using guidance outlined in Battelle-TBD-6001 Appendix C, external photon and beta dose may be reconstructed. Using ORAUT-OTIB-0024, external neutron dose may be reconstructed. Using ORAUT-OTIB-0006, external occupational X-ray dose may be reconstructed. 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-00136

ATTRIBUTION: Section 7.4 and its related subsections were completed by D. Watkins, Oak Ridge Associated Universities (ORAU), and D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The following subsections evaluate the assertions made on behalf of petition SEC-00136 for the Electro-Met site.

7.4.1 Dosimeters/Monitoring

ISSUE: The petitioner for SEC-00132 provided a statement by affidavit, in support of Item F.1, stating: *I* [petitioner name] *know for sure that my husband never wore a dosimetry badge at any time in his career with Union Carbide.*

RESPONSE: Petition SEC-00132 was merged with SEC-00136. NIOSH has been unable to locate badge data specific for the Electro-Met worker referenced in Petition SEC-00132. It is unclear from the documentation reviewed whether this employee was unmonitored due to oversight, was monitored but the records lost, or did not require monitoring. Badge data were located for employees with a similar job title (Clerk). In any case, NIOSH has located a substantial amount of film badge data from other Electro-Met workers. NIOSH believes that it has sufficient film badge data to reconstruct the external dose of every member of the evaluated class with sufficient accuracy.

ISSUE: The petitioner for SEC-00136 provided a statement (not an affidavit), in support of Item E.4, citing: 1) DOL/DOE records indicate no (or very little) monitoring; and 2) no, or inadequate, monitoring was performed, as indicated in a *USA Today* article.

RESPONSE: NIOSH found that monitoring records were not available for the entire evaluated class period from April 1, 1943 through June 30, 1953. However, as presented and evaluated in the preceding sections of this evaluation, sufficient film badge, air sample, and urinalysis results have been found to support bounding the dose (reconstructing external and internal doses with sufficient accuracy) for the class evaluated in this report.

7.4.2 Blowout Events

ISSUE: The petitioner for SEC-00136 provided a statement (not an affidavit), in support of Item E.4, citing blowouts during uranium metal fabrication.

RESPONSE: NIOSH has carefully reviewed an extensive amount of information pertaining to Electro-Met with regard to the occurrence of blowouts. In addition, interviews were conducted with former Electro-Met employees whom NIOSH specifically sought information regarding these events. As discussed in Section 5.2.3, NIOSH has discovered no documentation to support the occurrence of blowouts at Electro-Met. In the case that it is assumed that blowouts were a common occurrence (based on the frequency of occurrence discussions included in the petition and news article as reviewed in Section 5.2.3), the available Electro-Met monitoring information and dose evaluation methods reviewed in this report include and account for the potential personnel exposures associated with such occurrences. Based on the evaluation in this report, the available data serve to support a bounding approach to complete dose reconstructions for the evaluated class that accounts for all potential exposure conditions and situations that occurred during the operations at the Electro-Met site.

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

ATTRIBUTION: Section 7.5 was completed by D. Watkins, Oak Ridge Associated Universities (ORAU), and D. S. Mantooth, Dade Moeller and Associates, Inc. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

During the feasibility evaluation for SEC-00136, a number of issues were identified that needed further analysis and resolution. The issues and their current status are:

ISSUE: The approach taken by NIOSH in Battelle-TBD-6001 Appendix C to develop year-specific correction factors for inhalation doses does not appear to be claimant favorable. Doses in the early years may be understated. Battelle-TBD-6001 is based on data collected from 1948 through 1956. The airborne levels for all uranium refining facilities show a downward trend during this period. The TBD suggests a correction factor be applied to pre-1948 intakes to reflect the potentially higher airborne levels. [We] suggest that the correction is too low and is not favorable to claimants who were exposed prior to 1948 (SC&A, 2008).

RESPONSE: NIOSH reviewed the available information and concluded that, while airborne levels were higher at Electro-Met prior to 1948, few if any improvements were implemented before 1949. This fact, combined with the consistency in Electro-Met operations (as opposed to other metal refining sites) allows the assumption that airborne conditions during the operational periods from 1948 and earlier were reasonably stable. This analysis is discussed in Section 7.1.1.2 and Section 7.2.1.2 of this report.

ISSUE: NIOSH [Battelle-TBD-6001] did not consider radon exposures in developing inhalation exposure rates. Since pitchblende ore contains significant quantities of radium-226 and its progeny, this omission significantly understates inhalation exposure rates for workers involved with operations at the front end (ore processing) of the refining process (SC&A, 2008).

RESPONSE: As discussed in Section 5.2.1, the process of producing uranium tetrafluoride from uranium oxide removes the radon parent species. In addition, the residence time in the Electro-Met facility was insufficient to allow ingrowth of these parents to a degree to produce a significant radon hazard.

ISSUE: It is not clear that Battelle-TBD-6001 Appendix C considers the correction factor suggested by the TBD for intakes received prior to 1948. This would result in a dose estimate not favorable to the claimant.

