SEC Petition Evaluation Report

Petition SEC-00245

Report Rev Number:	0
Report Submittal Date:	November 30, 2017
Subject Expert(s):	Chris Miles
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition Number:	SEC-00245
Petition Type:	83.14
Petition A Receipt Date:	November 30, 2017
DOE/AWE Facility Name:	Ames Laboratory

Petition Class

NIOSH-Proposed Class Definition:	All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked in any area at the Ames Laboratory in Ames, Iowa, during the period from January 1, 1971 through December 31, 1989, 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 included in the Special Exposure Cohort.

Related Petition Summary Information

SEC Petition Tracking Number(s):	SEC-00038 SEC-00075 SEC-00166 SEC-00185
Petition Type:	83.13 83.13 83.13 83.14
DOE/AWE Facility Name:	Ames Laboratory
Petition Status:	Class added to the SEC for January 1, 1942 through December 31, 1954 Class added to the SEC for January 1, 1955 through December 31, 1970 Class added to the SEC for January 1, 1955 through December 31, 1960 Class added to the SEC for August 13, 1942 through December 31, 1970

Related Evaluation Report Information

Report Title:	SEC Petition Evaluation Report for Petition SEC-00038 SEC Petition Evaluation Report for Petition SEC-00075 SEC Petition Evaluation Report for Petition SEC-00166 SEC Petition Evaluation Report for Petition SEC-00185
DOE/AWE Facility Name:	Ames Laboratory

ORAU Preparation and Review

ORAU Lead Technical Evaluator:	Chris Miles
ORAU Peer Review Completed By:	Michael Kubiak

DCAS Review and Approval

Peer Review Completed By:	[Signature on File] *Thomas P. Tomes* November 30, 2017
SEC Petition Evaluation Reviewed By:	[Signature on File] *James W. Neton* November 30, 2017
SEC Petition Evaluation Approved By:	[Signature on File] *Stuart L. Hinnefeld* November 30, 2017

Evaluation Report Summary: SEC-00245, Ames Laboratory

The National Institute for Occupational Safety and Health (NIOSH) prepared this evaluation report in response to a petition to add a class of workers at the Ames Laboratory to the Special Exposure Cohort (SEC). The *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, (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*, describe the process for adding new classes to the SEC.

On August 24, 2011, the Advisory Board on Radiation and Worker Health (Advisory Board) discussed and accepted the class proposed by NIOSH in its *SEC Petition Evaluation Report for Petition SEC-00185, Ames Laboratory* (NIOSH, 2011). In its report, NIOSH evaluated the feasibility of reconstructing radiation doses for all workers who worked at Ames Laboratory during the time period of August 13, 1942 through December 31, 1970. Based on its research at that time and the prior evaluation reports identified on the cover page of this document, NIOSH defined a single class of employees for which it could not estimate radiation doses with sufficient accuracy from August 13, 1942 through December 31, 1970. The internal dose reconstruction infeasibility identified by NIOSH for that period was due primarily to a lack of data necessary to fully reconstruct internal doses during that time period, including doses from thorium and other radionuclides.

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations at Ames Laboratory is currently specified as August 13, 1942 to the present. Since the issuance of the 2011 report, NIOSH has continued its evaluation of Ames Laboratory for the post-1970 period. The current conclusions of this ongoing evaluation are presented in this report.

NIOSH-Proposed Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked in any area at the Ames Laboratory in Ames, Iowa, during the period from January 1, 1971 through December 31, 1989, 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 included in the Special Exposure Cohort.

Feasibility of Dose Reconstruction Findings

In addition to the dose reconstruction infeasibilities identified in the 2011 Evaluation Report (NIOSH, 2011) for the period from August 13, 1942 through December 31, 1970, NIOSH now finds it lacks sufficient internal dosimetry, air monitoring, and detailed operations descriptions to allow it to estimate internal exposures with sufficient accuracy for all workers at the site from January 1, 1971 through December 31, 1989. In this SEC-00245 evaluation report, NIOSH has determined that there is insufficient information to fully reconstruct internal doses from exposure to uranium and thorium (and their progeny), and other radionuclides, from January 1, 1971 through December 31, 1989. However, NIOSH has determined that partial internal dose reconstructions can be performed for workers who were monitored during this period.

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

- Principal sources of internal radiation dose for members of the evaluated class included exposures to uranium and thorium and their decay products. Other sources included fission and activation products, tritium, and miscellaneous other radionuclides used in research. The modes of exposure were inhalation and ingestion during metal fabrication, research and development, and machining activities or during the subsequent resuspension of these materials due to decontamination or decommissioning activities.

