SEC Petition Evaluation Report
Petition SEC-00190

Report Rev #:0 Report Submittal Date: 02/13/2012

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Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00190	83.13	July 28, 2011	November 17, 2011	Titanium Alloys Manufacturing

Petitioner-Requested Class Definition

All employees performing their duties who worked at Titanium Alloy Manufacturing Company in Niagara Falls, NY from 1950 to 1956.

Class Evaluated by NIOSH

All employees who worked in any area or building at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956.

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

None.

Related Petition Summary Information

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

Related Evaluation Report Information

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

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Evaluation Report Summary: SEC-00190, Titanium Alloys Manufacturing

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

Petitioner-Requested Class Definition

Petition SEC-00190 was received on July 28, 2011, and qualified on November 17, 2011. The petitioner requested that NIOSH consider the following class: *All employees performing their duties who worked at Titanium Alloy Manufacturing Company in Niagara Falls, NY from 1950 to 1956.*

Class Evaluated by NIOSH

Based on its preliminary research, and changes to the EEOICPA-covered period for the facility, NIOSH reduced the petitioner-requested class. NIOSH evaluated the following class: All employees who worked in any area or building at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956.

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

Based on its full research of the class under evaluation, NIOSH has obtained sufficient information on the types of materials, quantities of materials, and processing methods at Titanium Alloys Manufacturing to allow dose reconstruction to be performed with sufficient accuracy. 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. The available information 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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ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Joseph Guido, MJW Corporation. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked in any area or building at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

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

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

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

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

3.0 SEC-00190 Titanium Alloys Manufacturing Class Definitions

The following subsections address the evolution of the class definition for SEC-00190, Titanium Alloys Manufacturing. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00190 was received on July 28, 2011, and qualified on November 17, 2011. The petitioner requested that NIOSH consider the following class: *All employees performing their duties who worked at Titanium Alloy Manufacturing Company in Niagara Falls, NY from 1950 to 1956.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Titanium Alloys Manufacturing workers in question. The petitioner's requested time period was based on the EEOICPA Atomic Weapons Employer (AWE) covered period designated for the facility at the time (1950-1956). NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00190 for evaluation:

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

In support of his claim, the SEC-00190 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. In the original petition, the petitioner provided the following statements:

- *I personally worked on the lab arc furnace and later vacuumed the building, which was checked with a geiger counter. We had no dosage monitoring, no special breathing masks, no laundering or personal washing instruction. Only after reading my dose reconstruction, I realized we were melting uranium ores and compounds. We were told it was a secret project and were only told on a need only basis.*

- *Lack of monitoring the entire area over several days.*

Based on its Titanium Alloys Manufacturing research and data capture efforts, NIOSH determined that it has access to information on the specific activities performed and to surface contamination and air monitoring data. However, NIOSH also determined that internal and external exposure monitoring records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support the petition basis that internal and external radiation exposures and radiation doses were not adequately monitored at Titanium Alloys Manufacturing, 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 reduced the petitioner-requested class because the Department of Labor changed the start of the covered period at Titanium Alloys Manufacturing from January 1950 to January 1955 (Leiton, 2011). Therefore, NIOSH defined the following class for further evaluation: All employees who worked in any area or building at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956.

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

Based on its research, NIOSH has obtained information on the types and quantities of material and processing methods that allow dose reconstruction to be performed with sufficient accuracy. 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 is standard practice, NIOSH completed an extensive database and Internet search for information regarding Titanium Alloys Manufacturing. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission

(NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment 1 contains a summary of Titanium Alloys Manufacturing documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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

4.1 Site Profile Technical Basis Documents (TBDs)

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

- *Site Profiles for Atomic Weapons Employers that Worked Uranium and Thorium Metals,* Battelle-TBD-6000; Rev. 1; June 17, 2011; SRDB Ref ID: 30671

- *Technical Basis for Atomic Energy Operations at Blockson Chemical Company, Joliet, Illinois,* NIOSH Division of Compensation Analysis and Support; DCAS-TKBS-0002, Rev. 03; December 20, 2010; SRDB Ref ID: 91205

4.2 Technical Information Bulletins and Procedures

A Technical Information Bulletin is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. A procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following Technical Information Bulletins as part of its evaluation:

- *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 4; Oak Ridge Associated Universities; June 20, 2011; SRDB Ref ID: 98147

- *Estimation of Ingestion Intakes*, OCAS-TIB-009, Rev. 0, NIOSH Office of Compensation Analysis and Support; April 13, 2004; SRDB Ref ID: 22397

- *Guidance on Assigning Occupational X-ray Dose Under EEOICPA for X-rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 00; Oak Ridge Associated Universities; January 3, 2011; SRDB Ref ID: 89563

4.3 Facility Employees and Experts

In an attempt to obtain additional information, NIOSH pursued interviews with former Titanium Alloys Manufacturing employees. NIOSH attempts to identify interviewees with process knowledge of the period under evaluation were complicated by the short duration of interest (1955-1956), time elapsed, and a small dose reconstruction claim pool. NIOSH has reviewed the computer-assisted telephone interviews conducted for claims filed with NIOSH for energy employees who worked at Titanium Alloys Manufacturing during the period from 1955 through 1956. These interviews confirmed the use of radioactive materials at the site and indicated that monitoring was not provided. At least one individual indicated that knowledge of the type of material in use was often withheld from the workers. Neither the available interviews nor the petitioner identified any potential sources for additional monitoring or process data. To date, NIOSH attempts to contact labor union organizations associated with the period under evaluation have not provided any potential sources for additional information or data.

