SEC Petition Evaluation Report
Petition SEC-00096

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

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Site Expert(s):	N/A

Petition Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition Qualification Date	DOE/AWE Facility Name
SEC-00096	83.13	October 16, 2007	Westinghouse Atomic Power Development Plant (WAPDP)

Petitioner Class Definition
All Testers and Laboratory Researchers (to include Research Group Leaders) who worked in the L Building (and K Building as applicable) at Westinghouse Atomic Power Development Plant from 1942 through 1944.

Class Evaluated by NIOSH
All Atomic Weapons Employer employees who worked on the development of the ionic centrifuge at the Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania, from August 13, 1942 through December 31, 1944.

NIOSH-Proposed Class to be Added to the SEC
All Atomic Weapons Employer employees who worked at Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania from August 13, 1942 through December 31, 1944, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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	
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Evaluation Report Summary: SEC-00096
Westinghouse Atomic Power Development Plant (WAPDP)

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-00096, qualified on October 16, 2007, requested that NIOSH consider the following class: *All Testers and Laboratory Researchers (to include Research Group Leaders) who worked in the L Building (and K Building as applicable) at Westinghouse Atomic Power Development Plant from 1942 through 1944.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH evaluated the following class: All Atomic Weapons Employer employees who worked on the development of the ionic centrifuge at the Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania, from August 13, 1942 through December 31, 1944.

NIOSH-Proposed Class to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all Atomic Weapons Employer employees who worked at Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania from August 13, 1942 through December 31, 1944, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC. The class under evaluation was modified (see Section 3.0 below) because (1) the definition of the East Pittsburgh location encompassed two Westinghouse facilities; and (2) although it is apparent that there were a limited number of personnel directly involved in the ionic centrifuge research under evaluation, the Department of Labor (DOL) cannot distinguish specific workers or work locations for the NIOSH-proposed class.

Feasibility of Dose Reconstruction

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

Health Endangerment Determination

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

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation. Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under their employment or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

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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: Daniel H. Stempfley, Dade Moeller & Associates. 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.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all Atomic Weapons Employer employees who worked on the development of the ionic centrifuge at the Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania, from August 13, 1942 through December 31, 1944. 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

[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.

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 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-00096, Westinghouse Atomic Power Development Plant Class Definitions

The following subsections address the evolution of the class definition for SEC-00096, Westinghouse Atomic Power Development Plant (WAPDP). 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 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-00096, qualified on October 16, 2007, requested that NIOSH consider the following class for addition to the SEC: *All Testers and Laboratory Researchers (to include Research Group Leaders) who worked in the L Building (and K Building as applicable) at Westinghouse Atomic Power Development Plant from 1942 through 1944.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for WAPDP workers in question. NIOSH

[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.

deemed the following information and affidavit statements sufficient to qualify SEC-00096 for evaluation:

> Inasmuch as EEOICPA BULLETIN NO. 02-02, March 29, 2002, explicitly states that records have not been found for employees at the Westinghouse East Pittsburgh site, document 02-02 satisfies the requirement of Form B, Section F-2, regarding petition SEC-00096.

Based on its research and data capture efforts for WAPDP, NIOSH determined that there was the potential for weapons-related radiological work at the WAPDP site. The weapons-related radiological work involved the use of a modified version of a laboratory-scale magnetron, also called an "ionic centrifuge," which was evaluated as a potential uranium enrichment mechanism. NIOSH also determined that WAPDP radiological monitoring records are not complete for this radiological work during the time period under evaluation. NIOSH concluded that there is sufficient information to support the petition basis that internal and external radiation exposures and radiation doses were not adequately monitored for the petitioner-proposed class involved in the ionic centrifuge work at WAPDP, 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 the definition of the East Pittsburgh location encompassed two Westinghouse facilities, including the Westinghouse Electric plant in East Pittsburgh and the Westinghouse Research Laboratories in East Pittsburgh-Forest Hills. Therefore, a review of the potential atomic weapons research that may have occurred at the Westinghouse-East Pittsburgh location required NIOSH to modify the petitioner-proposed class to include all AWE employees rather than just those working in the L Building. NIOSH also modified the start date to be consistent with the start of the Manhattan Engineering District (MED). Therefore, NIOSH defined the following class for further evaluation: all Atomic Weapons Employer employees who worked on the development of the ionic centrifuge at WAPDP in East Pittsburgh, Pennsylvania, from August 13, 1942 through December 31, 1944.

3.3 NIOSH-Proposed Class to be Added to the SEC

Based on its research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employer employees who worked at Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania from August 13, 1942 through December 31, 1944, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC. The class under evaluation was modified because (1) the definition of the East Pittsburgh location encompassed two Westinghouse facilities (the Electric Plant in East Pittsburgh and the Research Facility in Forest Hills); and (2) although it is apparent that there were a limited number of personnel directly involved in the ionic centrifuge research under evaluation, the DOL cannot distinguish specific workers or work locations for the NIOSH-proposed class. Therefore, based on a NIOSH-DOL discussion, the direction was to recommend all workers/employees who worked at WAPDP.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

NIOSH data capture efforts for the WAPDP site focused on DOE databases, Westinghouse historical archives, worker outreach, the NRC, and the Internet. Attachment 1 contains a summary of WAPDP documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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), or Site Profile Sections, which 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 WAPDP operations or related topics/operations at other sites.

- *Site Profiles for Atomic Weapons Employers that Worked Uranium and Thorium Metals*, Battelle-TBD-6000; Rev. F0; December 13, 2006; SRDB Ref ID: 30671

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

- *TBD for the Y-12 National Security Complex – Occupational Internal Dose*, ORAUT-TKBS-0014-5; Rev. 01; May 10, 2005; SRDB Ref ID: 20206

- *TBD for the Y-12 National Security Complex – Occupational External Dose*, ORAUT-TKBS-0014-6; Rev. 00 PC-1; October 11, 2005; SRDB Ref ID: 20207

- *Site Profile for the Lawrence Berkeley National Laboratory*, ORAUT-TKBS-0049; Rev. 01; April 2, 2007; SRDB Ref ID: 31090

4.2 Technical Information Bulletins (TIBs)

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

- *TIB: Default Assumptions and Methods for Atomic Weapons Employer Dose Reconstructions,* Battelle-TIB-5000; Rev. 00; April 2, 2007; SRDB Ref ID: 32016

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

4.3 Facility Employees and Experts

To obtain additional information, NIOSH contacted five individuals, which resulted in one interview with a former Westinghouse employee.

- Personal Communication, 2007, *Personal Communication with Name Redacted*; Telephone Interview by ORAU Team; November 27, 2007; SRDB Ref ID: Currently undergoing DOE review

- Interview, 2004, *Interview with Name Redacted*; Interview conducted for the Archives of the California Institute of Technology; May 24, 2004; SRDB Ref ID: 55629

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 January 21, 2009)

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

Description	Totals
Total number of claims submitted for dose reconstruction	17
Total number of claims submitted for energy employees who meet the definition criteria for the NIOSH-evaluated class (August 13, 1942 through December 31, 1944).	14[1]
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).	1
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	1[2]
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	1[2]

Notes:
[1] Three of the claims did not include employment within the NIOSH-evaluated timeframe.
[2] The data are not within the covered time period.

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee.

4.5 NIOSH Data Capture Efforts and Site Research Database

Attachment 1 contains a summary of WAPDP documents obtained during the NIOSH data reconnaissance and data capture efforts. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class. One hundred and thirty-nine documents in this database were identified as pertaining to WAPDP. These documents were evaluated for their relevance to this petition. The documents include historical background on site operations before, during, and after the covered period of operations. To date, NIOSH has not discovered any personnel or area monitoring data or radiological source term information specific to any radiological operations performed during the period being evaluated in this report.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Petition Form B [Survivor] with Supporting Documents*; August 1, 2007; OSA Ref ID: 103556 and 103817