RESPONSE: Battelle-TBD-6001 Appendix C does not consider the correction factors suggested by the TBD, but uses a lognormal analysis of the existing data to provide a bounding estimate for intakes of uranium for all classes of workers. As reported in Section 7.2.3.1 of this report, scenarios were developed in which the intakes were estimated using Appendix C methodology. Considering all the available bioassay and air sample data, as well as the approach presented in Battelle-TBD-6001 Appendix C, NIOSH concludes that it can bound the dose for the class evaluated in this report.

ISSUE: The estimated intakes defined for three job classifications defined by Battelle-TBD-6001 Appendix C are based on data collected during 3 days in 1948 and again in 1949. It is unclear if this dataset reflects the entire operational period as suggested.

RESPONSE: NIOSH reviewed the available information and concluded that, while airborne levels were higher at Electro-Met prior to 1948, few if any improvements were implemented before 1949. This fact combined with the consistency of Electro-Met operations (as opposed to other metal refining sites) supports the assumption that airborne conditions during the operational periods from 1948 and earlier were reasonably stable. This analysis is discussed in Section 7.1.1.2 and 7.2.1.2 of this report.

ISSUE: Electro-Met was operational from 1943 through 1953, with periods of inactivity. Uranium-containing dust samples results collected over a 6 day period (3 days in 1948 and 3 in 1949) are assumed to reflect conditions over the entire 10 year period. The validity of this assumption must be determined to ensure, in the least, that the approach provides a bounding estimate of uranium uptakes.

RESPONSE: As reported in Section 7.2.3.1 of this report, scenarios were developed in which the intakes were estimated using Battelle-TBD-6001 Appendix C methodology. Considering all the available bioassay and air sample data, as well as the approach presented in Battelle-TBD-6001 Appendix C, NIOSH concludes that it can bound the dose for the class evaluated in this report.

ISSUE: There is no apparent basis for assigning exposures during standby periods to the "Other" category described in Battelle-TBD-6001 Appendix C. Battelle-TBD-6001 Appendix C evaluates internal and external exposures during standby periods at Electro-Met by using the methodology attributed to the "Other" category described as "…for those that do not routinely enter uranium production areas." This was based on the assumption that "…it is unlikely anyone handled uranium or uranium processing equipment. Also the uranium inventory was likely reduced…" However, no documented evidence has been located to substantiate this assumption.

RESPONSE: As discussed in Section 7.2.3.2 of this report, there are no individual data to support a bounding dose for standby operations. NIOSH will assess occupational exposures to establish a bounding internal/external dose according to the Battelle-TBD-6001 Appendix C methodology, with the assumption that activities during standby periods have much less exposure potential than operational periods.

7.6 Summary of Feasibility Findings for Petition SEC-00136

This report evaluates the feasibility for completing dose reconstructions for employees at the Electro-Metallurgical Corporation from April 1, 1943 through June 30, 1953. 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 7-1 summarizes the results of the feasibility findings at Electro-Met for each exposure source during the time period April 1, 1943 through June 30, 1953.

Table 7-1: Summary of Feasibility Findings for SEC-00136 April 1, 1943 through June 30, 1953		
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	

Notes:
[1] Internal includes an evaluation of airborne dust levels.

As of June 12, 2009, a total of 94 claims have been submitted to NIOSH for individuals who worked at Electro-Metallurgical Corporation and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for 88 individuals (~94%).

8.0 Evaluation of Health Endangerment for Petition SEC-00136

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

Based on Electro-Met process information, summary report information, source term information, and interviews with former Electro-Met personnel, 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-00136

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 workers who worked

in any area at the Electro-Metallurgical Corporation for the period from April 1, 1943 through June 30, 1953.

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-00136. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

10.0 References

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

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

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

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

OCAS-PR-004, *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, Rev. 0, National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; September 23, 2004; SRDB Ref ID: 32022

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

ORAUT-OTIB-0024, *Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds*, Rev. 00; Oak Ridge Associated Universities (ORAU); Oak Ridge, Tennessee; April 7, 2005; SRDB Ref ID: 19445

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Belmore, 1953, *Dismantlement of Electro-Met Company, Radiation Survey of December 10-12, 1952*, correspondence to W. B. Harris; F. M. Belmore; February 3, 1953; SRDB Ref ID: 59265

Blatz, 1949, *Proper Film Badge Placement*, correspondence to Mr. Winterhaler; Hanson Blatz; June 20, 1949; SRDB Ref ID: 8897, p. 28

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Dosimetry Results, Aug. 1944, *Dosimetry Results for Electro-Metallurgical Employees from August 26, 1944 through August 29, 1944*; SRDB Ref ID: 8887, pp. 9-10

Dosimetry Results, March 1948-Jan. 1949, *Dosimetry Results for Electro-Metallurgical Employees from March 15, 1948 through January 24, 1949*; SRDB Ref ID: 11547

Dosimetry Results, June 1948-June 1949, *Dosimetry Results for Electro-Metallurgical Employees from June 7, 1948 through June 13, 1949*; SRDB Ref ID: 11543

Dosimetry Results, Aug.-Dec. 1948, *Dosimetry Results for Electro-Metallurgical Employees from August 9, 1948 through December 20, 1948*; SRDB Ref ID: 11545

