SEC Petition Evaluation Report
Petition SEC-00140

Report Rev #: 0 Report Submittal Date: September 9, 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-00140	83.13	May 18, 2009	University of Rochester Atomic Energy Project

Petitioner Class Definition

Laboratory Technicians who worked in the University of Rochester Atomic Energy Project laboratory building at the University of Rochester in Rochester, New York, from September 1, 1943 through June 19, 1945.

Class Evaluated by NIOSH

All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971.

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

All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971, 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
None			

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
None	

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Evaluation Report Summary: SEC-00140
University of Rochester Atomic Energy Project

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-00140, qualified on May 18, 2009, requested that NIOSH consider the following class: *Laboratory Technicians who worked in the University of Rochester Atomic Energy Project laboratory building at the University of Rochester in Rochester, New York, from September 1, 1943 through June 19, 1945.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH expanded and extended the petitioner-requested class. NIOSH evaluated the following class: All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971.

The petitioner-requested class was expanded to include all workers because NIOSH found no basis for limiting the class to only Laboratory Technicians. Other potentially-exposed workers could have included, but may not have been limited to, Animal Caretakers, Guards, and Research Staff.

Although work for the Manhattan Engineering District (MED) at the University of Rochester officially began in March 1943 with the appointment of Dr. Stafford Warren as civilian consultant to the District (URAEP, 1943-1968), NIOSH concurs with the petitioner's start date of September 1, 1943, because there is documented evidence that the facilities for Atomic Energy Project (AEP) work were not ready for occupancy until September 1; there is no evidence to suggest that any work for the MED involving radioactive materials or radiation-generating machines took place at the university prior to that date.

The petitioner-requested class was also extended to include later years because, in addition to finding no evidence of personnel monitoring during the petitioner-proposed time period, NIOSH identified a lack of monitoring data (particularly internal monitoring data) for later years as well. The greatest potential cause of internal exposure at the University of Rochester Atomic Energy Project after 1951 was activities associated with the Alpha Laboratory, which operated from 1952 until "mothballed" in 1968. Alpha Lab gloveboxes and associated wastes were shipped from the AEP prior to October 30, 1971; therefore, the period beyond that date has been reserved in this evaluation report pending further review of dose reconstruction feasibility and health endangerment determinations for that time period.

External radiation monitoring data are available from 1953 through 1986, the end of the covered period specified by the Department of Energy. The period evaluated in this report, September 1, 1943 through October 30, 1971, includes all current claimants. NIOSH will prioritize the evaluation of the time period after October 30, 1971 if pertinent individual claims are submitted; currently, there are none.

NIOSH-Proposed Class(es) 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 employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971, 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 accepted (see Section 3.0 below) because internal monitoring data are very limited and insufficient for dose reconstruction purposes.

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 is not sufficient to document or estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the evaluated 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: Chris Miles, Quantaflux, LLC. 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 employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

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

[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.

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-00140, University of Rochester Atomic Energy Project

The following subsections address the evolution of the class definition for SEC-00140, University of Rochester Atomic Energy Project (AEP). When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-proposed class. If some portion of the petitioner-proposed class is qualified, NIOSH will specify that class along with a justification for any modification of petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00140, qualified on May 18, 2009, requested that NIOSH consider the following class for addition to the SEC: *Laboratory Technicians who worked in the University of Rochester Atomic Energy Project laboratory building at the University of Rochester in Rochester, New York, from September 1, 1943 through June 19, 1945.*

The petitioner provided information and affidavit statements in support of the petitioner's basis that radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored either through personal monitoring or through area monitoring. NIOSH deemed the following affidavit statement sufficient to qualify SEC-00140 for evaluation:

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

"To the best of my knowledge I was never monitored for radiation exposure for my work in the radiation area." (Affidavit, 2009)

Based on its AEP research and data capture efforts, NIOSH determined that internal and external monitoring records are not complete for all time periods or for all radionuclides. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH expanded and extended the petitioner-proposed class. The petitioner-requested class was expanded to include all workers because NIOSH found no basis for limiting the class to only Laboratory Technicians. Other potentially-exposed workers could have included Animal Caretakers, Guards, and Research Staff. Although MED work at the University of Rochester officially began in March 1943 with the appointment of Dr. Stafford Warren as civilian consultant to the District (URAEP, 1943-1968), NIOSH concurs with the petitioner's start date of September 1, 1943, because there is documented evidence that AEP facilities were not ready for occupancy until September 1; there is no evidence to suggest that any work for the MED involving radioactive materials or radiation-generating machines took place at the university prior to that date.

This petition was qualified based on the petitioner's belief that there was a lack of personnel monitoring. The petitioner-requested class was also extended to include later years because, in addition to finding no evidence of personnel monitoring during the petitioner-proposed time period, NIOSH identified a lack of monitoring data (particularly internal monitoring data) for later years as well. The greatest potential cause of internal exposure at the University of Rochester Atomic Energy Project (AEP) after 1951 was activities associated with the Alpha Laboratory, which operated from 1952 until "mothballed" in 1968. Alpha Lab gloveboxes and associated wastes were shipped from the AEP prior to October 30, 1971; therefore, the period beyond that date has been reserved in this evaluation report pending further review of dose reconstruction feasibility and health endangerment determinations for that time period. External radiation monitoring data are available from 1953 through 1986, the end of the covered period specified by the Department of Energy. The period evaluated in this report, September 1, 1943 through October 30, 1971, includes all current claimants. NIOSH will prioritize the evaluation of the time period after October 30, 1971 if pertinent individual claims are submitted; currently, there are none.

Therefore, NIOSH defined the following class for further evaluation: All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971.

3.3 NIOSH-Proposed Class(es) 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 employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971, 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.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding the University of Rochester Atomic Energy Project. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, the Atomic Energy Technical Report database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. In addition, finding aids for all relevant National Archives and Records Administration (NARA) facilities were reviewed for University of Rochester data and an exhaustive search was made of the University of Rochester holdings, including personnel and medical files. Attachment 1 summarizes NIOSH's data capture efforts. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

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

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document.

No Site Profile or TBD has been written for the University of Rochester Atomic Energy Project.

4.2 ORAU Technical Information Bulletins (OTIBs)

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

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

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed six former AEP employees and two members of the current University of Rochester radiation safety staff, including the Radiation Safety Officer. All interviews were conducted by phone and attended by ORAU team and NIOSH staff.

- Personal Communication, 2008a, *Personal Communication with former Health Physicist*; Telephone Interview by ORAU Team and NIOSH; June 17, 2008; SRDB Ref ID: 45530

- Personal Communication, 2008b, *Personal Communication with AEP former Graduate Student*; Telephone Interview by ORAU Team and NIOSH; June 10, 2008; SRDB Ref ID: 45531

- Personal Communication, 2008c, *Personal Communication with former Lab Technician*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45533

- Personal Communication, 2008d, *Personal Communication with former Chemist*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45535

- Personal Communication, 2008e, *Personal Communication with former Medical Researcher*; Telephone Interview by ORAU Team and NIOSH; June 10, 2008; SRDB Ref ID: 45536

- Personal Communication, 2008f, *Personal Communication with former Health Physicist*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45538

- Personal Communication, 2008g, *Personal Communication with current Radiation Safety staff (two individuals)*; Telephone Interview by ORAU Team and NIOSH; July 1, 2008; SRDB Ref ID: 47123

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 August 12, 2009)

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

Description	Totals
Total number of claims submitted for dose reconstruction	7*
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (September 1, 1943 through October 30, 1971).	6
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	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	1

* One of these seven claims, although covered by the class definition evaluated in this report, was pulled by the Department of Labor because the claimant qualified for an SEC class established for another site.

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. External dose monitoring records were obtained for one claimant. Internal dose data were not obtained for any of the six claimants.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. There are 946 document entries in this database that were identified as pertaining to the University of Rochester Atomic Energy Project. Many of these entries consisted of multiple individual documents that pertained to the AEP. These documents were evaluated for their relevance to this petition. The documents include historical background on research conducted at the AEP; services provided by the AEP, including assessment of internal and external exposures at other Manhattan Engineer District (MED) projects; external monitoring data; radioactive material licenses; and reports and publications on the AEP's on-going work.

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the University of Rochester AEP from September 1, 1943 to October 30, 1971 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 University of Rochester AEP Plant and Process Descriptions

In 1943, the MED contracted with the University of Rochester to provide research, consultation, and other services on the health hazards expected to arise in the facilities contributing to the atomic bomb program. The University of Rochester was chosen because various staff members of the School of Medicine and Dentistry had previously studied the pathological effects of radiation and the use of radioisotopes in research.

Dr. Stafford L. Warren of the University of Rochester was selected to head up the project. The two initial challenges facing Dr. Warren were: (1) outlining in detail a medical program for the MED; and (2) designing and erecting a building at Rochester in which a research group could be organized to investigate unexplored fields in medical research on the effects of radiation and other issues related to the development and production of the atomic bomb (Dowdy, 1945). Unless specified otherwise, the following information on buildings and their uses was drawn from *University of Rochester Atomic Energy Project Scope of the Work* (Scope of Work, 1959).

Building plans were drawn for the B Wing of the Medical School Annex in May 1943; the building was ready for occupancy on September 1, 1943. The B Wing was built next to an existing building (the A Wing) that had been completed in January 1942. The existing two-story building housed a new million-volt X-ray machine, which was to be used for non-destructive evaluation of castings and other war-related equipment. In September 1943, a group of "50 or more" individuals moved into the new building. These individuals consisted of guards, animal caretakers, lab technicians, a telephone operator, office workers, and research staff. By 1945, the building housed 350 persons (Dowdy, 1945). A 1959 historical document states that (at that time) the Project usually numbered between 250 and 300 (Scope of Work, 1959). A 1968 document states that (at that time) the total personnel of the Department usually numbered about 340, including 260 full-time employees, 30 student assistants, and 50 other students and fellows. The academic staff, including 14 to 17 technical associates, usually numbered about 70.

The Medical School Annex consisted of three wings (A, B, and C). Wing A (9700 ft^2), was constructed in 1942 by the University to house high-voltage X-ray equipment for testing castings for the Armed Forces. Wing B (originally 15,000 ft^2) and Wing C (originally 19,000 ft^2), were built by the Manhattan Engineer District in 1943 and 1944. Education space, O Wing (53,000 ft^2), was built by the AEC as an addition to the Medical School in 1950.