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

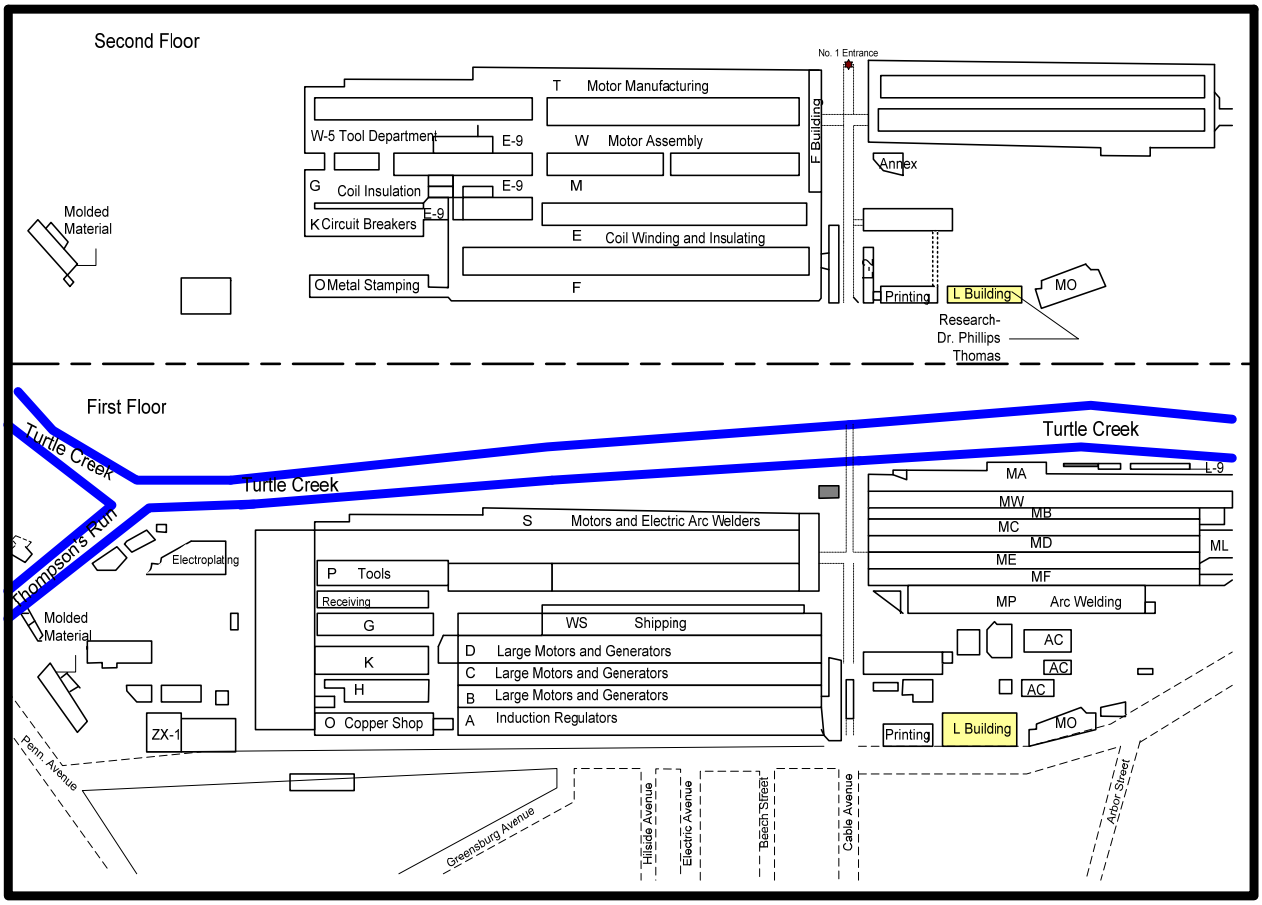
The following subsections summarize both radiological operations at WAPDP from August 13, 1942 through December 31, 1944 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity of the radionuclide of concern, and information generally 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 Westinghouse Atomic Power Development Plant and Process Descriptions

The WAPDP site, located in East Pittsburgh, Pennsylvania (also includes the Forest Hills, Pennsylvania location), is designated by the DOE Office of Health, Safety and Security (HSS) as an Atomic Weapons Employer (AWE) site (Worthington, 2008). The radiological activities related to weapons development work that occurred during the period from 1942 through 1944, are covered under the EEOICPA. The WAPDP site is located within the original Westinghouse Electric Company/Westinghouse Electric and Manufacturing Company facility location in East Pittsburgh, Pennsylvania (called the Turtle Creek site when the site was originally constructed). The Westinghouse Research Laboratories, located in East Pittsburgh-Forest Hills, is also considered to be part of the WAPDP location (Macosko, 2000).

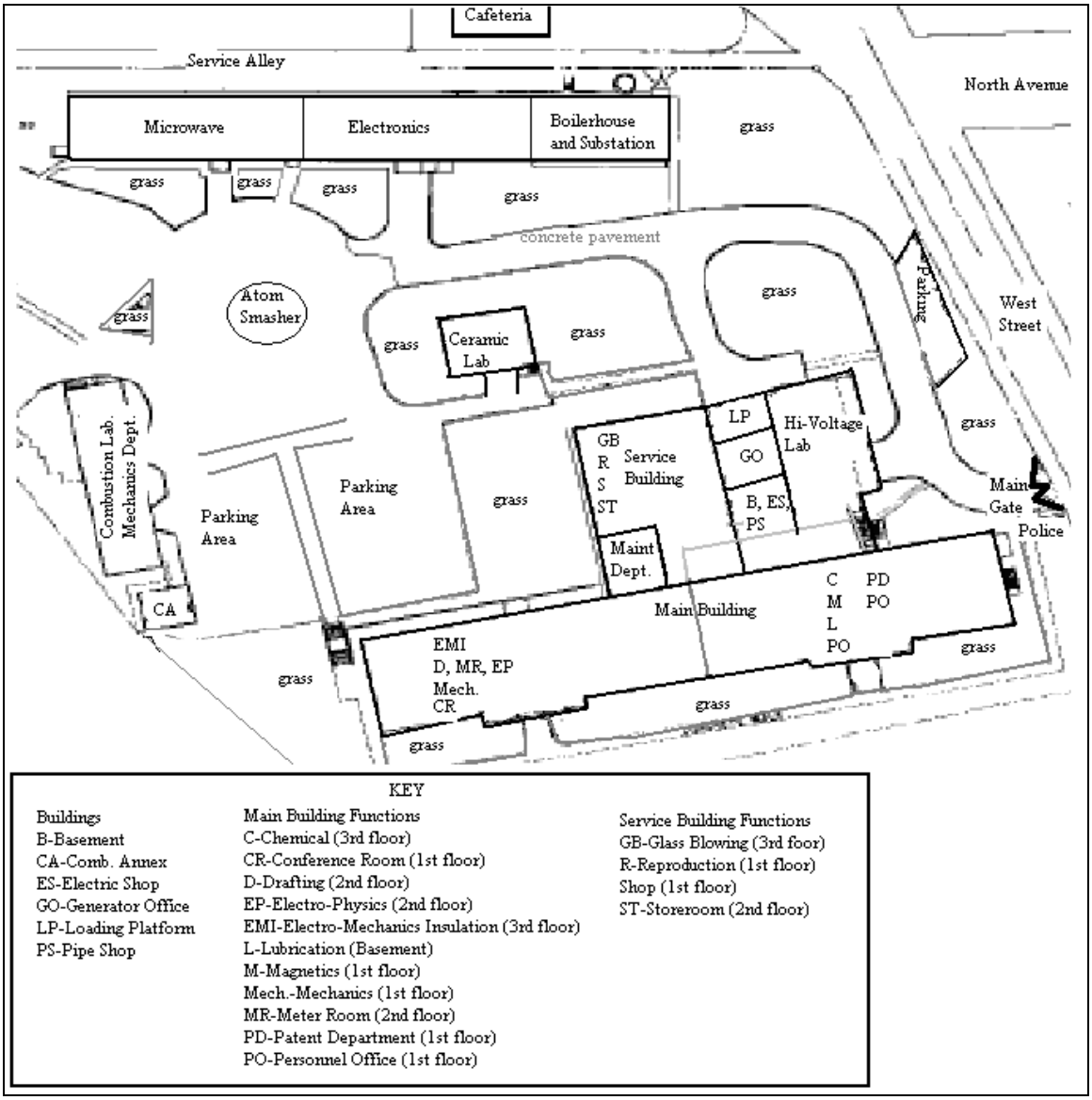
Figure 5-1 shows a top view of the East Pittsburgh Westinghouse Electric Plant floor plan. Figure 5-2 shows a map of the Westinghouse Electric Research Laboratories.

Figure 5-1: Top View of Westinghouse Electric Plant Floor Plan



Source: This map is a recreated version of the map found in reference: Westinghouse, 1936 & 1946.

Figure 5-2: Map of Westinghouse Electric Research Laboratories



Source: This map is a modified version of the map found in reference: Westinghouse, unknown date-b.

The DOE HSS indicates that WAPDP prepared uranium metal for Enrico Fermi's Stagg Field experiment at the University of Chicago, performed development activities, and performed pilot-scale production of uranium oxide fuel elements. WAPDP was also involved in research and development (R&D) work associated with uranium enrichment (Smyth, 1945). Based on NIOSH's research, the Westinghouse work associated with the ionic centrifuge was the only radiological work performed at the Westinghouse, East Pittsburgh facility during the covered period evaluated in this report. Table 5-1 provides a timeline of information for the applicable Westinghouse divisions and locations (including East Pittsburgh, Pennsylvania; Bloomfield, New Jersey; and Cheswick, Pennsylvania). The information provided extends beyond the covered period to permit adequate characterization of

the locations of the applicable operations and activities that support the NIOSH findings, as described in this report.

Table 5-1: Westinghouse Atomic Power Development Plant Timeline

Table 5-1 and its associated notes span 4 pages.