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of January 14, 2012)

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

Description	Totals
Total number of claims submitted for dose reconstruction	14
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1955 through December 31, 1956).	12
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	12
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	0

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. As noted in Table 4-1, NIOSH has not received external or internal monitoring data from Titanium Alloys Manufacturing for any claimants.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Seventy-two (72) documents in this database were identified as pertaining to Titanium Alloys Manufacturing. These documents were evaluated for their relevance to this petition. The documents include historical background on facility operations and the results of air and surface contamination sampling.

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-00190; DSA Ref ID: 104385 (Form B-SEC00190)*

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956 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 Titanium Alloys Manufacturing Plant and Process Descriptions

Titanium Alloys Manufacturing (TAM) was located in Niagara Falls, NY on an approximately 35-acre site (see Figure 5-1). The company was founded in 1906 and initially produced ferro carbon titanate, an alloy developed for use in steelmaking. The company went on to develop a process to separate titanium oxide leading to its use in the pigmentation of paint (Survey, Date Unknown).

TAM was issued a contract to supply zirconium for the AEC complex starting in 1950. Zirconium materials were provided to Electromet, Y-12, and Fernald, to name a few. Waste materials from zirconium operations were sent to the Lake Ontario Ordinance Works (LOOW); however, none of the operations involving these materials involved the use of radioactive materials (Collins, 1993; Epp, 1950; Fry, 1951; LOOW, 1982).

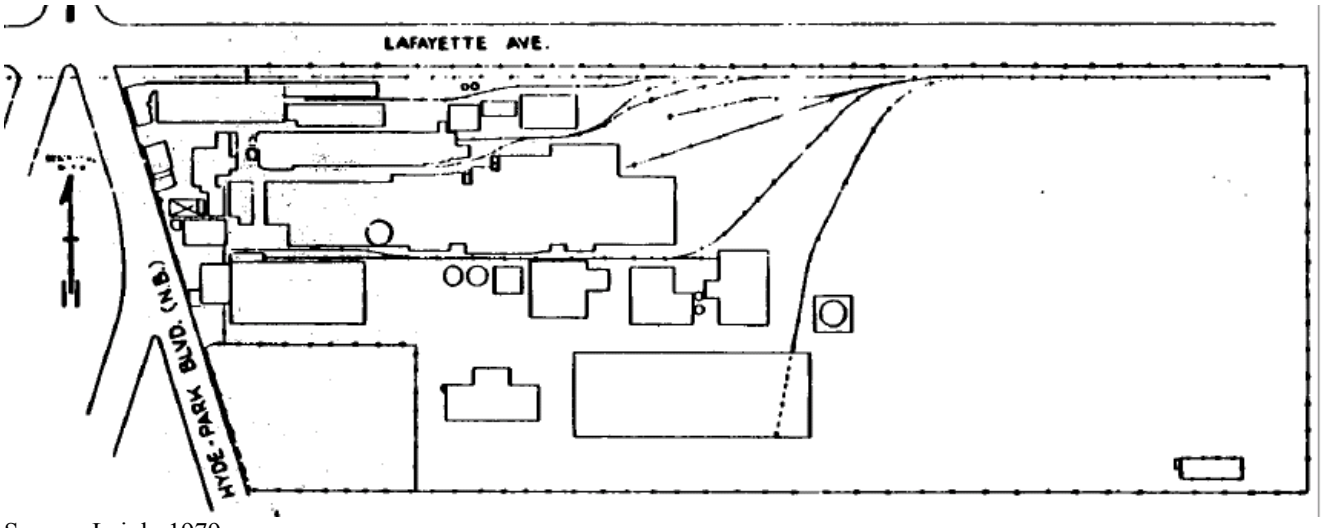
Current knowledge of the AEC-related uranium work at TAM is based on two work operations. The first operation is documented by air samples and surface contamination survey reports for uranium compound reduction activities performed July 10-11, 1956. The survey records indicate that uranium samples in several different chemical forms were processed at TAM. NIOSH currently has no information on the source of the samples or for whom this work was conducted (Health and Safety

Division, 1956). Based on the description of the activity, the operation appeared to be only a laboratory test. This work took place in the Building 103 Furnace Room and the Uranium Chemistry Laboratory.

The second operation is documented in a correspondence that indicates that in January 1955, the AEC Health and Safety Laboratory (HASL) requested that Mallinckrodt Chemical Works ship uranium-contaminated scrap to TAM for what is described as "AEC melt requirements." HASL requested 40 pounds of uranium-contaminated scrap stainless steel and 30 pounds of uranium-contaminated scrap aluminum, all cut into 3-inch by 3-inch squares (the stainless steel was approximately 1/4-inch thick; the aluminum was between 1/16-inch and 1/4-inch thick) (Klevin, 1955). An April 1956 journal article describes a pilot study by Klevin and Harris of the HASL in which decontamination of small quantities of uranium-contaminated nickel, stainless steel, copper, and aluminum scrap was performed by melting the material in a high-frequency furnace (Klevin, 1956). A citation in the article indicates that Titanium Alloys Manufacturing and American Smelting and Refining (Central Research Laboratory) "cooperated in processing the metal." Based on the 1955 request for steel and aluminum, it can be deduced that the decontamination by melting of these two materials was performed at Titanium Alloys Manufacturing.

