SEC Petition Evaluation Report
Petition SEC-00166

Report Rev #: 0 Report Submittal Date: July 26, 2010

Subject Expert(s):	Roger Halsey, Jason Davis
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00166	83.13	February 12, 2010	March 26, 2010	Ames Laboratory

Petitioner Class Definition

Scientists, production workers, technicians, salaried graduate students, physical plant workers, administrative and support staff who worked in the AEC and DOE facilities on the Ames Laboratory Campus variably known as Annexes 1 and 2, Hot Canyon, Wilhelm Hall or Metallurgy Building, Spedding Hall, Research and Chemistry Buildings at Ames Laboratory, Ames, Iowa, from January 1, 1955 through December 31, 1960, and excluding any workers covered by the SEC class approved for Petition SEC-00075.

Class Evaluated by NIOSH

All workers who worked in any DOE facilities on Ames Laboratory Campus from January 1, 1955 through December 31, 1960 (excluding any workers covered by the SEC class approved for Petition SEC-00075).

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 in any area of the Department of Energy facilities on the Ames Laboratory Campus from January 1, 1955 through December 31, 1960, 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 Special Exposure Cohort.

NOTE: NIOSH is continuing to research Ames Laboratory activities after 1960 to determine whether the class end date should be extended. If an extension is necessary, an 83.14 evaluation will be performed to add years.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00038	83.13	Ames Laboratory	SEC class approved
SEC-00075	83.13	Ames Laboratory	SEC class approved

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
SEC Petition Evaluation Report for Petition SEC-00038	Ames Laboratory
SEC Petition Evaluation Report for Petition SEC-00075	Ames Laboratory

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Peer Review Completed By:	[Signature on file] *LaVon Rutherford*	7/26/2010 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on file] *J. W. Neton*	*7/30/2010* *Date*
SEC Evaluation Approved By:	[Signature on file] *Stuart L. Hinnefeld*	*7/30/2010* *Date*

Evaluation Report Summary: SEC-00166, Ames Laboratory

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-00166 was received on February 12, 2010, and qualified on March 26, 2010. The petitioner requested that NIOSH consider the following class: *Scientists, production workers, technicians, salaried graduate students, physical plant workers, administrative and support staff who worked in the AEC and DOE facilities on the Ames Laboratory Campus variably known as Annexes 1 and 2, Hot Canyon, Wilhelm Hall or Metallurgy Building, Spedding Hall, Research and Chemistry Buildings at Ames Laboratory, Ames, Iowa, from January 1, 1955 through December 31, 1960.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH evaluated the following class: All workers who worked in any DOE facilities on Ames Laboratory Campus from January 1, 1955 through December 31, 1960 (excluding any workers covered by the SEC class approved for Petition SEC-00075).

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 in any area of the Department of Energy facilities on the Ames Laboratory Campus from January 1, 1955 through December 31, 1960, 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 Special Exposure Cohort. The class under evaluation was accepted (see Section 3.0 below) because internal dose for radionuclides other than uranium cannot be bounded for employees working in the Research Building (Spedding Hall). Because Ames Laboratory employment data do not associate individuals with specific buildings or rooms, it is not possible to specify that certain people did not work in the Research Building; therefore, NIOSH must extend its inability to bound internal dose to all employees on the Ames Campus.

NOTE: NIOSH is continuing to research Ames Laboratory activities after 1960 to determine whether the class end date should be extended. If an extension is necessary, an 83.14 evaluation will be performed to add years.

Feasibility of Dose Reconstruction

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

The NIOSH dose reconstruction feasibility findings are based on the following:

- Principal sources of internal radiation for members of the proposed class included exposures to thorium, thorium decay products including thoron, uranium, and the uranium decay products thorium-234 and protactinium-234m. Principal sources of external radiation for members of the proposed class included exposures to the uranium decay products thorium-234 and protactinium-234m and the thorium decay products, primarily radium-228.

- NIOSH finds that it is feasible to bound occupational medical dose for Ames Laboratory workers during all periods with sufficient accuracy. NIOSH also finds that it is feasible to bound external dose for all members of the evaluated class. Adequate documentation of film badge results for the period supports the estimation of individual external exposures.

- NIOSH finds that survey and process data are sufficient to bound internal uranium exposures for Ames Laboratory workers who worked in the Chemistry Building (Gilman Hall) and the Metallurgy Building (Wilhelm Hall). Internal uranium exposures for workers in the Research Building (Spedding Hall) can be bounded by following the guidance in the Ames technical basis document (ORAUT-TKBS-0055) and the information provided in *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001.

- NIOSH finds there are insufficient data, including bioassay results, ambient air concentrations, or process information to estimate with sufficient accuracy internal exposures to radionuclides other than uranium for workers in the Research Building (Spedding Hall) including the Hot Canyon within the Research Building. In addition, the Cave within the Hot Canyon did not provide a degree of containment that precluded the release of radioactive materials into the air. The air within the Cave was shared by the workers outside of it. Lacking bioassay data for these workers, air samples for the room, or detailed information on the materials being handled, NIOSH cannot estimate with sufficient accuracy the internal doses to personnel working in the Hot Canyon. Because Ames Laboratory employment data do not associate individuals with specific buildings or rooms, it is not possible to specify that certain people did not work in the Research Building; therefore, NIOSH must extend its inability to bound internal dose to all employees on the Ames Campus.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) 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 (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

- Although NIOSH found that it is not possible to completely reconstruct radiation doses for all of the evaluated class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, partial dose reconstructions for individuals employed at Ames Laboratory during the period from January 1, 1955 through December 31, 1960, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

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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Table of Contents

Tables

SEC Petition Evaluation Report for SEC-00166

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: Roger Halsey, Oak Ridge Associated Universities. 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 workers who worked in any DOE facilities on Ames Laboratory Campus from January 1, 1955 through December 31, 1960 (excluding any workers covered by the SEC class approved for Petition SEC-00075). It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

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

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

2.0 Introduction

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

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

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

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for at least 250 aggregated work days within the parameters established for the 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.[3]

3.0 SEC-00166 Ames Laboratory Class Definitions

The following subsections address the evolution of the class definition for SEC-00166, Ames Laboratory. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

[3] 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.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00166 was received on February 12, 2010, and qualified on March 26, 2010. The petitioner requested that NIOSH consider the following class: *Scientists, production workers, technicians, salaried graduate students, physical plant workers, administrative and support staff who worked in the AEC and DOE facilities on the Ames Laboratory Campus variably known as Annexes 1 and 2, Hot Canyon, Wilhelm Hall or Metallurgy Building, Spedding Hall, Research and Chemistry Buildings at Ames Laboratory, Ames, Iowa, from January 1, 1955 through December 31, 1960.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Ames Laboratory workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00166 for evaluation:

> The petitioner stated that "radiation monitoring was not routinely performed during this era." NIOSH had previously identified and stated in the *Site Profile for Ames Laboratory*, ORAUT-TKBS-00055, that not all persons who worked at the laboratory wore film badges and that few, if any, bioassay results for the time period have been located.

Based on its Ames Laboratory research and data capture efforts, NIOSH determined that internal and external monitoring data records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal radiation exposures and radiation doses were not adequately monitored at Ames Laboratory, either through personal monitoring or area monitoring. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH modified the petitioner-requested class. NIOSH discovered that two of the buildings included in the petitioner-requested class were not part of the Ames Laboratory during the proposed timeframe. The building known as Chemistry Annex I (also historically known as "Little Ankeny"), the Old Women's Gymnasium, and the TX Casting Building were demolished in 1953 (Struss, 1986). The building known as Chemistry Annex II (also known as the TX Preparation Building) was transferred from the government to Ames University in 1953 and became the Plumbing Shop; this building was demolished in 1972 (Struss, 1986).

In addition, a subset of the proposed class has been previously addressed in *SEC Petition Evaluation Report for Petition SEC-00075* (NIOSH, 2007). The class covered by this prior petition includes: *Sheet metal workers, physical plant maintenance and associated support staff (includes all maintenance shop personnel of Ames Laboratory), and supervisory staff who were monitored, or should have been monitored, for potential internal radiation exposures associated with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building) at the Ames Laboratory, for the time period from January 1, 1955 through December 31, 1970 and who were employed for a number of work days aggregating at least 250 work days, either solely under this employment or in combination with work*

days within the parameters (excluding aggregate work day parameters) established for other classes of employees included in the SEC.

Therefore, NIOSH defined the following class for further evaluation: All workers who worked in any DOE facilities on Ames Laboratory Campus from January 1, 1955 through December 31, 1960 (excluding any workers covered by the SEC class approved for Petition SEC-00075).

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 in any area of the Department of Energy facilities on the Ames Laboratory Campus from January 1, 1955 through December 31, 1960, 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 Special Exposure Cohort.

NOTE: NIOSH is continuing to research Ames Laboratory activities after 1960 to determine whether the class end date should be extended. If an extension is necessary, an 83.14 evaluation will be performed to add years.

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 Ames Laboratory. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, the Atomic Energy Technical Report database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One contains a summary of Ames Laboratory documents. The summary provides data capture details and general descriptions of the documents retrieved.

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

4.1 Site Profile Technical Basis Documents (TBDs)

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

- *Site Profile for Ames Laboratory*, ORAUT-TKBS-0055; Rev. 01; Oak Ridge Associated Universities; December 18, 2009; SRDB Ref ID: 78037

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

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

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. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIBs as part of its evaluation:

- *OTIB: Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, ORAUT-OTIB-0004, Rev. 03 PC-2; Oak Ridge Associated Universities; December 6, 2006; SRDB Ref ID: 29949

- *OTIB: 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

- *OTIB: Interpretation of Dosimetry Data for Assignment of Shallow Dose*, ORAUT-OTIB-0017, Rev. 01; Oak Ridge Associated Universities; October 11, 2005; SRDB Ref ID: 19434

- *OTIB: Use of Coworker Dosimetry Data for External Dose Assignment*, ORAUT-OTIB-0020, Rev. 02; Oak Ridge Associated Universities; December 4, 2008; SRDB Ref ID: 54985

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

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed four former Ames Laboratory employees. NIOSH selected individuals based on their known experience and the likelihood that they would be knowledgeable about: (1) workplace radiation fields, hazards, and practices to control worker exposure; (2) potential radionuclide intakes as evidenced by workplace controls, monitoring policies and procedures, and bioassay data; and (3) measurements of the beta, photon, and neutron exposure to workers.

- Personal Communication, 2010a, *Personal Communication with Former Ames Laboratory Employee*; Telephone Interview by ORAU Team; May 5, 2010; SRDB Ref ID: 81938

- Personal Communication, 2010b, *Personal Communication with Former Ames Laboratory Physicist*; Telephone Interview by ORAU Team; May 6, 2010; SRDB Ref ID: 81936

- Personal Communication, 2010c, *Personal Communication with Former Ames Laboratory Physics Assistant*; Telephone Interview by ORAU Team; May 6, 2010; SRDB Ref ID: 81937

- Personal Communication, 2010d, *Personal Communication with Former Ames Laboratory Worker*; Telephone Interview by ORAU Team member; May 28, 2010; SRDB Ref ID: 82038

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS 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 July 9, 2010)

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

Description	Totals
Total number of claims submitted for dose reconstruction	157
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (January 1, 1955 through December 31, 1960).	58
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).	36
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	15

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Interviews conducted with claimants were reviewed for additional information relating to internal and external monitoring data. No additional internal or external monitoring data were identified from these interviews.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Six hundred seventy-four documents in this database were identified as pertaining to Ames Laboratory. These documents were evaluated for their relevance to this petition. The documents include historical background on the site and processes, external monitoring data, and some bioassay data.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Petition Form B for SEC-00166*, February 12, 2010; OSA Ref ID: 111093
- *Excerpt from the Ames Laboratory Radworker II Radiation Producing Device User's Study Guide*, Ames Laboratory Office of Environment, Safety, Health and Assurance; April 30, 2008; OSA Ref ID: 111093
- *Excerpts from the Summary Meeting Minutes from the June 14-16, 2006 NIOSH/CDC Advisory Board Meetings*, NIOSH/CDC Advisory Board on Radiation Worker and Health; June 14-16, 2006; OSA Ref ID: 111093
- *Excerpt from the March 1960 "Ames Laboratory News*," Institute for Atomic Research, Iowa State University; March 18, 1960; OSA Ref ID: 111093
- Single page excerpt from a document of unknown origin citing sites (including Ames) eliminated from FUSRAP consideration as of December 1987; December 1987; OSA Ref ID: 111093
- *Excerpt from the Site Profile for the Ames Laboratory*, ORAUT-TKBS-0055; December 18, 2009; OSA Ref ID: 111093
- *Special Director's Message: Elevated Beryllium Levels Identified in Inactive Spedding Hall Fume Hood Vent Stacks*, Ames Laboratory; June 1, 2009; OSA Ref ID: 111093
- Single page of unknown origin describing types of wastes known to be at the site; unknown date; OSA Ref ID: 111093

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the Ames Laboratory from January 1955 to December 1960 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 Ames Laboratory Plant and Process Descriptions

The Ames Laboratory site consists of a number of buildings at Iowa State University (ISU) in Ames, Iowa. The precursor of the Ames Laboratory was the Ames Project, which was established in 1942 by a contract between the Metallurgical Laboratory at the University of Chicago and Iowa State College (the predecessor to Iowa State University) (Ames History, 1947). Ames Laboratory was established by the Atomic Energy Commission (AEC) in May 1947 (Karsjen, 2003).

The Ames Project/Laboratory played a key role in the production of strategic nuclear materials for the Manhattan Project and the AEC. Early in 1942, at the beginning of the Manhattan Project, the most pressing problem was the preparation of large amounts of pure uranium metal and casting of that metal into the shapes necessary for the development of nuclear reactors fuel (Ames, 1960). Iowa State College Chemistry Department faculty with expertise in rare earth metallurgy was called on to develop a method to purify uranium and reduce the cost of production (Ames, 1960).