Year(s)	Activity
1900	Westinghouse lamp manufacturing is transferred to the New York City Westinghouse location (McNall, unknown date)
1904	The Research Department at Westinghouse is formally organized as a Division of the Engineering Department (McGahey, 1986)
1907	Ground broken for erection of a lamp plant in Bloomfield, New Jersey (McNall, unknown date)
1910	Research function moved from the Westinghouse Electric Plant to its own East Pittsburgh-Forest Hills location (McGahey, 1986)
1916	Westinghouse laboratories are moved to a location one mile from East Pittsburgh (Forest Hills) (McGahey, 1986)
1917	Westinghouse lamp research begins in East Pittsburgh (McNall, unknown date)
1918	Filament research is discussed in R&D annual reports • Filament researchers include Dr. Ludwig Thomas, Dr. A. H. Compton, and Dr. Sill (McNall, unknown date)
1919	R&D annual reports indicate work with uranium and thorium and selective work with rare earth oxides is occurring at Westinghouse • Dr. Sill is testing uranium as a lamp filament (McNall, unknown date)
1920	Lamp research is still in East Pittsburgh (some lamp research processes occur with uranium and thorium) (McNall, unknown date)
1921-1922	The Westinghouse Lamp division and a new Research laboratory are moved from the East Pittsburgh location and added to the Bloomfield, New Jersey location, under the leadership of Dr. Rentschler (Westinghouse, 1942; McNall, unknown date)
1922	May 1922—Dr. Rentschler and Dr. Marden refine uranium samples (at Bloomfield, New Jersey) from uranium salts (Unknown author, unknown date)
1923-1924	Uranium is indentified as not suitable for filaments; although work on uranium is not completed at this point in time (based on Bloomfield research) (McNall, unknown date)
1927	Joseph Slepian (Westinghouse scientist at the Forest Hills Research Laboratory) patents an accelerator for electrons (based on induction as in a transformer) (Coltman, 1987)
1928	January 1, 1928—The Bloomfield, New Jersey Research Department is established as a separate department with Mr. Reges as Manager, Dr. Rentschler as Director, and Dr. Marden as Assistant Director (McNall, unknown date**)**
1931	Construction of million-volt Van de Graaff machine has begun in East Pittsburgh (Forest Hills) (McNall, unknown date)
1935-1941	Westinghouse engineer Robert P. Jackson's interest in commercial implications of nuclear physics is relayed to the Bloomfield, New Jersey Lamp Division's Director, Dr. Rentschler, and to the corporate Research laboratory at Forest Hill (under Lewis W. Chubb) (Coltman, 1987)
1937	Westinghouse becomes one of the first industries in the nation to establish a group/division to focus entirely on Nuclear Physics research Edward U. Condon heads support of the atom-smasher[1] research at Westinghouse (Coltman, 1987)
1938	Dr. William E. Shoupp comes to the Westinghouse Research Laboratories and carries out a study at the atom smasher that demonstrates the existence of photo-fission in uranium (split by a gamma instead of a neutron) (Coltman, 1987)
1939	Westinghouse atom smasher is operating A report from Europe states that a uranium atom split into almost equal parts is coupled with a tremendous release of energy (Westinghouse, 1942)
1940	Donald W. Kerst (University of Illinois) produces a working device called a betatron, based on Dr. Joseph Slepian's 1927 patent design (Coltman, 1987)

Table 5-1: Westinghouse Atomic Power Development Plant Timeline

Table 5-1 and its associated notes span 4 pages.

Year(s)	Activity
	Chemists at the Bloomfield Laboratories are the first to consistently prepare ductile uranium, and up to this point in time, the Bloomfield Laboratory is the only source of this metal (Unknown author, 1940)
1941	United States enters WWII; Westinghouse stops the atom-smasher activities and associated fundamental research effort (to turn much of its work to research in microwave radar): • Atom smasher is shut down and Dr. William Shoupp named head of the newly formed Electronics Department (Coltman, 1987) May 1941—Westinghouse engineers (at the Forest Hills location) identify that uranium contains 2.5 million times as much energy (confined within uranium) as is contained in an equivalent amount of coal (Westinghouse, 1942) Westinghouse is the only source of pure (or purified) uranium via the Westinghouse Lamp Research Laboratory (in Bloomfield, New Jersey): • Originally produced as a source for other scientists and to experiment with lamp filaments(as previously discussed) • Daily production is in one-pound lots (McGahey, 1986) • Late 1941—A small-scale process (uranium production) at the Westinghouse Lamp Research Laboratory (in Bloomfield) under the direction of H.C. Rentschler produces uranium of sufficient quality satisfactory for determining certain properties of uranium, such as melting point and hardness (Westinghouse Engineer, 1946) End of 1941—The only uranium metal in existence consisted of a few grains of good material made on an experimental basis, and a few pounds of highly impure pyrophoric powder made by Metal Hydrides Company (Smyth, 1945, pp. 63-65)
1942	Early 1942—A large team of scientists, including J. Slepian, assemble at the University of California to evaluate electromagnetic separation – specifically the calutron (Smyth, 1945) Early 1942—Dr. A. H. Compton (Director of wartime research at the University of Chicago) asks Dr. Rentschler for large-scale uranium production (300 pounds per day); initial order of 3 tons of "special material" to be used in the pile at the University of Chicago (McNall, unknown date), resulting in the following: • Westinghouse's Lamp Division laboratories in Bloomfield, New Jersey are diverted into the production of the only pure uranium available in the U.S. (Unknown author, unknown date**;** Unknown author, 1958) • Westinghouse Lamp Division laboratories produced high-purity uranium metal for the first atomic pile at the University of Chicago (Stagg Field) (McGahey, 1986; Unknown author, 1966) • Uranium is used in the photo-fission experiment at the Lamp Division in Bloomfield, New Jersey (using Rentschler's method of reducing uranium salts to metal, developed when uranium was being investigated as a lamp filament) (Coltman, 1987) • The Westinghouse process to produce uranium metal involves the electrolysis of KUF_4, which in turn is produced photochemically under the action of sunlight; it is found that uranium tetrafluoride could be used instead of KUF_4 – steps are taken to have Harshaw Chemical Company (in Cleveland, Ohio) and DuPont (in Penns Grove, New Jersey) produce this salt; the Harshaw/DuPont production starts in August and by October was up to 700 pounds per day (in both cases the method of manufacture was the hydrofluorination of Mallinckrodt-purified dioxide); this material was also provided to Westinghouse for production of uranium metal (Smyth, 1945, pp. 63-65) Summer 1942—Group is organized at Chicago under Oppenheimer (from the University of California) to address theoretical problems associated with neutron reactions; three goals of the University of Chicago pile: obtain a chain reaction, produce plutonium, and obtain data on a fast neutron reaction (Smyth, 1945, pp. 63-65)

Table 5-1: Westinghouse Atomic Power Development Plant Timeline

Table 5-1 and its associated notes span 4 pages.

Year(s)	Activity
	Summer 1942—Some work on the ionic centrifuge (modified magnetron) continues at the University of California (original evaluation of this method occurred starting in December 1941) and is continued by J. Slepian (at the Westinghouse Laboratories in Pittsburgh) on a small scale through the winter of 1944-1945 (Smyth, 1945) • Use of an unmodified magnetron to separate uranium isotopes is also evaluated, but is not successful and the evaluation is terminated (only lithium, no uranium, was used in the evaluation of this method) • The ionic centrifuge uranium isotope separation method is evaluated with uranium samples with no clear-cut results (Smyth, 1945) September 1942—The gaseous diffusion and centrifuge (mechanical) methods of uranium isotope separation are also under intensive study (Smyth, 1945) September 13-14, 1942—An Electromagnetic Separation plant (calutron) is authorized to be built in Oak Ridge, Tennessee (Smyth, 1945) November 1942—The Chicago pile was completed, incorporating approximately 6 tons of uranium (oxide and metal) (Smyth, 1945, pp. 63-65) November 5, 1942—General Groves authorizes the construction of a full-scale Electromagnetic Production plant in Oak Ridge, Tennessee (Smyth, 1945) December 2, 1942—First self-sustaining chain reaction (reactor) is achieved at the University of Chicago (Smyth, 1945, pp. 63-65) End of 1942—Westinghouse is producing 500 pounds of uranium daily and has provided most (all but a few hundred pounds) of the University of Chicago pile uranium (McGahey, 1986)
1942-1943	E. U. Condon and several people from Forest Hills (including some people involved with the atom-smasher effort) are sent to join uranium separation evaluation activities in Oak Ridge, Tennessee (Coltman, 1987) – evidence of the Westinghouse evaluation of the calutron operations in Oak Ridge, Tennessee
1943	Development work on magnetrons includes secondary emission cathodes (McNall, unknown date) – evidence of the ionic centrifuge work at Westinghouse-East Pittsburgh Early 1943 – The ionic centrifuge method of uranium isotope separation has virtually been eliminated from the U.S. Uranium Enrichment Development program (Smyth, 1945) Middle of 1943—F.H. Spedding from the Iowa State College (he set up production facilities at Ames, Iowa in fall 1942 and produced 1 ton of uranium by November 1942) is using the adopted Final Production method (Smyth, 1945, pp. 63-65) Fall 1943—The United States government's own facilities are able to completely take over the production of uranium from Westinghouse (Westinghouse Engineer, 1946) October 1943—Westinghouse's uranium production project is discontinued (Marden, unknown date)
1944	Westinghouse is providing support for the calutron in Oak Ridge, Tennessee (Klein, 1944) The ionic centrifuge method of uranium isotopic separation is deemed an unsatisfactory method of separation and is abandoned (Smyth, 1945; Slepian, 1955a; Slepian, 1955b) The U.S. Government evaluates information regarding the World War II-era (and modern-era) uranium enrichment methods (FAMS, 2008)
1946	Westinghouse (and other companies) coordinate with the MED for the disposal of centrifuge equipment

Table 5-1: Westinghouse Atomic Power Development Plant Timeline

Table 5-1 and its associated notes span 4 pages.