Dosimetry Results, Nov. 1948-Jan. 1949, *Dosimetry Results for Electro-Metallurgical Employees from November 1, 1948 through January 24, 1949*; SRDB Ref ID: 12402, p. 6

Dosimetry Results, Jan.-Sep. 1949, *Dosimetry Results for Electro-Metallurgical Employees from January 3, 1949 through September 26, 1949*; SRDB Ref ID: 11548

Dosimetry Results, March-May 1949, *Dosimetry Results for Electro-Metallurgical Employees from March 7, 1949 through May 30, 1949*; SRDB Ref ID: 8875, p. 11

Dust Sample Results, April 1944, *Electro-Met Dust Sample Results for April 5, 1944*; SRDB Ref ID: 8887, pp. 11-14

Dust Sample Results, July 1944, *Electro-Met Dust Sample Results for July 26, 1944*; SRDB Ref ID: 7727

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Mears, 1945, *Medical Program at Electro-Metallurgical Plant*, correspondence to the Area Engineer at Tonawanda, New York; B. J. Mears; May 4, 1945; SRDB Ref ID: 21849

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Williamson, 2000, *New Study Finds Multiple Myeloma Linked to Radiation Exposures of Nuclear Workers*; David Williamson, University of North Carolina at Chapel Hill; April 8, 2000; OSA Ref ID: 107789, pp. 6-9

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Electro Metallurgical			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
Primary Site/Company Name: Electro Metallurgical; DOE 1942-1953 Other company names: ElectroMet Corp. 1942-1953 Umetco Minerals Corp. 1942-1953 Union Carbide Corp. parent company, 1942-1999 Dow Chemical Company, successor company, acquired Union Carbide in 1999	Contacted Mike Glackin, Dow attorney, on 05/05/2009 to request access to any existing records. An update was requested on 05/28/2009. As of 05/21/2009, no records had been located.	N/A	0
State Contacted: John Abuno, New York State Department of Environmental Conservation	No relevant documents identified.	05/18/2009	0
Buffalo Marriott Hotel	Brief notes on Electro Metallurgical's uranium metal production.	04/18/2005	2
Department of Labor/Paragon	Progress reports, analyses of Electro Metallurgical calcium, survey for buried waste at LOOW, and status of Buffalo area FUSRAP sites.	12/30/2008	18
DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	02/03/2009	0
DOE EML/HASL	Record of a 1953 site visit to determine the cost of decontamination.	03/08/2005	1
DOE Hanford Declassified Document Retrieval System (DDRS)	Hanford trip and progress reports regarding uranium billet production at Electro Metallurgical.	02/03/2009	6
DOE Headquarters, Germantown, MD	Site FUSRAP evaluation, airborne radioactivity studies, an NYOO uranium operations flowchart, and identification of Electro Metallurgical as producing uranium metal by green salt reduction.	01/22/2004	9
DOE Legacy Management - Grand Junction	Tonawanda Area progress reports, site description, FUSRAP surveys and elimination report, material transfers, purchase orders, contracts and amendments, soil sampling, and comments on FUSRAP surveys.	03/12/2009	81
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	A report on the production of feed materials, report of the health and safety division, a hazardous waste appraisal, a chronology of residue placement at LOOW, and HASL-58, the symposium on occupational health experiences in the uranium industry.	04/01/2008	6
DOE OpenNet	NYOO monthly status reports and identification of Electro Metallurgical as a producer of uranium metal.	02/03/2009	7
DOE OSTI Energy Citations	No relevant documents identified.	02/03/2009	0
DOE OSTI Information Bridge	HW-13190 and a Hanford report which mentions Electro Metallurgical as a source of uranium billets.	02/03/2009	1
Google	FUSRAP sites summary, news reports of high exposures, news reports, and	04/28/2009	15

Table A1-1: Data Capture Synopsis for Electro Metallurgical			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
	a records inventory for Umetco Colorado operations.		
NARA - Kansas City	FUSRAP documents including surveys and MED weekly reports.	08/11/2008	8
NARA - Atlanta	Air dust samples, monthly reports, Linde health physics reports with some Electro Metallurgical results, survey results, urinalysis results, work report, hazards analysis, uranium transfers, weekly reports, R&D progress reports, and weekly production reports.	06/18/2008	34
National Academies Press (NAP)	No relevant documents identified.	02/03/2009	0
National Nuclear Security Administration (NNSA) - Nevada Site Office	Electro Metallurgical is identified as an early uranium processing facility in a Weldon Spring commemorative document.	05/11/2009	1
NRC Agencywide Document Access and Management (ADAMS)	No relevant documents identified.	02/03/2009	0
Oak Ridge Associated Universities	Process knowledge interviews, epidemiologic study, mortality studies, protocols for finding former employees, conference proceedings, listing of uranium processing papers, film badge results, and exposure monitoring data.	04/01/2004	11
Oak Ridge Operations Vault	Process knowledge interviews, description of uranium processing operations, study of occupational exposures, dosimetry results, progress reports, work reports, biopsy sample information, occurrences, emergency procedures, air dust reduction measures, and health physics reports.	10/28/2005	12
ORAU Team	ORAU Project spreadsheet and a site profile.	03/05/2008	2
Southern Illinois University, Edwardsville, IL	Electro Metallurgical is mentioned as an early uranium processing facility.	10/08/2008	2
Unknown	Ring dosimeter data, health hazards report, NYOO status reports, safety management evaluation, Tonawanda health physics report, film badge results, dismantlement surveys, air dust evaluation, FUSRAP elimination report, MED materials flow, urinalysis information, and contract numbers.	07/22/2003	40
Washington State University (U.S. Transuranium and Uranium Registries)	No relevant documents identified.	02/03/2009	0
Total			**256**