Many additions were built for the AEP effort. Additions to B Wing were: the Alpha Laboratory (second floor - 6,000 ft^2) in 1951; a third floor (5,200 ft^2) in 1961; and a low-level counting facility (600 ft^2) in 1964. In 1951, 900 ft^2 were added to C Wing for flash burn studies. In 1961, a radioactive storage vault (200 ft^2) was constructed off the tunnel joining the Annex and the Medical School. All of these additions were built by the AEC. During 1965 and 1966, additions totaling 50,000 ft^2 were added to the O Wing of the Medical School. The additions consisted of an underground radiation facility off the tunnel and an eight-story building (OO Wing) that adjoined O Wing and contained laboratories and lecture rooms. The total space occupied by the Department by January 1967 was approximately 160,000 sq. ft., exclusive of storage (URAEP, 1943-1968). Additional space was provided by other departments (e.g., Biology, Physics, Biochemistry and Radiology). (Scope of Work, 1959)

On December 31, 1946, the Project was transferred to the jurisdiction of the newly-formed United States Atomic Energy Commission and placed under the supervision of its New York Operations Office. The effort was henceforth referred to as the Atomic Energy Project (AEP). Outside services to operating plants were gradually reduced as these responsibilities were assumed by the Health and Safety Laboratory of the New York Office. Of the Rochester Project's original functions, only research and consultation remained. These efforts were later amplified by an educational program that got fully underway in 1950 when additional space was provided by the Commission. Although the project had been administered from its inception by the Medical School's Radiology Department, the personnel in large part were not academic members of that department. Consequently, in January 1948, a new pre-clinical department of Radiation Biology was formed to administer the Project. The department was divided into four divisions: Radiology and Biophysics, Radiation Chemistry and Toxicology, Medical, and Miscellaneous Research. Including those registering in 1967, there had been 799 graduate students in the Department from 1948 to 1968 (URAEP, 1943-1968).

One responsibility of the AEP in the early days was the collection and analysis of periodic medical examination data on personnel involved in atomic energy production in plants across the nation. The AEP also advised these plants on how to protect their employees by: (1) determining tolerance standards for exposures to radiation and toxic chemicals; (2) developing instruments to measure exposure; (3) measuring radiation intensities and concentrations of toxic dust in plants; and (4) suggesting measures to make operations safer. Certain plants were surveyed periodically to determine radiation and other hazards, and recommendations were made for safe operation. Film badge and analytical services were provided for plant personnel. Research programs were established in two broad fields: the biological effects of external radiation, and the toxicity of radioactive and chemical materials (Scope of Work, 1959).

Initial efforts focused on characterizing the biological effects of external X-ray or gamma ray exposure. The AEP relied heavily on controlled animal exposures for these studies. The X-ray machines were used to give daily radiation exposures to the animals. These studies were used to estimate the amount of exposure that could be safely tolerated by humans. The studies involved chronic exposures whereby animals were observed, sometimes for many years, for long-term effects. In other studies, animals were given lethal or near-lethal exposures to observe acute effects. Cyclotron neutrons were also used for these purposes (Dowdy, 1945).

Research was also conducted on internal deposition of radioactive materials. Airborne radioactive materials were of direct concern in most nuclear installations. They were of importance in weapons fallout, in the event of an accidental release of fission products from a power reactor, in the mining and processing of ores, in the chemical processing of nuclear fuels, and in laboratory or industrial processes involving radioactive materials. A program was instituted to study in detail the health hazards associated with such inhalation exposures. Among the radioactive materials studied or under study were isotopes of Ra, Pu, Po, U, Th, Rn, Be, Zr, In, P, Fe, Na, Ir, and Hg (Scope of Work, 1959). This work consisted primarily of inhalation studies involving various animals, although injection studies also were conducted.

In addition, during the atomic weapons testing era, the University of Rochester did some work with fallout fission products. The work involved the long-term effects of external radiation and ingestion of fallout radionuclides such as Sr-90 (Stannard, 1988).

From such observations, safe exposure levels could be ascertained for personnel working in all types of industrial, experimental, and biomedical operations. According to a 1945 document, since September 1943, 200 monkeys, 675 dogs, 20,000 rats, 277,400 mice, 100 hamsters, and 1200 rabbits were studied (Dowdy, 1945). A later study used about 500,000 mice to determine the rate of dominant mutations as a function of dose (URAEP, 1943-1968). Sacrificed animals were often incinerated in the on-site incinerator.

The Alpha Laboratory

The Alpha Laboratory in the Medical School Annex, which began operating in 1952, provided facilities for studying the radiotoxicology of uranium, Ra-226, Rn-222, Po-210, Pu-238, Pu-239, and other radionuclides. Located on the second floor of the B-Wing of the Annex, the facility was designed for handling aerosols of radioactive materials of higher specific activity than uranium, and for protecting investigators from the hazards of working with these radionuclides (Wilson, 1979).

The laboratory was a service facility meant to accommodate a variety of experiments simultaneously or in tandem, as needed. The facility was designed like a hot cell facility with dry glove boxes that were often built to order for the work at hand. The facility was divided into zones based on the level of chemical and radiological materials in use in those areas. The facility was designed to separate “clean” [white], “low risk” [green], and “high risk” [red] areas. Entry into the “red zone” was through a change room, while entry into the “green zone” was through a monitoring station. There was a small space available in the red area for storage of animals with significant body burdens and associated support facilities. The glove boxes were connected to the red areas, but could be operated from the green areas. The basic construction was wood, plywood, and plastic, which could be easily cleaned or replaced (Wilson, 1955).

The ventilation system was designed to minimize the loss of radioactive materials from the glove boxes. This was accomplished by maintaining the glove boxes at a negative pressure; the airflow was always from the low-risk to high-risk areas. The air was exhausted through a stack after passing through a “Cambridge Absolute Filter” and being monitored by a continuous stack monitor. To ensure the maintenance of proper airflow and pressure gradients, a back-up system was in place that was brought into operation by pressure-sensitive sensors. There was also a back-up generator in case of power failure (Wilson, 1955).

Each worker entering the red zone was required to dress in protective clothing and use a self-contained breathing apparatus. Personnel accessing the dry boxes from the green zone did so using neoprene gloves that provided high-tactile sensitivity without compromising integrity. The floor plan for this facility is seen in Figure 5-1. More details about the design of this facility can be found in the report *Physical Plant for a Radioactive Inhalation Laboratory* (Wilson, 1955).

The facility was used primarily for work with polonium and plutonium. The radon experiment was separate, but used some of the same components (Stannard, 1988).

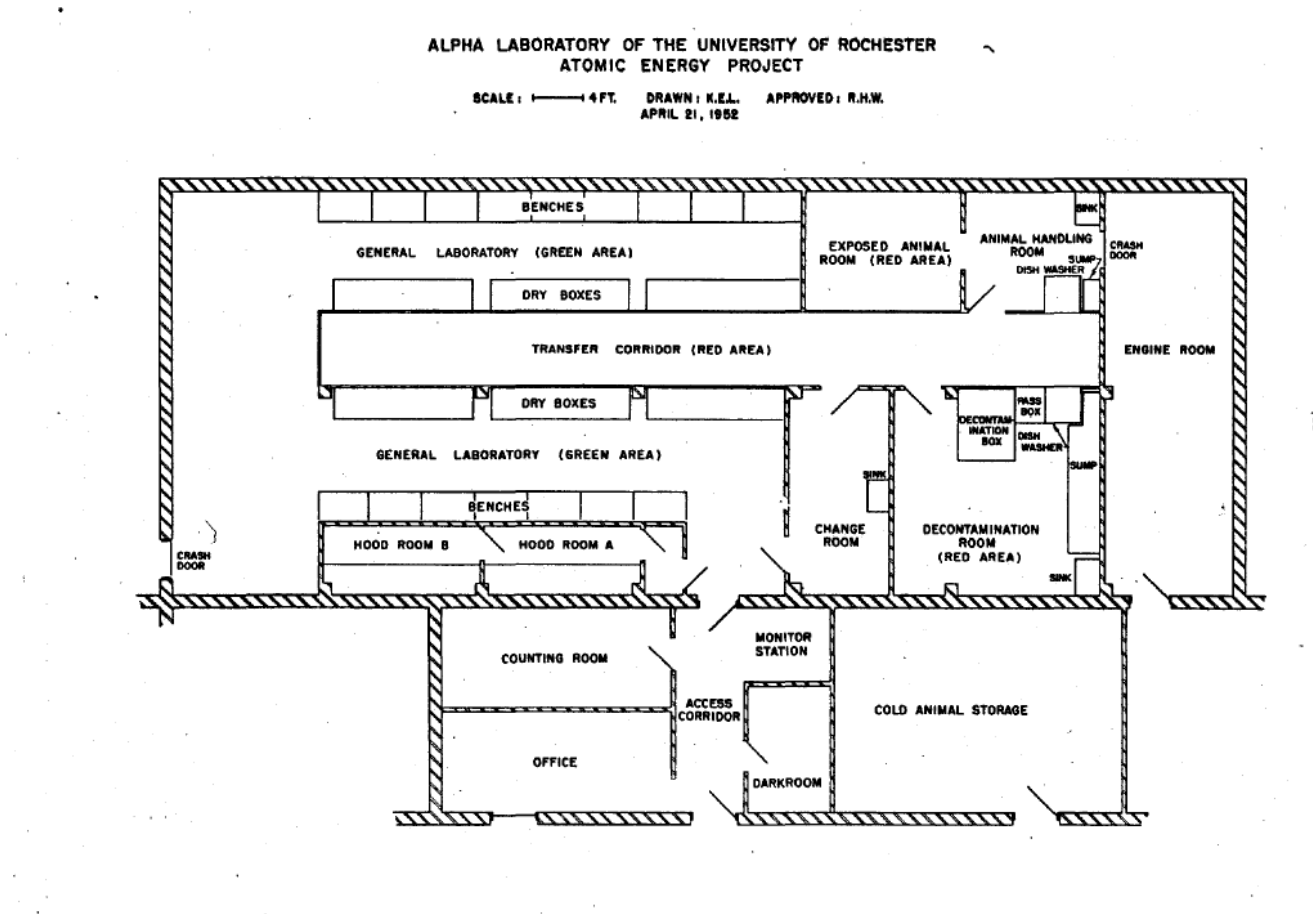

Figure 5-1: University of Rochester AEP Alpha Lab Floor Plan

The Alpha Lab was "mothballed" in October 1968 (Status Report, 1968). In December 1969, a work plan for Alpha Lab decontamination was developed. Residual contamination inventories were estimated at 16 Ci Pu-238, 1 mCi Pu-239, 1 gram Th-228, and 50 mCi Po-208 (Specifications, 1969). In 1971, all Alpha Lab glove boxes were removed and disposed of except for the radium box which served as the radon source for studies with that gas (Wilson, 1979). The total radioactivity was estimated at that time to be 20 Ci, with the principle radionuclide being Pu-238 and minor contributions listed as Pu-239, U-235, Ra-226, and Th-228 (Glove Boxes, 1971).