Year(s)	Activity
	(Armstrong, 1946a, Armstrong, 1946b, Fidler, 1946; Sturges, 1946)
1947	Atom-smasher activities are restarted (used as a compressed air tank for experiments in jet engine development during World War II) and the atom smasher returns to service as a particle accelerator (Coltman, 1987)
1948	October 6, 1948—Gwilym A. Price (chairman and president of Westinghouse) announces the formation of Westinghouse's Atomic Power Division (related to the Bettis facility), which is to concentrate solely on harnessing nuclear energy for the production of useful power (Unknown author, 1958)
1949	Westinghouse contracts with the U.S. Navy (Hyman G. Rickover) to provide naval and commercial reactor development (Technical leader is W.E. Shoupp) (Coltman, 1987) Westinghouse purchases an old airport (Bettis Field) and creates a Division (later known as Bettis Laboratory) of the AEC • The first goal of the Bettis Laboratory is to design a power plant for nuclear submarines (Coltman, 1987)
1953	Westinghouse plans the construction of the Cheswick plant to support the manufacture of nuclear components (Unknown author, 1958)
1955	August—Westinghouse forms its Commercial Atomic Power Group/Division with Dr. Shoupp serving as the Technical Director (Coltman, 1987) Churchill Borough, an ultra-modern laboratory facility (to supplement and/or replace the Forest Hills Laboratories), is scheduled to open (Fry, 1954) Lamp and electric tube research is carried out at the Bloomfield, New Jersey laboratories (Fry, 1954) Westinghouse moved from the Forest Hills location to the Churchill Borough Laboratory (Westinghouse, 2008)
1957	December—Bettis Laboratory supplies the first reactor for the commercial power plant at Shippingport, Pennsylvania (Coltman, 1987)
1958[2]	The atom smasher is replaced in function by a commercially-made unit of more modern design

Notes:
[1] The Westinghouse "atom smasher" is a belt-type electrostatic generator, which differs from a cyclotron. The belt-type was considered a superior machine for more exact work for critical measurements. Similar generators were subsequently built at Massachusetts Institute of Technology (built by R.J. Van de Graaff) and Carnegie Institute of Washington, as well as Westinghouse) (Westinghouse, 1942). The Westinghouse machine was the first atom smasher in the industry—5 million-volt, 60-foot high unit at the Westinghouse Research Laboratories (McGahey, 1986).
[2] Additional information regarding post-1958 years can be found in SRDB Ref ID: 6953. This file contains various documents regarding post-MED support contracts and information, as well as reactor/fuel R&D, as performed by Westinghouse.

The following subsections discuss three particular processes that are potentially SEC-related, as well as their applicability to WAPDP and the NIOSH-proposed class under evaluation in this report.

5.1.1 Preparation of Uranium for the Stagg Field Experiment

Westinghouse's support of the Stagg Field experiment was a result of Westinghouse's prior experience in the field of uranium refining (originally associated with Westinghouse's Lamp Division research regarding the use of uranium as a lamp filament). Based on NIOSH's research, the following information supports NIOSH's conclusion that MED-related uranium refining work was not performed at the Westinghouse, East Pittsburgh location:

- The uranium (and thorium) research that occurred at the East Pittsburgh location was associated with the Lamp Division (evaluation of materials for use as potential lamp filaments), which was moved from East Pittsburgh and was consolidated in the Bloomfield, New Jersey location sometime between 1920 and 1921 (McNall, unknown date**;** Westinghouse, 1942), thus explaining the presence of low-level radiological contamination (from uranium or thorium contaminants) at both locations, identified during FUSRAP surveys (Voigt, 1985). Based on this information, the MED-related uranium refining activities are limited to the Bloomfield, New Jersey location.

- The Westinghouse, East Pittsburgh FUSRAP survey indicates that Building "L", Lab 2L, was the designated location for uranium work (DOE, unknown date). NIOSH has not found any documentation indicating that the East Pittsburgh/Forest Hills facility performed any MED-related uranium refining activities associated with the delivery of uranium for the University of Chicago (Stagg Field) pile. Based on the available information, it appears that Building "L" at the East Pittsburgh facility was identified as a Research building, as indicated on 1936 and 1946 maps (Westinghouse, 1936 & 1946). Based on the historical documentation, this facility may have been the location of the original uranium filament testing before the transfer of that activity to Bloomfield, New Jersey between 1921 and 1922. However, NIOSH has found no indication that any of the Westinghouse contract work potentially involving uranium refining for the University of Chicago pile was performed at the East Pittsburgh (Forest Hills) location (Westinghouse, unknown date-a**;** Westinghouse, various dates).

- Some early research was performed using the atom smasher (R&D Facility–late 1930s up to 1941), but this research occurred before the initiation of the MED on August 13, 1942 (Westinghouse, 1942**;** Coltman, 1987). Supporting documentation indicates that the Forest Hills R&D Facility work (including operation of the atom smasher) was shifted to microwave radar testing during the World War II timeframe (Coltman, 1987).

- The leader of the Uranium laboratory, Dr. Rentschler, worked out of Bloomfield, New Jersey at the Lamp Research Facility, not at the East Pittsburgh (Forest Hills) location (McNall, unknown date**;** Unknown author, unknown date**;** Westinghouse, 1942**;** Westinghouse Engineer, 1946; Unknown author, 1958), further supporting NIOSH's conclusion that the work was performed at the Westinghouse-Bloomfield location and not at the East Pittsburgh location.

Based on this information, NIOSH has concluded that there is no link between the Westinghouse East Pittsburgh/Forest Hills facilities and any MED activities related to the refining/preparation of uranium for the University of Chicago-Stagg Field, Enrico Fermi uranium pile experiment. Further review of any activities related to this uranium process will not be performed as part of this SEC evaluation for the NIOSH-evaluated class defined in petition SEC-00096.

5.1.2 Development and Pilot-Scale Production of Uranium Oxide Fuel Elements

WAPDP work associated with uranium oxide fuel elements can be related to the reactor support activities performed by multiple Westinghouse facilities. Based on NIOSH's research, Westinghouse uranium fuel work included the early work at Bloomfield, New Jersey (discussed previously) and the naval and commercial reactor development activities performed by the Westinghouse Nuclear Fuels Divisions. The following information supports NIOSH's conclusion that the nuclear fuel research work and the pilot-scale production of fuel elements are not activities that are applicable to the

covered facility/period at WAPDP. Specifically, all uranium oxide fuel element work performed within the WAPDP covered time period was performed at Westinghouse locations other than the East Pittsburgh location. The work that was performed after the DOE HSS-defined covered period for the WAPDP site includes work at various Westinghouse locations; the non-covered work appears to be primarily related to Westinghouse commercial fuel work.

- 1945 correspondence indicates that the manipulation of the uranium metal (potential rod work—related to providing the different shapes and sizes of material for the University of Chicago pile) was performed by Dr. Marden at Bloomfield (Calvert, 1945).

- 1947 correspondence shows that the Westinghouse Research Laboratories-East Pittsburgh requested approval for research quantities of uranium to be used in Westinghouse research studies. The correspondence specifically mentions the Westinghouse Research Laboratories in East Pittsburgh, but with no apparent link to weapons work (it appears this research work is related to Navy reactor work) (Shoupp, 1947).

- Uranium rod work was initiated in 1948 to support commercial and U.S. Navy nuclear reactor research (Unknown author, 1958).

- 1957 correspondence regarding the fission distribution in the WAPDP uranium oxide fuel pellets specifically mentions WAPDP and fuel work, but includes no apparent link to weapons work; the timeframe associated with the uranium oxide fuel pellets work is outside of the WAPDP covered period (Fry, 1957)

- The Forest Hills R&D facility supported pilot-scale activities in 1959, with the facility being identified as WAPDP (AEC, 1959), but the timeframe is for a period outside of the WAPDP covered period.

Based on this information, NIOSH has concluded that there is no link between the Westinghouse East Pittsburgh/Forest Hills facilities and any MED/AEC-related uranium oxide fuel element work during the covered time period from 1942 through 1944. Further review of any activities related to this development and pilot-scale production of uranium oxide fuel elements will not be performed as part of this SEC evaluation for the NIOSH-evaluated class defined in petition SEC-00096.

5.1.3 Development Work Associated with Uranium Enrichment

Westinghouse work associated with research and development of the uranium enrichment processes was related to its support of the Office of Scientific Research and Development (OSRD)/MED research into uranium enrichment. From the beginning of the MED, the OSRD sponsored all research on the topic of uranium enrichment; many potential methods were evaluated. The early uranium enrichment research occurred at multiple locations across the MED complex, including (but not limited to) Princeton, Columbia University, the University of Virginia, the University of California, and the Standard Oil Development Company. Westinghouse was at least partially involved in the evaluation and development of equipment/methods to support four of the methods under evaluation by the MED during this era: (1) the centrifuge (mechanical) method (developed and evaluated by the Standard Oil Development Company in New Jersey), (2) electromagnetic-calutron (in Oak Ridge, Tennessee), (3) gaseous diffusion (in Oak Ridge, Tennessee), and (4) ionic centrifuge method based

on a modified version of a laboratory-scale magnetron (at the University of California-Berkeley and the Westinghouse Research Facility in East Pittsburgh). The following subsections outline Westinghouse's involvement in each of the identified OSRD/MED operations.

5.1.3.1 Centrifuge (mechanical)

NIOSH has found documentation indicating that Westinghouse supported MED operations performed by the Standard Oil Development Company as part of its evaluation of the centrifuge (mechanical) method of uranium separation/enrichment. The activities associated with the development of the centrifuge were associated with a 1940 Navy contract. The centrifuges were the result of a coordinated effort by Columbia University, the University of Virginia, the Standard Oil Development Company, and Westinghouse (Sturges, 1946**;** Woodbury, 1948, Chapter 22).