- In this current evaluation, NIOSH has determined that there are insufficient data available to estimate intakes from site research and developmental work with various radionuclides, and from remediation and decontamination work in various site buildings and grounds, for the period from January 1, 1971 through December 31, 1989. Although the major uranium and thorium production operations had concluded at Ames Laboratory prior to this time period, process development and research continued with those materials and with other radionuclides. Such operations took place in multiple buildings at Ames Laboratory, including the Metals Development Building, Spedding Hall, Wilhelm Hall, the Waste Handling Building in the Ames Laboratory Research Reactor area, and other locations. Decontamination and remediation activities were also prevalent throughout Ames Laboratory during this period.

- NIOSH has now concluded that there are insufficient internal dosimetry data or air monitoring data available to estimate intakes of uranium, thorium, or other radionuclides prior to 1990. By 1990, with the implementation of DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE, 1988), radiological control and dose assessment programs were reevaluated and improved.

- Based on the lack of internal dose monitoring data or air monitoring data for Ames Laboratory workers during the period from January 1, 1971 through December 31, 1989, NIOSH has determined that sufficiently accurate internal dose reconstruction is not feasible. NIOSH is continuing to evaluate the post-1989 period.

- Pursuant to 42 C.F.R. §83.13(c)(1), NIOSH determined that there is insufficient information for the period from January 1, 1971 through December 31, 1989 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 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, 1971 through December 31, 1989, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

The NIOSH evaluation did not identify any evidence that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures, such as nuclear criticality incidents or other events involving similarly high levels of exposures. However, the evidence reviewed in this evaluation indicates that some employees in the class may have accumulated chronic radiation exposures through intakes of uranium and thorium (and their progeny), and other radionuclides, as well as direct exposure to radioactive materials. Therefore, 42 C.F.R. §83.13(c) (3) (ii) requires NIOSH to specify that health may have been endangered for those employees covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

This page intentionally left blank

Table of Contents

Tables

SEC Petition Evaluation Report for SEC-00245

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Chris Miles; Quantaflux, LLC. 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 employees who worked at Ames Laboratory during a specified time. It provides information and analysis 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, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

This evaluation, in which NIOSH provides its findings both on the feasibility of estimating radiation doses of members of this class with sufficient accuracy and on health endangerment, was conducted in accordance with the requirements of EEOICPA and 42 C.F.R. § 83.14.

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 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 proposed class of employees through NIOSH dose reconstructions.[1]

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 petitioners and the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, 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

[1] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available on the NIOSH Radiation Dose Reconstruction Program page.

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 final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 NIOSH-Proposed Class Definition and Petition Basis

The NIOSH-proposed class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked in any area at the Ames Laboratory in Ames, Iowa, during the period from January 1, 1971 through December 31, 1989, 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 included in the Special Exposure Cohort. During this period, employees at this facility were involved with metal fabrication, research and development, and remediation activities associated with thorium, uranium, tritium, and various fission and activation products.

The evaluation responds to Petition SEC-00245, which was submitted by an EEOICPA claimant whose dose reconstruction could not be completed by NIOSH due to a lack of sufficient dosimetry-related information. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. §83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at the Ames Laboratory from August 13, 1942 through December 31, 1989 and the information available to NIOSH to characterize particular processes and radioactive source materials. Using available sources, NIOSH has attempted to gather process and source descriptions, information regarding the identity and quantities of radionuclides of concern, and information describing processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

Although this evaluation is for the period from January 1, 1971 through December 31, 1989, activities that took place in prior years are still relevant and are included in this section because prior activities likely resulted in residual contamination that would have affected workers in the later years.

4.1 Operations Description

This section summarizes the operations performed at Ames Laboratory that are relevant to the proposed SEC time period. Additional information associated with operations at Ames Laboratory during prior years (1942-1970) can be found in the NIOSH evaluation reports for petitions

[2] See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available on the NIOSH Radiation Dose Reconstruction Program page.

SEC-00038, SEC-00075, SEC-00166, and SEC-00185 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010; NIOSH 2011).