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
DOE CEDR http://cedr.lbl.gov/ COMPLETED 02/03/2009	"Electro Metallurgical" in abstract "Electromet Corp." in abstract "UMETCO Minerals" in abstract	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 02/03/2009	Electro Metallurgical Corporation (Simple search mode) Electromet contained in Title (Simple search mode) UMETCO Minerals (simple search mode)	10	6
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 02/03/2009	Electro Metallurgical Corporation in any field, published between 1942-1960 Electromet Corp in any field, published between 1942-1960 "UMETCO Minerals" in any field, published between 1942-1960	20	7
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 02/03/2009	Electro Metallurgical Corporation in any field, published between 1942-1960 "Electromet Corp" in any field, published between 1942-1960 "UMETCO Minerals" in any field, published between 1942-1960	26	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 02/03/2009	Electro Metallurgical Corporation in any field, published between 1942-1960 Electromet Corp in any field, published between 1942-1960 "UMETCO Minerals" in any field, published between 1942-1960	26	1
National Academies Press http://www.nap.edu/ COMPLETED 02/03/2009	"Electro Metallurgical Corporation" in any field "Electromet" in any field "UMETCO" in any field	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 02/03/2009	"Electro Metallurgical" in any field "Electromet Corp." in any field "UMETCO Minerals" in title	78	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 02/03/2009	"Electro Metallurgical" in any field "Electromet" in any field "UMETCO" in any field	0	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 05/11/2009	ElectroMet Corp ElectroMet Electro Metallurgical UMETCO Minerals Union Carbide	5	1

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
Google http://www.google.com COMPLETED 04/28/2009	"Electro-Metallurgical Corporation" "Electro-Metallurgical Corporation" oralloy "Electro-Metallurgical Corporation" postum "Electro-Metallurgical Corporation" tuballoy "Electro-Metallurgical Corporation" "uranyl nitrate hexahydrate" OR UNH "Electro-Metallurgical Corporation" "K-65" "Electro-Metallurgical Corporation" "sump cake" "Electro-Metallurgical Corporation" "uranium dioxide" "Electro-Metallurgical Corporation" "uranium tetrafluoride" "Electro-Metallurgical Corporation" "uranium trioxide" "Electro-Metallurgical Corporation" "uranium hexafluoride" "Electro-Metallurgical Corporation" accident "Electro-Metallurgical Corporation" "air count" "Electro-Metallurgical Corporation" "air dust" "Electro-Metallurgical Corporation" "air filter" "Electro-Metallurgical Corporation" "airborne test" "Electro-Metallurgical Corporation" alpha "Electro-Metallurgical Corporation" "belgian congo ore" "Electro-Metallurgical Corporation" bioassay OR bio-assay "Electro-Metallurgical Corporation" breath OR "breathing zone" OR BZ "Electro-Metallurgical Corporation" calibration "Electro-Metallurgical Corporation" columnation "Electro-Metallurgical Corporation" contamination "Electro-Metallurgical Corporation" curie "Electro-Metallurgical Corporation" "denitration" OR "denitration pot" "Electro-Metallurgical Corporation" derby OR regulus "Electro-Metallurgical Corporation" dose "Electro-Metallurgical Corporation" dosimeter "Electro-Metallurgical Corporation" dosimetric "Electro-Metallurgical Corporation" dosimetry "Electro-Metallurgical Corporation" electron "Electro-Metallurgical Corporation" environment	1,282	15