5.2 Radiological Exposure Sources from AEP Operations

The following subsections provide an overview of the internal and external exposure sources for the University of Rochester AEP class under evaluation.

5.2.1 Internal Radiological Exposure Sources from AEP Operations

There were numerous potential internal exposure sources from AEP operations, the majority of which were associated with the inhalation studies that took place at the facility, especially operations conducted in the Alpha Lab after its construction. Table 5-1 contains an incomplete summary of radioactive materials that were handled, potentially handled, or mentioned in some fashion in various documents associated with University of Rochester AEP operations.

Table 5-1: Potential Sources of Internal Exposure from AEP Operations
(This table spans three pages)

Year	Inventory/Information	SRDB Ref ID
1943		
1944	Request for 25 lbs. of material CAK-4 and 25 grams of TCl_3 (These are believed to be uranium-containing materials)	32185
1945		
1946	Letter requesting 10 mCi of Po-210	30760
1947		
1948	Order for thorium compounds, including 50 lbs. thorium fluoride, 50 lbs. thorium oxalate, 1 lb. thorium metal, and 50 lbs. thorium dioxide	32179
1949	Receipt logs for I-131(curie quantities), Au-198, Ca-45, Be-7, Fe-59, Na-24, P-32, C-14, Co-60, Ba-140, and others	51924
1950	Request for five 3-foot uranium rods, 1/8 inch diameter	32176
	Receipt logs for I-131, Na-24, P-32, S-35, C-14, Be-7, Zr-95, polonium, Y-91, Be-9, Ca-45, Cs-137, and Fe-59	51924
1951	Receipt logs for I-131(curie quantities), Au-198, Ca-45, Be-7, Fe-59, Na-24, P-32, C-14, Co-60, Ba-140, and others	51924
1952	Receipt logs for I-131(curie quantities), Au-198, Ca-45, Be-7, Fe-59, Na-24, P-32, C-14, Co-60, Ba-140, and others	51924
1953	Receipt logs for I-131(curie quantities), Au-198, Ca-45, Be-7, Fe-59, Na-24, P-32, C-14, Co-60, Ba-140, and others	51924
1954	From July through December, 600 mCi I-131 and 90 mCi P-32 delivered to AEP	51978
1955		
1956	Request to add 150 mCi Po-210 nitrate or chloride to AEC Byproduct Material License	51932
	AEC Byproduct Material License: One curie of any material between atomic numbers 3 through 83, in any form	51935
	AEC license: 100 mCi Th-234	52060
	Five-year nuclear material forecast estimates using 100 mCi per year of Pu-239; no projected use of U-233	52488
	50 mg Pu from Los Alamos National Laboratory (LANL) for inhalation program; 50 mCi Po-210 from Mound	52492
	100 mg radium, 31 mCi polonium nitrate, Cm-244 source of unknown activity or form	52489

Table 5-1: Potential Sources of Internal Exposure from AEP Operations
(This table spans three pages)

Year	Inventory/Information	SRDB Ref ID
1957	AEC license: 110 mCi Na-24	51989
	25 Ci tritium procurement limit	51994
	1 mCi Th-234 prepared at ORNL for AEP	52477
	98 mg U-233 from Y-12	52493
1958	Request to increase possession limit of Po-210 from 150 mCi to 1 Ci since higher-level animal exposures will soon be started	51988
	Increase Hg-203 limit to 2 Ci	51991
	2500 kg nat U	51993
	AEC license: 1 Ci Po-210, 25 Ci H-3	51991
	Monthly inventories: 67 lbs UO_2, 540 g thorium nitrate, 2321 g thorium dioxide, 23 lbs uranium nitrate	52095
	Mass balance report: 100 kg normal U, 73 g Pu, 50 g U-233, 65 kg thorium	52131
1959	U of R waste shipment data sheet lists 60 mCi Sr-90, 10+ mCi Pb-210, and much smaller quantities of Ra-226, Po-210, UO2, and Na-22	51904
	Monthly inventories: 67 lbs UO_2, 540 g thorium nitrate, 2321 g thorium dioxide, 23 lbs uranium nitrate	52009
1960	Request to AEC to incinerate 60 mCi I-131, 4.5 mCi C-14, 3 mCi P-32, microcuries of others	52063
	Material balance reports: 85 kg normal U, 22 kg thorium, 75 g plutonium	52287
1961	Proposed incineration limits of 150 mCi I-131, 150 mCi H-3, 150 mCi C-14, 10 mCi of other isotopes except Sr-90 and alpha-emitters	51940
	AEC Source Material License to include 2500 kg of natural uranium in the form of cylindrical slugs canned in aluminum	51945
1962	1962 forecasts: Several pounds of UO_2 to be used, 34 kg normal U projected for 1962, 2 g Pu-239 per quarter, 1 mCi Sr-90 to determine blood and bone uptakes in animals	52494
1963	NY Rad. Material License: 2500 kg nat. U slugs, 3.5 Ci I-131, 550 mCi P-32 soluble phosphate, 1.4 Ci Au-198 colloidal, 3 Ci of any byproduct material atomic number 3 through 83, 34 Ci tritium, 1 Ci unsealed Po-210, 2.5 Ci Hg-203, 100 mCi Th-234 (51983); receipt of 2 g Pu oxide	52388
1964	700 mCi Au-198	52114
1965	500 mCi each of Co-60 and Au-198	52113
	Source and/or Special Material inventories: 0.0239 g U-233, 0.9 g enriched UO_2, 6 lbs depleted UO_2, 6 lbs UO_2, 2277 g ThO_2, 22 lbs uranium nitrate. These monthly inventory sheets for 1965 indicate no usage other than about 0.008 g U-233.	52204
	2.7 mCi stock PuO_2 (1.3 ml) in dry box, 0.5 mCi Pu-239 in Decon Room, 0.4 mCi Pu-239O_2 in dry box in various dilutions, 0.5 mCi Pu-238 in Blower House, 16 Ci Pu-238O_2 in dry box, 17 Ci Pu-238O_2 in inhalation chamber dry box	52207
1966		
1967	D&D of Alpha Lab 30+ Ci Pu-238, personnel contamination incident described involving several individuals, positive nose swipes, elevated air contamination measured, area and object contamination exceeding 100,000 c/m long-lived alpha-emitter	51985
	Zero forecast use of Pu-238, Pu-239, or U-233 for the year	52454
1968	Alpha lab mothballed	51709
	Eleven glove boxes in Alpha Lab are described as being contaminated with radium, Po-210, Pu-238 (15 Ci), Th-228, and Pu-239	51709
1969	In work plan for Alpha Lab decontamination, residual inventory estimated at 16 Ci Pu-238, 1 mCi Pu-239, 1 gram Th-228, and 50 mCi Po-208	51745
	AEC letter talks about the loan of 20 mg U-236 and 20 mg Pu-242 in the form of targets used for reaction studies with the Van de Graaff accelerator	31858

Table 5-1: Potential Sources of Internal Exposure from AEP Operations (This table spans three pages)		
Year	**Inventory/Information**	**SRDB Ref ID**
1970	Radioactive material license application to add 30 Ci Kr-85 for inhalation studies	52158
	Zero forecast use of Pu-238, Pu-239, or U-233 for the year	52365
1971	Special shipping permit for transport of glove boxes estimates total activity at 20 Ci, with principal nuclide as Pu-238 and minor contributions from Pu-239, U-235, Ra-226, and Th-228; AEC material status report: 7 kg normal U, 72 g plutonium, 1.4 g Pu-238, and 2 kg thorium	52347
	Zero forecast use of Pu-238, Pu-239, or U-233 for the year	52365

5.2.2 External Radiological Exposure Sources from AEP Operations

External radiation exposure sources at the AEP consisted of radiation-producing machines, such as X-ray machines and accelerators, and a variety of radioactive materials.

5.2.2.1 Photon

The sources of external radiation at the AEP included a number of radiation-generating devices and radiation sources. The project had assorted X-ray generating machines used for various medical and industrial applications. These included a million-volt X-ray machine, a General Electric 1000 kVp Industrial X-ray unit, two General Electric 300 kVp Maxitron Therapy units, a Picker Zephyr Superficial Therapy unit maximum 120 kVp, and two high-intensity 50 kVp X-ray units (Description of Facilities, 1971).

The AEP also had two Co-60 irradiators. One was a J. L. Shepherd 6000 Ci unit designed for irradiating small samples. The second irradiator was a 10,000 Ci irradiator manufactured by ICN Corp. The unit had multiple sources consisting of three 30 Ci, three 300 Ci, and three 3000 Ci sources. In addition to the large fixed gamma sources, there were numerous smaller gamma sources used for assorted experiments and projects, including instrument calibration and checks (see Table 5-1). A significant source of gamma exposure was radon progeny from the radon chamber in the Alpha Laboratory (Personnel Protection, 1955).

5.2.2.2 Beta

Major potential sources of beta dose would have included the Pa-234m daughter of U-238. Uranium was used extensively at the AEP over the years. Another major source would have been P-32, which was also commonly used at the Project. There were numerous other radionuclides that likely contributed to beta dose to a lesser extent (see Table 5-1).

5.2.2.3 Neutron

The AEP machine-generated neutron sources were two cyclotrons (27" and 130") and a Texas Nuclear Neutron Generator (DT) with a maximum output of 10^9 n/s – 14 MeV neutrons (Description of Facilities, 1971; URAEP, 1943-1968). The project also used alpha/beryllium neutron sources (e.g., Pu-Be and Ra-Be) (Personal Communication, 2008a).

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

The following subsections provide an overview of the state of the available internal and external monitoring data for the University of Rochester AEP class under evaluation.

6.1 Available University of Rochester AEP Internal Monitoring Data

Available internal monitoring data for the University of Rochester Atomic Energy Project is sparse. There are various internal monitoring datasets available covering different radionuclides for different time periods; however, the data are not sufficiently comprehensive to support bounding internal dose. Although documentation discusses a bioassay program for different radionuclides, the available bioassay data are limited and inadequate for making reasonable estimates of worker intakes. There are almost no available area monitoring data that could be used to bound internal dose.