The Ames Laboratory site is located in Ames, Iowa and consists of a number of buildings at Iowa State University. Ames Laboratory has consisted of several buildings, some obtained from the University and some built after operations began. Over the lifetime of the facility, some of the buildings have been demolished. Buildings hosting radiological operations included the Physical Chemistry Annex I, the Physical Chemistry Annex II, the Chemistry Building (later called Gilman Hall), the Metallurgy Building (later called Wilhelm Hall), the Research Building (later called Spedding Hall), the Metals Development Building, and the Ames Laboratory Research Reactor. The Ames Laboratory workforce began with a few dozen researchers in 1942 and grew to almost 1000 individuals by 1970 (Monitoring Results, 1970). Ames Laboratory remains operational to this day; approximately 745 people are currently involved with the Laboratory either as full- or part-time employees or as Laboratory associates.

The Ames Project/Laboratory played a key role in the production of strategic nuclear materials for the Manhattan Project and the AEC. Between mid-1942 and August 1945, more than 1,000 tons of pure uranium metal was supplied to the Manhattan Project. Large-scale thorium production also took place at Ames Laboratory from 1943 through 1953. More than 65 tons of pure thorium metal and thorium compounds were produced during this time period. Residual contamination resulting from these early large-scale uranium and thorium operations persisted throughout the 1950s and 1960s and into the period of this evaluation, during which time workers were potentially exposed as a result of remediation activities that occurred in several of the affected buildings and waste burial areas.

Throughout its history, Ames Laboratory has conducted ongoing research work with laboratory quantities of various radioactive material, including plutonium, tritium, and C-14. Radionuclides mentioned in Gilman Hall surveys from 1967 through 1970 include Co-57, Sn-119, Ho-160, Er-169, Ag-110, Yb-169, tritium, and thorium (Rad Surveys, 1967-1970). Surveys in the Metals Development Building from 1966 through 1992 mention C-14, Nd-147, Tm-170, U-235, and natural uranium (Metals Development Surveys, 1966-1974; Metals Development Surveys, 1971-1992). The Laboratory also performed development work with larger-than-laboratory quantities of thorium and uranium in the Metals Development Building and Spedding Hall. These activities were ongoing throughout the time period of this evaluation and beyond.

The Ames Laboratory Research Reactor (ALRR), a heavy-water-moderated reactor, operated from 1961 through 1977. This reactor was located at the Applied Science Center (ASC), which is about a mile from the main campus. The reactor was decommissioned in 1978-1982. During the period of reactor operation and decommissioning, workers were potentially exposed to tritium and fission and activation products.

Also at the ASC is the Alpha Glovebox Facility, used for studying plutonium and uranium chemistry, and the Waste Disposal Building, used for storing and packaging radioactive and hazardous wastes. Waste burial sites located in the ASC area were another potential source of worker exposures, particularly during remediation. In 1987, the Annex 1 refuse disposal site at the ASC was excavated and the contents disposed of at Hanford (Appraisal Report, 1990).

4.2 Radiation Exposure Potential from Operations

The following subsections provide an overview of the internal and external exposure potential for the Ames Laboratory class under evaluation. Descriptions of facility-specific radiological operations are presented in more detail in Section 4.4.

4.2.1 Internal Exposure Potential

Sources of internal radiation dose for members of the evaluated class included exposures to uranium and thorium and their decay products. Other sources included fission and activation products, tritium, and miscellaneous other radionuclides used in research. The modes of exposure were inhalation and ingestion during metal fabrication, research and development, and machining activities, or during the subsequent resuspension of these materials due to decontamination or decommissioning activities.

4.2.2 External Exposure Potential

The potential for external radiation doses from uranium, uranium decay products, thorium, and thorium decay products existed at the Ames Laboratory site. In addition, workers at the Ames Laboratory Research Reactor had the potential for external gamma and neutron exposure.

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor. HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of employees covered by this report. Details regarding external dose are, therefore, not addressed in this document.

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations at Ames Laboratory is currently specified as August 13, 1942 to the present in the DOE EEOICPA covered facilities database (https://ehss.energy.gov/Search/Facility/ViewByName.aspx).

As shown on the cover page of this report, there have been four previous SEC evaluation reports that have resulted in the DHHS designating that a class of Ames Laboratory workers be included in the SEC:

- SEC-00038: January 1, 1942 through December 31, 1954 (2006 designation)
- SEC-00075: January 1, 1955 through December 31, 1970 (2007 designation)
- SEC-00166: January 1, 1955 through December 31, 1960 (2010 designation)
- SEC-00185: August 13, 1942 through December 31, 1970 (2011 designation)

This current evaluation considers additional information obtained on radiological work performed at Ames Laboratory and the feasibility of reconstructing intakes from those operations.