The initial Ames process for uranium metal production was based on the chemical reduction of uranium tetrafluoride by calcium metal. Finely-ground uranium tetrafluoride was mixed with granulated calcium metal and the mixture was poured into a refractory-lined container. A fuse wire buried in the charge was electrically heated to initiate the reaction, which continued until both uranium metal and calcium fluoride were in the molten state. The more dense uranium collected at the bottom of the container where it was allowed to cool to room temperature, after which it was removed for casting. The uranium metal was cast by placing it in a graphite crucible, heating it in a vacuum, and allowing the liquid metal to flow into graphite molds of specific shapes (Ames History, 1947). The uranium production process was improved (although made more complex) by replacing the calcium reagent with magnesium metal (Ames History, 1947).

By November 1942, successful methods were developed and the Ames Project supplied approximately one-third of the uranium used in the Chicago pile (Karsjen, 2003). Between mid-1942 and August 1945, more than 1,000 tons of pure uranium metal was supplied to the Manhattan Project (Ames, 1960). The Ames Project was asked to turn over its process to industry in 1945.

Following bombardment experimentation in 1942, thorium was considered to be a potential alternative source of nuclear reactor fuel (Ames History, 1947). Thorium production had been initiated at the “Little Ankeny” facility as early as 1943. Production and research activities continued at Little Ankeny until 1949, when they were moved to the newly-completed “Metallurgy Building,”

which was built by DOE for Ames Laboratory research. The Metallurgy Building was later renamed Harley Wilhelm Hall. Purified thorium was produced at Wilhelm Hall using a five-stage process:

1. Solution and precipitation
2. Calcination and hydrofluorination
3. Metal reduction
4. Thorium metal casting
5. Machining

Prior to a turnover of thorium production to industry in April 1953, more than 65 tons of pure thorium metal and thorium compounds were produced by the Ames Laboratory (Ames, 1960).

Chemistry Building (Gilman Hall)

The initial Ames Project work was conducted in the Chemistry Building in early 1942. The process for purifying uranium metal and the methods and equipment for increasing production were developed in the Chemistry Building (Ames History, 1947). Experiments to purify uranium metal continued through September, 1942 (Payne, 1992, pdf pp. 90-92). Pure uranium metal was being produced at a rate of 100 pounds per week by October (Wilhelm, post-1959, pdf p. 36). The chemical reduction component of the operations was moved to the Physical Chemistry Annex I by December. Uranium casting remained in the Chemistry Building until "early 1943" when it was also moved to Annex I (Wilhelm, post-1959, pdf p. 43). Uranium research continued in the Chemistry Building, including determination of uranium properties, studies of uranium corrosion, development of protective coatings for uranium, and development of uranium alloys and compounds (Ames History, 1947). Other research in the Chemistry Building involved development of pure thorium metal, thorium alloys and compounds, yttrium metal, cerium metal, and beryllium metal (Ames, 1960). Analytical work centered on plutonium chemistry and the radiochemistry of the separation of fission products from uranium and plutonium, which was conducted in the “hot laboratory” between 1942 and 1951 (Ames, 1960). The Chemistry Building was decontaminated and surveyed in May 1976 (Voss, 1979).

Metallurgy Building (Wilhelm Hall)

This report considers exposure sources other than those covered by the previous *SEC Petition Evaluation Report for Petition SEC-00075* (NIOSH, 2007), which addressed a class of workers who also worked within the Metallurgy Building.

The Metallurgy Building, constructed by the AEC, was completed in October 1949 (Ames, 1951, pdf p. 7). The building houses research directed toward the development of special metals and alloys used in nuclear energy projects (Ames, 1962, pdf p. 23). Zircaloy was initially developed at Ames Laboratory as part of a basic study of the zirconium-tin alloy phase diagram (Ames, 1962, pdf p. 24). The subject of reactor coolants was studied, as were the heat-transfer properties of various metals and alloys (Ames, 1951). Equipment available for research, development, and production in metallurgy included many types of furnaces; high-vacuum systems; pyrometric devices; fabricating and testing machines; metallographs; X-ray diffractometers; and ultrasonic, spectrographic, dilatometric, and other instruments for examination and study of metals and alloys (Ames, 1962, pdf p. 24). A glovebox line in the Metallurgy Building was used to study the behavior of plutonium in molten metal systems (Ames, 1962).

Thorium production and research activities were moved from Physical Chemistry Annex 1 to the Metallurgy Building in 1949 and thorium work continued until 1953 (Hokel, 1998). Poor contamination control practices and poor ventilation contributed to contamination of the building (Hokel, 1998). However, contamination levels have been reduced by mitigation, decontamination, remodeling, and renovation projects (Hokel, 1998). Contamination still exists in many interspatial areas of the building and in some relatively inaccessible areas (Hokel, 1998).

Research Building (Spedding Hall)

The Research Building was constructed by the AEC and occupied in early 1951 (Ames, 1951). Many metals, including the rare earths, were investigated for mechanical, chemical, electrical, and other properties, and were studied by experimental techniques that probed the inner structures and forces of the materials (Ames, 1962). Research facilities in the building included a 150-kV accelerator that produced 14-MeV neutrons; a glovebox line for radiochemistry experiments; and a “Hot Canyon” (Ames, 1967).

The Hot Canyon, a two-story-high room, included a shielded area called the "Cave" that allowed workers to use remote manipulators behind an eight-inch-thick steel wall with lead glass windows (Ames, 1962, pdf p. 12). Electrical, vacuum, water, gas, and compressed air lines built into the wall allowed workers to remotely perform experiments on highly-radioactive materials (Iowa Official Register, 1961-1962). There was no roof over the Cave nor was there any barrier to separate the air where the workers stood from the air where experiments were performed. In addition, photographs of workers in the Hot Canyon show them working without respiratory protection (Ames, 1962, pdf p 12; Iowa Official Register, 1961-1962, pdf pp. 253-255).

Research activities included electron beam welding; the study of electronic structure of metals; and the separation, preparation, and measurement of properties of the rare earth metals (Ames, 1967). The initial research on liquid metal coolants was done at Ames Laboratory in an engineering test loop used in corrosion, fluid-flow, and heat transfer studies with liquid sodium (Ames, 1967).

Physical Chemistry Annex 1

The production of uranium metal was conducted in the Physical Chemistry Annex 1 building, which was an old wooden structure east of the Dairy Industries building and west of Wallace Road (Karsjen, 2003). Uranium operations began there in mid-1942 and ended on August 5, 1945 when the uranium purification process was transferred to industry. More than 1,000 tons of pure uranium and more than 300 tons of uranium scrap were produced during this period (Karsjen, 2003). In 1943, an open porch area was enclosed (to control dusty operations) and additions were constructed to accommodate increases in uranium production (Payne, 1992). Beginning in 1943, the building was also used to produce thorium metal until the processing equipment was transferred to the new Metallurgy Building in 1949 or 1950 (Ames, 1960). The Physical Chemistry Annex 1 building was torn down in 1953 (Karsjen, 2003).

Physical Chemistry Annex 2

The Physical Chemistry Annex 2 Building was a brick fireproof structure built east of Wallace Road in early 1944 to house the recovery of uranium from scrap uranium metal turnings collected from other Manhattan Project sites (Ames History, 1947). Operations in this building produced more than 300 tons of recovered uranium metal through December 1945 (Ames History, 1947). Operations ended in 1953. Iowa State College, the predecessor to Iowa State University, purchased the building in 1953 and converted it to a plumbing shop; it was razed in 1972 (Ames, 1985).

5.2 Radiological Exposure Sources from Ames Laboratory Operations

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

5.2.1 Internal Radiological Exposure Sources from Ames Laboratory Operations

The primary source of internal radiological exposure resulting from Ames operations was inhalation and/or ingestion of uranium metal, uranium tetrafluoride, uranium decay products, thorium metal, thorium tetrafluoride, and thorium decay products,.

5.2.1.1 Uranium

The radiological hazard presented by uranium metal or compounds results primarily from alpha particles emitted by U-238 (4.15 MeV and 4.20 MeV) and its isotopes U-235 (4.37 MeV, 4.40 MeV, and 4.58 MeV) and U-234 (4.27 MeV and 4.77 MeV). Naturally-occurring uranium is 0.71% (w/w) U-235 and 0.0055 (w/w) U-234. NIOSH assumes that uranium tetrafluoride received at Ames was derived solely from naturally-occurring ores. This assumption is based on the knowledge that the uranium produced at Ames was fabricated into fuel for use in the Chicago pile, which only used uranium of natural enrichment. On an activity basis (i.e., dpm/gram) the U-235 will be present in negligible amounts at these enrichment levels, but the U-234 activity will be at a level that is essentially equal to U-238 due to its much shorter half-life (2.46×10^5 years for U-234, and 4.47×10^9 years for U-238).

Other alpha-emitting radionuclides occur naturally as part of the U-238 decay process. However, these would have been removed when the uranium feed materials were processed to generate the uranium tetrafluoride provided to Ames for the metal reduction process. Sufficient time would not have elapsed for the in-growth of these progeny to reach appreciable activities that would pose an additional hazard to Ames personnel.

Uranium daughters, including radon, are not considered because of the short time since the process material was separated from the ore.

5.2.1.2 Thorium

Th-232 decays into Ra-228, emitting two primary alpha particles of 3.95 MeV (24%) and 4.01 MeV (76%). The decay series contains several other progeny, most of which decay by alpha particle emission, but each has a half-life of less than 12 hours.

5.2.1.3 Thoron

One isotope of particular interest in the Th-232 decay chain is Rn-220, or thoron. It is a noble gas that is constantly being released to the atmosphere from Ra-228. Thoron and its daughter products become a source of internal exposure. Due to the short half-lives of the Th-232 daughters, the production of thoron activity is always between 42% and 100% of the Th-232 activity.

5.2.2 External Radiological Exposure Sources from Ames Laboratory Operations

Based on information and documentation available to NIOSH, the potential for external radiation doses from uranium, uranium decay products, thorium, and thorium decay products existed at the Ames Laboratory site. The following subsections provide an overview of the external exposure sources.

5.2.2.1 Photon

Uranium metal and uranium tetrafluoride were handled by Ames Laboratory employees. External exposures to photon radiation would have resulted from the immediate daughter radionuclides in the uranium decay chain. The uranium progeny that result in the most significant photon exposures include Th-234 and Pa-234m (Rad Handbook, 1970). Note that these isotopes have relatively short half-lives and can be assumed to be in equilibrium with the parent U-238. Because of their short half-lives, the exposure potential from these isotopes would travel with the parent and will not be considered separately.

The significance of emissions from thorium depends on the state of equilibrium with the Th-232 parent (which is a factor of the time elapsed since the thorium process feed material was separated) (OCAS-IG-001). As time passed, thorium approached secular equilibrium. As a result, photon exposure rates would also have increased with the in-growth of Ra-228. Photon exposure rates as high as 22 mR/hr were reported for a thorium storage area, suggesting that this raw material for the thorium production process was not newly-separated (Klevin, 1952).

Table 5-1 provides the energies of the gamma emission from the primary isotopes of concern at the Ames Laboratory.

Table 5-1: Gamma Emissions of Primary Interest

Radionuclide	Gamma Energy (MeV)	
Uranium-238	None	
Thorium-234	0.063	(3.5%)
	0.093	(4%)
Protactinium-234m	0.766	(0.2%)
	1.00	(0.6%)
Uranium-235	0.144	(11%)
	0.163	(5%)
	0.186	(54%)
	0.205	(5%)
Thorium-231	0.026	(15%)
	0.084	(6.5%)
Uranium-234	0.053	(0.1%)
Thorium-232	0.059	(0.19%)
	0.126	(0.04%)
Radium-228	0.0067	(6×10^{-5}%)
Actinium-228	0.338	(11.4%)
	0.911	(27.7%)
	0.969	(16.6%)
	1.588	(3.5%)
Thorium-228	0.084	(1.19%)
	0.132	(0.11%)
	0.166	(0.08%)
	0.216	(0.27%)
Bismuth-212	0.040	(1%)
	0.727	(11.8%)
	1.620	(2.75%)
Lead-208	2.614	(100%)

Source: Radiological Health Handbook, 1998. A more complete list for uranium and thorium progeny can be found in this document (Rad Handbook, 1998).

5.2.2.2 Beta

Exposure to beta sources for Ames Laboratory employees would have resulted principally from uranium and thorium decay products. In the uranium-series decay scheme, beginning with U-238, the short-lived isotope Pa-234m emits the most energetic beta particle (2.28 MeV). It is this beta particle that accounts for the shallow-dose hazard associated with handling uranium and uranium tetrafluoride. Table 5-2 provides the energies of the beta emission from the primary isotopes of concern at the Ames Laboratory.

Table 5-2: Beta Emissions of Primary Interest

Radionuclide	Beta Energy (MeV, max.)	
Uranium-238	None	
Thorium-234	0.10	(19%)
	0.193	(79%)
Protactinium-234m	2.28	(99%)
Uranium-235	None	
Thorium-231	0.205	(15%)
	0.287	(49%)
	0.304	(35%)
Uranium-234	None	
Thorium-232	None	
Radium-228	0.0389	(100%)
Actinium-228	0.983	(7%)
	1.014	(6.6%)
	1.115	(3.4%)
	1.17	(32%)
	1.74	(12%)
	2.08	(8%)
	(+33 more • s)	
Thorium-228	None	
Bismuth-212	1.59	(8%)
	2.246	(48.4%)
Lead-208	None	

Source: Radiological Health Handbook, 1998. A more complete list for uranium and thorium progeny can be found in this document (Rad Handbook, 1998).

5.2.2.3 Neutron

There was a small potential for personnel neutron exposures from the uranium operations at Ames Laboratory. As described in Section 5.2.1, site personnel received and handled uranium tetrafluoride. Low-atomic-number elements such as fluorine emit neutrons with an average energy of about 1.5 MeV when struck by alpha particles (referred to as alpha-neutron ["• -n"] reactions). The intensity of the radiation field from these reactions increases as a function of the enrichment. Because only uranium with a natural isotopic ratio ("natural enrichment") was used at Ames Laboratory, the radiation field was significantly lower than for the beta or gamma components; therefore, neutron radiation is not considered a significant exposure concern.