The existence of a program to monitor worker intakes is described in various memos and reports. The earliest available evidence of monitoring that would be useful in estimating internal dose is a 1944 memo that includes the results from dust samples collected at the Bronson Avenue location in areas where feed was mixed with uranium. The results are reported in $\mu g/m^3$ of X dust. The memo summarizes the results by saying they were slightly above the tolerance level of 150 $\mu g/m^3$. There is a 1949 AEC New York Operations Office data report for uranium in urine that provides ten sample results determined by fluorimetry (in mg/l) (Urine Results, 1949). A 1952 letter from Dr. Love to Dr. Mermagen discusses the methods used by Brookhaven National Laboratory to analyze for Po in urine (Love, 1952). This method is further discussed in the AEP report, *Polonium Urinalysis*, which states that routine analysis of polonium began in January 1953 (Polonium Urinalysis, 1957). This report discusses the collection and analysis methods, the sampling frequency, and the types of individuals covered by this bioassay program. It also provides a summary of results for the period of January 1 to December 31, 1956.

A detailed description of internal monitoring is provided in the 1955 AEP document, *Personnel Protection in the Radioactive Inhalation Program* (Personnel Protection, 1955). This report summarizes the radiation protection practices employed at the special laboratory (Alpha Lab) where inhalation-exposure studies used alpha- and beta-emitting isotopes. It specifies a maximum allowable airborne concentration of $5x10^{-12}$ µCi/ml for alpha emitters as well as the maximum airborne concentrations for different isotopes that would result in a dose of 0.3 rem/week to the critical organ. The report also discusses the requirements of the air sampling program, the urine analysis program, the hematological monitoring program, and the use of personal protective equipment.

A 1961 memo documents an air sample collected in the Hot Lab (Alpha Lab) in order to monitor for alpha and beta activity (Hot Lab, 1961). A 1970 memo discusses bioassay samples for individuals involved with the removal of glove boxes from the Alpha Lab. The memo lists the individuals who may be involved and the frequency and type of sampling needed (Pu Analyses, 1970).

Table 6-1 summarizes the currently available internal dosimetry-related data.

Table 6-1: Available Internal Monitoring Data (1943 to 1971)

Sample Type	Sample Date	No of Samples	Comment	SRDB Ref ID
Uranium in air	March 1944	Six air samples	Dust samples in Bronson Avenue Facility.	5909
Uranium in urine	1949	Five urine samples	Single samples from five individuals.	9249
None	1952	---	Letter from University of Rochester stating intent to start own bioassay program (Po-210 and Pu in urine) and asking for method.	53340
Alpha Lab bioassay program description	March 23,1955	---	General information about bioassay for Alpha Lab.	52208
Polonium in urine	1957	92 urine samples (summary data only)	Polonium method report states that Po-210 analyses started at University of Rochester in 1953. Report contains some summary data for 1956 (pdf p. 16); 92 analyses done in 1956.	31935
Hot Lab air sample for alpha emitters	June 22, 1961	One air sample	Memo describing air sample.	52212
I-131 analysis	1962	Seven urine samples	Special reports for one person.	52213
Plutonium bioassay request	Sept. 1970	---	Request for baseline and then weekly 24-hr. samples from 15 individuals removing glove boxes from the Alpha Lab.	51716

6.2 Available University of Rochester AEP External Monitoring Data

Available external monitoring data for the University of Rochester Atomic Energy Project can be grouped in two general categories: (1) individual exposure data; and (2) summary data for a group or department covering a specific time period.

The earliest external monitoring data are from 1947 and documented in a memo dated 1956 (Exposures, 1956). The memo lists all whole-body radiation exposure for all personnel working at the University of Rochester, not just AEP personnel. The data are summarized by group and sorted into dose levels for the years 1947 to 1956.

There are some external monitoring data on Individual External Dose Cards for 1952, but the data are sparse (Dose Cards, various years). Individual external monitoring data for AEP employees are available starting in 1953. The available data for 1953 are just for the second quarter, including neutron data for the cyclotron personnel (Bausa, 1953; Exposures, 1953). Additional data for this time period may be on the External Exposure cards.

Brookhaven National Lab (BNL) provided an external dosimetry service from 1953 to 1971. Dosimeters were exchanged bi-weekly until 1963, when the exchange became quarterly. Individual data are not available on the BNL forms for all time periods. Some of the data not recorded on the forms includes the second half of 1957, 1958, 1959, 1960, and 1962. For 1961, data on the BNL forms are available for the first three quarters. The data not available on the forms for each monitoring period may be available on the External Dose Cards as an annual total (or a recorded less-than value). Annual dose summaries provided to regulators (AEC/DOE) are available from 1958 through the end of the covered period (1986). The data in these summaries are broken down by the number of individuals who had a dose in a certain range. Beginning in 1969, some Eberline dose reports are seen (see Table 6-2); however, there are no identifiers so the type of dosimetry data is unclear.

Table 6-2 summarizes the currently available external dosimetry-related data.

Table 6-2: Available External Monitoring Data (1947 to 1971)
(This table spans four pages)

Dates	No of Persons / Pages of Data	Frequency	Comment	SRDB Ref ID
1947-1956	Annual summary data by division	NA	Memo dated 10-15-56 summarizing exposure data by year and department. Does not contain individual data.	52833
1950-1960	121; handwritten logbook entries by name	Bi-monthly external exposure records	Handwritten logbook; hard to decipher; from all Univ. of Rochester departments	58764
03/1953	One page of beta/gamma and neutron badges (all visitor)	Bi-Monthly	Brookhaven National Laboratory (BNL) neutron badge service for Univ. of Rochester start-up (page of visitor badge readings)	54047
Apr to Jun 1953	Five pages of individual data with names	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54048
Jun to Dec 1954	71 pages, by name; also visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54049
1954	71 pages of individual dose cards	Dose cards	From BNL; also includes 21 pages of University of Iowa data.	53947
Jul to Dec 1954	13 pages, by name, also visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54051
Jan to Dec 1955	107 pages, by name, also visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54050
Jan to Dec 1955	34 pages, by name, also visitor badges	Bi-monthly dose data	BNL forms labeled Rochester S.C. (Small Cyclotron); also some handwritten pages	54052
1956	Five pages	Monthly	Film badge for large cyclotron	52840

Table 6-2: Available External Monitoring Data (1947 to 1971)
(This table spans four pages)

Dates	No of Persons / Pages of Data	Frequency	Comment	SRDB Ref ID
1956	105 pages names/visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54045
1956	28 pages; lists names and visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester S.C. (Small Cyclotron)	53990
Jan to Jun 1957	49 pages; has names/visitor badges	Bi-monthly dose data	BNL forms with film badge data for Univ. of Rochester	54046
Jan to Jun 1957	15 pages with names	Bi-monthly dose data	BNL forms, film badge data for Univ. of Rochester S.C. (Small Cyclotron)	53991
1958	139	Annual Summary	Only summary data; 133 below 1 rem	51824
1959	80 (cyclotron); 112 (AEP)	Annual Summary	Only summary data; 111 below 1 rem	51827
1959	Exposure record for one individual	Special Report	Also includes blood counts	52209
1960	143 (AEP), 78 (cyclotron?)	Annual Summary	Summary data only	51829
1952-1980	1059 pages; about 3177 individuals	Film badge data	Pages of individual dose cards for entire Univ. of Rochester (not just AEP); contains "less than" annual summary data	51689
1956-57	Handwritten dose data, some for Univ. of Rochester	Bi-weekly data	Eight pages of handwritten dose info from BNL with doses either from other sites or incurred by workers from other sites; Not clear; some are from Univ. of Rochester. Year only on cover form.	54042
1961	217 (AEP); 90 (cyclotron)	Annual Summary	Summary data only	51830
Jan - Sep 1961	46 handwritten pages by name	external exposure records (bi-monthly)	Handwritten logbook; hard to decipher; from all Univ. of Rochester departments	58765
1962	159 (AEP); 487 all of Univ. of Rochester	Annual Summary	Summary data form sheet; all of Univ. of Rochester included	51831
1963	176 (AEP); 520 all of Univ. of Rochester	Annual Summary	Summary data; has number of persons monitored by division in back; also has list of high exposures (handwritten).	51832
1963	65 pages; entries by name	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location	58766
1963	74 pages; log entries by name	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location	58767
1964	192 (AEP); 284 total reported (not all of Univ. of Rochester)	Annual Summary	Summary data only	51834

Table 6-2: Available External Monitoring Data (1947 to 1971) (This table spans four pages)				
Dates	**No of Persons / Pages of Data**	**Frequency**	**Comment**	**SRDB Ref ID**
1964	191 pages; handwritten log entries by name/dept; some BNL dose letters	Quarterly mostly	Forms grouped by department/location	58768
1965	190 (AEP); 632 (all of Univ. of Rochester)	Annual Summary	Has some detail attached (quarterly by dept and person; also high exposures by name)	51835
1965	230 pages; handwritten log entries; some BNL dose letters	Quarterly mostly	Forms grouped by department/location	58769
1966	261 (AEP); 884 (all of Univ. of Rochester)	Annual Summary	Summary data only	51838
1966	291 pages; handwritten log entries; some BNL dose letters	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location	58770
1967	277 (AEP); 975 (all of Univ. of Rochester)	Annual Summary	Summary data only	51841
1967	12 page summary for 1967	Annual Summary	Divided up by section	51874
1967	321 pages; handwritten log entries; some BNL dose letters	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location	58771
1968	299 (AEP); 1063 (all of Univ. of Rochester)	Annual Summary	More detail attached; number monitored by division and highest exposures	51871
1968	13 page summary for 1968	Annual Summary	Annual summary divided by department	51875
1968	285 pages; log entries and dose cards; some BNL dose letters,	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location; some lost dosimeter documentation included	58772
1968	83 pages; log entries; some BNL dose letters	Quarterly and annual totals with some bi-monthly entries	Forms grouped by department/location	58773
1968	Nine pages; Nuclear Chicago report	Annual totals and quarterly results	No identifiers; only badge numbers; film report	58780

Table 6-2: Available External Monitoring Data (1947 to 1971)
(This table spans four pages)