4.4 Site Locations Associated with Radiological Operations

This section summarizes information on the major buildings of Ames Laboratory. This section ends with NIOSH's conclusion regarding whether it is feasible to: (1) define boundaries between radiological and non-radiological areas; and (2) to characterize employee movements across the Ames Laboratory site.

- **Chemistry Building (Gilman Hall)**

  The initial Ames Project work was conducted in early 1942 in the Chemistry Building. This work included developing the process for purifying uranium metal as well as the methods and equipment for increasing production. Experiments to purify uranium metal continued through September 1942. Pure uranium metal was being produced at a rate of 100 pounds per week by October. By December 1942, the chemical reduction component of the operations was moved to Physical Chemistry Annex 1. Uranium casting remained in the Chemistry Building until "early 1943" when it was also moved to Annex 1. 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. Other research occurring in the Chemistry Building involved development of pure thorium metal, thorium alloys and compounds, yttrium metal, cerium metal, and beryllium metal. 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. Radiological surveys from 1967 through 1970 suggest that laboratory work with radioactive materials persisted in the building at least until 1970 (Rad Surveys, 1967-1970). Radionuclides mentioned in those surveys include Co-57, Sn-119, Ho-160, Er-169, Ag-110, Yb-169, tritium, and thorium. A radiological survey of Rooms 37 and 38 conducted on December 13, 1982 indicates that those rooms were being cleared for transfer to the University. All results were background (Final Survey, 1982). The Chemistry Building was decontaminated and surveyed in May 1976 (Ames History, 1979). The stairwell enclosure area was decontaminated and returned to an unrestricted use category in 1981-1982 (Appraisal Report, 1990).

- **Metallurgy Building (Wilhelm Hall)**

  The Metallurgy Building, constructed by the AEC, was completed in October 1949. The building housed research directed toward the development of special metals and alloys used in nuclear energy projects. Zircaloy was initially developed at Ames Laboratory as part of a basic study of the zirconium-tin alloy phase diagram. The subject of reactor coolants was studied, as were the heat-transfer properties of various metals and alloys. 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. A glovebox line in the Metallurgy Building was used to study the behavior of plutonium in molten-metal systems.

  Thorium production and research activities were moved from Physical Chemistry Annex 1 to the Metallurgy Building in 1949 and thorium work continued there until 1953. Poor contamination-control practices and poor ventilation contributed to building contamination. However, contamination levels were reduced by mitigation, decontamination, remodeling, and renovation

projects. Contaminated ductwork was removed and disposed in the early 1990s (Hokel, 1998). Decontamination and contamination survey activities continued in Wilhelm Hall throughout the 1980s and 1990s (Hokel, 1998). Contamination still exists in many interspatial areas of the building and in some relatively-inaccessible areas.

- **Research Building (Spedding Hall)**

  The Research Building was constructed by the AEC and occupied in early 1951. Many metals, including the rare earths, were investigated for mechanical, chemical, electrical, and other properties, through experimental techniques that probed the inner structures and forces of the materials. 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."

  The Hot Canyon, a two-story-high room, included an open-topped, shielded area called the "Cave" that allowed workers to use remote manipulators behind an eight-inch-thick steel wall with lead glass windows. Electrical, vacuum, water, gas, and compressed air lines built into the wall allowed workers to remotely perform experiments on highly-radioactive materials. 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.

  Research activities included electron-beam welding, the study of the electronic structure of metals, as well as the separation, preparation, and measurement of properties of the rare earth metals. 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.

  A 1979 paper, *Thorium Metal Preparation*, describes a process for preparing 30 kg of thorium metal (Peterson, 1979). During this process, wet thorium fluoride would be treated with HF at high temperature in Spedding Hall.

- **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. 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. In 1943, an open-porch area was enclosed (to control dusty operations) and additions were constructed to accommodate increases in uranium production. 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. The Physical Chemistry Annex 1 building was torn down in 1953. The building site was surveyed in May 1976, and designated acceptable for future construction (Ames History, 1979). In 1977, soil samples were taken; results showed that no further remediation was needed for the site (Appraisal Report, 1990).

- **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. Operations in this building produced more than 300 tons of recovered uranium metal through December 1945. Iowa State College, the predecessor to Iowa State University, purchased the building in 1953 and converted it to a plumbing shop. The building was razed in 1972 (Ames History, 1986). Samples taken in 1988 showed uranium present above background concentrations in one of the bore holes, but the amount did not exceed EPA guidelines given in 40 CFR 192.1. It was stated that further remediation was not anticipated at this site (Appraisal Report, 1990).