5.2.3 Incidents

NIOSH did not identify any documented accidents at the Ames Laboratory site that resulted in exceptionally high personnel exposure levels (such as a criticality event). During an interview, a former worker described an incident where two persons were present when a Co-60 sealed source was exposed. The worker did not have any details as to the strength of the source or when the incident happened but did specifically state that it was never documented. The worker stated that both persons present were wearing film badges and were shielded from the source by "solid" concrete blocks. The worker, who was a Health Physics Manager, also stated that the film badges "did not indicate anything (Personal Communication 2010a)."

Incident reports have been identified for several X-ray exposure incidents (Daane, 1959; Voss, 1959-1960). In each of these cases, the employees involved are identified by name and the reports contain information on exposure time, X-ray tube operating potential, and tube current. Three minor contamination events have been identified (Contamination Reports, 1959-1961; Radiation Incident, 1960), including a thorium spill in the Hot Canyon area of Spedding Hall (Thorium Data, 1957). In each of these cases, gamma and beta surface swipes were taken of potentially-contaminated areas and nasal swabs were taken from the employees involved. In the case of the Spedding Hall thorium spill, urinalysis was performed for two of the individuals involved. As with the X-ray exposure incidents, the employees involved in these three contamination incidents are identified by name in the corresponding documentation.

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 Ames Laboratory class under evaluation.

6.1 Available Ames Laboratory Internal Monitoring Data

A review of all documents and data available to NIOSH identified some bioassay data for the period from January 1, 1942 through December 31, 2005. Only limited *in vitro* bioassay data have been found for the years 1942 through 1945.

NIOSH has identified 90 bioassay (urine) samples collected in March 1952 and analyzed for thorium by the AEC (Samples, 1952-1953). NIOSH has also identified approximately 70 bioassay (urine) samples collected and analyzed for thorium by the AEC in 1953 (Samples, 1952-1953). NIOSH has not identified any thorium bioassay samples or results after 1953.

Most identified internal monitoring data are from the time prior to the class under evaluation, during uranium and thorium production. Urinalysis results for two individuals and nasal swipes for four individuals involved in a thorium spill incident have been located (Thorium Data, 1957). NIOSH has not identified any indication of a routine internal monitoring program for members of the class under evaluation or that is applicable for dose reconstruction for members of the class.

NIOSH has not located any documentation indicating that Ames Laboratory conducted a routine air sampling program for uranium, plutonium, or thorium during the operation of Ames Laboratory. However, NIOSH has found some air sampling data. Twenty-two general area air dust (uranium) samples were collected as part of a special study performed in May, June, and July of 1943 by the Army Corp of Engineers (Dust Samples, May-June 1943; Dust Samples, July 1943). The purpose of the sampling was not identified in the associated documentation. In addition, approximately 700 general air sample results for thorium were collected in an AEC study performed in March 1952 (Klevin, 1952); approximately 270 breathing zone air samples were also collected during this study. Air sampling data from Wilhelm Hall, collected by Iowa State University in February 1953, were also identified (Hokel, 1998).

Details regarding the various analyses used and the associated minimum detectable activities are presented in the *Site Profile for Ames Laboratory* (ORAU-TKBS-0055).

6.2 Available Ames Laboratory External Monitoring Data

Ames Laboratory staff received regular film badge service beginning in 1953. NIOSH has located film badge results for over five hundred individual workers during the time period under evaluation (External Dose Records, 1952-2005). These records are biweekly results associated with named individuals and include gamma, beta, and in some cases, neutron exposure results.

NIOSH has examined available external records and has determined that not all of the workers in the class under evaluation were monitored for external radiation exposure during the 1955 through 1970 time frame. External dosimetry use at Ames Laboratory appears to have targeted professional level staff employees who had a known potential for occupational exposure.

Details regarding the various analyses used and the associated minimum detectable activities are presented in the *Site Profile for Ames Laboratory* (ORAUT-TKBS-0055). Table 6-1 provides a brief summary of the external dosimetry program pertinent to this evaluation. Table 6-2 provides a summary of the external dosimetry records available to NIOSH for Ames employee external dose reconstruction.

Table 6-1: Ames Laboratory Dosimeter Program									
Dosimeter Type	**Dosimeter Provider**	**Period of Use**	**Exchange Frequency[a]**	**MRD[b] (mrem)**			**MDL[c] (mrem)**		
				Skin	**• / • deep**	**Neutron**	**Skin**	**Deep**	**Neutron**
• / • film	Ames Laboratory in-house system	Jan 1954–Feb 1957	Biweekly	25	25	---	40	40	---
• / • film	Ames Laboratory in-house system	Mar 1957–Dec 1961	Biweekly	10	10	---	40	40	---
• / • /NTA film	Brookhaven National Laboratory (BNL)	Apr 1954–June 1957	Biweekly	15	15	10	40	40	---
• / • /NTA film	NCA	July 1957–June 1963	Biweekly	10	10	10	40	40	---

a. The exchange frequency was established from dosimetry reports.
b. MRD = minimum recordable dose; based on minimum doses recorded on dosimetry reports.
c. Estimated minimum detection level (MDL) typical of film dosimeter capabilities (NAS, 1989; NIOSH, 1993; Wilson, 1960; Wilson, 1987; Wilson, 1990).

Table 6-2: Ames Laboratory Dosimeter Results Summary						
Item Summarized	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**
Total number of dosimeters issued	2,433	2,324	*	2,582	2,936	2,319
Total number of neutron dosimeters issued	991	742	757	736	800	1,121

* Individual badge data not available.

Details regarding the various analyses used and the associated minimum detectable activities are presented in the *Site Profile for Ames Laboratory* (ORAU-TKBS-0055).

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

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

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class as summarized in Section 7.5. This approach is discussed in DCAS's SEC Petition Evaluation Internal Procedures which are available at http://www.cdc.gov/niosh/ocas. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00166 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Ames Laboratory 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

As discussed in Section 6.1, NIOSH has not located any documentation indicating that Ames Laboratory conducted routine air sampling or internal monitoring programs for uranium, plutonium, or thorium during the operation of Ames Laboratory. Therefore, an internal monitoring data sufficiency and pedigree evaluation is not possible for the internal monitoring data type.

The urinalysis results corresponding to the thorium spill described in Sections 5.2.3 and 6.1 are handwritten entries in the original accident/incident data logs.

Air sample results collected during a March 1952 AEC study are presented in report form and are variously recorded as daily weighted air concentrations, average breathing zone concentrations, and average general air concentrations (Klevin, 1952). Also included in this report are copies of the original, handwritten sample data sheets for 28 thorium air samples. Air sampling data from Wilhelm Hall, collected by Iowa State University in February 1953 (Hokel, 1998), includes 98 room survey results using an Eberline PAC-4G-3 meter and 53 results using a PUG-1E µR meter. These results carry units of cpm and mR/hr, respectively, and are reported variously as single survey measurements, data ranges, and averages of multiple surveys.

Although these measurements were taken outside the time period under evaluation, the data are used in ORAUT-TKBS-0055 to summarize air concentrations and daily intakes of Th-232 at Wilhelm Hall using the assumption that the highest measured air concentrations can be used as worst-case values to estimate subsequent thorium contamination levels after production ceased. ORAUT-TKBS-0055 provides a methodology to interpolate inhalation and ingestion thorium values for the time period under evaluation based on these values.

7.1.2 External Monitoring Data Pedigree Review

NIOSH has access to film badge records for 538 employees over the evaluation period. For the years 1955-1956 and 1958-1960, the badge records are in original handwritten reports and identified by the employee's name and badge number. The reports list report gamma and beta data separately, and provide raw film badge density data along with calibration badge data and calibration curves. Data from these badge records are summarized in weekly exposure reports that divide the records by building. Annual reports are also available that list the total monthly exposure for each badged employee in mrep. For 1957, the available data are limited to the annual summaries, providing monthly exposures for each monitored individual.

NIOSH also has access to bi-weekly neutron badge reports for the entire evaluation period. As with the beta/gamma film badge reports, these reports are in the form of original, handwritten data logs that list the monitored individuals by name along with the total number of neutron tracks. Also provided in these reports are data for two control badges and four test badges for each bi-weekly period.

In summary, the available external dosimetry monitoring data are available in sufficient quantity and quality to adequately represent external beta, photon, and neutron dose for the Ames Laboratory class under evaluation for the period from January 1, 1955 through December 31, 1960.

7.2 Evaluation of Bounding Internal Radiation Doses at Ames Laboratory

The principal source of internal radiation doses for members of the class under evaluation was inhalation and ingestion of uranium and thorium (ORAUT-TKBS-0055). The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding Process-Related Internal Doses

NIOSH has not located any urinalysis, other bioassay, or routine air sampling results for the class period under evaluation (January 1, 1955 through December 31, 1960). Most identified internal monitoring data are from the time prior to the class under evaluation (during uranium and thorium production).

Alternative Data Sources for Bounding Internal Dose

Although internal monitoring data are lacking, daily inhalation and ingestion values for internal uranium exposure may be estimated following the guidance in ORAUT-TKBS-0055 and the information provided in *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001 (see Section 7.2.3).

Internal exposure from thorium and uranium operations to workers outside of the buildings (ambient environmental exposure) is estimated in ORAUT-TKBS-0055 (see Section 7.2.2).

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

Internal exposure from thorium and uranium operations to workers outside of the buildings is estimated in ORAUT-TKBS-0055. In this TBD, assumptions are made regarding the releases made during the operational years and the resulting air concentrations. Post-operations levels are estimated to be one one-hundreth (1/100) of operational levels, as shown in Table 7-1.

Table 7-1: Environmental Intake Estimates for Uranium and Thorium for Ames Laboratory

Radionuclide(s)	Absorption Type	Intake (pCi/d)
U (assume U-234)	F, M, or S	0.05
Th-232, Ra-228, Th-228	M or S	0.0007 each

Source: ORAUT-TKBS-0055, Table 4-7

In ORAUT-TKBS-0055, annual internal exposure estimates from fission products present in the Hot Canyon were estimated based on the maximum activity allowed in the containment, filtration efficiencies of the filter media used, and ratios of typical fission products; the estimates are shown in Table 7-2. These amounts were calculated using an annual throughput of 50 curies per year, an airborne fraction of 0.002, and a filter efficiency of 99.5% (Bihl, 2006).

This source term was dispersed into the air using the least-dispersing approach, and therefore, the mode resulting in the highest concentration, as recommended by NRCP Publication 123, *Screening Models for Releases of Radionuclides to Air, Surface Water, and Ground Water* (NCRP Pub 123, 1996). This approach is also conservative because it assumes that workers are at the location with the highest air concentrations continuously and that wind and weather patterns remained constant and minimally-dispersing throughout the year.

Table 7-2: Annual Fission Product Environmental Intake Estimates for the Hot Canyon

Radionuclide	Intake (pCi/d)
Ce-141	1.92
Ce-144	19.1
Cs-134	0.470
Cs-137	1.81
Eu-155	0.122
Fe-55	1.50
Nb-95	21.7
Pm-147	4.75
Ru-103	2.79
Ru-106	7.34
Sr-89	4.85
Sr-90	1.37
Y-91	7.93
Zr-95	11.4

Source: ORAUT-TKBS-0055, Table 4-2

7.2.3 Methods for Bounding Internal Dose at Ames Laboratory

7.2.3.1 Methods for Bounding Operational Period Internal Dose

Chemistry Building (Gilman Hall)

Daily inhalation and ingestion values for internal uranium exposure may be estimated by following the guidance in *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001. Contamination in the building resulted from the development of the metal reduction and recasting processes that were used in later, fully-operational facilities - the same facilities that were used by the authors of Battelle-TBD-6001 to develop exposure estimates. Battelle-TBD-6001 references ORAUT-OTIB-0004, *Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, to obtain a reasonable maximum time-weighted air concentration for facilities that refined uranium. In that document, it is assumed that 100 times the maximum allowable concentration (MAC) or 7000 dpm/m^3 existed throughout the entire production area of the generic facility for one year. This results in a level of floor contamination of 3.44 x 10^7 pCi/square meter. Note that this is more than 100 grams of settled uranium dust per square meter.

While no measurements of the floor contamination in the Chemistry Building prior to the time period under evaluation have been located by NIOSH, surveys made in 1974 employing a gas proportional survey meter found no readings in excess of background (Voss, 1979, pdf p. 19).

In addition, an ambient level of 7000 pCi/m^3 is conservative as "[v]entillating hoods to take the dust away from workers were already being used before the war and obviously continued throughout" and "typical laboratory precautions were taken" (Payne, 1992, pdf p. 206).

Production in the Chemistry Building began in October 1942 and ended in early 1943, more than eleven years prior to the beginning of the time period under evaluation (1955 through 1960). Normal cleaning methods during these years would have reduced the floor contamination levels.

For the Ames Chemistry Building, the generic exposure estimate from Battelle-TBD-6001 is reduced by a factor of ten to obtain an air concentration of 3.4 pCi/m^3. The reduction was made: (1) because the production time in the Chemistry Building was approximately six months instead of the full year assumed for generic production facilities in Battelle-TBD-6001; (2) because of the intervening years between the cessation of production and the beginning of the class period; and (3) because standard laboratory precautions that were taken. Thus, an employee working a ten-hour day in the Chemistry Building may be estimated to have received 4.1 pCi/day of uranium through inhalation. OCAS-TIB-009, *Estimation of Ingestion Intakes*, uses a factor of 0.2 times the activity per cubic meter of air to obtain a daily ingestion estimate. This gives an estimate of 0.68 pCi/day of uranium ingested. These estimates are applied to all workers within the Chemistry Building.

Research Building (Spedding Hall)

Radioactive materials in use in the Research Building were research quantities and were handled within glove boxes and remotely handled within the Cave in the Hot Canyon. There were no indications of breaches to the glove boxes in any of the reviewed documents, in any of the employee interviews, or in the petition.