Dates	No of Persons / Pages of Data	Frequency	Comment	SRDB Ref ID
1969	388 (AEP); 1233 (all of Univ. of Rochester)	Annual Summary	Summary data only	51872
1969	388 (AEP); 1233 (all of Univ. of Rochester)	Addition to Annual Summary	1969 exposure summary by department; has dose ranges and highest exposures	51876
1969	306 pages; log entries; some BNL dose letters	Bi-monthly, some quarterly	Forms grouped by department/location	58774
1969	98 pages; log entries	Bi-monthly, some quarterly	Forms grouped by department/location	58775
1969	Eight pages; Eberline film badge report	Data covers one month	No identifiers; only badge numbers	58781
1970	268 (AEP); 454 (AEP + Cyclotron)	Annual Summary	1970 exposure summary by department with dose ranges, highest exposures	51870
1970	136 pages; log entries	Mostly quarterly	Forms grouped by department/location	58776
1970	205 pages; log entries	Quarterly mostly	Forms grouped by department/location	58777
1970	13 pages; Eberline film badge report	Quarterly with annual total	No identifiers; only badge numbers	58782
1971	274 (AEP)	Annual Summary	1971 exposure summary	51873
1971	14 page summary for 1971	Annual Summary	Exposure summary by department with dose ranges.	52005
1971	343 pages; handwritten entries	Bi-monthly, some quarterly	Forms grouped by department/location	58784
1971	15 pages, Eberline summary film badge report	Quarterly with annual total	Forms grouped by department/location	58783

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

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

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. This approach is discussed in OCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00140 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of University of Rochester AEP Data

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

7.1.1 Internal Monitoring Data Pedigree Review

The available internal monitoring data for the time period under investigation in this evaluation report (September 1, 1943 through October 30, 1971) are summarized in Section 6.1 and Table 6-1. These data are extremely limited and certainly insufficient in quantity to adequately represent the class under evaluation. In terms of data pedigree, the data that do exist are legible, well-documented, notated with the appropriate units, identified by radionuclide, and typical of what would be found at other facilities for the time period under evaluation. A more comprehensive data pedigree evaluation commensurate with the purposes of this report would involve comparing and validating larger datasets for representativeness, consistency, job categories, and monitoring locations. However, the limited, incomplete, and sporadic nature of the available internal monitoring data do not allow for this depth of analysis.

7.1.2 External Monitoring Data Pedigree Review

The available external dosimetry data are summarized in Section 6.2 and Table 6-2. Although there is evidence of external personnel monitoring conducted as early as 1947 (Exposures, 1956), individual dose records are not readily available until 1952 (Dose Cards, various years; Dose Cards, 1980s). Such records are in the form of dose cards (Dose Cards, various years), annual summary reports, and individual film badge records; they include photon, beta, and neutron monitoring results.

In light of the evaluation conclusions reached in this report regarding internal dose reconstruction feasibility for the University of Rochester AEP, NIOSH did not perform an extensive external data sufficiency and pedigree evaluation for external data for the period under evaluation. Although no specific conclusions were drawn about the external data and the ability to bound dose for the class under evaluation, NIOSH has drawn following general conclusion: the external data may be used on a case-by-case basis for the purpose of partial dose reconstructions.

7.2 Evaluation of Bounding Internal Radiation Doses at the AEP

The principal source of internal radiation doses for members of the class under evaluation was airborne contamination associated with animal inhalation studies. The primary alpha emitters studied were uranium, polonium, radium, and plutonium. Major efforts were also devoted to determinations of toxicities of radon, thorium, Sr-90, and P-32. Other radionuclides were also studied. 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 Evaluation of Bounding Process-Related Internal Doses

Despite documented evidence that internal monitoring programs were in place for various operations, available urinalysis and air monitoring data (presented in Section 6.1) do not sufficiently represent the class evaluated in this report. The available internal monitoring data consist of a single set of six uranium-in-air monitoring results from 1944, five uranium-in-urine results from 1949, polonium-in-urine summary data from 1956 (92 samples), and I-131 bioassay data for a single individual in 1962. No other internal monitoring data have been found for the time period under evaluation. These few data do not sufficiently represent the class.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

The ambient environmental internal dose will not be evaluated because NIOSH has obtained no information associated with environmental ambient monitoring for the site.

7.2.3 Methods for Bounding Internal Dose at University of Rochester AEP

The available University of Rochester AEP data are insufficient to support establishing a bounding dose estimate for the radionuclides of concern. No alternative methodologies for bounding internal dose have been identified.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

Available evidence indicates that routine bioassay programs were in place throughout the evaluation period, which validates, at least from the perspective of the health physics professionals responsible at the time, that bioassay programs were warranted. However, the resulting data from those programs are generally unavailable. The available data are summarized in Table 6-1. NIOSH considers the few bioassay data, summarized above, to be insufficient for purposes of bounding intakes for the numerous radionuclides that were extensively used at the AEP during the time period under evaluation in this report. Therefore, NIOSH has concluded that it is not feasible to reconstruct or bound internal dose for the class of workers under evaluation in this report.

7.3 Evaluation of Bounding External Radiation Doses at the AEP

The principal sources of external radiation doses for members of the evaluated class were photon, beta, and neutron radiation. X-ray generating devices, including the “Million Volt” X-ray machine, were used extensively for controlled animal exposures. Photon and beta radiation doses would have also resulted from handling, and being in the vicinity of, the many radioactive materials used in the facility. Neutron-emitting sources included two cyclotrons, a 14-MeV neutron generator (DT), and alpha-beryllium sources (e.g., Po-Be and Ra-Be).

As discussed in Section 7.1.2, due to NIOSH’s finding regarding internal dose (inability to bound), the following subsections are included in the event that partial dose reconstructions are deemed necessary.

7.3.1 Evaluation of Bounding Operations-Related External Doses

Prior to 1952, although summary data are available, individual external dosimetry records are nonexistent. It is therefore unlikely that operations-related doses may be bounded or reconstructed with sufficient accuracy before 1952.

Since external dosimetry data are generally available from 1952 through the end of the evaluated period (October 31, 1971), it is likely that external dose reconstructions may be performed, if deemed necessary from 1952 through 1971. Such data would be evaluated for usability on a case-by-case, as needed basis, using NIOSH established protocols for dose reconstructions.

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

Environmental monitoring data are unavailable for the time period under evaluation. However, environmental dose is accounted for, and bounded by, existing external personnel monitoring data.

7.3.3 AEP Occupational X-Ray Examinations

There are indications that AEP personnel were required to have medical x-ray examinations (X-ray Invoices, 1943-1947). Dose from occupationally-required medical X-rays should therefore be assumed to have occurred in the absence of data to the contrary.

7.3.4 Methods for Bounding External Dose at University of Rochester AEP

Although NIOSH likely has sufficient data to support bounding external dose for the class under evaluation, an exhaustive evaluation of this topic is unwarranted for the purposes of this report because NIOSH is concluding that it cannot determine bounding internal doses for the class due to a lack of internal monitoring data.

Medical X-ray Dose

Medical dose for AEP workers can bounded using the assumptions and applicable protocols in the complex-wide Technical Information Bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006.

7.3.5 External Dose Reconstruction Feasibility Conclusion

Since NIOSH has found that it is unable to bound internal dose, an exhaustive evaluation of feasibility of external dose reconstruction was not performed for the purposes of this report. However, partial dose reconstructions may be feasible, on a case-by-case basis, using available personnel monitoring data. Dose from medical exams are feasible using the methodologies outlined in ORAUT-OTIB-0006.

7.4 Evaluation of Petition Basis for SEC-00140

The petition basis provided in SEC-00140 is that radiation exposures and radiation doses potentially incurred by members of the proposed class were not monitored either through personal monitoring or through area monitoring. In support of this basis, the petitioner provided an affidavit which included the following statement: *"To the best of my knowledge I was never monitored for radiation exposure for my work in the radiation area"* (Affidavit, 2009).

NIOSH concurs with the petitioner's statement in that NIOSH has been unable to find any evidence of personal or area monitoring for the petitioner-proposed time period, September 1, 1943 through June 19, 1945. In addition, the evaluation period was extended to October 30, 1971, due to a lack of internal monitoring data.

7.5 Summary of Feasibility Findings for Petition SEC-00140

This report evaluates the feasibility for completing dose reconstructions for employees at the University of Rochester AEP from September 1, 1943 through October 30, 1971. 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.

Personal monitoring and/or area monitoring data are not always required to bound doses at a given facility. However, if these monitoring data are not available, NIOSH must have detailed source term and process information to develop a sufficiently accurate exposure model. NIOSH has determined that it does not have adequate internal or external monitoring data for members of the evaluated class from September 1, 1943 through December 31, 1952. Internal monitoring data are insufficient for reconstructing or bounding dose for any of the evaluation period, September 1, 1943 through October 30, 1971. NIOSH has also determined that the available source term and process information are inadequate to bound internal dose in the absence of internal monitoring data. NIOSH has therefore concluded that internal dose reconstruction is not feasible for the University of Rochester AEP from September 1, 1943 through October 30, 1971.

Table 7-1 summarizes the results of the feasibility findings at the University of Rochester AEP for each exposure source during the time period September 1, 1943 through October 30, 1971.

Table 7-1: Summary of Feasibility Findings for SEC-00140
September 1, 1943 through October 30, 1971

Source of Exposure	Reconstruction Likely Feasible[1]	Reconstruction Not Feasible
Internal		**X[2]**
External		
- Gamma	X (beginning in 1953)	X (pre-1953)
- Beta	X (beginning in 1953)	X (pre-1953)
- Neutron	X (beginning in 1953)	X (pre-1953)
- Occupational Medical X-ray	X	

PARTIAL DOSE RECONSTRUCTION INFORMATION:

[1] EXTERNAL: Since this evaluation concludes that internal dose cannot be estimated for the entire evaluation period, an exhaustive examination of the feasibility of external dose reconstruction is unwarranted. The topic of external dose reconstruction is included in this table for completeness and for consistency with other SEC evaluation reports. Should partial dose reconstructions be necessary for future claimants, external dose will be evaluated on a case-by-case basis.

[2] INTERNAL: Although NIOSH has determined that it is not feasible to reconstruct internal doses for all cancers and all radionuclides, it may be feasible, on a case-by-case basis, to perform partial dose reconstructions when specific internal dose data exist.

As of August 12, 2009, a total of seven claims have been submitted to NIOSH for individuals who worked at the University of Rochester AEP. One claim, although covered by the class definition evaluated in this report, was pulled by the Department of Labor because the claimant qualified for an SEC class established for another site. The remaining six are covered by the class definition and a dose reconstruction has been completed for one of these individuals; five are still active.