- **Metals Development Building**

  Constructed in 1959-1961 (Ames Facilities, 2009), the Metals Development Building is a four-story structure containing approximately 45,000 square feet of working space (Ames Brochure, undated). It was built to better enable the Ames Laboratory to conduct metal process development research on larger-than-laboratory scale and to evaluate the commercial feasibility of any process developed (Press Packet, 1960). It was also intended to provide space in which to carry out the pure metals program for the AEC. It was equipped with rooms used for metals fabrication, including rooms containing lathes, cutoff saws, grinders, hammer mills, a large extrusion press, and a rolling mill (Environmental Survey, 1989). Research and development activities involving thorium and other radionuclides have taken place in this building beginning in the 1960s and extending throughout the entire period of this evaluation. A 1979 paper, *Thorium Metal Preparation*, describes a process for preparing 30 kg of thorium metal (Peterson, 1979). A precipitation and filtering process to convert thorium nitrate to thorium fluoride was to take place in a hood in the Metals Development Building, either in Room 220 or 221. The wet thorium fluoride would be transferred to a special hood in Room 296 where it would be dried. Treatment with HF at high temperature would be done in Spedding Hall. The document states: "Thorium metal has been melted a number of times during the past few years in the arc-melting furnaces and the electron beam furnace without serious problems." The paper goes on to state: "Machining, cutting and sampling will be done in the Special Metals Handling Facility and all turnings and sawdust will be included in the casting residue." Surveys in the Metals Development Building, including gamma spectroscopy data from 1982, clearly indicate the presence of thorium (Rad Surveys, 1978-1991).

  According to a 1989 DOE environmental report, high-purity metals (including depleted uranium and thorium) were being prepared in batches of up to 25 pounds. Small amounts of carbon-14 were being used for diffusion studies in metals. Machining of depleted uranium and thorium metals was being conducted exclusively in Room 161. Radioactive metals prepared in Spedding Hall were also being machined in the dedicated machine shop, Room 161 (Environmental Survey, 1989).

- **Applied Science Center (Ames Laboratory Research Reactor)**

  The Ames Laboratory also occupies space at the Applied Science Center (ASC), an Iowa State University (ISU) facility located approximately one mile northwest of the ISU main campus. The ASC occupies roughly 18 acres. It was the site of the Ames Laboratory Research Reactor (ALRR). Construction of the ALRR, a 5-MW, heavy-water-moderated research reactor, began in

1961; the reactor was first operated in February 1965 (Ames, 1967; Voigt, 1981). The reactor fuel was 93% enriched uranium-235 contained in 24 fuel assemblies in a hexagonal arrangement in a core 30 inches across and 25 inches high (Voigt, 1981). The reactor shielding was an irregular decahedral prism shape with a thermal column on one face and nine faces with beam tubes from which radiation beams (primarily neutrons) could be extracted and directed to experimental areas surrounding the reactor. Operation of the reactor resulted in airborne tritium concentrations in occupied spaces of the building. A routine tritium bioassay program was part of the radiation safety program at the reactor (Voss, 1971). Operation of the reactor ended in December 1977. At the time operations ended, the heavy-water coolant contained approximately 1.7 Curies of tritium per liter (Voigt, 1981). Decommissioning began in January 1978 and was completed in September 1981 (Fact Sheet, 1994).

The ASC is also the site for the Alpha Glovebox Facility, used to conduct studies of plutonium and uranium chemistry. In a 1990 Environmental Protection Appraisal Report, the Alpha Glovebox Facility was identified as the only facility at Ames Laboratory with the potential for radioactive air emissions (Appraisal Report, 1990). The 1989 DOE environmental survey report (Environmental Survey, 1989) indicates that depleted uranium solutions prepared in this facility contain approximately one gram of uranium and that a total of approximately one gram of plutonium has been used in the facility since 1983. The Waste Disposal Building, also located at the ASC, is used for storage and packaging of radioactive and hazardous wastes. In 1988, the Blockhouse building at the ASC was removed; contaminated block, floor, and other materials were disposed of at Hanford. Contaminated soil and pieces of other equipment were also removed. Upon completion of that work, further remediation was not required (Appraisal Report, 1990).

The Annex 1 refuse disposal site at the ASC (consisting of dirt, concrete rubble, and pieces of wood) was excavated and the contents disposed of at Hanford in 1987. No radioactivity was found at this site when it was resampled (Appraisal Report, 1990). The Chemical Disposal Site, located near the ASC, was remediated in 1994 and released for unrestricted use in 1998 (Environmental Report, 2010).