A review of documents in the NIOSH database related to hot cells and glove boxes at other facilities indicated that the internal path is not a concern when there was no breach of the containment device. However, the Cave within the Hot Canyon did not provide containment similar to that described in these documents. Specifically, for the experiments being performed, the Cave did not provide a degree of containment that precluded the release of radioactive materials into the air (Iowa Official Register, 1961-1962). The air within the Cave was shared by the workers outside of it. Lacking bioassay data for these workers, air samples for the room, or detailed information on the materials being handled, NIOSH cannot estimate internal doses to personnel working in the Hot Canyon. Because Ames Laboratory employment data do not associate individuals with specific buildings or rooms (DOL, 2010), it is not possible to specify that certain people did not work in the Research Building; therefore, NIOSH must extend its inability to bound internal dose to all employees on the Ames Campus.

Metallurgy Building (Wilhelm Hall)

The Ames site profile, ORAUT-TKBS-0055, provides a process for estimating inhalation and ingestion thorium values for the years 1955 through 1960. Although no contamination measurements of the Metallurgy Building have been located for these years, measurements prior to the time period and after it are documented (Klevin, 1952; Hokel, 1998). ORAUT-TKBS-0055 provides a methodology to interpolate levels for the intervening years based on the known data.

The methodology assumes a continuous rate of contamination reduction between the 1952 levels (Klevin, 1952) and levels found in later surveys (beginning in 1984 and continuing through the early 1990s) (Hokel, 1998). This is a conservative assumption because the later survey results indicated no detectable thorium levels in the majority of locations in the building; thorium contamination was located only in relatively inaccessible areas. The method in ORAUT-TKBS-0055 assumes that the highest levels found were present throughout the building.

Table 7-3 lists the estimated inhalation and ingestion values for the class period under evaluation.

Table 7-3: Inhalation and Ingestion Values for the Metallurgy Building

Year	Air concentration (dpm/m^3)	Chronic inhalation intake (pCi/d)	Chronic ingestion intake (pCi/d)
1955	448	1330	40.4
1956	392	1160	35.3
1957	343	1020	30.9
1958	300	887	27
1959	262	776	23.6
1960	229	679	20.6

The methodology applied to the Metallurgy Building is different from that applied to the Chemistry Building because of two significant differences: (1) the contamination levels in the Metallurgy Building prior to and after the class period were documented; and (2) in an application to the State Historical Society of Iowa, the historical integrity of the building is characterized as "high" (Architectural Survey, 2009); in other words, much of the interior surfaces remain as they were when constructed.

NOTE: This methodology was not applicable to the Metallurgy Building in the previous evaluation for petition SEC-00075 because the persons within that class worked closely with expected, but unmeasured, thorium contamination in air ducts resulting from production operations. However, this methodology does serve to bound the thorium dose in this work location for the worker class evaluated in this report (excluding any workers covered by the SEC class approved for Petition SEC-00075).

Thoron would be produced in the Metallurgy Building as a result of the presence of thorium. A 1953 survey found an average level of 5.86 pCi/l of thoron in the building (Klevin, 1952, pdf p. 4). A 1996 survey found no thoron in excess of background. (Hokel, 1998, pdf p. 11)

Following the same logic as above, estimates may be made for the intervening years, including the years of the class under evaluation. Because the thoron is produced from the thorium contamination, thoron would have been reduced (in a proportional fashion) as the thorium itself was reduced. This method is conservative because the thoron measured in 1953 was a result of production levels of thorium present while the thoron levels during the time period under evaluation resulted from only residual contamination.

The amount of thoron being released in 1953 would have been a function of the time since the thorium was separated from its daughters. The 1953 value is divided by 42% to obtain 13.9 pCi/l because that is the least equilibrium ratio for Ra-224 (the immediate parent to thoron) to Th-232, and the contamination in the period under evaluation can be assumed to be in full equilibrium between the two isotopes. Table 7-4 shows the estimated thoron concentrations for the Ames Metallurgy Building.

Table 7-4: Estimated Thoron Concentrations in the Metallurgy Building	
Year	**Air Concentration (pCi/l)**
1955	11.2
1956	10.0
1957	9.0
1958	8.0
1959	7.2
1960	6.5

7.2.3.2 Methods for Bounding Ambient Environmental Internal Dose

As discussed in Section 7.2.2, internal exposure from thorium and uranium operations to workers outside of the buildings is estimated in ORAUT-TKBS-0055. In this TBD, assumptions are made regarding the releases made during the operational years and the resulting air concentrations. Post-operations levels are estimated to be one one-hundreth (1/100) of operational levels (see Table 7-1).

Annual internal exposure estimates from fission products present in the Hot Canyon were estimated based on the maximum activity allowed in the containment, filtration efficiencies of the filter media used, and ratios of typical fission products (see Table 7-2). This source term was dispersed into the air using the least-dispersing approach, and therefore, the mode resulting in the highest concentration, as recommended by NRCP Publication 123, *Screening Models for Releases of Radionuclides to Air, Surface Water, and Ground Water* (NCRP Pub 123, 1996). This approach is also conservative because it assumes that workers are at the location with the highest air concentrations continuously and that wind and weather patterns remained constant and minimally-dispersing throughout the year.

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH finds that survey and process data are sufficient to bound internal uranium exposures for Ames Laboratory workers who worked in the Chemistry Building (Gilman Hall) and the Metallurgy Building (Wilhelm Hall). Internal uranium exposures for workers in the Research Building (Spedding Hall) can be bounded by following the guidance in the Ames technical basis document (ORAUT-TKBS-0055) and the information provided in *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001.

NIOSH finds there are insufficient data, including bioassay results, ambient air concentrations, or process information to estimate with sufficient accuracy internal exposures to radionuclides other than uranium for workers in the Research Building (Spedding Hall) including the Hot Canyon within the Research Building. In addition, the Cave within the Hot Canyon did not provide a degree of containment that precluded the release of radioactive materials into the air. Ames Laboratory employment data do not associate individuals with specific buildings or rooms. Therefore, NIOSH finds that it is infeasible to completely reconstruct internal doses for the class under evaluation due to insufficient monitoring data, limitations on the degree of containment in the Research Building, and the inability to specify that certain people did not work in the Research Building.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from January 1, 1955 through December 31, 1960, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at Ames Laboratory during the period from January 1, 1955 through December 31, 1960, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at Ames Laboratory

The principal source of external radiation doses for members of the evaluated class was uranium and thorium from production and research operations (ORAUT-TKBS-0055).

The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

7.3.1 Evaluation of Bounding Process-Related External Doses

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

7.3.1.1 Personnel Dosimetry Data

During the period under evaluation, process and research-related external exposures were monitored with film badges. For certain workers, the records available to NIOSH are essentially complete (ORAUT-TKBS-0055, Section 6.0).

While external dosimetry data are not available for all members of the class under evaluation, monitoring data do exist for some Ames Laboratory employees within the class. Workers with job titles such as scientist, chemist, metallurgist, engineer, technician, or machinist (who were more likely to incur known higher exposures) were typically monitored for external exposures (ORAUT-TKBS-0055, Section 6.3.1). These workers were exposed to sources that included electron accelerators, electron beam welding, beta-ray spectrometers, and X-ray and neutron diffraction spectrometers. NIOSH believes that external monitoring data obtained from workers associated with the aforementioned activities can be used to bound external exposures to all members of the class under evaluation.

Photon

The available personnel external monitoring data, in the form of film badge results, provide external photon/gamma dose information for the personnel working during the operational period at the Ames Laboratory. These data are sufficient to support bounding photon dose for members of the class under evaluation, as described in Section 7.3.4.1.

Beta

The available personnel external monitoring data, in the form of film badge results, provide external beta dose information for the personnel working during the operational period at the Ames Laboratory. These data are sufficient to support bounding photon dose for members of the class under evaluation, as described in Section 7.3.4.1.

Neutron

The available personnel external monitoring data, in the form of film badge results, provide external neutron dose information for the personnel working during the operational period at the Ames Laboratory. These data are sufficient to support bounding photon dose for members of the class under evaluation, as described in Section 7.3.4.1.

7.3.1.2 Alternative Data Sources for Bounding External Dose

A co-worker data study has been performed to permit dose reconstruction for individuals for which external monitoring data were unavailable or incomplete. The co-worker data study for Ames Laboratory includes all available dosimetry records from 1952 through 1981 (ORAUT-TKBS-0055). All dose results were analyzed, including zeros and blank values, to determine the 50th- and 95th percentile doses for each year for beta, gamma, and neutron exposures (McCartney, 2006). If any part of a worker's dosimetry record was missing (or unidentified as in the case where dosimetry was not provided), the 95th-percentile dose from the co-worker data would be applied in the years for which records are missing (ORAUT-OTIB-0020). Details of the co-worker study and its application can be found in ORAUT-TKBS-0055.

7.3.2 Evaluation of Bounding Residual Period External Doses

The *Site Profile for Ames Laboratory* describes the rationale, historical background, and data for reconstructing ambient environmental external doses for unmonitored personnel who were outside operational facilities on the site (ORAUT-TKBS-0055). External dose from radioactive materials outside the body may be determined from immersion in a cloud of inert gases, deposition of particles on the skin, or adjacent operational facilities. As discussed in the Site Profile, these environmental doses may be assigned to Ames Laboratory claimants for the applicable periods as defined for each Ames Laboratory location.

7.3.3 Ames Laboratory Occupational X-Ray Examinations

Occupational medical examinations were conducted for the staff of Ames Laboratory as prescribed by the Medical Services of the Manhattan Project (Stone, 1951; Van Horn, 1943). Pre-employment examinations included a chest X-ray and urine analysis. Annual physical examinations also included a chest X-ray. X-ray film records from the early and mid-1950s indicated that some workers, likely those working with beryllium, received chest X-rays on a quarterly frequency while other workers might have chest X-rays on an annual or semiannual frequency. In 1957, the frequency of chest X-rays was changed to twice per year for all Ames Laboratory staff (Van Bemmel, 1957). X-ray film records indicate that the frequency of chest X-rays was changed to annual in 1960 and biannual in 1982. The actual dates of chest X-rays for claimants have been reported by Ames Laboratory in

response to data requests for each claim. X-ray examinations of Ames Laboratory staff members were conducted at the Iowa State Student Health Center/College Hospital. All X-ray films examined in the archives at Ames Laboratory were 14-inches by 17-inches; there was no evidence of any X-rays being taken with photofluorographic X-ray equipment.

7.3.4 Methods for Bounding External Dose at Ames Laboratory

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

- Photon Dose
- Beta Dose
- Neutron Dose
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon Dose

External photon doses can be reconstructed for the period January 1, 1955 through December 31, 1960 by applying co-worker photon dose distributions for workers without monitoring data, or for each monitoring period where results are not provided. Due to the lack of production activities during this time period, the co-worker dose distributions for Ames Laboratory for this period are based on monitoring records for individuals performing research activities. These individuals represent the population with the maximum exposure potential; maximum recorded exposures for this group can be used to bound the dose for other Ames Laboratory workers.

Beta Dose

Shallow doses can be reconstructed for the period January 1, 1955 through December 31, 1960 by applying co-worker dose distributions for workers without monitoring data, or for each monitoring period where results are not provided. Due to the lack of production activities during this time period, the co-worker dose distributions for Ames Laboratory for this period are based on monitoring records for individuals performing research activities. These individuals represent the population with the maximum exposure potential; maximum recorded exposures for this group can be used to bound the dose for other Ames Laboratory workers.

Neutron Dose

Neutron doses can be reconstructed for the period January 1, 1955 through December 31, 1960 by applying co-worker dose distributions for workers without monitoring data, or for each monitoring period where results are not provided. Due to the lack of production activities during this time period, the co-worker dose distributions for Ames Laboratory for this period are based on monitoring records for individuals performing research activities. These individuals represent the population with the maximum exposure potential; maximum recorded exposures from this group can be used to bound the dose for other Ames Laboratory workers.

Medical X-ray Dose

NIOSH considers reconstruction of medical dose for all Ames Laboratory workers feasible by using actual claimant data, the X-ray examination frequencies documented in Section 7.3.3, and the bounding assumptions and applicable protocols specified in the complex-wide *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006.

7.3.4.2 Methods for Bounding Ambient Environmental External Doses

Ambient environmental dose for monitored workers is accounted for in an individual's recorded dose. Potential ambient environmental dose for unmonitored workers, such as non-badged administrative personnel, is bounded by the available data for monitored individuals, as assessed in this report or can be reconstructed on a case-by-case basis following the guidance in ORAUT-TKBS-0055. Occupational environmental dose was not measured (i.e., via direct radiation dosimeters) until 1953 when workers were badged (Badging, 2006; Synchrotron Badging, 2006); it was not calculated from environmental media concentrations until 1962 (Voss, 1963).

External exposures to workers outside the buildings from thorium and uranium operations were negligible and may have been captured through routine film badge dosimetry. However, during the class period under evaluation, the laboratory also operated a synchrotron. Details of the exposure assumptions are contained in ORAUT-TKBS-0055. Results from a survey taken during a full-power test (Synchrotron Survey, 1961) were used to estimate the highest potential exposure due to sky shine to a worker who was close to, but not within, the facility bounds. This provides an additional 25 millirem of external exposure per year. This estimate is very conservative because it assumes that the synchrotron operated at full power throughout each year even though it rarely operated at those levels, and also assumes that workers would have been continuously at the same location during the year.

7.3.5 External Dose Reconstruction Feasibility Conclusion

NIOSH considers reconstruction of external radiation dose feasible for the Ames worker class under evaluation. Such reconstruction can be accomplished using co-worker data distributions and the bounding assumptions and applicable protocols specified in various complex-wide Technical Information Bulletins. NIOSH also considers reconstruction of medical X-ray dose feasible.

7.4 Evaluation of Petition Basis for SEC-00166

The following subsections evaluate the assertions made on behalf of petition SEC-00166 for the Ames Laboratory.