Interest in the decontamination of scrap metals by melting occurred after a study conducted by the New York Operations Office (Blatz, 1951) reported that uranium contamination was reduced in contaminated scrap metal. This observation allowed for the shipment of 2400 tons of contaminated scrap metal to Diamond Magnesium between 1952 and 1953 (Diamond, 1990).

The pilot study at TAM was performed by the HASL to demonstrate this process and determine the health and safety implications. Full-scale operation of the melting process demonstrated at TAM was performed by National Lead of Ohio at Knoxville Iron between 1957 and 1958 (Knoxville, 1958) and by Y-12 at Oak Ridge Processing Company in 1958 (Oak Ridge, 1974). The quantity of material processed was 6000 tons of scrap metal at Knoxville Iron and 27,000 tons at the Oak Ridge Processing Company.



Source: Leigh, 1979

Figure 5-1: Titanium Alloys Manufacturing Complex at Niagara Falls, NY

5.2 Radiological Exposure Sources from TAM Operations

Uranium work at TAM is documented by air samples and surface contamination survey reports for activities performed between July 10 and 11, 1955. These documents describe the activity performed as reduction of uranium ore and uranium compounds. The "uranium ore" description is indicated on a removable contamination report; the accompanying air monitoring report contains a description of the processed compound and indicates it to be UO_2. For this reason, the processing of uranium ore is not believed to have occurred at TAM. Additional compounds listed on the sheets were $U0_2$, UF_4 and UF_6. No information was located on the source of these materials or the reason for the sampling; however, based on the quantity of material mentioned (in the case of UF_4, three grams), the activities appear to be bench-scale testing (Health and Safety Division, 1956).

Additional work with uranium was indicated in a 1955 correspondence from the Atomic Energy Commission (AEC) Health and Safety Laboratory directing Mallinckrodt Chemical Works to ship uranium-contaminated scrap metal (40 pounds of steel and 30 pounds of aluminum) to TAM. The documentation lists the purpose to be for "AEC melt requirements." Specific direction was provided on the size and shape of the material (3-inch by 3-inch squares; the stainless steel was approximately 1/4-inch thick; the aluminum was between 1/16-inch and 1/4-inch thick) (Klevin, 1955).

Correspondence between TAM and the AEC indicated an interest by TAM in processing scrap thorium. An AEC license for possession of 10 pounds of thorium was issued in 1955 to process scrap thorium materials. However, additional correspondence indicates that the AEC did not agree to furnish thorium as requested, but agreed to sell ten pounds of thorium to TAM if TAM submitted an application for it to be used for other purposes. The AEC indicated it had no interest in purchasing refined thorium from TAM. NIOSH has no reference indicating TAM ever received the 10 pounds of thorium. (Dowling, 1955; Roth, 1955; Urban, 1955).

A general description of the activities at the TAM site is contained in a 1982 Nuclear Regulatory Commission (NRC) report (Leigh, 1979). The report states that the site was "authorized by License No. SMB-00211 to possess and use uranium and thorium as reagents in general chemical, physical, ceramic and metallurgical research and to store thorium fluoride and monazite ore." One FUSRAP document (FUSRAP, 2001) states that License SMB-00211 is to have expired on June 1962; another NRC document indicates the license may have been extended beyond 1962. A 1979 radiological survey report stated that the manufacturing process "used beach sands containing naturally occurring radioactive materials for the production of rare earth chemicals." The results of this survey indicate that the site met the NRC criteria for unrestricted release. There is no evidence that these activities occurred during the 1955-1956 period. The referenced license (SMB-00211) was issued on June 28, 1961 (NRC License Tracking, 1999).

5.2.1 Internal Radiological Exposure Sources from TAM Operations

The primary source of internal radiological exposure resulting from TAM operations was inhalation and/or ingestion of uranium contained in uranium compounds and scrap materials.

5.2.1.1 Uranium

The radiological hazard presented by uranium metal or compounds results primarily from alpha particles emitted by U-238 (4.15 MeV and 4.20 MeV) and its isotopes U-235 (4.37 MeV, 4.40 MeV, and 4.58 MeV) and U-234 (4.72 MeV and 4.77 MeV). Naturally-occurring uranium is 0.71% (w/w) U-235 and 0.0055% (w/w) U-234. It was reported (Klevin, 1956) that the material melted at Titanium Alloys Manufacturing was 'natural uranium.'

It is also known that some AEC 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. Since the dates of operation (1955-1956) are after the introduction of recycled uranium into the AEC complex, recycled uranium is assumed to be present in the material processed at the TAM site.

Other alpha-emitting radionuclides occur naturally as part of the U-238 decay process; however, these would have been removed during the processing of uranium feed materials to generate the uranium compounds present at TAM. Sufficient time would not have elapsed to allow in-growth of these progeny to appreciable activities such that an additional hazard would have been posed to site personnel.