The mechanical centrifuge uranium enrichment method incorporated the "cream separator principle" of isotope separation/enrichment (Woodbury, 1948). The first gram quantities of enriched uranium were produced at the University of Virginia using the mechanical centrifuge method (DOE, 1997). Pilot plants were built by Standard Oil Development Company (in Baway, New Jersey) and Westinghouse (in Bayonne, New Jersey). Engineering difficulties led the MED to shelve this project, with the focus shifting to gaseous and electromagnetic separation (Sturges, 1946**;** Woodbury, 1948**;** DOE, 1997). The OSRD/MED provided direction to Westinghouse, the Standard Oil Development Company, and Princeton University regarding the disposition/disposal of the equipment and project documentation associated with each respective enrichment method that was evaluated (and eventually terminated). Specifically, the sites were allowed to dispose of the uncontrolled/unclassified portions of their information and equipment, and were directed to maintain the potentially classified/controlled equipment pieces for the OSRD, pending further disposition directions (Fidler, 1946; Sturges, 1946; Armstrong, 1946a; Armstrong 1946b; Westinghouse, 1946). NIOSH has concluded that there is no indication that Westinghouse performed any of this uranium work at the East Pittsburgh/Forest Hills research and development facility. Therefore, although Westinghouse may have developed and designed equipment to support uranium enrichment by centrifuge, NIOSH has concluded that none of this work with radioactive materials (uranium) occurred at the Westinghouse East Pittsburgh/Forest Hills facilities during the covered time period from 1942 through 1944. Further review of any activities related to these operations will not be performed as part of this SEC evaluation for the NIOSH-evaluated class defined in petition SEC-00096.

5.1.3.2 Oak Ridge Electromagnetic (Calutron) and Gaseous Diffusion Support

NIOSH has found documentation indicating that Westinghouse supported MED gaseous diffusion and calutron work in Oak Ridge, Tennessee during the covered time period evaluated in this report (Westinghouse, 1950). The cyclotron/magnetron construction (i.e., huge magnets) was performed at the Westinghouse Switchgear Division in Pittsburgh, Pennsylvania, in support of University of California research; the equipment was installed in Oak Ridge (Sturges, 1946; Woodbury, 1948, Chapter 22). There is no indication that Westinghouse performed any calutron uranium enrichment work at the East Pittsburgh/Forest Hills Research and Development facility. NIOSH has concluded that, although Westinghouse may have developed and designed equipment to support uranium enrichment by gaseous diffusion or by calutron, none of this work with radioactive materials (uranium) occurred at the Westinghouse East Pittsburgh/Forest Hills facilities during the covered time period from 1942 through 1944. Further review of any activities related to these operations will not

be performed as part of this SEC evaluation for the NIOSH-evaluated class defined in petition SEC-00096.

5.1.3.3 Ionic Centrifuge (modified magnetron)

NIOSH has found documentation indicating that Westinghouse coordinated with the University of California-Berkeley in the evaluation, research, and development of the uranium enrichment process using a laboratory-scale magnetron and a modified version of a laboratory-scale magnetron (referred to as "ionic centrifuge"). A portion of this uranium work was performed at the East Pittsburgh/Forest Hills Research and Development facility (Smyth, 1945, pp. 119-120). Available documentation discusses the involvement of Westinghouse's Dr. Joseph Slepian in the review and development of the ionic centrifuge uranium enrichment method (Fowler, 2008; Bush-Conant File pp. 26-30; Slepian, 1955a; Slepain, 1955b). Based on this information, NIOSH has concluded that Westinghouse-East Pittsburgh/Forest Hills was involved in the design and development of the ionic centrifuge uranium enrichment method during the covered period of 1942 through 1944 at WAPDP. This work involved laboratory-scale quantities of uranium (Woodbury, 1948, Chapter 23).

As presented in Table 5-1, the ionic centrifuge method of uranium isotope separation had virtually been eliminated from the U.S. Uranium Enrichment Development program by early 1943 (Smyth, 1945). However, J. Slepian (at the Westinghouse Laboratories in Pittsburgh, Pennsylvania) continued this operation on a small scale through the winter of 1944 (Smyth, 1945). Considering the scale and scope of the work, as well as the fact that the process failed as a potential enrichment process (Slepian, 1955a; Slepian, 1955b) and was terminated, the end date of covered radiological activities is considered to be December 31, 1944.

Based on its research, NIOSH has concluded that the ionic centrifuge work is the only weapons-related operation that was performed at the Westinghouse-East Pittsburgh site. Specifically, the ionic centrifuge work involved enrichment research with uranium to support the OSRD/MED efforts, and was performed during the 1942 through 1944 timeframe listed within the covered period for the Westinghouse Atomic Power Development site. Therefore, only the review of the ionic centrifuge work will be included in this SEC evaluation for the NIOSH-evaluated class defined in petition SEC-00096.

5.2 Radiological Exposure Sources from WAPDP Operations

The following subsections provide an overview of the internal and external exposure sources for the WAPDP class under evaluation. Based on its research, NIOSH has not discovered any other radiological operations at the WAPDP site, other than the ionic centrifuge work, that may have resulted in MED/AEC-related internal or external radiological exposures during the covered time period under evaluation. Therefore, the potential internal and external radiological exposure scenarios at WAPDP are limited to those OSRD/MED operations, as discussed in Section 5.1, associated with the performance of laboratory-scale research and the development of the ionic centrifuge method of uranium enrichment during the period evaluated in the report.

The centrifuge-related work originated from the University of California-Berkeley laboratories where uranium enrichment using magnetrons (as well as other methods) was being evaluated. A Westinghouse researcher, Dr. Joseph Slepian (known for his electrical equipment work) identified a

potential method of uranium enrichment using a modified magnetron, which he deemed "ionic centrifuge." Dr. Slepian carried out his research with this method into 1944 at the East Pittsburgh Research laboratories. This work involved research with a laboratory-scale magnetron and very small quantities of uranium (Woodbury, 1948, Chapter 23). As previously indicated, this work did not reveal consistent results; it was virtually eliminated from the U.S. Uranium Enrichment Development program by early 1943, and was completely abandoned in late 1944 (Smyth, 1945; Slepian, 1955a; Slepian, 1955b). Specific discussions regarding the potential internal and external hazards associated with this work are included in the sections that follow.

5.2.1 Internal Radiological Exposure Sources

As previously indicated, the ionic centrifuge work involved research with a modified version of a laboratory-scale magnetron and very small quantities of uranium (Woodbury, 1948, Chapter 23). This work did not reveal consistent results and was eventually abandoned as a viable uranium enrichment method in 1944 (Smyth, 1945; Slepian, 1955a; Slepian, 1955b). As this was limited-scope work with small amounts of uranium, there was a low probability of producing elevated air concentrations of uranium. The primary internal exposure pathway during these research activities could have occurred by means of inhalation and/or ingestion of radioactive materials (uranium compounds).

5.2.1.1 Uranium

The OSRD/MED work associated with the electromagnetic enrichment/separation of uranium used uranium in the form of uranium tetrachloride (UCl_4) (FAMS, 2008). The UCl_4 was heated and converted into a gas prior to electromagnetic separation. The inhalation of uranium from this work likely posed an internal radiological exposure hazard. The low-level enriched material resulting from the early enrichment processes that were under development were likely used as feed for further high-level enrichment in Oak Ridge. The enrichment levels achieved from the low-level enrichment phases were likely between 12-20% (Smyth, 1945; FAMS, 2008). Specific information is not clearly documented regarding the highest enrichment level that was attained using this method; therefore, it is possible that higher levels of enrichment were achieved using the ionic centrifuge method.

Because processed uranium was used in the evaluation of this enrichment method, exposures due to uranium byproducts, resulting from the uranium refining process, are not likely and therefore are not included in this internal review.

5.2.2 External Radiological Exposure Sources

Based on its research, NIOSH has determined that WAPDP work involved personnel exposures to small quantities of uranium. Although the amounts of radioactive material (uranium) present at any one time during the laboratory-scale research of uranium enrichment method were very small, the potential for photon, beta (from uranium progeny), and neutron exposures did exist.

5.2.2.1 Beta-Photon

Natural uranium emits both beta particles (electrons) and photons (X-ray and gamma photons). The two primordial components of natural uranium are uranium-238 and uranium-235, but some of their decay products grow into equilibrium quickly enough to be hazardous in processing metal. Uranium-

238 transitions by alpha decay to thorium-234, emitting traces of weakly penetrating ~ 13 keV L X-rays. However, thorium-234 transitions primarily to protactinium-234m (with a 1.17 minute half-life), which in turn transitions to uranium-234 with the emission of a 2.28-MeV beta particle in 98.6% of transitions. This relatively high-energy beta particle accounts for significant external beta dose rates. It also produces significant Bremsstrahlung X-rays, primarily in the 30-250 keV energy range. The photons emitted from protactinium-234m are responsible for the external doses from uranium progeny. Because protactinium-234m is a decay product of thorium-234, the dose rate due to protactinium-234m will decay with an effective half-life of 24.1 days. Based on the limited quantities of uranium present at WAPDP during the period evaluated in this report, NIOSH does not expect that there would be significant external beta-gamma exposures at the site. Potential external beta-gamma exposures are evaluated further in Section 7 of this report.

An external photon source that also potentially existed at WAPDP included X-ray exposures from medical X-rays performed as a condition of employment. Information associated with medical X-rays and X-ray units used during the time period evaluated in this report are addressed in Battelle-TBD-6001 and ORAUT-OTIB-0006.