8.0 Evaluation of Health Endangerment for Petition SEC-00140

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

NIOSH has obtained numerous documents containing information about the varied studies involving the use of unsealed radioactive materials at the University of Rochester AEP. NIOSH has concluded that the potential for internal radiation dose existed for workers at the site. NIOSH has also identified considerable evidence that internal monitoring programs existed during the time period under evaluation in this report. NIOSH has not, however, been able to locate a sufficient quantity of those monitoring results for the purpose bounding potential intakes for members of the class. 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. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is required.

9.0 Class Conclusion for Petition SEC-00140

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 employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the University of Rochester Atomic Energy Project in Rochester, New York, from September 1, 1943 through October 30, 1971, 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 expanded to include all workers rather than only laboratory technicians, as proposed by the petitioner. The class was also

extended from the petitioner-proposed end date of June 19, 1945 to October 30, 1971 for reasons indicated in Section 3.2 of this report.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database (SRDB), for information relevant to SEC-00140. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

10.0 References

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000;* Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p 22,296; May 2, 2002; SRDB Ref ID: 19391

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

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

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

Affidavit, 2009, Affidavit by *[name redacted] submitted in support of SEC Petition SEC-00140, University of Rochester Atomic Energy Project;* March 3, 2009; OSA Ref ID: 108366

Bausa, 1953, Letter discussing neutron monitoring results, to G. J. Bausa (University of Rochester Atomic Energy Project) from F. P. Cowan (Health Physics Division, Brookhaven National Laboratory); April 8, 1953; SRDB Ref ID: 54047

Description of Facilities, 1971, *Description of Facilities and Types of Sources or Radiation Producing Machines*, unknown author; University of Rochester Atomic Energy Project; date on hand-drawn floor diagram: May 13, 1971; SRDB Ref ID 52358

Dose Cards, 1980s, University of Rochester External Radiation Exposure History, University of Rochester; various monitored personnel names and dates in the 1980s; SRDB Ref ID: 51976

Dose Cards, various years, Individual external dose exposure cards for monitored employees, various names; University of Rochester Atomic Energy Project; various dates; SRDB Ref ID: 51689

Dowdy, 1945, *The Rochester Story of the Manhattan Project*, A. H. Dowdy, University of Rochester Library; 1945; SRDB Ref ID: 32195

Exposures, 1953, Handwritten log of exposures at various AEC sites, including University of Rochester; unknown author; various personnel, site locations, and dates; SRDB Ref ID: 54042

Exposures, 1956, *Whole-Body Radiation Exposures* [also includes external monitoring data], memorandum to Director, Division of Biology and Medicine, U.S. Atomic Energy Commission from H. Mermagen, University of Rochester; October 15, 1956; SRDB Ref ID: 52833

Glove Boxes, 1971, *Disposal of Glove Boxes – Shipping Container Permit*, letter to R. W. Wilson (University of Rochester AEP) from A. L. Kranz (U. S. Atomic Energy Commission); March 18, 1971; SRDB Ref ID: 51750

Hot Lab, 1961, *Survey, Air Samples*, intramural correspondence to R. Hayes from H. Mermagen; University of Rochester; June 22, 1961; SRDB Ref ID: 52212

Love, 1952, Letter regarding procedures used for Po analysis at Brookhaven, to H. Mermagen (University of Rochester) from R. A. Love (Brookhaven National Laboratory); October 10, 1952; SRDB Ref ID: 53340

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

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

Personal Communication, 2008a, *Personal Communication with Health Physicist*; Telephone Interview by ORAU Team and NIOSH; June 17, 2008; SRDB Ref ID: 45530

Personal Communication, 2008b, *Personal Communication with AEP Graduate Student*; Telephone Interview by ORAU Team and NIOSH; June 10, 2008; SRDB Ref ID: 45531

Personal Communication, 2008c, *Personal Communication with Lab Technician*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45533

Personal Communication, 2008d, *Personal Communication with Chemist*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45535

Personal Communication, 2008e, *Personal Communication with Medical Researcher*; Telephone Interview by ORAU Team and NIOSH; June 10, 2008; SRDB Ref ID: 45536

Personal Communication, 2008f, *Personal Communication with Health Physicist*; Telephone Interview by ORAU Team and NIOSH; June 9, 2008; SRDB Ref ID: 45538

Personal Communication, 2008g, *Personal Communication with Radiation Safety staff (two individuals)*; Telephone Interview by ORAU Team and NIOSH; July 1, 2008; SRDB Ref ID: 47123

Personnel Protection, 1955, *Personnel Protection in the Radioactive Inhalation Room*, G. H. Whipple, J. N. Stannard, G. J. Miller, M. L. Ingram, and T. T. Mercer; UR-310; University of Rochester Atomic Energy Project, Medical Division; March 23, 1955; SRDB Ref ID: 52208

Polonium Urinalysis, 1957, *Polonium Urinalysis*, C. A. Krebs and G. H. Whipple; UR-501; University of Rochester Atomic Energy Project, Medical Division; August 7, 1957; SRDB Ref ID: 31935

Pu Analyses, 1970, *Urinalyses for Pu*, intramural correspondence to H. Mermagen from R. H. Wilson; University of Rochester; September 22, 1970; SRDB Ref ID: 51716

Scope of Work, 1959, *University of Rochester Atomic Energy Project Scope of the Work*, rough draft, various authors; University of Rochester Library; date unclear, but likely1959; SRDB Ref ID: 52752

Specifications, 1969, *Specifications for Removal, Packaging and Disposal of Radioactively Contaminated Glove Boxes and Radioactive Waste Accumulation from the Alpha Inhalation Laboratory*, University of Rochester Atomic Energy Project, Department of Radiation Biology and Biophysics; October 24, 1969; SRDB Ref ID: 51745

Stannard, 1988, Radioactivity and Health: A History, J. N. Stannard (University of Rochester); prepared for the U.S. Department of Energy by Pacific Northwest Laboratory; DOE/RL/01830-T59; October 1988; SRDB Ref ID: 22738

Status Report, 1968, Status Report on Alpha Lab Dry Box Disposal, intramural correspondence to A. Rothstein and W. F. Neuman from H. Mermagen; University of Rochester; October 17, 1968; SRDB Ref ID: 51709

URAEP, 1943-1968, *URAEP 1943-1968*, various authors; likely part of, or a precursor to, *A Brief History of the University of Rochester Atomic Energy Project from 1943-1968*, which was edited H. A. Blair; University of Rochester Library; date unclear but likely 1968; SRDB Ref ID: 51971

Urine Results, 1949, Urine sample results report, U. S. Atomic Energy Commission, New York Operations Office, Medical Division; September 9, 1949; SRDB Ref ID: 9249

Wilson, 1955, Physical Plant for a Radioactive Inhalation Laboratory, R. H. Wilson, W. F. Neuman, A. Rothstein, J. K. Scott; University of Rochester Atomic Energy Project; UR-302; November 22, 1955; SRDB Ref ID: 31930

Wilson, 1979, *Final Decommissioning of the University of Rochester Alpha Laboratory*, R. H. Wilson, W. D. Gregory, H. D. Maillie; Department of Radiation Biology and Biophysics, The University of Rochester School of Medicine and Dentistry; December 12, 1979; SRDB Ref ID: 51721

X-ray Invoices, 1943-1947, Invoices for X-ray services at Strong Memorial Hospital, University of Rochester; various dates for various personnel from 1943 to 1947; SRDB Ref ID: 30707

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for University of Rochester AEP

Data Capture Information	Data Captured Description	Date Completed	Uploaded
Primary Site/Company Name: University of Rochester Atomic Energy Project; DOE 1943-1986 Other Site Names: University of Rochester resources that were searched: Radiation Safety Office/Unit, University of Rochester Medical School Miner Library, including the Joe Howland Papers collection, the Rush Rhees Library Atomic Energy Project collection, Physical Plant Department, Human Resources Department, Occupational Medicine Department, and the University Health Service	Annual aggregate exposure summary reports, dose record cards, Landauer film badge reports, radioactive material inventories, accountability, transfers, licensing documentation, medical school annex surveys, limited bioassay results, research reports, quarterly reports, dosimetry information, and documented communication with the university's Radiation Safety Officer, confirming that the Human Resources Department, the Occupational Medicine Department, and the University Health Service do not and did not maintain dosimetry records.	08/14/2009	521
State Contacted: New York State Department of Environmental Conservation	D&D surveys, investigation of alleged radioactive waste burial, process information, and inventory records.	03/07/2007	15
CDC Interlibrary Loan	Radiation safety in the Manhattan Project.	04/01/2008	1
Claimant	FOIA request for University of Rochester medical records.	04/18/2005	1
Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	04/15/2008	0
Department of Labor/Paragon	Niagara Falls area documents with University of Rochester references.	12/30/2008	22
DOE Brookhaven National Laboratory (BNL)	Discussion of urinalysis techniques.	10/21/2008	1
DOE Chicago Operations Office	Verification that the Chicago Ops Office does not hold University of Rochester contract closeout files.	05/10/2007	1
DOE Germantown	Inspections and histories of thorium processing operations, beryllium hazards and controls, advisory committee for biology and medicine meeting minutes, and thorium accountability.	06/11/2003	4
DOE Hanford Declassified Document Retrieval System (DDRS)	Monthly irradiation processing report and analysis of airborne radioactivity and limits.	10/17/2008	3
DOE Legacy Management Considered Sites	No relevant documents identified.	05/30/2008	0
DOE Legacy Management - Grand Junction	Tonawanda reports, survey plans, and a background report.	04/14/2009	8
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	U and Th metabolism and excretion, respiratory studies and experiments, breath measurements, reports of health and epidemiological meetings, early NYOO health and safety reports and meetings, proceedings of a bio-assay and analytical chemistry meeting, production report, process knowledge interview, and a proposal for an epidemiology study.	11/26/2008	92