5.2.1.2 Recycled Uranium Contaminants (Np-237, Pu-239)

Based on the timeframe, the uranium source term processed at TAM during the period under evaluation might have contained recycled uranium. Recycled uranium might have been processed at TAM during the period under evaluation. Based on a review of recycled uranium contaminants at Hanford and Fernald, estimates of contaminants that might have contributed the most to internal doses are shown in Table 5-1. The activity fractions shown in Table 5-1 are based on the specific activity of depleted uranium, which increases the proportion of the contaminants by activity. The contaminant level for depleted uranium overestimates the contaminants in uranium of normal enrichment by about 40%.

Table 5-1: Estimated Contaminant Activity Fractions in Recycled, Depleted U Source Term
(pCi contaminant per pCi uranium)

Uranium	Plutonium-239	Neptunium-237	Technecium-99	Thorium-232	Thorium-228
1	0.00246	0.00182	0.379	2.73 E -06	2.73 E -06

Source: Battelle-TBD-6000, Table 3.2

5.2.2 External Radiological Exposure Sources from TAM Operations

The primary source of external radiological exposure resulting from TAM operations was exposure to gamma and beta radiation emitted from uranium and associated short-lived progeny.

5.2.2.1 Photon

The majority of the photons from natural uranium metals are in the 30-250 keV energy range. Solid uranium objects provide considerable shielding of the lower-energy photons and harden the spectrum, causing the majority of the photons emitted from a solid uranium object (such as a billet or rod) to have energies greater than 250 keV. While it is recognized that solid uranium sources will have a hardened photon spectrum, exposure to a thin layer of uranium on a surface will result in a larger fraction of exposure to lower-energy photons (Battelle-TBD-6000).

Table 5-2 shows the primary isotopes and photon energies associated with the recovery and clean-up of uranium. Exposure to these photons was possible during the period under evaluation from direct radiation during metal-handling and to submersion in metal-contaminated air.

Table 5-2: Principal Radiation Emissions from Natural U and Its Short-Lived Decay Products

Radionuclide	Half-life	Beta Energy (MeV Max)	Photon (x or γ) Energy (MeV)
U-238	4.468 x 10^9 years	None	x: 0.013 (8.8%)
Th-234	24.1 days	0.096 (25%)	x: 0.013 (9.6%)
		0.189 (73%)	γ: 0.063 (3.8%)
			γ: 0.093 (5.4%)
Pa-234m	1.17 minutes	2.28 (98.6%)	γ: 0.765 (0.2%)
		~1.4 (1.4%)	γ: 01.001 (0.6%)
U-235	7.038 x 10^8 years	None	x: 0.013 (31%)
			x: 0.090-0.105 (9.3%)
			γ: 0.144 (10.5%)
			γ: 0.163 (4.7%)
			γ: 0.186 (54%)
			γ: 0.205 (4.7%)
Th-231	25.5 hours	0.206 (15%)	x: 0.013 (71%)
		0.288 (49%)	γ: 0.026 (14.7%)
		0.305 (35%)	γ: 0.084 (6.4%)
U-234	244,500 years	None	x: 0.013 (10.5%)
			γ: 0.053 (0.2%)

Source: Battelle-TBD-6000, pdf p. 20. The table shows the principal radiation emissions from natural uranium and its short-lived decay products that were of concern for external radiation (not including bremsstrahlung).

5.2.2.2 Beta

Table 5-2 shows the principal beta emitters and their energies for the uranium present at TAM. As indicated in this table, there are a significant number of high-energy beta radiations that represent a shallow dose exposure concern to site workers. Workers who handled the uranium would have received shallow dose exposures. The primary exposure areas would have been the hands and forearms, the neck and face, and other areas of the body that might not have been covered.

5.2.2.3 Neutron

Based on the type and quantity of material present at TAM, neutrons could have arisen from the α-n reaction with light elements, interactions with the oxides, and through spontaneous fission. Data provided in Battelle-TBD-6000 show that any neutron dose rate would be negligible compared to beta/gamma dose rates in dose calculations.

5.2.3 Incidents

The information available to NIOSH gives no indication of incidents occurring at the site during the period under evaluation. The petitioner describes a time when the facility was vacuumed and there were individuals monitoring with a Geiger counter. The description of this event is consistent with monitoring which may occur during routine decontamination activities and, as such, is not considered by NIOSH to be indicative of an off-normal incident.

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 Titanium Alloys Manufacturing class under evaluation.

6.1 Available TAM Internal Monitoring Data

No internal monitoring data are available to NIOSH for the period under evaluation.

6.2 Available TAM External Monitoring Data

No external monitoring data are available to NIOSH for the period under evaluation.

6.3 Other Available Data

Air Sample Data

A limited number of air samples were located for the period under evaluation, as shown in Table 6-1. These samples were taken in both the Uranium Chemistry Laboratory and the Building 103 Furnace Room.