7.4.1 Lack of Routine Radiation Monitoring

SEC-00166: *It is not feasible to estimate exposures with reasonable accuracy using very limited data. Since they did not have any monitoring records for me and stated they could only do a partial dose reconstruction for me, I should be automatically considered for the SEC.*

Response: NIOSH reviewed the petitioner's personal dose reconstruction report and determined that a complete and accurate dose reconstruction was completed; however, NIOSH also determined that some of the associated discussion in the report was in error and, therefore, misleading. The discussion unnecessarily mentions the inability to completely reconstruct doses for workers specified in the evaluation report for petition SEC-00075. The petitioner did not fall under this class of workers, which included: sheet metal workers, physical plant maintenance and associated support staff (including all maintenance shop personnel of Ames Laboratory), and supervisory staff who were monitored, or should have been monitored for potential internal radiation exposures associated with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building) at the Ames Laboratory, for the time period from January 1, 1955 through December 31, 1970.

Consequently, the petitioner filed an SEC petition (SEC-00166). However, the petitioner held a job function for which monitoring would not be expected. As described in Section 7.3, while external dosimetry data are not available for all members of the class under evaluation, monitoring data do exist for some Ames Laboratory employees in the class. Workers with job titles such as scientist, chemist, metallurgist, engineer, technician, or machinist (who were more likely to incur known higher exposures) were typically monitored for external exposures (ORAUT-TKBS-0055, Section 6.3.1). These data were used to develop a co-worker model that assigns doses based on job titles to workers who may not have been monitored.

7.4.2 Advisory Board Meeting Statements by DCAS Staff

SEC-00166: The petitioner asserts that Advisory Board meeting notes point to limitations in the available data that might prevent the completion of dose reconstructions for members of the class under evaluation. Specifically, the petition points to the following statements made by Dr. Neton, Associate Director of Science, Division of Compensation Analysis and Support:

> "… as a whole, dosimetry data is sparse. Monitoring and source term information is spotty. Under the first prong of the two-prong test established by EEOICPA, NIOSH came to the determination that the available monitoring records and process description are insufficient to complete dose reconstruction with sufficient accuracy."

Response: The statements noted above were made in reference to the time period evaluated under the SEC-00038 petition. They do not specifically indicate a lack of monitoring data or limitations in monitoring data that would prevent the completion of dose reconstructions for the January 1, 1955 through December 31, 1960 time period.

7.5 Summary of Feasibility Findings for Petition SEC-00166

This report evaluates the feasibility for completing dose reconstructions for employees at the Ames Laboratory from January 1, 1955 through December 31, 1960. NIOSH found that the available monitoring records, process descriptions and source term data available are not sufficient to complete dose reconstructions for all members of the evaluated class of employees.

Table 7-5 summarizes the results of the feasibility findings at Ames Laboratory for each exposure source during the time period January 1, 1955 through December 31, 1960.

Table 7-5: Summary of Feasibility Findings for SEC-00166
January 1, 1955 through December 31, 1960

Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal		**X**
- U and progeny	X	
- Th and progeny	X	
- Other Radionuclides (Research Bldg.)		X
External	**X**	
- Gamma	X	
- Beta	X	
- Neutron	X	
- Occupational Medical X-ray	X	

NOTE: NIOSH is continuing to research Ames Laboratory activities after 1960 to determine whether the class end date should be extended. If an extension is necessary, an 83.14 evaluation will be performed to add years.

As of July 9, 2010, a total of 58 claims have been submitted to NIOSH for individuals who worked at Ames Laboratory and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for 36 individuals (~62%).

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Ames Laboratory during the period from January 1, 1955 through December 31, 1960, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00166

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.

Due to the limitation on the degree of containment in the Cave within the Hot Canyon and insufficient data (i.e., bioassay results, ambient air concentrations, or process information), it is not feasible to estimate internal radiation dose for workers in the Research Building (Spedding Hall). Because Ames Laboratory employment data do not associate individuals with specific buildings or rooms, it is not possible to specify that certain people did not work in the Research Building; therefore, NIOSH must extend its inability to bound internal dose to all employees on the Ames Campus for the period from January 1, 1955 through December 31, 1960. 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-00166

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 in any area of the Department of Energy facilities on the Ames Laboratory Campus from January 1, 1955 through December 31, 1960, 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 Special Exposure Cohort. The class under evaluation was accepted because internal dose for radionuclides other than uranium cannot be bounded for employees working in the Research Building (Spedding Hall). Because Ames Laboratory employment data do not associate individuals with specific buildings or rooms, it is not possible to specify that certain people did not work in the Research Building; therefore, NIOSH must extend its inability to bound internal dose to all employees on the Ames Campus.

NOTE: NIOSH is continuing to research Ames Laboratory activities after 1960 to determine whether the class end date should be extended. If an extension is necessary, an 83.14 evaluation will be performed to add years.

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-00166. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

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

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Voss, 1979, *History and Current Radiological Condition of the Ames Laboratory*, correspondence and Report; Milo D. Voss; December 3, 1979; SRDB Ref ID: 18840

Wilhelm, post-1959, *A History of Uranium Metal Production in America*; H. A. Wilhelm; Date from context-sometime after 1959 (date of oldest reference); SRDB Ref ID: 18825

Wilson, 1960, *Detection Level of the Film Badge System*, R. H. Wilson; Radiation Protection Operation, Hanford Laboratories Operation, Exposure Evaluation and Records; HW-67697; November 28, 1960; SRDB Ref ID: 15403

Wilson, 1987, *Historical Review of Personnel Dosimetry Development and its Use in Radiation Protection Programs at Hanford, 1944 to the 1980s*, Report PNL-6125; R. H. Wilson; February 1987; SRDB Ref ID: 262

Wilson, 1990, *Description and Evaluation of the Hanford Personnel Dosimeter Program From 1944 Through 1989*, prepared for the U.S. Department of Energy by Pacific Northwest Laboratory, Battelle Memorial Institute; PNL-7447 / UC606; September 1990; SRDB Ref ID: 4793

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Primary Site/Company Name: Ames Laboratory DOE; 1942-present Contact: Industrial Safety Other Site Names: Iowa State	242-Pu-94 experiment in room 29 Spedding Hall, activity in reactor effluents, air sample data sheets, Ames Laboratory description, environmental reports, atomic space living on the Manhattan Project, bioassay procedure and results, bremsstrahlung doses from natural uranium ingots, design and operation of a pilot plant for purification of thorium, external dose records, film badge specifications, health physics aspects of the neutron generator, incident reports, neutron film badge data, radiation surveys, reactor effluent reports, results of indoor radon monitoring, survey of ISU medical x-ray machine, Th-232, U-238, and beryllium contamination in Wilhelm Hall at Ames Laboratory, and X-ray machine monitoring including doses from chest x-rays.	03/14/2007	286
State Contacted: Iowa Department of Public Health Contact: Bureau of Radiological Health	No relevant data identified.	06/03/2010	0
Cincinnati Public Library	In-situ characterization technique for screening contaminated soils, instructions in applications of nuclear devices at Iowa State University, reduction of uranium with magnesium, radiation safety in the Manhattan Project 1942-1946, and uranium metal by carbon reduction of uranium oxide in vacuum.	05/25/2010	9
Claimant	Miscellaneous Linde material.	04/18/2005	1
Department of Labor/Paragon	Draft background and resurvey recommendations for the Atomic Energy Commission portion of the Lake Ontario Ordnance Works, uranium compounds, and operational reports.	12/30/2008	3
DOE Argonne National Laboratory	Organization of National Nucleonics Program.	04/02/2008	1
DOE Brookhaven National laboratory	Air monitoring parameters.	03/01/2006	1
DOE Germantown	Documents regarding Westinghouse Atomic Power Development Plant, beryllium history, procurement, procedures and policies, exposure, hazards and safety, history and characterization about the University of California, elimination report, monthly accountability, thorium information, site summary and history, and Forest Hills location designation change and addition to covered facility list along with supporting documentation.	06/18/2008	5

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
DOE Hanford	Hanford has provided a response to ORAU Team provided key words. The key word search results have been promulgated to affected Project and DCAS personnel for review and selection of desired material. Responses are due close of business June 28, 2010, afterwhich a summarized request will be submitted to Hanford and subsequent data capture scheduled.	OPEN	N/A
DOE Legacy Management - Grand Junction Office	Ames Laboratory site description, Brookhaven request for thorium fluoride, cast rod production, radiological survey program, Manhattan District History Book I - General Volume 4 Auxiliary Activities, monthly progress report, preparation of KUF5 and K2UCL6, processing losses of material, receiving report for stabilized zirconia casting mix, sewer contamination incident, shipment of thorium, soil contamination south end of physical chemistry annex, thorium operations at Ames, report of fire at Ames, and transmittal of invoices and receiving reports.	04/30/2010	50
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	DOE precious metals program, analytical results for Ames thorium billet A-520, incineration of radioactive solid wastes, out of specification plutonium, uranium recycling, report on separation of thorium from a thorium fluoride sludge, Ames thorium process, status of off-site fuel element development programs, summary technical report, production of uranium feed materials, and ultrasonic inspection of thorium metal.	05/13/2010	18
DOE Los Alamos National Laboratory	Los Alamos uranium metallurgy technical series	08/22/2007	3
DOE Office of Scientific and Technical Information (OSTI)	Report on survey of irradiation facilities.	09/25/2006	1
DOE Pacific Northwest National Laboratory (PNNL)	GENII version 2 user's guide.	03/12/2007	1
DOE Savannah River Site	Production of thorium at Ames, trip report including thorium meeting division of research, and thorium slugs for irradiation program.	07/22/2008	3
Internet - Ames Public Library	No relevant data identified.	06/18/2010	0
Internet - Department of Energy	Methods of separating U233 from thorium.	06/18/2008	1
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	03/20/2010	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Monthly Report Hanford Atomic Products Operation for April 1953.	03/20/2010	2

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - DOE Legacy Management Considered Sites	Monthly progress report, authority review for MED operations conducted at Ames Laboratory, interim overview and certification activities report, research reactor facility, production of thorium metal, uranium contained in the Iowa State College dump, and a Tonawanda area progress report.	04/18/2010	9
Internet - DOE OpenNet	Semiannual reports of the Atomic Energy Commission, Manhattan District History, Book I - General, Volume 7 - Medical Program, and activation test results of samples.	03/20/2010	8
Internet - DOE OSTI Energy Citations	No relevant data identified.	03/20/2010	0
Internet - DOE OSTI Information Bridge	Analysis of enriched and depleted uranium oxide powders, annual site environmental report, effects of temperature on mechanical properties or normal uranium dingot, in-situ monitoring of actinides and rare earth elements, low enrichment fuel conversion, neutron scattering studies, Nuclear Science and Technology extracts from Journal of Metallurgy and Ceramics, performance assessment modeling of high level nuclear waste forms from the pyroprocess fuel cycle, performance testing of multi-metal continuous emissions monitors, plutonium contamination monitoring, quarterly reports, radiological survey, sputtering of vanadium and niobium under 14.1 Mev neutron impact, uranium enrichment using plasma centrifuges, and X-ray K-edge analysis of drain lines in Wilhelm Hall.	03/20/2010	81
Internet - Google	Environment, safety, health, and assurance trend analysis, contamination in Spedding Hall prior to start of energy savings project, application for use of radioactive materials, devices, and lasers, decontamination with lasers, dosimetry/personnel monitoring, Frank Harold Spedding information, campus maps, radiation safety manual, Radiological Protection Program information, RSO interview, annual site environmental report containing radiological doses and releases, and a waste minimization/pollution prevention plan.	04/11/2010	44
Internet - HP Journal	No relevant data identified.	06/14/2010	0
Internet - Iowa State University Library	No relevant data identified.	06/18/2010	0
Internet - Journal of Occupational and Environmental Health	No relevant data identified.	06/14/2010	0
Internet - National Academies Press (NAP)	No relevant data identified.	03/20/2010	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	03/20/2010	0

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
Internet - NRC Agencywide Document Access and Management (ADAMS)	Annual operations report on Iowa State University's UTR- 10 Reactor, final status survey report for the Iowa State University UTR-10 Reactor, termination of facility operating license No. R-59 for the UTR-10 research reactor, notification of reactor operator license cancellations, request for license amendment, and shipment of uranium fuel.	03/20/2010	19
Internet - US Army Corps of Engineers	No relevant data identified.	04/18/2010	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	03/20/2010	0
Kansas City Federal Records Center	Film badge reports.	10/16/2008	4
National Archives and Records Administration (NARA) - Atlanta	Accountability reports of source and fissionable materials, acid treatment of thorium metal, air sampling results, breakdown of finished metal into green salt lots, comparison of yields from Mallinckrodt and Harshaw feed material, crushing brown oxide pellets, description of work done at Ames, instructions for billet production, Madison Square area monthly accountability reports, myrnalloy production - Iowa, procedures for handling by-product materials, proposed research program of Iowa, reactor development, receiving report receipts at Ames of thorium, trip report, requirements for x-slugs, semi-monthly reports, shipments of materials, thorium accountability report, thorium bearing residues, indoor radon study volumes 1 and 2, and urine results.	05/14/2010	130
National Archives and Records Administration (NARA) - College Park	Unclassified Records Review: Survey reports and accountability related to beryllium, NCRP fertile women recommendation. (Research is ongoing with archivists at NARA Atlanta and NARA College Park to confirm location of records originally thought to be at the NARA Atlanta. Once boxes are located, data capture will be arranged.) Classified Records Review: Correspondence from 1947-1950	OPEN	2
National Archives and Records Administration (NARA) - Kansas City	Information on Oak Ridge facility decontamination history.	03/30/2005	1
National Institute of Occupational Safety and Health (NIOSH)	Memorandum of understanding.	11/24/2009	1
National Technical Information Service (NTIS)	Summary of environmental emissions including equipment, facilities, and economic evaluations.	06/08/2010	1
ORAU Team	Default assumptions and methods for atomic weapons employer dose reconstructions, occupational environmental doses for Ames Laboratory, U and Th operations, and processing uranium products.	06/24/2010	16
ORO Vault	List of papers written on uranium.	11/24/2003	1