Table A1-1: Data Capture Synopsis for University of Rochester AEP			
Data Capture Information	**Data Captured Description**	**Date Completed**	**Uploaded**
DOE Los Alamos National Laboratory (LANL)	Process knowledge interview.	12/06/2007	1
DOE Oak Ridge Operations Vault	Film badge results.	03/30/2007	1
DOE OpenNet	Quarterly reports regarding metabolic and inhalation studies, status reports, and interviews regarding human radiation experiments.	08/31/2009	84
DOE OSTI Energy Citations	Descriptions of research being conducted and early methodology for establishing maximum permissible dose levels.	04/15/2008	4
DOE OSTI Information Bridge	Quarterly reports, description of hazards in arc melting thorium, and human radiation experiments oral histories.	06/02/2009	15
Environmental Measurement Laboratory (EML) Library	An IH and medical survey of a thorium refinery using University of Rochester research as a reference.	02/14/2005	1
Google	Interviews regarding human radiation experiments and a 1963 aerosol research paper presented at the HP meeting.	04/23/2008	14
Kansas City (Lee's Summit) Federal Records Center	Dosimetry reports.	10/16/2008	13
NARA - Atlanta	Material transactions, WWII personnel assignments, research proposals, progress reports, dosimetry services, accountability reports, breath samples, and litigation documents.	06/20/2008	86
NARA - College Park	Request made to access records.	In Process	0
NARA - Kansas City	Historical information.	08/14/2008	3
National Academies Press (NAP)	No relevant documents identified.	04/15/2008	0
National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	04/23/2008	0
NRC Agencywide Document Access and Management (ADAMS)	NRC FUSRAP sites review.	04/15/2008	1
Oak Ridge Associated Universities (ORAU) Team	Process knowledge interviews, Data Capture Completion Verification, and a trip report.	08/24/2008	12
SAIC	Radiation exposure summaries.	09/02/2004	6
Southern Illinois University, Edwardsville, IL	University of Rochester waste disposed in the St. Louis area.	10/08/2008	1
Unknown	Thorium processing and transactions, University of Rochester site information, beryllium transactions, and University of Rochester dosimetry services and studies.	03/22/2004	42
US Army Corps of Engineers	Response to an allegation of buried radioactive material on the University of Rochester campus.	11/29/2007	1
Washington State University (U.S. Transuranium and Uranium Registries)	No relevant documents identified.	04/15/2008	0

Table A1-1: Data Capture Synopsis for University of Rochester AEP			
Data Capture Information	**Data Captured Description**	**Date Completed**	**Uploaded**
Washington University Libraries - St. Louis	Inhalation study facilities design and construction and reports on Ra and Po urinalysis.	04/26/2007	7
Y-12	Proposed toxicological study and discussion of thorium inhalation studies.	05/02/2007	1
TOTAL			**962**

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
CEDR http://cedr.lbl.gov/ COMPLETED 04/15/2008	University of Rochester in Title	0	0
DOE Energy Citations http://www.osti.gov/energycitations/ COMPLETED 04/15/2008	"University of Rochester Atomic Energy Project" in any field "University of Rochester Atomic Energy Project" in any field and "Radiation" in Title	4,357	4
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 10/17/2008	UR in document number University of Rochester in Title	36	3
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 05/30/2008	University of Rochester	2	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 08/31/2009	University of Rochester W. Blair as author A. Dowdy as author	154	84
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 06/02/2009	"University of Rochester Atomic Energy Project" in any field "University of Rochester Atomic Energy Project" in any field and "Radiation" in Title	1,784	15

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
Google http://www.google.com COMPLETED 04/23/2008	"University of Rochester Atomic Energy Project" –NIOSH "University of Rochester Atomic Energy Project" oralloy "University of Rochester Atomic Energy Project" postum "University of Rochester Atomic Energy Project" tuballoy "University of Rochester Atomic Energy Project" "uranyl nitrate hexahydrate" OR UNH "University of Rochester Atomic Energy Project" "K-65" "University of Rochester Atomic Energy Project" "sump cake" "University of Rochester Atomic Energy Project" "uranium dioxide" "University of Rochester Atomic Energy Project" "uranium tetrafluoride" "University of Rochester Atomic Energy Project" "uranium trioxide" "University of Rochester Atomic Energy Project" "uranium hexafluoride" "University of Rochester Atomic Energy Project" accident "University of Rochester Atomic Energy Project" "air count" "University of Rochester Atomic Energy Project" "air dust" "University of Rochester Atomic Energy Project" "air filter" "University of Rochester Atomic Energy Project" "airborne test" "University of Rochester Atomic Energy Project" alpha "University of Rochester Atomic Energy Project" "belgian congo ore" "University of Rochester Atomic Energy Project" beta "University of Rochester Atomic Energy Project" bioassay OR "University of Rochester Atomic Energy Project" bio-assay "University of Rochester Atomic Energy Project" breath OR "University of Rochester Atomic Energy Project" "breathing zone" OR "University of Rochester Atomic Energy Project" BZ "University of Rochester Atomic Energy Project" "body burden" "University of Rochester Atomic Energy Project" calibration "University of Rochester Atomic Energy Project" "chest count" "University of Rochester Atomic Energy Project" columnation "University of Rochester Atomic Energy Project" contamination "University of Rochester Atomic Energy Project" curie	21,450,225	14