5.2.2.2 Neutron

There were two potential sources of neutrons for the work being evaluated at WAPDP. First, neutrons arise from alpha-neutron reactions where the reactant is chlorine, which was used in the electromagnetic uranium enrichment processes. Second, there is a small amount of spontaneous fission that occurs in uranium. The production of neutrons by alpha-neutron interactions in uranium compounds varies according to the light element involved in the interaction. Based on the limited quantities of uranium present at WAPDP during the period evaluated in this report, NIOSH believes that there would not be significant external neutron exposures at the site. However, without additional source term and process information, NIOSH cannot definitively establish the potential levels of neutron exposure in this class.

5.2.3 Incidents

No documented discrete radiological incidents or accidents that resulted in exceptionally high-level personnel exposures or overexposures (such as a criticality event) at WAPDP were identified or discovered by NIOSH during the data research and investigations performed in support of this SEC evaluation. NIOSH is not aware of any recorded histories of fires, spills, or other releases at WAPDP.

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

As of the date of this evaluation, NIOSH has been unable to find any records of internal or external monitoring for WAPDP employees; this includes its search for bioassay, air monitoring, dosimetry, and area radiation monitoring data. Because there was a very limited amount of OSRD/MED uranium available during the time period evaluated in this report, and because uranium was highly controlled and sought after by the OSRD/MED, NIOSH believes that only limited quantities of source material were present at the WAPDP site. NIOSH's evaluation of its ability to reconstruct the dose for the

NIOSH-evaluated class, using available information/documentation and dose reconstruction means available, is discussed in Section 7 of this report.

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 ensure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.6. 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-00096 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Westinghouse Atomic Power Development Plant Data

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

As previously discussed, NIOSH has been unable to find records of internal or external monitoring for WAPDP employees. In addition, very limited information regarding source term information is

available for the ionic centrifuge work performed at WAPDP. Therefore, a data sufficiency and pedigree evaluation for WAPDP workers is not possible for these data types.

7.2 Evaluation of Bounding Internal Radiation Doses at WAPDP

As discussed in Section 5 of this report, the principal source of internal radiation doses for members of the class under evaluation was uranium compounds used in the evaluation of the ionic centrifuge method of uranium enrichment. 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 Alternative Internal Data Source-Uranium Compounds

Based on the type of work performed, as identified during NIOSH's research for this evaluation report, the ionic centrifuge enrichment method is an electromagnetic method of isotope separation closely resembling the calutron electromagnetic operation. From the perspective of uranium enrichment, the electromagnetic process uses UCl_4 in isotope separation and subsequent uranium-235 enrichment. NIOSH reviewed the ionic centrifuge process in comparison to the calutron uranium enrichment process. The electromagnetic separation processes evaluated and performed at WAPDP were very small in scale, as compared to the processes developed and used at Y-12 and the University of California. Therefore, from the perspective of internal uranium dose for Westinghouse Atomic Power Development employees involved in the ionic centrifuge research work, the internal dose reconstruction methods for Y-12 and/or the University of California calutron workers represent a potentially bounding internal exposure scenario.

However, for the period under evaluation in this report, Y-12 and University of California internal dose reconstruction processes are not available to support estimating or bounding the internal dose for the WAPDP's NIOSH-evaluated class. The Y-12 calutron work for the 1942-1944 timeframe has been evaluated under the SEC process (SEC-00018 petition evaluation), and a class that encompasses the Y-12 calutron workers has been included in the Special Exposure Cohort. The findings of the SEC-00018 Evaluation Report indicate that internal dose for calutron workers cannot be reconstructed with sufficient accuracy. Specifically, the findings from an internal exposure perspective in the SEC-00018 report were: (1) Y-12 employees involved in calutron operations were exposed to airborne levels of uranium that could not be determined because of a lack of bioassay and air monitoring data; (2) there was a lack of source term and process information because of varying levels of uranium enrichment and production rates, and because the operations were not comparable to other MED/AEC operations for which data exist; and (3) there was a lack of sufficient information permitting individual internal dose reconstruction with sufficient accuracy during the covered/evaluated period (SEC-00018; SEC-00026; SEC-00098; ORAUT-TKBS-0014-5; ORAUT-TKBS-0014-6). The University of California dose reconstruction methods are defined in ORAUT-TKBS-0049, but do not provide definitive internal dose reconstruction methods for the electromagnetic isotope separation operations during the time period evaluated in this report.

Because there are no available data for the radiological operations performed at WAPDP in East Pittsburgh, and because the sites/operations that could serve as a surrogate for the purpose of establishing a bounding internal dose reconstruction method (including the Y-12 and University of California calutron operations and activities) are not available or developed for the WAPDP operations timeframe, no method can be readily established to support bounding or reconstructing the internal dose at WAPDP for this evaluation.

7.2.1.2 Residual Contamination

Since there was no evidence of residual contamination in the storage locations, internal exposure pathways such as inhalation, ingestion, and resuspension were not a concern for WAPDP workers. Therefore, assessment of internal dose due to residual contamination is not necessary.

7.2.2 Internal Dose Reconstruction Feasibility Conclusion

NIOSH did not find personnel monitoring data, area monitoring data, or source term data to estimate internal exposures at WAPDP for the period of August 13, 1942 through December 31, 1944, from uranium compounds used in the evaluation of the ionic centrifuge to enrich uranium at the Westinghouse Research Laboratories in East Pittsburgh. NIOSH has not found any information regarding work activities, nor are the source terms known. In addition, NIOSH evaluated the applicability of two potential surrogate operations from Y-12 and the University of California calutron operations and found that information and associated radiological data were lacking for both sites. Therefore, NIOSH has concluded that it is not possible to determine the magnitude of any potentially unmonitored internal doses at WAPDP. Based on the lack of relevant data, NIOSH is unable to estimate with sufficient accuracy the potential internal exposures associated with the ionic centrifuge operations at WAPDP for the period from August 13, 1942 through December 31, 1944.

7.3 Evaluation of Bounding External Radiation Doses at WAPDP

As discussed in Section 5 of this report, the principal source of external radiation doses for members of the proposed class was uranium compounds used in the evaluation of the ionic centrifuge method of uranium enrichment. 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 Alternative Data Sources-External Dose

As discussed in Section 7.2.1.1, NIOSH's research indicates that the ionic centrifuge enrichment method is an electromagnetic method of isotope separation closely resembling the calutron electromagnetic operation. As assessed in the internal review, the electromagnetic separation processes evaluated and performed at WAPDP were very small in scale compared to the processes developed and used at Y-12 and the University of California. Therefore, NIOSH concluded that the external dose reconstruction methods for Y-12 and/or the University of California calutron workers

would represent a potentially bounding external exposure scenario, from the perspective of external dose from uranium compounds for WAPDP employees involved in the ionic centrifuge research work.
However, for the period under evaluation in this report, the Y-12 and University of California external dose reconstruction processes are not available to support estimating or bounding the external dose for the WAPDP evaluated class. As discussed in Section 7.2.1.1, the Y-12 calutron work for the 1942-1944 timeframe has been evaluated under the SEC process (SEC-00018 petition evaluation), and a class that encompasses the Y-12 calutron workers has been included in the Special Exposure Cohort (SEC-00018 ER; ORAUT-TKBS-0014-5; ORAUT-TKBS-0014-6). The findings documented in the SEC-00018 Evaluation Report indicate that external dose for calutron workers, other than medical X-rays performed as a condition of employment, cannot be reconstructed with sufficient accuracy. Specifically, the findings from an external exposure perspective in the SEC-00018 Evaluation Report were: (1) there was a lack of source term and process information because of varying levels of uranium enrichment and production rates, and because the operations were not comparable to other MED/AEC operations for which data exist; (2) there was a lack of sufficient information permitting individual external dose reconstruction with sufficient accuracy during the covered/evaluated period (SEC-00018; SEC-00026; SEC-00098; ORAUT-TKBS-0014-5; ORAUT-TKBS-0014-6); and (3) sufficient information exists to support reconstructing the dose (for the purpose of partial dose reconstructions) from medical X-ray for Y-12 workers. The University of California dose reconstruction methods are defined in ORAUT-TKBS-0049, but do not provide definitive external dose reconstruction methods for the electromagnetic isotope separation operations during the time period evaluated in this report.

Because there are no available data for the radiological operations performed at WAPDP in East Pittsburgh, and because the sites/operations that could serve as a surrogate for the purpose of establishing a bounding external dose reconstruction method (including the Y-12 and University of California calutron operations and activities) are not available for the WAPDP operations timeframe, no method can be readily established to support bounding or reconstructing the occupational external dose at WAPDP for this evaluation.

7.3.1.2 Residual Contamination

Since there was no evidence of residual contamination in the storage locations, internal exposure pathways such as inhalation, ingestion, and resuspension were not a concern for WAPDP workers. Therefore, assessment of internal dose due to residual contamination is not necessary.

7.3.2 Westinghouse Atomic Power Development Plant Occupational X-Ray Examinations

NIOSH has not found any records indicating that employees at WAPDP were required to complete medical examinations, including chest X-rays prior to beginning work, on a periodic basis (e.g., annually), or following termination. Although no records have been identified that indicate occupational medical X-rays were required, for the purpose of partial dose reconstructions during the time period evaluated in this report, X-ray exams are assumed to have been required at termination. Organ doses from posterior-anterior chest X-rays for all time periods are available in ORAUT-OTIB-0006. NIOSH believes that by using this methodology, occupational medical X-ray doses can be reconstructed.