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded To SRDB**
SAIC	Radiation exposures by AEC Operating Office, radiation exposure summaries, and a summary of whole body radiation exposures to external penetrating radiation.	09/02/2004	7
San Bruno Federal Records Center	Summaries of fuels and materials development programs.	01/31/2006	1
Sandy Cohen & Associates (SC&A)	Highly enriched uranium working group report, and TR-119 to attend the research materials coordination and planning meeting.	07/02/2008	4
Southern Illinois University	Disposal of radioactive wastes in the metropolitan St. Louis area.	10/08/2008	2
Unknown	Air samples, Blockson Chemical Company and other FUSRAP site information, semi-annual report of the Atomic Energy Commission, location of HP medical records - Mancuso Study, occupational exposure to thorium and beryllium, radiological hazards and controls for uranium operations, results of the doe indoor radon study, site history information, and urine, air dust, and slag sample results.	10/18/2003	34
TOTAL			**750**

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
Ames Public Library www.Catalogue.amespubliclibrary.org COMPLETED 06/18/2010	Manhattan Engineering District + Ames Manhattan Project + Ames Ames Laboratory + nuclear Ames Laboratory + atomic Ames Laboratory + atomic Ames + uranium	0	0
DOE CEDR http://cedr.lbl.gov/ COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	0	0

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	2	2
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 04/18/2010	Ames Laboratory Research Reactor Facility Iowa State University	9	9
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	66	8
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/19/2010 "Iowa State University"+01/01/1942 - 03/19/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/19/2010 "Institute for Atomic Research"+01/01/1942 - 03/19/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	12,319	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/14/2010 "Ames Lab"+01/01/1942 - 03/15/2010 "Iowa State University"+01/01/1942 - 03/18/2010 "Iowa State University"+01/01/1942 - 03/19/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/19/2010 "Institute for Atomic Research"+01/01/1942 - 03/19/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	4,718	81
Google http://www.google.com COMPLETED 04/11/2010	americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am" +"Ames Lab" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th" +"Ames Lab"	127,347	44

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"+"Ames Lab" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"+"Ames Lab" thorium OR Th232 OR Th-232 OR "Th 232" OR 232Th OR 232-Th+"Ames Lab" "232 Th" OR "Z metal" OR myrnalloy OR "chemical 10-66" OR "chemical 10-12"+"Ames Lab" ionium OR UX1 OR UX2 OR Th-230 OR Th230 OR "Th 230" OR 230-Th OR "230 Th"+"Ames Lab" 230Th OR Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th"+"Ames Lab" tritium OR H3 OR H-3 OR mint OR HTO+"Ames Lab" uranium OR U233 OR U-233 OR "U 233" OR 233U OR 233-U OR "233 U" +"Ames Lab" U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U" "Ames Lab" U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U" OR U238+"Ames Lab" "U 238" OR U-238 OR 238-U OR 238U OR "238 U"+"Ames Lab" U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U" OR "uranium extraction" OR "black oxide" OR "brown oxide"+"Ames Lab" "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3+"Ames Lab"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	UF4 OR UF6 OR C-216 OR C-616 OR C-65 OR C-211 OR U3O8+"Ames Lab" plutonium OR Pu-238 OR Pu238 OR "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu"+"Ames Lab" Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu OR "239 Pu"+"Ames Lab" Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" +"Ames Lab" Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"+"Ames Lab" radium OR Ra-226 OR Ra226 OR "Ra 226" OR 226-Ra OR 226Ra OR 226-Ra+"Ames Lab" Ra-228 OR Ra228 OR "Ra 228" OR 228Ra OR 228-Ra OR "228 Ra"+"Ames Lab" radon OR Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn OR "222 Rn"+"Ames Lab" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn"+"Ames Lab" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"+"Ames Lab" strontium OR Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr"+"Ames Lab" oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate" OR UNH OR K-65 OR "sump cake"+"Ames Lab"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"uranium dioxide" OR "uranium tetrafluoride" OR "uranium trioxide"+"Ames Lab" "uranium hexafluoride" OR "air count"+"Ames Lab" accident+"Ames Lab" "air dust" OR "air filter" OR "airborne test"+"Ames Lab" "alpha particle" OR "belgian congo ore" OR bioassay OR bio-assay+"Ames Lab" breath OR "breathing zone" OR BZ OR calibration OR "chest count" OR collimation OR columnation+"Ames Lab" contamination OR curie OR denitration OR "denitration pot"+"Ames Lab" derby OR regulus OR dose OR dosimeter+"Ames Lab" dosimetric OR dosimetry+"Ames Lab" electron+"Ames Lab" environment+"Ames Lab" "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure"+"Ames Lab" external+"Ames Lab" "F machine" OR fecal OR "feed material" OR femptocurie+"Ames Lab" film OR fission OR fluoroscopy+"Ames Lab" "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gas proportional" OR "gaseous diffusion"+"Ames Lab"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	health OR "health instrument" OR "health physics"+"Ames Lab" "H.I." OR HI OR HP OR "highly enriched uranium" OR HEU+"Ames Lab" hydrofluorination OR "in vitro" OR "in vivo"+"Ames Lab" incident OR ingestion OR inhalation OR internal+"Ames Lab" investigation+"Ames Lab" isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"+"Ames Lab" log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU+"Ames Lab" "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie+"Ames Lab" "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe"+"Ames Lab" nuclear OR Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion" OR "type A"+"Ames Lab" NTA OR "occupational radiation exposure" OR occurrence OR "ore concentrate" OR "PC Project"+"Ames Lab" permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP+"Ames Lab" "phosphate research" OR photofluorography OR photon OR picocurie OR pitchblende OR "pocket ion chamber" OR PIC+"Ames Lab" problem+"Ames Lab" procedure+"Ames Lab"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	radeco OR radiation+"Ames Lab" radioactive+"Ames Lab" radioactivity+"Ames Lab" radiograph OR radiological+"Ames Lab" "Radiological Survey Data Sheet" OR RSDS OR radionuclide OR raffinate OR reactor+"Ames Lab" respiratory OR "retention schedules" OR roentgen+"Ames Lab" sample+"Ames Lab" "air sample"+"Ames Lab" "dust sample" OR "general area air sample"+"Ames Lab" "solvent extraction"+"Ames Lab" source+"Ames Lab" "sealed source"+"Ames Lab" spectra+"Ames Lab" spectrograph+"Ames Lab" spectroscopy+"Ames Lab" spectrum+"Ames Lab" standard+"Ames Lab" "operating standard" OR "processing standard"+"Ames Lab" survey+"Ames Lab" "building survey" OR "routine survey"+"Ames Lab" "special survey" OR "technical basis"+"Ames Lab" "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD OR "Tiger Team"+"Ames Lab" "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC+"Ames Lab" "working level" OR WL+"Ames Lab" X-ray+"Ames Lab" "X ray"+"Ames Lab" Xray+"Ames Lab"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"x-ray screening"+"Ames Lab" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am"+"Iowa State University" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"+"Iowa State University" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"+"Iowa State University" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"+"Iowa State University" thorium+"Iowa State University" Th232 OR Th-232+"Iowa State University" "Th 232" OR 232Th OR 232-Th+"Iowa State University" "232 Th" OR "Z metal" OR myrnalloy OR "chemical 10-66" OR "chemical 10-12"+"Iowa State University" ionium OR UX1 OR UX2 OR Th-230 OR Th230 OR "Th 230" OR 230-Th OR "230 Th"+"Iowa State University" 230Th OR Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th"++"Iowa State University" tritium +"Iowa State University" H3+"Iowa State University" H-3+"Iowa State University" mint+"Iowa State University" HTO+"Iowa State University" uranium+"Iowa State University" U233 OR U-233 OR "U 233"+"Iowa State University" 233U OR 233-U OR "233 U" +"Iowa State University"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U"+"Iowa State University" U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U" OR U238 +"Iowa State University" "U 238" OR U-238 OR 238-U OR 238U OR "238 U"+"Iowa State University" U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U" OR "uranium extraction" OR "black oxide" OR "brown oxide"+"Iowa State University" "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3+"Iowa State University" UF4 OR UF6 OR C-216+"Iowa State University" C-616 OR C-65 OR C-211 OR U3O8+"Iowa State University" plutonium+"Iowa State University" Pu-238 OR Pu238+"Iowa State University" "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" +"Iowa State University" Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu OR "239 Pu"+"Iowa State University" Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" +"Iowa State University" Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"+"Iowa State University" radium+"Iowa State University" Ra-226 OR Ra226+"Iowa State University" "Ra 226" OR 226-Ra OR 226Ra OR 226-Ra+"Iowa State University"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	Ra-228 OR Ra228 OR "Ra 228" OR 228Ra OR 228-Ra OR "228 Ra"+"Iowa State University" radon+"Iowa State University" Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn OR "222 Rn"+"Iowa State University" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn"+"Iowa State University" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"+"Iowa State University" strontium+"Iowa State University" Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr"+"Iowa State University" oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate"+"Iowa State University" UNH+"Iowa State University" K-65 OR "sump cake"+"Iowa State University" "uranium dioxide" OR "uranium tetrafluoride" OR "uranium trioxide"+"Iowa State University" "uranium hexafluoride" OR "air count"+"Iowa State University" accident+"Iowa State University" "air dust" OR "air filter" OR "airborne test"+"Iowa State University" "alpha particle" OR "belgian congo ore"+"Iowa State University" bioassay OR bio-assay+"Iowa State University" breath OR "breathing zone" OR BZ OR calibration OR "chest count" OR collimation OR columnation+"Iowa State University"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	contamination+"Iowa State University" curie+"Iowa State University" denitration OR "denitration pot"+"Iowa State University" dose+"Iowa State University" derby+"Iowa State University" regulus OR dosimeter+"Iowa State University" dosimetric OR dosimetry+"Iowa State University" electron+"Iowa State University" environment+"Iowa State University" "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure"+"Iowa State University" external+"Iowa State University" fecal+"Iowa State University" "F machine" OR "feed material" OR femptocurie+"Iowa State University" film+"Iowa State University" fission OR fluoroscopy+"Iowa State University" "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gas proportional" OR "gaseous diffusion"+"Iowa State University" health+"Iowa State University" "health instrument" OR "health physics"+"Iowa State University" "H.I." OR HI OR HP+"Iowa State University" "highly enriched uranium" OR HEU+"Iowa State University" hydrofluorination OR "in vitro" OR "in vivo"+"Iowa State University" incident+"Iowa State University" ingestion OR inhalation OR internal+"Iowa State University" investigation+"Iowa State University"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"+"Iowa State University" log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU+"Iowa State University" "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie+"Iowa State University" "mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe"+"Iowa State University" nuclear+"Iowa State University" Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion" OR "type A" +"Iowa State University" NTA OR "occupational radiation exposure" OR "ore concentrate" OR "PC Project"+"Iowa State University" occurrence+"Iowa State University" permit+"Iowa State University" "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP+"Iowa State University" "phosphate research" OR photofluorography OR photon OR picocurie OR pitchblende OR "pocket ion chamber" OR PIC+"Iowa State University" problem+"Iowa State University" procedure+"Iowa State University" radeco OR radiation+"Iowa State University" radioactive+"Iowa State University"		

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

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"x-ray screening"+"Iowa State University" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am"+"Ames Laboratory Research Reactor Facility" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"+"Ames Laboratory Research Reactor Facility" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"+"Ames Laboratory Research Reactor Facility" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po"+"Ames Laboratory Research Reactor Facility" thorium+"Ames Laboratory Research Reactor Facility" Th232 OR Th-232+"Ames Laboratory Research Reactor Facility" "Th 232" OR 232Th OR 232-Th+"Ames Laboratory Research Reactor Facility" "232 Th" OR "Z metal" OR myrnalloy OR "chemical 10-66" OR "chemical 10-12"+"Ames Laboratory Research Reactor Facility" ionium OR UX1 OR UX2 OR Th-230 OR Th230 OR "Th 230" OR 230-Th OR "230 Th"+"Ames Laboratory Research Reactor Facility" 230Th OR Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th"+"Ames Laboratory Research Reactor Facility" tritium+"Ames Laboratory Research Reactor Facility" H3+"Ames Laboratory Research Reactor Facility" H-3+"Ames Laboratory Research Reactor Facility" mint+"Ames Laboratory Research Reactor Facility" HTO+"Ames Laboratory Research Reactor Facility" uranium+"Ames Laboratory Research Reactor Facility"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	U233 OR U-233 OR "U 233"+"Ames Laboratory Research Reactor Facility" U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U"+"Ames Laboratory Research Reactor Facility" U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U" OR U238 +"Ames Laboratory Research Reactor Facility" "U 238" OR U-238 OR 238-U OR 238U OR "238 U"+"Ames Laboratory Research Reactor Facility" U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U" OR "uranium extraction" OR "black oxide" OR "brown oxide"+"Ames Laboratory Research Reactor Facility" "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3+"Ames Laboratory Research Reactor Facility" UF4 OR UF6 OR C-216+"Ames Laboratory Research Reactor Facility" C-616 OR C-65 OR C-211 OR U3O8+"Ames Laboratory Research Reactor Facility" plutonium+"Ames Laboratory Research Reactor Facility" Pu-238 OR Pu238+"Ames Laboratory Research Reactor Facility" "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu" +"Ames Laboratory Research Reactor Facility" Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu OR "239 Pu"+"Ames Laboratory Research Reactor Facility" Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" +"Ames Laboratory Research Reactor Facility"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"+"Ames Laboratory Research Reactor Facility" radium+"Ames Laboratory Research Reactor Facility" Ra-226 OR Ra226+"Ames Laboratory Research Reactor Facility" "Ra 226" OR 226-Ra OR 226Ra OR 226-Ra +"Ames Laboratory Research Reactor Facility" Ra-228 OR Ra228 OR "Ra 228" OR 228Ra OR 228-Ra OR "228 Ra"+"Ames Laboratory Research Reactor Facility" radon+"Ames Laboratory Research Reactor Facility" Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn OR "222 Rn"+"Ames Laboratory Research Reactor Facility" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn"+"Ames Laboratory Research Reactor Facility" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"+"Ames Laboratory Research Reactor Facility" strontium+"Ames Laboratory Research Reactor Facility" Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr"+"Ames Laboratory Research Reactor Facility" oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate"+"Ames Laboratory Research Reactor Facility" UNH+"Ames Laboratory Research Reactor Facility" K-65 OR "sump cake"+"Ames Laboratory Research Reactor Facility" "uranium dioxide" OR "uranium tetrafluoride" OR "uranium trioxide"+"Ames Laboratory Research Reactor Facility"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"uranium hexafluoride" OR "air count"+"Ames Laboratory Research Reactor Facility" accident+"Ames Laboratory Research Reactor Facility" "air dust" OR "air filter" OR "airborne test"+"Ames Laboratory Research Reactor Facility" "alpha particle" OR "belgian congo ore"+"Ames Laboratory Research Reactor Facility" bioassay OR bio-assay+"Ames Laboratory Research Reactor Facility" breath OR "breathing zone" OR BZ OR calibration OR "chest count" OR collimation OR columnation+"Ames Laboratory Research Reactor Facility" contamination+"Ames Laboratory Research Reactor Facility" curie+"Ames Laboratory Research Reactor Facility" denitration OR "denitration pot"+"Ames Laboratory Research Reactor Facility" dose+"Ames Laboratory Research Reactor Facility" derby+"Ames Laboratory Research Reactor Facility" regulus OR dosimeter+"Ames Laboratory Research Reactor Facility" dosimetric OR dosimetry+"Ames Laboratory Research Reactor Facility" electron+"Ames Laboratory Research Reactor Facility" environment+"Ames Laboratory Research Reactor Facility" "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure"+"Ames Laboratory Research Reactor Facility"		