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" "denitration" OR "University of Rochester Atomic Energy Project" "denitration pot" "University of Rochester Atomic Energy Project" derby OR "University of Rochester Atomic Energy Project" regulus "University of Rochester Atomic Energy Project" "derived air concentration" OR "University of Rochester Atomic Energy Project" DAC "University of Rochester Atomic Energy Project" dose "University of Rochester Atomic Energy Project" dosimeter "University of Rochester Atomic Energy Project" dosimetric "University of Rochester Atomic Energy Project" dosimetry "University of Rochester Atomic Energy Project" electron "University of Rochester Atomic Energy Project" environment "University of Rochester Atomic Energy Project" "Ether-Water Project" "University of Rochester Atomic Energy Project" exposure OR "University of Rochester Atomic Energy Project" "exposure investigation" OR "University of Rochester Atomic Energy Project" "radiation exposure" "University of Rochester Atomic Energy Project" external "University of Rochester Atomic Energy Project" "F machine" "University of Rochester Atomic Energy Project" fecal "University of Rochester Atomic Energy Project" "feed material" "University of Rochester Atomic Energy Project" femptocurie "University of Rochester Atomic Energy Project" film "University of Rochester Atomic Energy Project" fission "University of Rochester Atomic Energy Project" fluoroscopy "University of Rochester Atomic Energy Project" "Formerly Utilized Sites Remedial Action Program" OR "University of Rochester Atomic Energy Project" FUSRAP		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" gamma-ray OR "University of Rochester Atomic Energy Project" "gamma ray" "University of Rochester Atomic Energy Project" "gas proportional" "University of Rochester Atomic Energy Project" "gaseous diffusion" "University of Rochester Atomic Energy Project" health OR "University of Rochester Atomic Energy Project" "health instrument" OR "University of Rochester Atomic Energy Project" "health physics" OR "University of Rochester Atomic Energy Project" H.I. OR "University of Rochester Atomic Energy Project" HI OR "University of Rochester Atomic Energy Project" HP "University of Rochester Atomic Energy Project" highly enriched uranium" OR "University of Rochester Atomic Energy Project" HEU "University of Rochester Atomic Energy Project" hydrofluorination "University of Rochester Atomic Energy Project" "in vitro" "University of Rochester Atomic Energy Project" "in vivo" "University of Rochester Atomic Energy Project" incident "University of Rochester Atomic Energy Project" ingestion "University of Rochester Atomic Energy Project" inhalation "University of Rochester Atomic Energy Project" internal "University of Rochester Atomic Energy Project" investigation "University of Rochester Atomic Energy Project" isotope "University of Rochester Atomic Energy Project" isotopic "University of Rochester Atomic Energy Project" "isotopic enrichment" "University of Rochester Atomic Energy Project" "JS Project" "University of Rochester Atomic Energy Project" Landauer "University of Rochester Atomic Energy Project" "liquid scintillation" "University of Rochester Atomic Energy Project" log OR "University of Rochester Atomic Energy Project" "log sheet" OR "University of Rochester Atomic Energy Project" "log book"		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" "low enriched uranium" OR "University of Rochester Atomic Energy Project" LEU "University of Rochester Atomic Energy Project" "lung count" "University of Rochester Atomic Energy Project" "maximum permissible concentration" OR "University of Rochester Atomic Energy Project" MPC "University of Rochester Atomic Energy Project" metallurgy "University of Rochester Atomic Energy Project" microcurie "University of Rochester Atomic Energy Project" millicurie "University of Rochester Atomic Energy Project" "mixed fission product" OR "University of Rochester Atomic Energy Project" MFP "University of Rochester Atomic Energy Project" monitor OR "University of Rochester Atomic Energy Project" "air monitoring" "University of Rochester Atomic Energy Project" nanocurie "University of Rochester Atomic Energy Project" "nasal wipe" "University of Rochester Atomic Energy Project" neutron "University of Rochester Atomic Energy Project" "nose wipe" "University of Rochester Atomic Energy Project" nuclear OR "University of Rochester Atomic Energy Project" "Chicago-Nuclear" OR "University of Rochester Atomic Energy Project" "nuclear fuels" "University of Rochester Atomic Energy Project" "nuclear track emulsion" OR "University of Rochester Atomic Energy Project" "type A" OR "University of Rochester Atomic Energy Project" NTA "University of Rochester Atomic Energy Project" "occupational radiation exposure" "University of Rochester Atomic Energy Project" occurrence "University of Rochester Atomic Energy Project" "ore concentrate"		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" "PC Project" "University of Rochester Atomic Energy Project" permit OR "University of Rochester Atomic Energy Project" "radiation work permit" OR "University of Rochester Atomic Energy Project" "safe work permit" OR "University of Rochester Atomic Energy Project" "special work permit" OR "University of Rochester Atomic Energy Project" RWP OR "University of Rochester Atomic Energy Project" SWP "University of Rochester Atomic Energy Project" "phosphate research" "University of Rochester Atomic Energy Project" photon "University of Rochester Atomic Energy Project" picocurie "University of Rochester Atomic Energy Project" pitchblende "University of Rochester Atomic Energy Project" "pocket ion chamber" OR "University of Rochester Atomic Energy Project" PIC "University of Rochester Atomic Energy Project" problem "University of Rochester Atomic Energy Project" procedure "University of Rochester Atomic Energy Project" radeco "University of Rochester Atomic Energy Project" radiation "University of Rochester Atomic Energy Project" radioactive "University of Rochester Atomic Energy Project" radioactivity "University of Rochester Atomic Energy Project" radiograph "University of Rochester Atomic Energy Project" radiological "University of Rochester Atomic Energy Project" "Radiological Survey Data Sheet" OR "University of Rochester Atomic Energy Project" RSDS "University of Rochester Atomic Energy Project" radionuclide "University of Rochester Atomic Energy Project" raffinate "University of Rochester Atomic Energy Project" reactor "University of Rochester Atomic Energy Project" respiratory "University of Rochester Atomic Energy Project" "retention schedules" "University of Rochester Atomic Energy Project" roentgen		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" sample OR "University of Rochester Atomic Energy Project" "air sample" OR "University of Rochester Atomic Energy Project" "dust sample" OR "University of Rochester Atomic Energy Project" "general area air sample" "University of Rochester Atomic Energy Project" sampling OR "University of Rochester Atomic Energy Project" "air sampling" OR "University of Rochester Atomic Energy Project" "dust sampling" OR "University of Rochester Atomic Energy Project" "general area air sampling" "University of Rochester Atomic Energy Project" "solvent extraction" "University of Rochester Atomic Energy Project" source OR "University of Rochester Atomic Energy Project" "sealed source" "University of Rochester Atomic Energy Project" spectra "University of Rochester Atomic Energy Project" spectrograph "University of Rochester Atomic Energy Project" spectroscopy "University of Rochester Atomic Energy Project" spectrum "University of Rochester Atomic Energy Project" standard OR "University of Rochester Atomic Energy Project" "operating standard" OR "University of Rochester Atomic Energy Project" "processing standard" "University of Rochester Atomic Energy Project" survey "building survey" OR "University of Rochester Atomic Energy Project" "routine survey" OR "University of Rochester Atomic Energy Project" "special survey" "University of Rochester Atomic Energy Project" "technical basis" "University of Rochester Atomic Energy Project" "thermal diffusion" "University of Rochester Atomic Energy Project" "thermoluminescent dosimeter" OR "University of Rochester Atomic Energy Project" TLD		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" "Tiger Team" "University of Rochester Atomic Energy Project" "tolerance dose" "University of Rochester Atomic Energy Project" "Uranium aluminum alloy" OR "University of Rochester Atomic Energy Project" Ualx OR "University of Rochester Atomic Energy Project" "Uranium aluminide" "University of Rochester Atomic Energy Project" urinalysis "University of Rochester Atomic Energy Project" urine "University of Rochester Atomic Energy Project" "whole body count" OR "University of Rochester Atomic Energy Project" WBC "University of Rochester Atomic Energy Project" "working level" OR "University of Rochester Atomic Energy Project" WL University of Rochester Atomic Energy Project "X-ray" OR "University of Rochester Atomic Energy Project" "X ray" "University of Rochester Atomic Energy Project" "X-ray" OR "University of Rochester Atomic Energy Project" "X ray" OR "University of Rochester Atomic Energy Project" Xray OR "University of Rochester Atomic Energy Project" "X-ray Screening" "University of Rochester Atomic Energy Project" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" "University of Rochester Atomic Energy Project" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "University of Rochester Atomic Energy Project" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" "University of Rochester Atomic Energy Project" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" thorium OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th OR "232 Th" OR "Z metal" OR myrnalloy OR "chemical 10-66" OR "chemical 10-12" OR ionium OR UX1 OR UX2 "University of Rochester Atomic Energy Project" Th-230 OR Th230 OR "Th 230" OR 230-Th OR "230 Th" OR 230Th OR Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th" "University of Rochester Atomic Energy Project" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np" "University of Rochester Atomic Energy Project" uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" OR U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" OR U235 OR "U 235" OR U-235 OR 235-U "University of Rochester Atomic Energy Project" 235U OR "235 U" OR U238 OR "U 238" OR U-238 OR 238-U OR 238U OR "238 U" OR U308 OR "U 308" OR U-308 OR 308-U OR 308U OR 308 U OR "uranium extraction" "University of Rochester Atomic Energy Project" "black oxide" OR "brown oxide" OR "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3 OR UF4 OR UF6 OR C-216 OR C-616 OR C-65 OR C-211 OR U3O8 "University of Rochester Atomic Energy Project" 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" "University of Rochester Atomic Energy Project" 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"		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester Atomic Energy Project" 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 "University of Rochester Atomic Energy Project" radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn "University of Rochester Atomic Energy Project" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" "University of Rochester Atomic Energy Project" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa" "University of Rochester Atomic Energy Project" strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" "University of Rochester" oralloy "University of Rochester" postum "University of Rochester" tuballoy "University of Rochester" "uranyl nitrate hexahydrate" OR UNH "University of Rochester" "K-65" "University of Rochester" "sump cake" "University of Rochester" "uranium dioxide" "University of Rochester" "uranium tetrafluoride" "University of Rochester" "uranium trioxide" "University of Rochester" "uranium hexafluoride" "University of Rochester" accident "University of Rochester" "air count" "University of Rochester" "air dust" "University of Rochester" "air filter" "University of Rochester" "airborne test" "University of Rochester" alpha "University of Rochester" "belgian congo ore" "University of Rochester" bioassay OR "University of Rochester" bio-assay		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" breath OR "University of Rochester" "breathing zone" OR "University of Rochester" BZ "University of Rochester" calibration "University of Rochester" columnation "University of Rochester" contamination "University of Rochester" curie "University of Rochester" "denitration" OR "University of Rochester" "denitration pot" "University of Rochester" derby OR "University of Rochester" regulus "University of Rochester" dose "University of Rochester" dosimeter "University of Rochester" dosimetric "University of Rochester" dosimetry "University of Rochester" electron "University of Rochester" environment "University of Rochester" "Ether-Water Project" "University of Rochester" exposure OR "University of Rochester" "exposure investigation" OR "University of Rochester" "radiation exposure" "University of Rochester" external "University of Rochester" "F machine" "University of Rochester" fecal "University of Rochester" "feed material" "University of Rochester" femptocurie "University of Rochester" film "University of Rochester" fission "University of Rochester" fluoroscopy "University of Rochester" "Formerly Utilized Sites Remedial Action Program" OR "University of Rochester" FUSRAP "University of Rochester" gamma-ray		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" "gas proportional" "University of Rochester" "gaseous diffusion" "University of Rochester" health OR "University of Rochester" "health instrument" OR "University of Rochester" "health physics" OR "University of Rochester" H.I. OR "University of Rochester" HI OR "University of Rochester" HP "University of Rochester" "highly enriched uranium" OR "University of Rochester" HEU "University of Rochester" hydrofluorination "University of Rochester" "in vitro" "University of Rochester" "in vivo" "University of Rochester" incident "University of Rochester" ingestion "University of Rochester" inhalation "University of Rochester" internal "University of Rochester" investigation "University of Rochester" isotope "University of Rochester" isotopic "University of Rochester" "isotopic enrichment" "University of Rochester" "JS Project" "University of Rochester" Landauer "University of Rochester" "liquid scintillation" "University of Rochester" log OR "University of Rochester" "log sheet" OR "University of Rochester" "log book" "University of Rochester" "low enriched uranium" OR "University of Rochester" LEU "University of Rochester" "maximum permissible concentration" OR "University of Rochester" MPC "University of Rochester" metallurgy "University of Rochester" microcurie		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" millicurie "University of Rochester" "mixed fission product" OR "University of Rochester" MFP "University of Rochester" monitor OR "University of Rochester" "air monitoring" "University of Rochester" nanocurie "University of Rochester" "nasal wipe" "University of Rochester" neutron "University of Rochester" "nose wipe" "University of Rochester" nuclear OR "University of Rochester" "Chicago-Nuclear" OR "University of Rochester" "nuclear fuels" "University of Rochester" "nuclear track emulsion" OR "University of Rochester" "type A" OR "University of Rochester" NTA "University of Rochester" "occupational radiation exposure" "University of Rochester" occurrence "University of Rochester" "ore concentrate" "University of Rochester" "PC Project" "University of Rochester" permit OR "University of Rochester" "radiation work permit" OR "University of Rochester" "safe work permit" OR "University of Rochester" "special work permit" OR "University of Rochester" RWP OR "University of Rochester" SWP "University of Rochester" "phosphate research" "University of Rochester" photon "University of Rochester" picocurie "University of Rochester" pitchblende "University of Rochester" "pocket ion chamber" OR "University of Rochester" PIC		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" problem "University of Rochester" procedure "University of Rochester" radeco "University of Rochester" radiation "University of Rochester" radioactive "University of Rochester" radioactivity "University of Rochester" radiograph "University of Rochester" radiological "University of Rochester" "Radiological Survey Data Sheet" OR "University of Rochester" RSDS "University of Rochester" radionuclide "University of Rochester" raffinate "University of Rochester" reactor "University of Rochester" respiratory "University of Rochester" "retention schedules" "University of Rochester" roentgen "University of Rochester" sample OR "University of Rochester" "air sample" OR "University of Rochester" "dust sample" OR "University of Rochester" "general area air sample" "University of Rochester" sampling OR "University of Rochester" "air sampling" OR "University of Rochester" "dust sampling" OR "University of Rochester" "general area air sampling" "University of Rochester" "solvent extraction" "University of Rochester" source OR "University of Rochester" "sealed source" "University of Rochester" spectra "University of Rochester" spectrograph "University of Rochester" spectroscopy "University of Rochester" spectrum		

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" standard OR "University of Rochester" "operating standard" OR "University of Rochester" "processing standard" "University of Rochester" survey "building survey" OR "University of Rochester" "routine survey" OR "University of Rochester" "special survey" "University of Rochester" "technical basis" "University of Rochester" "thermal diffusion" "University of Rochester" "thermoluminescent dosimeter" OR "University of Rochester" TLD "University of Rochester" "Tiger Team" "University of Rochester" "tolerance dose" "University of Rochester" urinalysis "University of Rochester" urine "University of Rochester" "whole body count" OR "University of Rochester" WBC "University of Rochester" "working level" OR "University of Rochester" WL "University of Rochester" "X-ray" OR "University of Rochester" "X ray" OR "University of Rochester" Xray OR "University of Rochester" "X-Ray Screening" "University of Rochester" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" "University of Rochester" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" "University of Rochester" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"		

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

Table A1-2: Database Searches for University of Rochester AEP			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"University of Rochester" radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn "University of Rochester" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn" "University of Rochester" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa" "University of Rochester" strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr" "University of Rochester" "Energy Citations Database" University of Rochester "Atomic Energy Project" "University of Rochester Atomic Energy Project" in any field		
National Academies Press http://www.nap.edu/ COMPLETED 04/15/2008		433	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 04/23/2008		0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 04/15/2008		7	1
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 04/15/2008	University of Rochester	7	0

Table A1-3: OSTI Documents Ordered for University of Rochester AEP			
Document Number	**Document Title**	**Requested Date**	**Received Date**
No documents ordered.			