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electro-Metallurgical Corporation" "Ether-Water Project" "Electro-Metallurgical Corporation" exposure OR "exposure investigation" OR "radiation exposure" "Electro-Metallurgical Corporation" external "Electro-Metallurgical Corporation" "F machine" "Electro-Metallurgical Corporation" fecal "Electro-Metallurgical Corporation" "feed material" "Electro-Metallurgical Corporation" femptocurie "Electro-Metallurgical Corporation" film "Electro-Metallurgical Corporation" fission "Electro-Metallurgical Corporation" fluoroscopy "Electro-Metallurgical Corporation" "Formerly Utilized Sites Remedial Action Program" OR FUSRAP "Electro-Metallurgical Corporation" gamma-ray "Electro-Metallurgical Corporation" "gas proportional" "Electro-Metallurgical Corporation" "gaseous diffusion" "Electro-Metallurgical Corporation" health OR "health instrument" OR "health physics" OR H.I. OR HI OR HP "Electro-Metallurgical Corporation" highly enriched uranium" OR HEU "Electro-Metallurgical Corporation" hydrofluorination "Electro-Metallurgical Corporation" "in vitro" "Electro-Metallurgical Corporation" "in vivo" "Electro-Metallurgical Corporation" incident "Electro-Metallurgical Corporation" ingestion "Electro-Metallurgical Corporation" inhalation "Electro-Metallurgical Corporation" internal "Electro-Metallurgical Corporation" investigation "Electro-Metallurgical Corporation" isotope "Electro-Metallurgical Corporation" isotopic "Electro-Metallurgical Corporation" "isotopic enrichment" "Electro-Metallurgical Corporation" "JS Project" "Electro-Metallurgical Corporation" Landauer "Electro-Metallurgical Corporation" "liquid scintillation"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electro-Metallurgical Corporation" log OR "log sheet" OR "log book" "Electro-Metallurgical Corporation" "low enriched uranium" OR LEU "Electro-Metallurgical Corporation" "maximum permissible concentration" OR MPC "Electro-Metallurgical Corporation" metallurgy "Electro-Metallurgical Corporation" microcurie "Electro-Metallurgical Corporation" millicurie "Electro-Metallurgical Corporation" "mixed fission product" OR MFP "Electro-Metallurgical Corporation" monitor OR "air monitoring" "Electro-Metallurgical Corporation" nanocurie "Electro-Metallurgical Corporation" nanocurie "nasal wipe" "Electro-Metallurgical Corporation" neutron "Electro-Metallurgical Corporation" "nose wipe" "Electro-Metallurgical Corporation" nuclear OR "Chicago-Nuclear" OR "nuclear fuels" "Electro-Metallurgical Corporation" "nuclear track emulsion" OR "type A" OR NTA "Electro-Metallurgical Corporation" "occupational radiation exposure" "Electro-Metallurgical Corporation" occurrence "Electro-Metallurgical Corporation" "ore concentrate" "Electro-Metallurgical Corporation" "PC Project" "Electro-Metallurgical Corporation" permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP "Electro-Metallurgical Corporation" "phosphate research" "Electro-Metallurgical Corporation" photon "Electro-Metallurgical Corporation" picocurie "Electro-Metallurgical Corporation" pitchblende "Electro-Metallurgical Corporation" "pocket ion chamber" OR PIC "Electro-Metallurgical Corporation" problem "Electro-Metallurgical Corporation" procedure "Electro-Metallurgical Corporation" radeco "Electro-Metallurgical Corporation" radiation "Electro-Metallurgical Corporation" radioactive "Electro-Metallurgical Corporation" radioactivity		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electro-Metallurgical Corporation" radiograph "Electro-Metallurgical Corporation" radiological "Electro-Metallurgical Corporation" "Radiological Survey Data Sheet" OR RSDS "Electro-Metallurgical Corporation" radionuclide "Electro-Metallurgical Corporation" raffinate "Electro-Metallurgical Corporation" reactor "Electro-Metallurgical Corporation" respiratory "Electro-Metallurgical Corporation" "retention schedules" "Electro-Metallurgical Corporation" roentgen "Electro-Metallurgical Corporation" sample OR "air sample" OR "dust sample" OR "general area air sample" "Electro-Metallurgical Corporation" sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" "Electro-Metallurgical Corporation" "solvent extraction" "Electro-Metallurgical Corporation" source OR "sealed source" "Electro-Metallurgical Corporation" spectra "Electro-Metallurgical Corporation" spectrograph "Electro-Metallurgical Corporation" spectroscopy "Electro-Metallurgical Corporation" spectrum "Electro-Metallurgical Corporation" standard OR "operating standard" OR "processing standard" "Electro-Metallurgical Corporation" survey "building survey" OR "routine survey" OR "special survey" "Electro-Metallurgical Corporation" "technical basis" "Electro-Metallurgical Corporation" "thermal diffusion" "Electro-Metallurgical Corporation" "thermoluminescent dosimeter" OR TLD "Electro-Metallurgical Corporation" "Tiger Team" "Electro-Metallurgical Corporation" "tolerance dose" "Electro-Metallurgical Corporation" urinalysis "Electro-Metallurgical Corporation" urine "Electro-Metallurgical Corporation" "whole body count" OR WBC "Electro-Metallurgical Corporation" "working level" OR WL		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electro-Metallurgical Corporation" "X-ray" OR "X ray" OR Xray "Electro-Metallurgical Corporation" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" "Electro-Metallurgical