7.3.3 External Dose Reconstruction Feasibility Conclusion

NIOSH did not find personnel monitoring data, area monitoring data, or source term data to estimate external exposures at WAPDP for the period of August 13, 1942 through December 31, 1944, associated with the ionic centrifuge process to enrich uranium at the Westinghouse Research Laboratories in East Pittsburgh. NIOSH was unable to find information regarding WAPDP work activities or source term data. NIOSH also evaluated the applicability of two potential surrogate operations from Y-12 and the University of California calutron operations, and found that information and associated radiological data were lacking for both sites. Therefore, NIOSH has concluded that it is not possible to determine the magnitude of any potentially unmonitored external doses at WAPDP. Based on the lack of relevant data, NIOSH is unable to estimate with sufficient accuracy the potential external exposures associated with the ionic centrifuge operations at WAPDP for the period from August 13, 1942 through December 31, 1944. However, for the purposes of partial dose reconstructions (for workers with non-presumptive cancers or with less than 250 days of employment) NIOSH can reconstruct the medical X-ray exposures using ORAUT-OTIB-0006.

7.4 Evaluation of Petition Basis for SEC-00096

The following subsections evaluate the assertions made on behalf of petition SEC-00096 for WAPDP.

7.4.1 Lack of Records

SEC-00096: *Inasmuch as EEOICPA BULLETIN NO. 02-02, March 29, 2002, explicitly states that records have not been found for employees at the Westinghouse East Pittsburgh site, document 02-02 satisfies the requirement of Form B, Section F-2, regarding petition SEC00096.*

NIOSH concurs that radiological monitoring records for the class evaluated in this report are not available. This basis provided the necessary supporting documentation/statement resulting in the qualification of petition SEC-00096; the findings of this evaluation are the subsequent response to this item.

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

During the feasibility evaluation for SEC-00096, an additional issue was identified that needed further analysis and resolution.

- ISSUE: Evaluate the ability to reconstruct internal or external calutron exposures based on Y-12 or University of California (Lawrence Berkley National Laboratory) exposure scenarios.

  RESPONSE: As discussed in Section 7, the Y-12 and University of California (Lawrence Berkley National Laboratory) calutron work is a potential surrogate dose reconstruction methodology source for reconstructing the internal and external dose for the WAPDP ionic centrifuge workers. However, the methodologies are neither available nor fully defined for either Y-12 or the

University of California (Lawrence Berkley National Laboratory) for the timeframe under evaluation in this report. Therefore, the ability to bound the WAPDP radiation doses (reconstruct with sufficient accuracy) is not possible using WAPDP data or source term information, or through the use of surrogate data from an equivalent site.

7.6 Summary of Feasibility Findings for Petition SEC-00096

This report evaluates the feasibility for completing dose reconstructions for employees at WAPDP from August 13, 1942, through December 31, 1944. NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-1 summarizes the results of the feasibility findings at WAPDP for each exposure source during the time period August 13, 1942 through December 31, 1944.

Table 7-1: Summary of Feasibility Findings for SEC-00096
August 13, 1942 through December 31, 1944

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal		**X**
- U		X
External		**X**
- Beta-Photon		X
- Neutron		X
- Occupational Medical X-ray	X	

As of January 21, 2009, a total of 14 claims have been submitted to NIOSH for individuals who worked at Westinghouse Atomic Power Development Pant and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for 1 individual (~.06%).

8.0 Evaluation of Health Endangerment for Petition SEC-00096

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 the lack of available data, little information on source terms and activities, and few available surveys, NIOSH's evaluation determined that it is not feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources.

9.0 Class Conclusion for Petition SEC-00096

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all Atomic Weapons Employer employees who worked at Westinghouse Atomic Power Development Plant in East Pittsburgh, Pennsylvania from August 13, 1942 through December 31, 1944, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC. The class under evaluation was modified (see Section 3.0 below) because (1) the definition of the East Pittsburgh location encompassed two Westinghouse facilities; and (2) although it is apparent that there were a limited number of personnel directly involved in the ionic centrifuge research under evaluation, the Department of Labor (DOL) cannot distinguish specific workers or work locations for the NIOSH-proposed class.

NIOSH has carefully reviewed all material submitted 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-00096. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

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10.0 References

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Westinghouse Atomic Power Development Plant			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
Primary Site/Company Name: Westinghouse Atomic Power Development Plant. 1942 -1944; AWE Other Site Names: East Pittsburgh Plant Westinghouse collection located at the Senator John Heinz History Center, Pittsburgh, PA	Annual report, general information on atom smasher, famous Westinghouse firsts, chronology of Westinghouse events from 1867-1980, top view of streets and buildings of East Pittsburgh, through the years with Westinghouse, atoms to zirconium, photographs of East Pittsburgh exterior, chronology of significant events in the development of atomic power, a brief background of the Westinghouse Lamp Division, Lamp Division 'by-product' speeded bomb, map of research laboratories, and Westinghouse uranium discussions and photos.	12/20/2007	30
State Contacted: Mr. David Allard, CHP, Director PA Department of Environmental Protection, Bureau of Radiation Protection (717-787-2480)	No relevant data identified.	02/08/2008	0
RIDC Keystone Commons, current Property Manager	No relevant data identified.	12/21/2007	0
Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	08/21/2008	0
Department of Energy (DOE)	Trip reports, Forest Hills location designation change and addition to covered facility list along with supporting documentation, communications between AEC and Westinghouse, methods of separating U-233 from thorium, production of tritium and U-233, and use of thorium as pile flattering material.	06/18/2008	30
DOE Germantown	Beryllium hazards.	Unknown	1
DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	08/21/2008	0
DOE Legacy Management Considered Sites	Uranium procurement, certification docket, and preliminary survey.	10/17/2007	4
Legacy Management - Grand Junction	Disposition of thoria scrap, request for uranium - requisition P-57, shipment of chemical KB-2, and shipment of uranyl nitrate.	04/02/2008	6
DOE Legacy Management - MoundView	List of contractors, survey of normal uranium scrap materials,	05/21/2008	22

Table A1-1: Data Capture Synopsis for Westinghouse Atomic Power Development Plant			
Data Capture Information	**Data Capture Description**	**Completed**	**Uploaded into SRDB**
(Fernald Holdings, includes Fernald Legal Database)	thorium-related documents, transfer and progress reports.		
DOE OpenNet	No relevant data identified.	01/05/2008	0
DOE OSTI	Status for pressurized water reactivity accident analysis.	09/05/2008	1
DOE OSTI Energy Citations	WRAP module 1 sampling strategy and waste characterization alternatives study.	08/19/2008	1
DOE OSTI Information Bridge	Mixed waste information.	08/21/2008	3
DOE Protecting Human Subjects (CEDR)	No relevant data identified.	08/21/2008	0
ORAU Team	Atom smasher incident and correspondence.	10/26/2005	3
General Atomics	Nuclear material transfer reports.	11/02/2005	1
Google	IEEE milestones Westinghouse atom smasher, atomic energy for military purposes official report on the development of the Atomic Bomb, and history of research and technology.	08/26/2008	13
Lawrence Berkeley National Laboratory	Various laboratory contracts.	02/06/2007	1
NARA Atlanta	Thorium rolling and request for U-238 photo fission study.	05/23/2008	3
NARA San Bruno FRC	Summaries of fuels and materials.	01/31/2006	1
National Academies Press (NAP)	No relevant data identified.	08/21/2008	0
National Institute of Health	No relevant data identified.	08/21/2008	0
National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	08/21/2008	0
NRC Agencywide Document Access and Management (ADAMS)	SNM license, inspections, and air sampling.	08/21/2008	3
SAIC	Radiation exposure summary.	09/02/2004	2
Viacom	Radiation survey and facility description.	06/15/2005	4
Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	08/21/2008	0
Washington University Libraries - St. Louis	No relevant data identified.	08/21/2008	0
Unknown	Elimination report for WAPDP, air dust samples, IH and radiation audits, and a facility description.	09/19/2008	9
Total			**138**

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 10/17/2007	N/A	4	4
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 01/05/2008	Westinghouse after 12/31/1941 "East Pittsburgh"" "westinghouse atomic power development" "Westinghouse Atomic Power Development Plant" No key word used. Rather searched all documents for generation dates between Jan 1, 1939 and Dec 31, 1945 "pittsburgh" along with a bracketing dates of 01/01/1939 and 12/31/1945. "Westinghouse Electric" Manufacturing	20,485	0
DOE Energy Citations http://www.osti.gov/energycitations/ COMPLETED 08/19/2008	"Westinghouse Atomic Power Development Plant" "East Pittsburg Plant" Forest Hills Westinghouse	294	1
CEDR http://cedr.lbl.gov/ COMPLETED 08/21/2008	Westinghouse Atomic Power Development Plant "East Pittsburgh Plant" Forest Hills	0	0
DOE Hanford DDRS	Westinghouse (period 1942 – 1946)	11	0

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
http://www2.hanford.gov/declass/ COMPLETED 08/21/2008	WAPD Forest Hills Westinghouse		
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 08/21/2008	"Westinghouse Atomic Power Development Plant" "Westinghouse" "East Pittsburgh" No key word used. Rather searched all documents for generation dates between Jan 1, 1940 and Dec 31, 1945 "Westinghouse Research Lab" "East Pittsburgh" "Stagg Field" "Westinghouse Electric" Manufacturing "Westinghouse Research Laboratories" "Manhattan Project" Forest Hills Westinghouse	509	3
National Academies Press http://www.nap.edu/ COMPLETED 08/21/2008	"Westinghouse" "East Pittsburgh" "Forest Hills"	210	0
National Institute of Health http://www.nih.gov/ COMPLETED 08/21/2008	"Forest Hills"	28	0