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

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

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	radiograph OR radiological+"Ames Laboratory Research Reactor Facility" "Radiological Survey Data Sheet" OR RSDS+"Ames Laboratory Research Reactor Facility" radionuclide+"Ames Laboratory Research Reactor Facility" raffinate OR reactor+"Ames Laboratory Research Reactor Facility" respiratory OR "retention schedules" OR roentgen+"Ames Laboratory Research Reactor Facility" sample+"Ames Laboratory Research Reactor Facility" "air sample"+"Ames Laboratory Research Reactor Facility" "dust sample" OR "general area air sample"+"Ames Laboratory Research Reactor Facility" "solvent extraction"+"Ames Laboratory Research Reactor Facility" source+"Ames Laboratory Research Reactor Facility" "sealed source"+"Ames Laboratory Research Reactor Facility" spectra+"Ames Laboratory Research Reactor Facility" spectrograph+"Ames Laboratory Research Reactor Facility" spectroscopy+"Ames Laboratory Research Reactor Facility" spectrum+"Ames Laboratory Research Reactor Facility" standard+"Ames Laboratory Research Reactor Facility" "operating standard" OR "processing standard"+"Ames Laboratory Research Reactor Facility" survey+"Ames Laboratory Research Reactor Facility" "building survey" OR "routine survey"+"Ames Laboratory Research Reactor Facility"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"special survey" OR "technical basis"+"Ames Laboratory Research Reactor Facility" "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD OR "Tiger Team"+"Ames Laboratory Research Reactor Facility" "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC +"Ames Laboratory Research Reactor Facility" "working level" OR WL+"Ames Laboratory Research Reactor Facility" X-ray+"Ames Laboratory Research Reactor Facility" "X ray"+"Ames Laboratory Research Reactor Facility" Xray+"Ames Laboratory Research Reactor Facility" "x-ray screening"+"Ames Laboratory Research Reactor Facility" americium OR Am241 OR Am-241 OR "AM 241" OR 241Am OR 241-Am OR "241 Am"+"Institute for Atomic Research" ionium OR Th230 OR Th-230 OR "Th 230" OR 230Th OR 230-Th OR "230 Th"+"Institute for Atomic Research" neptunium OR Np237 OR Np-237 OR "Np 237" OR 237Np OR 237-Np OR "237 Np"+"Institute for Atomic Research" polonium OR Po210 OR Po-210 OR "Po 210" OR 210Po OR 210-Po OR "210 Po" +"Institute for Atomic Research" thorium+"Institute for Atomic Research" Th232 OR Th-232+"Institute for Atomic Research" "Th 232" OR 232Th OR 232-Th+"Institute for Atomic Research" "232 Th" OR "Z metal" OR myrnalloy OR "chemical 10-66" OR "chemical 10-12"+"Institute for Atomic Research" ionium OR UX1 OR UX2 OR Th-230 OR Th230 OR "Th 230" OR 230-Th OR "230 Th"+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	230Th OR Th-234 OR Th234 OR "Th 234" OR 234-Th OR 234Th OR "234 Th"+"Institute for Atomic Research" tritium+"Institute for Atomic Research" H3+"Institute for Atomic Research" H-3+"Institute for Atomic Research" mint+"Institute for Atomic Research" HTO+"Institute for Atomic Research" uranium+"Institute for Atomic Research" U233 OR U-233 OR "U 233"+"Institute for Atomic Research" U234 OR "U 234" OR U-234 OR 234U OR 234-U OR "234 U"+"Institute for Atomic Research" U235 OR "U 235" OR U-235 OR 235-U OR 235U OR "235 U" OR U238 +"Institute for Atomic Research" "U 238" OR U-238 OR 238-U OR 238U OR "238 U"+"Institute for Atomic Research" U308 OR "U 308" OR U-308 OR 308-U OR 308U OR "308 U" OR "uranium extraction" OR "black oxide" OR "brown oxide"+"Institute for Atomic Research" "green salt" OR "orange oxide" OR "yellow cake" OR UO2 OR UO3+"Institute for Atomic Research" UF4 OR UF6 OR C-216+"Institute for Atomic Research" C-616 OR C-65 OR C-211 OR U3O8+"Institute for Atomic Research" plutonium+"Institute for Atomic Research" Pu-238 OR Pu238+"Institute for Atomic Research" "Pu 238" OR 238Pu OR 238-Pu OR "238 Pu"+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	Pu-239 OR Pu239 OR "Pu 239" OR 239Pu OR 239-Pu OR "239 Pu"+"Institute for Atomic Research" Pu-240 OR Pu240 OR "Pu 240" OR 240Pu OR 240-Pu OR "240 Pu" +"Institute for Atomic Research" Pu-241 OR Pu241 OR "Pu 241" OR 241Pu OR 241-Pu OR "241 Pu"+"Institute for Atomic Research" radium+"Institute for Atomic Research" Ra-226 OR Ra226+"Institute for Atomic Research" "Ra 226" OR 226-Ra OR 226Ra OR 226-Ra +"Institute for Atomic Research" Ra-228 OR Ra228 OR "Ra 228" OR 228Ra OR 228-Ra OR "228 Ra"+"Institute for Atomic Research" radon+"Institute for Atomic Research" Rn-222 OR Rn222 OR "Rn 222" OR 222Rn OR 222-Rn OR "222 Rn"+"Institute for Atomic Research" thoron OR Rn-220 OR Rn220 OR "Rn 220" OR 220Rn OR 220-Rn OR "220 Rn"+"Institute for Atomic Research" protactinium OR Pa-234m OR Pa234m OR "Pa 234m" OR 234mPa OR 234m-Pa OR "234m Pa"+"Institute for Atomic Research" strontium+"Institute for Atomic Research" Sr-90 OR Sr90 OR "Sr 90" OR 90-Sr OR 90Sr OR "90 Sr"+"Institute for Atomic Research" oralloy OR postum OR tuballoy OR "uranyl nitrate hexahydrate"+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	UNH+"Institute for Atomic Research" K-65 OR "sump cake"+"Institute for Atomic Research" "uranium dioxide" OR "uranium tetrafluoride" OR "uranium trioxide"+"Institute for Atomic Research" "uranium hexafluoride" OR "air count"+"Institute for Atomic Research" accident+"Institute for Atomic Research" "air dust" OR "air filter" OR "airborne test"+"Institute for Atomic Research" "alpha particle" OR "belgian congo ore"+"Institute for Atomic Research" bioassay OR bio-assay+"Institute for Atomic Research" breath OR "breathing zone" OR BZ OR calibration OR "chest count" OR collimation OR columnation+"Institute for Atomic Research" contamination+"Institute for Atomic Research" curie+"Institute for Atomic Research" denitration OR "denitration pot"+"Institute for Atomic Research" dose+"Institute for Atomic Research" derby+"Institute for Atomic Research" regulus OR dosimeter+"Institute for Atomic Research" dosimetric OR dosimetry+"Institute for Atomic Research" electron+"Institute for Atomic Research" environment+"Institute for Atomic Research" "Ether-Water Project" OR exposure OR "exposure investigation" OR "radiation exposure"+"Institute for Atomic Research" external+"Institute for Atomic Research" fecal+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"F machine" OR "feed material" OR femptocurie+"Institute for Atomic Research" film+"Institute for Atomic Research" fission OR fluoroscopy+"Institute for Atomic Research" "Formerly Utilized Sites Remedial Action Program" OR FUSRAP OR gamma-ray OR "gas proportional" OR "gaseous diffusion"+"Institute for Atomic Research" health+"Institute for Atomic Research" "health instrument" OR "health physics"+"Institute for Atomic Research" "H.I." OR HI OR HP+"Institute for Atomic Research" "highly enriched uranium" OR HEU+"Institute for Atomic Research" hydrofluorination OR "in vitro" OR "in vivo"+"Institute for Atomic Research" incident+"Institute for Atomic Research" ingestion OR inhalation OR internal+"Institute for Atomic Research" investigation+"Institute for Atomic Research" isotope OR isotopic OR "isotopic enrichment" OR "JS Project" OR Landauer OR "liquid scintillation"+"Institute for Atomic Research" log OR "log sheet" OR "log book" OR "low enriched uranium" OR LEU+"Institute for Atomic Research" "maximum permissible concentration" OR MPC OR metallurgy OR microcurie OR millicurie+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"mixed fission product" OR MFP OR monitor OR "air monitoring" OR nanocurie OR "nasal wipe" OR neutron OR "nose wipe"+"Institute for Atomic Research" nuclear+"Institute for Atomic Research" Chicago-Nuclear OR "nuclear fuels" OR "nuclear track emulsion"+"Institute for Atomic Research" "type A" +"Institute for Atomic Research" NTA OR "occupational radiation exposure" OR "ore concentrate" OR "PC Project"+"Institute for Atomic Research" occurrence+"Institute for Atomic Research" permit+"Institute for Atomic Research" "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP+"Institute for Atomic Research" "phosphate research" OR photofluorography OR photon OR picocurie OR pitchblende OR "pocket ion chamber" OR PIC+"Institute for Atomic Research" problem+"Institute for Atomic Research" procedure+"Institute for Atomic Research" radeco OR radiation+"Institute for Atomic Research" radioactive+"Institute for Atomic Research" radioactivity+"Institute for Atomic Research" radiograph OR radiological+"Institute for Atomic Research" "Radiological Survey Data Sheet" OR RSDS+"Institute for Atomic Research" radionuclide+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	raffinate OR reactor+"Institute for Atomic Research" respiratory OR "retention schedules" OR roentgen+"Institute for Atomic Research" sample+"Institute for Atomic Research" "air sample"+"Institute for Atomic Research" "dust sample" OR "general area air sample"+"Institute for Atomic Research" "solvent extraction"+"Institute for Atomic Research" source+"Institute for Atomic Research" "sealed source"+"Institute for Atomic Research" spectra+"Institute for Atomic Research" spectrograph+"Institute for Atomic Research" spectroscopy+"Institute for Atomic Research" spectrum+"Institute for Atomic Research" standard+"Institute for Atomic Research" "operating standard" OR "processing standard"+"Institute for Atomic Research" survey+"Institute for Atomic Research" "building survey" OR "routine survey"+"Institute for Atomic Research" "special survey" OR "technical basis"+"Institute for Atomic Research" "thermal diffusion" OR "thermoluminescent dosimeter" OR TLD OR "Tiger Team"+"Institute for Atomic Research" "tolerance dose" OR urinalysis OR urine OR "whole body count" OR WBC +"Institute for Atomic Research" "working level" OR WL+"Institute for Atomic Research" X-ray+"Institute for Atomic Research"		

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"X ray"+"Institute for Atomic Research" Xray+"Institute for Atomic Research" "x-ray screening"+"Institute for Atomic Research" ESH&A Program Manual+"Ames Lab" ESH&A Program Manual+"Iowa State University" ESH&A Program Manual+"Ames Laboratory Research Reactor Facility" ESH&A Program Manual+"Institute for Atomic Research" Harley A. Wilhelm+"Ames Lab" Harley A. Wilhelm+"Iowa State University" Harley A. Wilhelm+"Ames Laboratory Research Reactor Facility" Harley A. Wilhelm+"Institute for Atomic Research" Harley Wilhelm+"Ames Lab" "Harley Wilhelm"+"Iowa State University" Harley Wilhelm+"Ames Laboratory Research Reactor Facility" Harley Wilhelm+"Institute for Atomic Research" "Frank Spedding"+"Ames Lab" "Frank Spedding"+"Iowa State University" Frank Spedding+"Ames Laboratory Research Reactor Facility" Frank Spedding+"Institute for Atomic Research"		
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 06/14/2010	Ames Iowa State	43	0
Iowa State University Library www.primofe-1.lib.iastate.edu COMPLETED 06/18/2010	Manhattan Engineering District + Ames Manhattan Engineering + Ames	0	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 06/14/2010	Ames Iowa State	30	0
National Academies Press http://www.nap.edu/ COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010	2,288	0

Table A1-2: Database Searches for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded to SRDB**
	"Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010		
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	550	19
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 04/18/2010	"Ames Lab" "Iowa State University" "Ames Laboratory Research Reactor Facility" "Institute for Atomic Research"	1	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 03/20/2010	"Ames Lab"+01/01/1942 - 03/20/2010 "Iowa State University"+01/01/1942 - 03/20/2010 "Ames Laboratory Research Reactor Facility"+01/01/1942 - 03/20/2010 "Institute for Atomic Research"+01/01/1942 - 03/20/2010 "Harley A. Wilhelm"+01/01/1942 - 03/20/2010 "Frank Spedding"+01/01/1942 - 03/20/2010	0	0