Corporation" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "Electro-Metallurgical Corporation" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" "Electro-Metallurgical Corporation" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po" "Electro-Metallurgical Corporation" 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" OR ionium OR UX1 OR UX2 "Electro-Metallurgical Corporation" 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" "Electro-Metallurgical Corporation" tritium OR H3 OR H-3 OR mint OR HTO "Electro-Metallurgical Corporation" 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" OR U235 OR "U 235" OR U-235 OR 235-U "Electro-Metallurgical Corporation" 235U OR "235 U" OR U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR 308 U OR "uranium extraction" "Electro-Metallurgical Corporation" "black oxide" OR "brown oxide" OR "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 "Electro-Metallurgical Corporation" 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"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electro-Metallurgical Corporation" 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" "Electro-Metallurgical Corporation" 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 "Electro-Metallurgical Corporation" radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn "Electro-Metallurgical Corporation" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" "Electro-Metallurgical Corporation" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa" "Electro-Metallurgical Corporation" strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" "Electromet Corp." "Electromet Corp." oralloy "Electromet Corp." postum "Electromet Corp." tuballoy "Electromet Corp." "uranyl nitrate hexahydrate" OR UNH "Electromet Corp." "K-65" "Electromet Corp." "sump cake" "Electromet Corp." "uranium dioxide" "Electromet Corp." "uranium tetrafluoride" "Electromet Corp." "uranium trioxide" "Electromet Corp." "uranium hexafluoride" "Electromet Corp." accident "Electromet Corp." "air count" "Electromet Corp." "air dust" "Electromet Corp." "air filter" "Electromet Corp." "airborne test" "Electromet Corp." alpha "Electromet Corp." "belgian congo ore" "Electromet Corp." bioassay OR bio-assay "Electromet Corp." breath OR "breathing zone" OR BZ		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electromet Corp." calibration "Electromet Corp." columnation "Electromet Corp." contamination "Electromet Corp." curie "Electromet Corp." "denitration" OR "denitration pot" "Electromet Corp." derby OR regulus "Electromet Corp." dose "Electromet Corp." dosimeter "Electromet Corp." dosimetric "Electromet Corp." dosimetry "Electromet Corp." electron "Electromet Corp." environment "Electromet Corp." "Ether-Water Project" "Electromet Corp." exposure OR "exposure investigation" OR "radiation exposure" "Electromet Corp." external "Electromet Corp." "F machine" "Electromet Corp." fecal "Electromet Corp." "feed material" "Electromet Corp." femptocurie "Electromet Corp." film "Electromet Corp." fission "Electromet Corp." fluoroscopy "Electromet Corp." "Formerly Utilized Sites Remedial Action Program" OR FUSRAP "Electromet Corp." gamma-ray "Electromet Corp." "gas proportional" "Electromet Corp." "gaseous diffusion" "Electromet Corp." health OR "health instrument" OR "health physics" OR H.I. OR HI OR HP "Electromet Corp." highly enriched uranium" OR HEU "Electromet Corp." hydrofluorination "Electromet Corp." "in vitro" "Electromet Corp." "in vivo"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electromet Corp." incident "Electromet Corp." ingestion "Electromet Corp." inhalation "Electromet Corp." internal "Electromet Corp." investigation "Electromet Corp." isotope "Electromet Corp." isotopic "Electromet Corp." "isotopic enrichment" "Electromet Corp." "JS Project" "Electromet Corp." Landauer "Electromet Corp." "liquid scintillation" "Electromet Corp." log OR "log sheet" OR "log book" "Electromet Corp." "low enriched uranium" OR LEU "Electromet Corp." "maximum permissible concentration" OR MPC "Electromet Corp." metallurgy "Electromet Corp." microcurie "Electromet Corp." millicurie "Electromet Corp." "mixed fission product" OR MFP "Electromet Corp." monitor OR "air monitoring" "Electromet Corp." nanocurie "Electromet Corp." nanocurie "nasal wipe" "Electromet Corp." neutron "Electromet Corp." "nose wipe" "Electromet Corp." nuclear OR "Chicago-Nuclear" OR "nuclear fuels" "Electromet Corp." "nuclear track emulsion" OR "type A" OR NTA "Electromet Corp." "occupational radiation exposure" "Electromet Corp." occurrence "Electromet Corp." "ore concentrate" "Electromet Corp." "PC Project" "Electromet Corp." permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP "Electromet Corp." "phosphate research" "Electromet Corp." photon "Electromet Corp." picocurie		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electromet Corp." pitchblende "Electromet Corp." "pocket ion chamber" OR PIC "Electromet Corp." problem "Electromet Corp." procedure "Electromet Corp." radeco "Electromet Corp." radiation "Electromet Corp." radioactive "Electromet Corp." radioactivity "Electromet Corp." radiograph "Electromet Corp." radiological "Electromet Corp." "Radiological Survey Data Sheet" OR RSDS "Electromet Corp." radionuclide "Electromet Corp." raffinate "Electromet Corp." reactor "Electromet Corp." respiratory "Electromet Corp." "retention