Table 6-1: TAM Air Monitoring Data				
Location	**Sample Date**	**Sample Number**	**Sample Description**	**Result (dpm/m^3)**
Uranium Chemistry Lab	7/10/1956	7376	GA in front of reactor section of lab hood during apparatus warm-up period. Approx. 3 grams of UF_4 in furnace.	4
		7377	GA In front of condenser & scrubber section of hood during same period as above.	ND
		7378	GA Same location as 7376 sample during fluorination of UF_4 sample (20 min).	ND
		7379	GA Same location as 7377 during fluorination of UF_4 sample.	1
		7380	GA In front of reactor section of lab hood during heating of condenser.	ND
		7381	GA In front of condenser section of lab hood during above period.	ND
		7382	GA Same location as 7380 during blowing and precipitating of UF_6 with NAOH.	ND
		7383	GA Simultaneous with 7382, sample location as 7381.	ND
Building 103 Furnace Room	7/11/1956	7392	GA induction furnace area during period while furnace was charged with UO_2.	2
		7393	GA continuation of 7392.	3
		7394	GA continuation of 7393.	6

Source: Health and Safety Division, 1956

In addition to the aforementioned air sample datasheets, a description of airborne radioactivity levels during the processing of scrap metal was provided by Klevin in the report on the melting operation (Klevin, 1956). This report indicates that airborne radioactivity levels were less than 10 dpm/m^3 in all but one sample collected during melting operations. The one high sample showed an air concentration of 80 dpm/m^3, For perspective, air dust measurements taken during the full-scale operations described Section 5.1 ranged from 9 to 318 dpm/m^3 at Knoxville Iron (Knoxville, 1958), and from <1 to 17 dpm/m^3 at the Oak Ridge Processing Company (Oak Ridge, 1974).

Surface Contamination Data

A limited number of workplace contamination samples were located for the period under evaluation, as shown in Table 6-2. These samples were taken in the Building 103 Furnace Room.

Table 6-2: TAM Surface Contamination Data				
Location	**Sample Date**	**Sample Number**	**Sample Description**	**Result (dpm/100 cm^2)**
Building 103 Furnace Room	7/11/1956	7384	Floor, center aisle near arc furnace.	16
		7385	Floor, center aisle between arc furnace and induction furnace	23
		7386	Floor, near induction furnace.	27
		7387	Scale, by induction furnace.	5
		7388	Side of induction furnace panel.	520
		7389	Large tool box top near south wall	39
		7390	Work bench top north end of room	12
		7391	Lab bench top in Room 103 office	22

Source: Health and Safety Division, 1956

Klevin reported the surface contamination present on materials entered into the scrap-metal melting activities conducted at TAM (Klevin, 1956), as shown in Table 6-3.

Table 6-3: Surface Contamination Present on Materials Designated for Scrap Melting				
Material	**Description**	**Surface Contamination, dpm/100 cm^2 (Total / Removable)**		
		Minimum	**Maximum**	**Average**
Stainless Steel	Top	1,800 / 58	8,750 / 97	375 / 42
	Bottom	6,850 / 297	26,800 / 530	500 / 133
	Remelt	100 / 10.5	120 / 15.7	75 / 8
	Slag from Melt	NR / 4.8	NR / 6.3	NR / 3.7
Aluminum	Top	8,245 /50.9	18,000 / 94.3	1,530 / 10
	Bottom	4,450 / 45.8	7,500 / 61.7	1,625 / 24.6
	Remelt	3,870 / 10.4	6,800 / 13.7	2,000 / 3.3
	Slag from Melt	5 / 17.1	6,500 / 20.9	3,700 / 13.1

NR = Not Reported

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 as summarized in Section 7.5. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00190 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Titanium Alloys Manufacturing Data

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

7.1.1 Internal Monitoring Data Pedigree Review

While no internal monitoring data have been located, air monitoring and surface contamination data are available in the form of original data sheets and, as such, are primary data sources. Air monitoring and surface contamination data for scrap-metal melting was contained in a peer-reviewed journal article. Therefore, no additional pedigree review was performed for those data.

7.1.2 External Monitoring Data Pedigree Review

NIOSH did not locate any external monitoring data for the operational period under evaluation (January 1, 1955 through December 31, 1956). Therefore, a data sufficiency and pedigree evaluation is not possible for this data type for this period.

7.2 Evaluation of Bounding Internal Radiation Doses at TAM

The principal source of internal radiation doses for members of the class under evaluation was inhalation and ingestion of uranium and uranium progeny contained in dusts and fumes associated with the furnace operations.

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 Airborne Levels

Air samples were taken on two occasions: one set of samples in the Chemistry Lab, and another in the Building 103 Furnace Room. The maximum measured air concentration reported for uranium compound reduction activities was 6 dpm/m^3 (see Table 6-1). Based on the reported background count rate, the minimum detectable air concentration would have been approximately 15 dpm/m^3. This value is based on information in the air monitoring reports for background count rate (0.27 cpm), count time (15 minutes), counter efficiency (0.41), volume (0.2 m^3), and filter collection efficiency (0.7) (Health and Safety Division, 1956). The average reported air concentration during the scrap-metal melting operations in the Furnace Room was reported as less than 10 dpm/m^3 with the maximum reported air concentration being 80 dpm/m^3 (Klevin, 1956).

7.2.1.2 Alternative Data Sources for Bounding Internal Dose

Available records indicate that the quantity of material processed at TAM was small. Sample data sheets for the operation in the Chemistry Laboratory indicate quantities in process of three grams (Health and Safety Division, 1956). While exact details are not available, it appears to be a bench-scale test operation. The total quantity of uranium scrap received totaled 70 pounds (40 pounds of contaminated steel and 30 pounds of contaminated aluminum) (Klevin, 1955).

7.2.2 Evaluation of Bounding Residual Period Internal Doses

TAM does not have a designated residual radiation period. Accordingly, evaluation of residual radiation period dose is not relevant.