Table A1-3: Cincinnati Public Library Documents Ordered			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: NA OSTI ID: 85990 Ref ID: 81050	In-Situ Characterization Technique for Screening Contaminated Soils from Journal of Environmental Engineering, Vol 121(7):521-526, July 1995	05/04/2010	05/04/2010
DOC Number: NA OSTI ID: 4351662 Ref ID: 81221	Reduction of Uranium With Magnesium, Metal Progress, Vol 69(3):81-88, Mar 1956	05/04/2010	05/04/2010
DOC Number: NA OSTI ID: 5268990 Ref ID: 81220	Waste Fuel Mix Saves University $41,600 Yearly from Energy User News Vol 7(23):5, Jun 7, 1982	05/04/2010	05/04/2010
DOC Number: CONF-890604 OSTI ID: 6757028 Ref ID: 81219	The Role of the Iowa State University Research Reactor in Nuclear Engineering Education from Transactions of the American Nuclear Society, Vol 59, Annual Meeting of the American Nuclear Society, 4-8 Jun 1989	05/04/2010	05/05/2010
DOC Number: CONF-690312 OSTI ID: 4150845 Ref ID: 81286	Instructions in Applications of Nuclear Devices at Iowa State University from Education for Peaceful Uses of Nuclear Explosives from Symposium on Education for the Peaceful uses of Nuclear Explosives Pp 281-283, Jan 1970	05/04/2010	05/10/2010
DOC Number: CONF-660630; IS-1379 OSTI ID: 4509093 Ref ID: 81752	Uranium Metal by Carbon Reduction of Uranium Oxide in Vacuum from Vacuum Metallurgy Conference, Jun 14, 1966	05/04/2010	05/25/2010
DOC Number: NA OSTI ID: 4663051 Ref ID: 81288	Environmental Trace Element Survey at a Heavy Metals Refining Site, Nuclear Methods in Environmental Research from Meeting on Nuclear Methods in Environmental Research, Pp 172-185, Jan 1971	04/28/2010	05/11/2010
DOC Number: NA OSTI ID: 381792 Ref ID: 81287	Full-Scale Technology Demonstration of a Polyethylene Encapsulation Process for Radioactive, Hazardous, and Mixed Wastes from Journal of Environmental Science and Health, Part A: Environmental Science and Engineering, Vol 31(7):1767-1780, Aug 1996	04/28/2010	05/11/2010
DOC Number: UNI-SA-103; CONF-821005-4 OSTI ID: 5115872 Ref ID: NA	Decommissioning of the Ames Laboratory Research Reactor from DOE International Decommissioning Symposium, Oct 10, 1982	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-4789 OSTI ID: 5402590 Ref ID: 25824	Decommissioning of the Ames Laboratory Research Reactor. Final Report, Dec 1981	04/28/2010	04/28/2010
DOC Number: IS-4798 OSTI ID: 5304492 Ref ID: 25429	Environmental Monitoring Summary for Ames Laboratory: Calendar Year 1981, Apr 1982	04/28/2010	04/28/2010
DOC Number: IS-1098 OSTI ID: 4641828 Ref ID: 25884	Survey of Environmental Radioactivity (Cy 1963?), December 1964	04/28/2010	04/28/2010
DOC Number: PB-274552 OSTI ID: 6812936 Ref ID: 81261	Evaluation of the Ames Solid Waste Recovery System. Part I. Summary of Environmental Emissions: Equipment, Facilities, and Economic Evaluations. Interim Report 5 Feb 76--4 Feb 77, Nov 1977	04/28/2010	06/08/2010
DOC Number: CC-2401 OSTI ID: 4365563 Ref ID: NA	A Method of Recovering Thorium from Slag Materials. Problem Assignment No. 16, Mar 23, 1945	04/28/2010	
DOC Number: WASH-149 OSTI ID: 4360605 Ref ID: NA	Air Cleaning Seminar, Ames Laboratory, September 15-17, 1952, Mar 1954	04/28/2010	
DOC Number: ANL-7934? OSTI ID: 4638706 Ref ID: NA	Ames Laboratory Holly Programming System, January 1972	04/28/2010	
DOC Number: ANL-7934? OSTI ID: 4650114 Ref ID: NA	Ames Laboratory Interactive Hardware Programmed Polly, January 1972	04/28/2010	
DOC Number: IS-4955 OSTI ID: 6617260 Ref ID: NA	Ames Laboratory Quarterly Report, October 1, 1987--December 31, 1987, Feb 1988	04/28/2010	
DOC Number: IS-3483 OSTI ID: 4249469 Ref ID: NA	Ames Laboratory Reactor Operator Training Program, Aug 1974	04/28/2010	
DOC Number: IS-1500 OSTI ID: 4530066 Ref ID: NA	Annual Summary Research Report in Engineering, Oct 31, 1966	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-1500, Sect M OSTI ID: 4518493 Ref ID: NA	Annual Summary Research Report in Metallurgy, Oct 31, 1966	04/28/2010	
DOC Number: IS-1500, Sect P OSTI ID: 4508143 Ref ID: NA	Annual Summary Research Report in Physics, Oct 31, 1966	04/28/2010	
DOC Number: IS-900 OSTI ID: 4666506 Ref ID: NA	Annual Summary Research Report of Chemistry, Engineering, Metallurgy, Physics And Reactor Divisions, July 1, 1963-June 30, 1964, Sep 1964	04/28/2010	
DOC Number: AECU-1817 OSTI ID: 4394686 Ref ID: NA	Backscattering of Beta-Rays In Windowless Geiger-Muller Counters, Oct 31, 1952	04/28/2010	
DOC Number: AECD-3249 OSTI ID: 4399591 Ref ID: NA	Compounds of Thorium with Transition Metals I. The Thorium-Manganese System, Aug 24, 1951	04/28/2010	
DOC Number: M-4585 OSTI ID: 4365308 Ref ID: NA	Corrosion of Thorium and Related Materials, Oct 31, 1956	04/28/2010	
DOC Number: IS-T-1555 OSTI ID: 10140375 Ref ID: NA	Encapsulation of Hazardous Wastes into Agglomerates, Jan 28, 1992	04/28/2010	
DOC Number: DOE/EA-0434 OSTI ID: 7043259 Ref ID: NA	Environmental Assessment for US Department of Energy Support of an Iowa State University Linear Accelerator Facility at Ames, Iowa, May 1990	04/28/2010	
DOC Number: IS-4734 OSTI ID: 5309715 Ref ID: NA	Environmental Monitoring at Ames Laboratory: Calendar Year 1979, Apr 1980	04/28/2010	
DOC Number: IS-4844 OSTI ID: 6681447 Ref ID: NA	Environmental Research and Development Measurement and Dosimetry. Quarterly Report, April 1, 1983-June 30, 1983, Oct 1983	04/28/2010	
DOC Number: IS-4869 OSTI ID: 6011268 Ref ID: NA	Environmental Research and Development: Measurement and Dosimetry. Quarterly Report, April 1-June 30, 1984, Sep 1984	04/28/2010	
DOC Number: ANL-7934? OSTI ID: 4626725 Ref ID: NA	General Description of the Ames Laboratory Polly, January 1972	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-4818 OSTI ID: 5722416 Ref ID: NA	Health and Environmental Research. Quarterly Report, April 1-June 30, 1982, Nov 1982	04/28/2010	
DOC Number: IS-4791 OSTI ID: 5171787 Ref ID: NA	Health and Environmental Research. Quarterly Report, October 1-December 31, 1981. [Health And Environmental Effects of Waste and Biomass to Energy Processes], Apr 1982	04/28/2010	
DOC Number: IS-4841 OSTI ID: 5534946 Ref ID: NA	Identification and Characterization of Pollutants. Quarterly Report, January 1-March 31, 1983, Jun 1983	04/28/2010	
DOC Number: ISC-653 OSTI ID: 4362480 Ref ID: NA	Kinetics of the Reaction Between Thorium and Water Vapor, Jun 1955	04/28/2010	
DOC Number: DOE/ER/75360-2 OSTI ID: 5374102 Ref ID: NA	Low Enrichment Fuel Conversion for Iowa State University, Aug 1990	04/28/2010	
DOC Number: IS-4718 OSTI ID: 5585528 Ref ID: NA	Office of Health and Environmental Research. Quarterly Report, April 1, 1979-June 30, 1979. [Ames Municipal Solid Waste Recovery System], Oct 1979	04/28/2010	
DOC Number: IS-2600 OSTI ID: 4691951 Ref ID: NA	Physics Division, January 1971	04/28/2010	
DOC Number: CC-2962 OSTI ID: 4365562 Ref ID: NA	Precipitation of Thorium Oxalate from Nitric Acid Solutions. Problem No. 117, Oct 1945	04/28/2010	
DOC Number: AECD-4001 OSTI ID: 4360182 Ref ID: NA	Progress Report in Metallurgy, April 1, 1949 to September 30, 1949, Nov 15, 1949	04/28/2010	
DOC Number: ISC-135 OSTI ID: 4409518 Ref ID: NA	Progress Report in Physics for the Period July 1, 1950, to December 31, 1950, Mar 15, 1951	04/28/2010	
DOC Number: IS-4740 OSTI ID: 5375416 Ref ID: NA	Quarterly Report, 1 January-31 March 1980, May 1980	04/28/2010	
DOC Number: IS-4735 OSTI ID: 5267734 Ref ID: NA	Quarterly Report, 1 October-31 December 1979, Mar 1980	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-4707 OSTI ID: 5829597 Ref ID: NA	Quarterly Report, January 1-March 31, 1979, Jul 1979	04/28/2010	
DOC Number: ISC-69 OSTI ID: 4337900 Ref ID: NA	Quarterly Summary Research Report for April, May, and June 1949, Nov 28, 1949	04/28/2010	
DOC Number: AECD-4023 OSTI ID: 4360181 Ref ID: NA	Quarterly Summary Research Report for July, August, and September 1951, Nov 15, 1951	04/28/2010	
DOC Number: AECD-3929 OSTI ID: 4366878 Ref ID: NA	Quarterly Summary Research Report for October, November, and December 1950, Jan 30, 1951	04/28/2010	
DOC Number: ISC-642 OSTI ID: 4364249 Ref ID: NA	Quarterly Summary Research Report in Engineering for April, May, June 1955, Nov 23, 1955	04/28/2010	
DOC Number: ISC-487 OSTI ID: 4363962 Ref ID: NA	Quarterly Summary Research Report in Physics for January, February, and March 1954, Jun 26, 1954	04/28/2010	
DOC Number: ISC-533 OSTI ID: 4382994 Ref ID: NA	Quarterly Summary Research Report in Physics for July, August, and September 1954, Dec 21, 1954	04/28/2010	
DOC Number: IS-900 OSTI ID: 4643927 Ref ID: NA	Reactor Division, Oct 31, 1965	04/28/2010	
DOC Number: CONF-641207-5 OSTI ID: 4643940 Ref ID: NA	Regulations and Control for Radiation Protection. Paper No. 64-819 From American Society of Agricultural Engineers, Winter Meeting, Dec 31, 1965	04/28/2010	
DOC Number: AECD-4046 OSTI ID: 4360180 Ref ID: NA	Semi-Annual Progress Report in Metallurgy for The Period October 1, 1950- March 31, 1951, May 1951	04/28/2010	
DOC Number: ISC-757 OSTI ID: 4358865 Ref ID: NA	Semi-Annual Summary Research Report in Chemistry for January-June 1956, Oct 12, 1956	04/28/2010	
DOC Number: ISC-834 OSTI ID: 4368061 Ref ID: NA	Semi-Annual Summary Research Report in Chemistry for July-December 1956, Mar 15, 1957	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: ISC-760 OSTI ID: 4366223 Ref ID: NA	Semi-Annual Summary Research Report in Engineering for January-June 1956, Oct 1, 1956	04/28/2010	
DOC Number: ISC-836 OSTI ID: 4366534 Ref ID: NA	Semi-Annual Summary Research Report in Engineering for July-December 1956, Mar 15, 1957	04/28/2010	
DOC Number: ISC-463 OSTI ID: 4361723 Ref ID: NA	Solubility of Carbon in Thorium, Feb 18, 1954	04/28/2010	
DOC Number: AECD-3206; ISC-102 OSTI ID: 4408189 Ref ID: NA	Some Studies on the Uranium-Thorium-Zirconium Ternary Alloy System, June 1950	04/28/2010	
DOC Number: IS-1523 OSTI ID: 4439008 Ref ID: NA	Survey of Environmental Radioactivity (Cy 1966?), January 1967	04/28/2010	
DOC Number: IS-2154 OSTI ID: 4768629 Ref ID: NA	Survey of Environmental Radioactivity for Period January 1, 1969 to June 30, 1969, Jan 1969	04/28/2010	
DOC Number: IS-1924 OSTI ID: 4486804 Ref ID: NA	Survey of Environmental Radioactivity for Period January 1--June 30, 1968, Jan 1968	04/28/2010	
DOC Number: IS-1647 OSTI ID: OSTI ID: 4275110 Ref ID: NA	Survey of Environmental Radioactivity for Period, January 1, 1967--June 30, 1967, Jan 1967	04/28/2010	
DOC Number: ISC-14 OSTI ID: 4338203 Ref ID: NA	The Chelate Compounds of Plutonium (Thesis), May 25, 1946	04/28/2010	
DOC Number: IS-986 OSTI ID: 4649643 Ref ID: NA	The Creep of Thorium Near Room Temperature, Sep 1964	04/28/2010	
DOC Number: ISC-417 OSTI ID: 4406585 Ref ID: NA	The Determination of Mesothorium in Thorium Nitrate, Nov 1953	04/28/2010	
DOC Number: AECD-3544; ISC-391 OSTI ID: 4408551 Ref ID: NA	The Niobium-Thorium Alloy System, Aug 13, 1953	04/28/2010	

Table A1-4: OSTI Documents Requested			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: TSC-700 OSTI ID: 4357623 Ref ID: NA	The Stress-Strain Characteristics of Uranium, Dec 1955	04/28/2010	
DOC Number: ISC-48 OSTI ID: 4363430 Ref ID: NA	Thorium Alloys--The Thorium-Bismuth System, Jul 12, 1950	04/28/2010	
DOC Number: DOE/EH-0264 OSTI ID: 10154495 Ref ID: NA	Tiger Team Assessment of the Ames Laboratory, Mar 1992	04/28/2010	