schedules" "Electromet Corp." roentgen "Electromet Corp." sample OR "air sample" OR "dust sample" OR "general area air sample" "Electromet Corp." sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" "Electromet Corp." "solvent extraction" "Electromet Corp." source OR "sealed source" "Electromet Corp." spectra "Electromet Corp." spectrograph "Electromet Corp." spectroscopy "Electromet Corp." spectrum "Electromet Corp." standard OR "operating standard" OR "processing standard" "Electromet Corp." "building survey" OR "routine survey" OR "special survey" "Electromet Corp." "technical basis" "Electromet Corp." "thermal diffusion" "Electromet Corp." "thermoluminescent dosimeter" OR TLD		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electromet Corp." "Tiger Team" "Electromet Corp." "tolerance dose" "Electromet Corp." urinalysis "Electromet Corp." urine "Electromet Corp." "whole body count" OR WBC "Electromet Corp." "working level" OR WL "Electromet Corp." "X-ray" OR "X ray" OR Xray "Electromet Corp." americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" "Electromet Corp." ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "Electromet Corp." neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" "Electromet Corp." polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po" "Electromet Corp." 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" OR ionium OR UX1 OR UX2 "Electromet Corp." 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" "Electromet Corp." tritium OR H3 OR H-3 OR mint OR HTO "Electromet Corp." 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" OR U235 OR "U 235" OR U-235 OR 235-U "Electromet Corp." 235U OR "235 U" OR U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR 308 U OR "uranium extraction" "Electromet Corp." "black oxide" OR "brown oxide" OR "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 Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Electromet Corp." 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" "Electromet Corp." 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" "Electromet Corp." 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 "Electromet Corp." radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn "Electromet Corp." thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" "Electromet Corp." protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa" "Electromet Corp." strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" "UMETCO Minerals" "Niagara Falls" "UMETCO Minerals" oralloy "UMETCO Minerals" postum "UMETCO Minerals" tuballoy "UMETCO Minerals" "uranyl nitrate hexahydrate" OR UNH "UMETCO Minerals" "K-65" "UMETCO Minerals" "sump cake" "UMETCO Minerals" "uranium dioxide" "UMETCO Minerals" "uranium tetrafluoride" "UMETCO Minerals" "uranium trioxide" "UMETCO Minerals" "uranium hexafluoride" "UMETCO Minerals" "Niagara Falls" accident "UMETCO Minerals" "Niagara Falls" "air count" "UMETCO Minerals" "Niagara Falls" "air dust" "UMETCO Minerals" "Niagara Falls" "air filter" "UMETCO Minerals" "Niagara Falls" "airborne test" "UMETCO Minerals" "Niagara Falls" alpha		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" "belgian congo ore" "UMETCO Minerals" "Niagara Falls" bioassay OR bio-assay "UMETCO Minerals" "Niagara Falls" breath OR "breathing zone" OR BZ "UMETCO Minerals" "Niagara Falls" calibration "UMETCO Minerals" "Niagara Falls" columnation "UMETCO Minerals" "Niagara Falls" contamination "UMETCO Minerals" "Niagara Falls" curie "UMETCO Minerals" "Niagara Falls" "denitration" OR "denitration pot" "UMETCO Minerals" "Niagara Falls" derby OR regulus "UMETCO Minerals" "Niagara Falls" dose "UMETCO Minerals" "Niagara Falls" dosimeter "UMETCO Minerals" "Niagara Falls" dosimetric "UMETCO Minerals" "Niagara Falls" dosimetry "UMETCO Minerals" "Niagara Falls" electron "UMETCO Minerals" "Niagara Falls" environment "UMETCO Minerals" "Niagara Falls" "Ether-Water Project" "UMETCO Minerals" "Niagara Falls" exposure OR "exposure investigation" OR "radiation exposure" "UMETCO Minerals" "Niagara Falls" external "UMETCO Minerals" "Niagara Falls" "F machine" "UMETCO Minerals" "Niagara Falls" fecal "UMETCO Minerals" "Niagara Falls" "feed material" "UMETCO Minerals" "Niagara Falls" femptocurie "UMETCO Minerals" "Niagara Falls" film "UMETCO Minerals" "Niagara Falls" fission "UMETCO Minerals" "Niagara Falls" fluoroscopy "UMETCO Minerals" "Niagara Falls" "Formerly Utilized Sites Remedial Action Program" OR FUSRAP "UMETCO Minerals" "Niagara Falls" gamma-ray "UMETCO Minerals" "Niagara Falls" "gas proportional" "UMETCO Minerals" "Niagara Falls" "gaseous diffusion"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" health OR "health instrument" OR "health physics" OR H.I. OR HI OR HP "UMETCO Minerals" "Niagara Falls" highly enriched uranium" OR HEU "UMETCO Minerals" "Niagara Falls" hydrofluorination "UMETCO Minerals" "Niagara Falls" "in vitro" "UMETCO Minerals" "Niagara Falls" "in vivo" "UMETCO Minerals" "Niagara Falls" incident "UMETCO Minerals" "Niagara Falls" ingestion "UMETCO Minerals" "Niagara Falls" inhalation "UMETCO Minerals" "Niagara Falls" internal "UMETCO Minerals" "Niagara Falls" investigation "UMETCO Minerals" "Niagara Falls" isotope "UMETCO Minerals" "Niagara Falls" isotopic "UMETCO Minerals" "Niagara Falls" "isotopic enrichment" "UMETCO Minerals" "Niagara Falls" "JS Project" "UMETCO Minerals" "Niagara Falls" Landauer "UMETCO Minerals" "Niagara Falls" "liquid scintillation" "UMETCO Minerals" "Niagara Falls" log OR "log sheet" OR "log book" "UMETCO Minerals" "Niagara Falls" "low enriched uranium" OR LEU "UMETCO Minerals" "Niagara Falls" "maximum permissible concentration" OR MPC "UMETCO Minerals" "Niagara Falls" metallurgy "UMETCO Minerals" "Niagara Falls" microcurie "UMETCO Minerals" "Niagara Falls" millicurie "UMETCO Minerals" "Niagara Falls" "mixed fission product" OR MFP "UMETCO Minerals" "Niagara Falls" monitor OR "air monitoring" "UMETCO Minerals" "Niagara Falls" nanocurie "UMETCO Minerals" "Niagara Falls" nanocurie "nasal wipe" "UMETCO Minerals" "Niagara Falls" neutron "UMETCO Minerals" "Niagara Falls" "nose wipe"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" nuclear OR "Chicago-Nuclear" OR "nuclear fuels" "UMETCO Minerals" "Niagara Falls" "nuclear track emulsion" OR "type A" OR NTA "UMETCO Minerals" "Niagara Falls" "occupational radiation exposure" "UMETCO Minerals" "Niagara Falls" occurrence "UMETCO Minerals" "Niagara Falls" "ore concentrate" "UMETCO Minerals" "Niagara Falls" "PC Project" "UMETCO Minerals" "Niagara Falls" permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP "UMETCO Minerals" "Niagara Falls" "phosphate research" "UMETCO Minerals" "Niagara Falls" photon "UMETCO Minerals" "Niagara Falls" picocurie "UMETCO Minerals" "Niagara Falls" pitchblende "UMETCO Minerals" "Niagara Falls" "pocket ion chamber" OR PIC "UMETCO Minerals" "Niagara Falls" problem "UMETCO Minerals" "Niagara Falls" procedure "UMETCO Minerals" "Niagara Falls" radeco "UMETCO Minerals" "Niagara Falls" radiation "UMETCO Minerals" "Niagara Falls" radioactive "UMETCO Minerals" "Niagara Falls" radioactivity "UMETCO Minerals" "Niagara Falls" radiograph "UMETCO Minerals" "Niagara Falls" radiological "UMETCO Minerals" "Niagara Falls" "Radiological Survey Data Sheet" OR RSDS "UMETCO Minerals" "Niagara Falls" radionuclide "UMETCO Minerals" "Niagara Falls" raffinate "UMETCO Minerals" "Niagara Falls" reactor "UMETCO Minerals" "Niagara Falls" respiratory "UMETCO Minerals" "Niagara Falls" "retention schedules" "UMETCO Minerals" "Niagara Falls" roentgen		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" sample OR "air sample" OR "dust sample" OR "general area air sample" "UMETCO Minerals" "Niagara Falls" sampling OR "air sampling" OR "dust sampling" OR "general area air sampling" "UMETCO Minerals" "Niagara Falls" "solvent extraction" "UMETCO Minerals" "Niagara Falls" source OR "sealed source" "UMETCO Minerals" "Niagara Falls" spectra "UMETCO Minerals" "Niagara Falls" spectrograph "UMETCO Minerals" "Niagara Falls" spectroscopy "UMETCO Minerals" "Niagara Falls" spectrum "UMETCO Minerals" "Niagara Falls" standard OR "operating standard" OR "processing standard" "UMETCO Minerals" "Niagara Falls" "building survey" OR "routine survey" OR "special survey" "UMETCO Minerals" "Niagara Falls" "technical basis" "UMETCO Minerals" "Niagara Falls" "thermal diffusion" "UMETCO Minerals" "Niagara Falls" "thermoluminescent dosimeter" OR TLD "UMETCO Minerals" "Niagara Falls" "Tiger Team" "UMETCO Minerals" "Niagara Falls" "tolerance dose" "UMETCO Minerals" "Niagara Falls" urinalysis "UMETCO Minerals" "Niagara Falls" urine "UMETCO Minerals" "Niagara Falls" "whole body count" OR WBC "UMETCO Minerals" "Niagara Falls" "working level" OR WL "UMETCO Minerals" "Niagara Falls" "X-ray" OR "X ray" OR Xray "UMETCO Minerals" "Niagara Falls" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" "UMETCO Minerals" "Niagara Falls" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "UMETCO Minerals" "Niagara Falls" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" "UMETCO Minerals" "Niagara Falls" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" 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" OR ionium OR UX1 OR UX2 "UMETCO Minerals" "Niagara Falls" 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" "UMETCO Minerals" "Niagara Falls" tritium OR H3 OR H-3 OR mint OR HTO "UMETCO Minerals" "Niagara Falls" 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" OR U235 OR "U 235" OR U-235 OR 235-U "UMETCO Minerals" "Niagara Falls" 235U OR "235 U" OR U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR 308 U OR "uranium extraction" "UMETCO Minerals" "Niagara Falls" "black oxide" OR "brown oxide" OR "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 "UMETCO Minerals" "Niagara Falls" 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" "UMETCO Minerals" "Niagara Falls" 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" "UMETCO Minerals" "Niagara Falls" 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 "UMETCO Minerals" "Niagara Falls" radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn "UMETCO Minerals" "Niagara Falls" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn"		

Table A1-2: Database Searches for Electro Metallurgical			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"UMETCO Minerals" "Niagara Falls" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa" "UMETCO Minerals" "Niagara Falls" strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" Union Carbide “ElectroMet Corp” OR “Umetco Minerals Corp” OR “Electro-Metallurgical Corp”		

Table A1-3: OSTI Documents Ordered for Electro Metallurgical			
Document Number	**Document Title**	**Requested Data**	**Date Received**
No documents ordered.	N/A	N/A	N/A