7.2.3 Methods for Bounding Internal Dose at TAM

7.2.3.1 Methods for Bounding Operational Period Internal Dose

NIOSH has determined that uranium internal exposures during the operational period can be bounded using measured air concentration data. For the uranium reduction operations conducted between July 10, 1956 and July 11, 1956, the calculated MDA of 15 dpm/m^3 for the associated air samples can be used (see Section 7.2.1.1).

For the scrap-metal melting operations, the highest reported air result value of 80 dpm/m^3 can be used (Klevin, 1956). Klevin provides a description of the melting process and indicates that one melt was performed for each material type (Klevin 1956). Accordingly, melting operations are assumed to take place over a two day period in 1955, occurring after January 18, 1955 (the date the material was requested). Decontamination of the facility is assumed to last one work day. Based on the maximum

reported total surface contamination level from Table 6-3 (26,800 dpm/100 cm^2), and the appropriate re-suspension factor of 1 E-5 m^{-1} representative of decontamination efforts (ORAUT-OTIB-0070), the calculated air concentration during decontamination activities is 26.8 dpm/m^3. Based on this information and assumptions, a bounding internal inhalation dose estimate for scrap-melting operations in 1955 can be based on two days of exposure at 80 dpm/m^3 and one day at 27 dpm/m^3. Dose from ingestion during this same period is determined based on these same air concentrations using the methodology in OCAS-TIB-009.

Tables 7.1 and 7.2 provide a summary of the intake quantities associated with the air sample information reported above. Doses from scrap-melting operations are assigned in the year 1955, and doses from uranium compound reduction operations are assigned in the year 1956.

Intakes are assigned from scrap-melting operations to workers with covered employment in the period January 18, 1955 through December 31, 1955. Intakes are assigned from uranium compound reduction operations to workers with covered employment on July 10 and 11, 1956.

Table 7-1: Estimated Annual Inhalation Intake Quantity for TAM

Activity	Period	Total Annual Intake (pCi)					
		Uranium	Pu-239	Np-237	Tc-99	Th-232	Th-228
Scrap Melting	1955	8.1E+02	2.0E+00	1.5E+00	3.1E+02	2.2E-03	2.2E-03
Uranium Compound Reduction	1956 (July 10-11)	1.3E+02	3.2E-01	2.4E-01	4.9E+01	3.5E-04	3.5E-04

Table 7-2: Estimated Annual Ingestion Intake Quantity for TAM

Activity	Period	Total Annual Intake (pCi)					
		Uranium	Pu-239	Np-237	Tc-99	Th-232	Th-228
Scrap Melting	1955	1.7E+01	4.1E-02	3.1E-02	6.4E+00	4.6E-05	4.6E-05
Uranium Compound Reduction	1956 (July 10-11)	2.7E+00	6.6E-03	4.9E-03	1.0E+00	7.4E-06	7.4E-06

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

This evaluation concludes that internal dose at Titanium Alloys Manufacturing can be bounded using the air sample data reported during operations.

Based on the assessment provided in this section, NIOSH's conclusion is that reported air sample data provides a reasonable approach to bound internal dose for the operational period for all members of

the class under evaluation. NIOSH may choose to employ a more refined approach when reconstructing individual doses based on information associated with individual claims. NIOSH will use appropriate dose reconstruction methods, including best-estimate approaches that employ new details of site operations, if discovered, to complete individual dose reconstructions.

7.3 Evaluation of Bounding External Radiation Doses at TAM

The principal source of external radiation doses for members of the evaluated class was exposure to beta and gamma radiation emanating from uranium-bearing materials. 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

NIOSH has not identified any external monitoring records or personal dosimetry data associated with the uranium processing that occurred during the period under evaluation. NIOSH has not been able to identify any radiation level surveys or area dose rate monitoring data for this time period.

Information on the quantity of uranium present within the scrap metal processed at TAM can be used to bound the external dose from exposure to this material. The concentration of uranium in input scrap material and slag ranged from 0.3 µg/g to 83 µg/g for stainless steel, and 800 µg/g to 6500 µg/g for aluminum (Klevin, 1956). Based on the reported quantities of scrap metal shipped to TAM (30 lb. of aluminum and 40 lb. of stainless steel), the total amount of uranium contained in these materials would be 89 grams of U within the aluminum material and 1.5 grams of U within the stainless steel.

7.3.2 Evaluation of Bounding Residual Period External Doses

TAM does not have a designated residual radiation period. Accordingly, evaluation of residual radiation period dose is not relevant.

7.3.3 TAM Occupational X-Ray Examinations

Although no specific information regarding occupational medical dose has been identified for TAM, the dose associated with medical X-ray exams, if required as a condition of employment, can be bounded by using the assumptions in the complex-wide Technical Information Bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006). NIOSH believes this methodology supports its ability to bound the occupational medical X-ray doses for the TAM class under evaluation.