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 08/21/2008	Westinghouse WAPD "Forest Hills"	20	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 08/21/2008	Westinghouse Atomic Power Development Westinghouse (period 1942 – 1960) Westinghouse electric" & "East Pittsburgh" "Forest Hills"	40	3
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 08/21/2008	Westinghouse Atomic Power Development Plant "East Pittsburgh Plant" Forest Hills	0	0
Washington University Library - St. Louis http://library.wustl.edu/ COMPLETED 08/21/2008	"Forest Hills"	2	0
Google http://www.google.com COMPLETED 08/26/2008	Enrico Fermi and Westinghouse and Stagg "Westinghouse Electric Corp" "East Pittsburgh" americium, OR Am241, OR Am-241, OR "AM 241", OR 241Am, OR 241-Am, OR "241 Am" "Westinghouse Electric Corp" "East Pittsburgh" ionium, OR Th230, OR Th-230, OR "Th 230", OR 230Th, OR 230-Th, OR "230 Th"	4,062	13

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Westinghouse Electric Corp" "East Pittsburgh" neptunium, OR Np237, OR Np-237, OR "Np 237", OR 237Np, OR 237-Np, OR "237 Np" "Westinghouse Electric Corp" "East Pittsburgh" polonium, OR Po210, OR Po-210, OR "Po 210", OR 210Po, OR 210-Po, OR "210 Po" "Westinghouse Electric Corp" "East Pittsburgh" 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" "Westinghouse Electric Corp" "East Pittsburgh" UX1, OR UX2, OR Th-234, OR Th234, OR "Th 234", OR 234-Th, OR 234Th, OR "234 Th" "Westinghouse Electric Corp" "East Pittsburgh" tritium, H3, H-3, mint, HTO "Westinghouse Electric Corp" "East Pittsburgh" 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" "Westinghouse Electric Corp" "East Pittsburgh" U235, OR "U 235", OR U-235, OR 235-U, OR 235U, OR "235 U", OR U238, OR "U 238", OR U-238, OR 238-U, OR 238U, OR "238 U" "Westinghouse Electric Corp" "East Pittsburgh" U308, OR "U 308", OR U-308, OR 308-U, OR 308U, OR "308 U", OR "uranium extraction", OR "black oxide", OR "brown oxide"		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Westinghouse Electric Corp" "East Pittsburgh" "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 "Westinghouse Electric Corp" "East Pittsburgh" 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" "Westinghouse Electric Corp" "East Pittsburgh" 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" "Westinghouse Electric Corp" "East Pittsburgh" 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" "Westinghouse Electric Corp" "East Pittsburgh" radon, OR Rn-222, OR Rn222, OR "Rn 222", OR 222Rn, OR 222-Rn, OR "222 Rn" "Westinghouse Electric Corp" "East Pittsburgh" thoron, OR Rn-220, OR Rn220, OR "Rn 220", OR 220Rn, OR 220-Rn, OR "220 Rn" "Westinghouse Electric Corp" "East Pittsburgh" protactinium, OR Pa-234m, OR Pa234m, OR "Pa 234m", OR 234mPa, OR 234m-Pa, OR "234m Pa" "Westinghouse Electric Corp" "East Pittsburgh" strontium, OR Sr-90, OR Sr90, OR "Sr 90", OR 90-Sr, OR 90Sr, OR "90 Sr"		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"Westinghouse Electric Corp" "East Pittsburgh" oralloy, OR postum, OR tuballoy, OR "uranyl nitrate hexahydrate", OR UNH, OR K-65, OR "sump cake" "Westinghouse Electric Corp" "East Pittsburgh" uranium dioxide, OR "uranium tetrafluoride", OR "uranium trioxide" "Westinghouse Electric Corp" "East Pittsburgh" uranium hexafluoride, OR accident, OR "air count" "Westinghouse Electric Corp" "East Pittsburgh" "air dust", OR "air filter", OR "airborne test" "Westinghouse Electric Corp" "East Pittsburgh" alpha, OR "belgian congo ore", OR bioassay, OR bio-assay "Westinghouse Electric Corp" "East Pittsburgh" breath, OR "breathing zone", OR BZ, OR calibration, OR columnation "Westinghouse Electric Corp" "East Pittsburgh" contamination, OR curie, OR denitration, OR "denitration pot" "Westinghouse Electric Corp" "East Pittsburgh" derby, OR regulus, OR dose, OR dosimeter "Westinghouse Electric Corp" "East Pittsburgh" dosimetric, OR dosimetry, OR electron, OR environment "Westinghouse Electric Corp" "East Pittsburgh" "Ether-Water Project", OR exposure, OR "exposure investigation", OR "radiation exposure" "Westinghouse Electric Corp" "East Pittsburgh" external, OR "F machine", OR fecal, OR "feed material", OR femptocurie, OR		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	film, OR fission, OR fluoroscopy "Westinghouse Electric Corp" "East Pittsburgh" "Formerly Utilized Sites Remedial Action Program", OR FUSRAP, OR gamma-ray, OR "gas proportional", OR "gaseous diffusion" "Westinghouse Electric Corp" "East Pittsburgh" health, OR "health instrument", OR "health physics", OR "H.I.", OR HI, OR HP, OR "highly enriched uranium", OR HEU "Westinghouse Electric Corp" "East Pittsburgh", hydrofluorination, OR "in vitro", OR "in vivo", OR incident, OR ingestion, OR inhalation, OR internal "Westinghouse Electric Corp" "East Pittsburgh" investigation, OR isotope, OR isotopic, OR "isotopic enrichment", OR "JS Project", OR Landauer, OR "liquid scintillation" "Westinghouse Electric Corp" "East Pittsburgh" log, OR "log sheet", OR "log book", OR "low enriched uranium", OR LEU "Westinghouse Electric Corp" "East Pittsburgh" "maximum permissible concentration", OR MPC, OR metallurgy, OR microcurie, OR millicurie "Westinghouse Electric Corp" "East Pittsburgh" "mixed fission product", OR MFP, OR monitor, OR "air monitoring", OR nanocurie, OR "nasal wipe", OR neutron, OR "nose wipe" "Westinghouse Electric Corp" "East Pittsburgh" nuclear, OR Chicago-Nuclear, OR "nuclear fuels", OR "nuclear track emulsion", OR "type A" "Westinghouse Electric Corp" "East Pittsburgh" NTA, OR		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	"occupational radiation exposure", OR occurrence, OR "ore concentrate", OR "PC Project" beta OR "body burden" OR "chest count" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA "derived air concentration" OR DAC OR gamma-ray "Westinghouse Atomic Development Plant" -ORAU -NIOSH –EEOICPA gamma ray OR "lung count" OR palm "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA palmolive OR thoria OR "chemical 1066" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA "chemical 10 66" OR "chemical 18-12" OR "chemical 1812" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA "chemical 18 12" OR "chemical 1012" OR "chemical 10 12" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA uranium extraction "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA beta OR "body burden" OR "chest count" "East Pittsburgh Plant" -ORAU -NIOSH -EEOICPA "derived air concentration" OR DAC OR gamma-ray "East Pittsburgh Plant" -ORAU -NIOSH –EEOICPA "gamma ray" OR "lung count" OR palm "East Pittsburgh Plant" -		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	ORAU -NIOSH –EEOICPA palmolive OR thoria OR "chemical 1066" "East Pittsburgh Plant" -ORAU -NIOSH -EEOICPA "chemical 10 66" OR "chemical 18-12" OR "chemical 1812" "East Pittsburgh Plant" -ORAU -NIOSH -EEOICPA "chemical 18 12" OR "chemical 1012" OR "chemical 10 12" "East Pittsburgh Plant" -ORAU -NIOSH -EEOICPA "chemical 1012" OR "chemical 10 12" OR "uranium extraction" "East Pittsburgh Plant " -ORAU -NIOSH -EEOICPA collimation OR photofluorography OR "uranium aluminum alloy" "East Pittsburgh Plant" -ORAU -NIOSH -EEOICPA UAlx OR x-ray-screening OR "uranium aluminide" "East Pittsburgh Plant " -ORAU -NIOSH –EEOICPA collimation OR photofluorography OR "uranium aluminum alloy" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA UAlx OR "uranium aluminide" OR "x-ray screening" "Westinghouse Atomic Power Development Plant" -ORAU -NIOSH -EEOICPA thorium billets slugs "Forest Hills" -NIOSH –ORAU Hanford thorium "Forest Hills" -NIOSH -ORAU uranium Westinghouse "Forest Hills" -NIOSH -ORAU -Canadian		

Table A1-2: Database Searches for Westinghouse Atomic Power Development Plant			
Database/Source	**Keywords**	**Hits**	**Uploaded into SRDB**
	-high westinghouse thorium "Forest Hills" -NIOSH -ORAU -high Westinghouse contamination "Forest Hills" -ORUA -NIOSH -school Westinghouse slugs "Forest Hills" -ORUA -NIOSH -school "Westinghouse Atomic Power Development Plant"		

Table A1-3: OSTI Documents Ordered for Westinghouse Atomic Power Development Plant			
Document Number	**Document Title**	**Requested Data**	**Date Received**
No documents ordered	N/A	N/A	N/A