7.3.4 Methods for Bounding Operational Period External Dose at TAM

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
- Medical X-ray Dose (as applicable per Section 7.3.3)

Photon Dose

Although no external monitoring data are available to NIOSH for the TAM site, Table 6-1 of Battelle-TBD-6000 can be used to bound the operational period photon dose. This table provides dose rates at the surface, one foot, and one meter from various uranium shapes. While not cited in the Battelle document, the corresponding material dimensions are presented in the research paper upon which the table was based (Anderson, 2005). The total quantity of uranium present within all of the TAM scrap material is indicated to be 90 grams. The smallest object modeled in Battelle-TBD-6000 (uranium slug) would contain a much higher mass of uranium (2000 gram). Based on this fact, the external dose to scrap-metal workers at TAM can be bounded using the dose rates at one foot from the slug listed in Table 6-1 of Battelle-TBD-6000. This value is 0.0524 mrem/hr.

Combining the information above with the exposure scenarios described in Section 7.2.3.1, the dose rate at one foot can be applied during:

- the two days of melting operations in 1955;
- the one day of decontamination in 1955; and
- the two days of uranium compound reduction operations in July 1956.

The total doses would be 1.3 mrem in 1955 associated with the three-day exposure period for scrap-melting operations; and 1 mrem in 1956 associated with the two-day uranium compound reduction operations.

Doses are assigned from scrap-melting operations to workers with covered employment in the period January 18, 1955 through December 31, 1955. Doses are assigned from uranium compound reduction operations to workers with covered employment on July 10 and 11, 1956.

Beta Dose

Although no external monitoring data are available to NIOSH for the TAM site, the methodology indicated above for photon exposure can be used to reconstruct the beta dose. Section 6.3 in Battelle-TBD-6000 provides justification for the use of a factor of 10 multiplier to calculate beta exposure based on the photon dose at one foot. Using this relationship, the beta dose rate for TAM workers at one foot would be 0.524 mrad/hr. This beta dose rate results in 12.6 mrad in 1955 associated with the three-day exposure period for scrap-melting operations; and 8.4 mrad in 1956 associated with the two-day uranium compound reduction operations

Beta doses are assigned from scrap-melting operations to workers with covered employment in the period January 18, 1955 through December 31, 1955. Beta doses are assigned from uranium compound reduction operations to workers with covered employment on July 10 and 11, 1956.

Medical X-ray Dose

Although NIOSH has not located specific parameters associated with occupational medical X-rays (i.e., specific information on the X-ray devices), default values of entrance KERMA developed for the three most commonly-used occupational medical diagnostic procedures are available in ORAUT-OTIB-0006. The ORAUT-OTIB-0006 values can be used to support bounding the medical X-ray dose for the time period under evaluation. These default values are upper-limit values developed from review of patient doses as reported in the literature, machine characteristics, and knowledge of X-ray procedures used during different time periods. These default values can be used in lieu of actual measurement data or entrance KERMA derived from technique factors to bound the occupational X-ray exposures for the TAM site. NIOSH believes this methodology supports its ability to bound occupational medical X-ray doses (reconstruct the medical X-ray dose with sufficient accuracy) for the operational period for the class under evaluation.

7.3.5 External Dose Reconstruction Feasibility Conclusion

This evaluation concludes that external dose reconstruction for personnel working during the operational period at Titanium Alloys Manufacturing is feasible. Using source term quantities and exposure rate modeling from Battelle-TBD-6000, external dose estimates are plausible and bounding for the TAM operational period. Based on its assessment of these doses, NIOSH concludes that these methods provide reasonable approaches to conservatively bound external doses for all members of the class under evaluation. NIOSH may choose to employ a more refined approach when reconstructing individual doses based on information obtained during the evaluation of individual claims.

7.4 Evaluation of Petition Basis for SEC-00190

The following subsections evaluate the assertions made on behalf of petition SEC-00190 for Titanium Alloys Manufacturing.

7.4.1 Decontamination of the Research Area

SEC-00190: The petitioner states that at one point the entire research area was vacuumed and afterwards was checked with a Geiger counter.

As discussed in Section 5.2.3, the description given is consistent with decontamination and survey efforts that were not uncommon in facilities like Titanium Alloys Manufacturing. The evaluated internal and external doses described in sections 7.2.3.1 and 7.3.4 of this evaluation report include the contribution from decontamination of the facility at the conclusion of activities.

7.4.2 Absence of Monitoring Data

SEC-00190: The petitioner states that monitoring for external and internal radiation was not performed nor were workers at the facility informed of the presence of radioactive materials.

NIOSH has identified sufficient TAM-specific air monitoring data to bound exposures at TAM.

7.5 Summary of Feasibility Findings for Petition SEC-00190

This report evaluates the feasibility for completing dose reconstructions for employees at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-3 summarizes the results of the feasibility findings at Titanium Alloys Manufacturing for each exposure source during the time period January 1955 through December 1956.

Table 7-3: Summary of Feasibility Findings for SEC-00190
January 1, 1955 through December 31, 1956

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal	**X**	
- U	X	
- Recycled U Contaminants	X	
External	**X**	
- Gamma	X	
- Beta	X	
- Neutron	N/A	N/A
- Occupational Medical X-ray	X	

As of January 14, 2012, a total of 12 claims have been submitted to NIOSH for individuals who worked at Titanium Alloys Manufacturing during the period under evaluation in this report. Dose reconstructions have been completed for 12 individuals (100%).

8.0 Evaluation of Health Endangerment for Petition SEC-00190

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. Section 83.13 requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If

the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has sufficient information on the types and quantities of material processed at Titanium Alloys Manufacturing as well as sufficient air monitoring data to bound internal and external exposures. 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. Therefore, a health endangerment determination is not required.

9.0 Class Conclusion for Petition SEC-00190

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes all employees who worked in any area or building at Titanium Alloys Manufacturing from January 1, 1955 through December 31, 1956.

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-00190. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

10.0 References

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Titanium Alloys Manufacturing			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site/Company Name: Titanium Alloys Manufacturing; AWE 1955-1956 [Name and title redacted], National Lead Industries; [Phone no. redacted] Alternate Site Names: Humphreys Gold Co. Titanium Alloys Mfg Co, Div. Of National Lead Titanium Alloy Metals Titanium Pigment Co. Physical Size of the Site: 35 Acres Site Population: Undetermined	No relevant documents identified.	01/18/2012	0
State Contacted: [Name and title redacted], Bureau of Environmental Radiation Protection [Phone No. redacted]	No relevant documents identified.	01/03/2012	0
Department of Labor / Paragon	Background and resurvey recommendations for the AEC portion of the Lake Ontario Ordnance Works, weekly and monthly reports.	12/30/2008	6
DOE Germantown	Thorium information and site history.	09/11/2002	1
DOE Legacy Management - Grand Junction Office	Commercial facilities used by National Lead Company of Ohio, final voucher for Titanium Alloys Manufacturing, FUSRAP elimination recommendation, monazite dredging operations, NRC Region 1 inspection report with release survey, raw material feed for FMPC Thorium Plant, request for thorium scrap, shipment documents, trip reports, source material license C-3413 for thorium metal, and a Titanium Alloy Manufacturing Division progress report.	08/22/2011	27
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	Proposed work for New Brunswick Laboratory and a summary technical report.	05/21/2008	3
DOE Office of Scientific and Technical Information (OSTI)	A process development report.	02/11/2011	1
Florida Archives	No relevant documents identified.	01/17/2012	0
Internet	Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities (December 2006).	01/25/2007	1

Table A1-1: Data Capture Synopsis for Titanium Alloys Manufacturing			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - Defense Technical Information Center (DTIC)	No relevant documents identified.	09/30/2011	0
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	11/29/2011	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant documents identified.	09/14/2011	0
Internet - DOE Legacy Management Considered Sites	DOE response for information concerning subcontractors at Fernald. NOTE: 2 documents were added by Site Association Review.	09/14/2011	2
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	09/14/2011	0
Internet - DOE OpenNet	Monthly status reports. NOTE: 2 documents were added by Site Association Review.	09/14/2011	2
Internet - DOE OSTI Energy Citations	No relevant documents identified.	09/14/2011	0
Internet - DOE OSTI Information Bridge	Quarterly reports, contamination of molten thorium and ion exchanger development and testing. NOTE: 2 documents were added by Site Association Review.	09/14/2011	3
Internet - Google	The Bomb that fell on Niagara, potentially contaminated sites list, radiation exposure report details, and an Adirondack chronology.	09/14/2011	11
Internet - Health Physics Journal	No relevant documents identified.	11/29/2011	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	11/29/2011	0
Internet - National Academies Press (NAP)	No relevant documents identified.	09/14/2011	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	A FUSRAP sites review. NOTE: 3 documents were added by Site Association Review.	09/14/2011	3
Internet - USACE/FUSRAP	No relevant documents identified.	09/14/2011	0
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	09/14/2011	0
National Archives and Records Administration (NARA) - Atlanta	Purchase Order WCX-A-16 Covering Zirconium Tetrachloride Anhydrous for Y-12 Plant.	08/16/2011	1
National Archives and Records Administration (NARA) - Kansas City	Love Canal and Niagara Frontier Region history.	08/14/2008	1
Unknown	Correspondence files, New York Operations Office monthly and weekly reports, production processes at Titanium Alloys Manufacturing, radiological surveys, receipts and shipment documentation, and Westinghouse Nuclear Fuels Division and Westinghouse Atomic Power Development Plant information.	09/11/2002	10
TOTAL			**72**

Table A1-2: Databases Searched for Titanium Alloys Manufacturing			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Titanium Alloys Manufacturing Rev 00, (83.13) 01-20-12			
Defense Technical Information Center (DTIC) https://www.dtic.mil/ COMPLETED 09/30/2011	See Note above	0	0
DOE CEDR http://cedr.lbl.gov/ COMPLETED 11/29/2011	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 09/14/2011	See Note above	0	0
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 09/14/2011	See Note above	130	0
DOE NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 09/14/2011	See Note above	0	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 09/14/2011	See Note above	2	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 09/14/2011	See Note above	50	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 09/14/2011	See Note above	28	1
Google http://www.google.com COMPLETED 09/14/2011	See Note above	281,402	11
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 11/29/2011	See Note above	2	0

Table A1-2: Databases Searched for Titanium Alloys Manufacturing			
Database/Source	**Keywords / Phrases**	**Hits**	**Selected**
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 11/29/2011	See Note above	0	0
National Academies Press http://www.nap.edu/ COMPLETED 09/14/2011	See Note above	21	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 09/14/2011	See Note above	4	0
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 09/14/2011	See Note above	0	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 09/14/2011	See Note above	0	0

Table A1-3 OSTI Documents Requested for Titanium Alloys Manufacturing			
Document Number	**Document Title**	**Requested Date**	**Received Date**
No documents requested.			