NIOSH has concluded that, although the facilities listed above are specifically identified for the use of AEC- or DOE-related radiological materials, documentation available to NIOSH does not indicate any definite boundaries between radiological and non-radiological areas for the period being evaluated. Furthermore, NIOSH has determined that the site-specific and claimant-specific data available for the time period of this evaluation are insufficient to allow NIOSH to characterize employee movements across the Ames Laboratory site.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has determined that the site-specific and claimant-specific data available for Ames Laboratory for the time period under evaluation are insufficient to allow NIOSH to determine that any specific work group was not potentially exposed to radioactive material releases or possible subsequent contamination. NIOSH has found no specific information associated with tracking the movement of personnel on site, and thus cannot use job titles or duties to corroborate work in specific areas or associated radiological exposures. NIOSH has concluded that it has insufficient information associating job titles and/or job assignments with specific radiological operations or conditions.

Without such information, NIOSH is unable to define potential radiation exposure conditions based on employee job descriptions.

5.0 Summary of Available Monitoring Data for the Proposed Class

The primary data used for determining internal exposures are derived from personal monitoring data, such as urinalyses, fecal samples, and whole-body counting results. If these are unavailable, the air monitoring data from breathing zone and general area monitoring are used to estimate the potential internal exposure. If personal monitoring and breathing zone area monitoring are unavailable, internal exposures can sometimes be estimated using more general area monitoring, process information, and information characterizing and quantifying the source term.

This same hierarchy is used for determining the external exposures to the cancer site. Personal monitoring data from film badges or thermoluminescent dosimeters (TLDs) are the primary data used to determine such external exposures. If there are no personal monitoring data, exposure rate surveys, process knowledge, and source term modeling can sometimes be used to reconstruct the potential exposure.

A more detailed discussion of the information required for dose reconstruction can be found in OCAS-IG-001, *External Dose Reconstruction Implementation Guideline,* and OCAS-IG-002, *Internal Dose Reconstruction Implementation Guideline*. These documents are available at: http://www.cdc.gov/niosh/ocas/ocasdose.html.

5.1 Data Capture Efforts and Sources Reviewed

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding Ames Laboratory that included applying over three hundred unique keywords in an online search engine. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI SciTech Connect) database, the Energy Citations database, Hanford Declassified Document Retrieval System, and the DOD Defense Technical Information Center (DTIC). 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, DOE-National Nuclear Security Administration-Nevada Site Office-search, DOE Price-Anderson Noncompliance Tracking System, and the DOE Occurrence Reporting Processing System (ORPS). Attachment One contains a summary of Ames Laboratory documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

Three members of the ORAU Team traveled to the Ames Laboratory site during the week of June 12-16, 2017 in order to physically examine and capture relevant documents for this evaluation.

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.

5.2 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 5-1 summarizes the results of this review. (NOCTS data available as of November 8, 2017.)

Table 5-1: No. of Ames Laboratory Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	252
Total number of claims submitted for energy employees who worked during the period under evaluation (January 1, 1971 through December 31, 1989)	123
Total number of claims submitted for energy employees who started their employment during the period under evaluation (January 1, 1971 through December 31, 1989)	59
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	97
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	16
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	21

NIOSH reviewed each claim that fell within the period under evaluation to determine whether internal and/or external personal monitoring records could be obtained for the employee. As indicated in Table 5-1, of the total number of claims submitted for energy employees who worked within the time period under this evaluation, 16 (13%) contain internal monitoring data and 21 (17%) contain external monitoring data.

5.3 Employee Interviews

To obtain additional information in support of its 2006, 2007, and 2010 evaluations of Petitions SEC-00038, SEC-00075, and SEC-00166, NIOSH interviewed multiple former Ames Laboratory employees. Details regarding these interviews may be found in the SEC-00038, SEC-00075, and SEC-00166 Ames Laboratory evaluation reports (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010). Additional interviews for the specific purpose of supporting this evaluation were not conducted.

5.4 Internal Monitoring Data

Current and historical internal dosimetry results are maintained at the Ames Laboratory. 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.

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

Uranium bioassays were conducted during the production era in 1944 and 1945 (Industrial Medicine, 1951).

During and after the operation of the Ames Laboratory Research Reactor, the laboratory instituted a bioassay program for tritium (Tritium Results, 1968-1975; Ames, 1973) for "[a]ll persons who have been exposed to tritium (HTO) during their routine operations of the year" (Tritium Results, 1968-1975). Tritium results have been obtained for the years 1968 through 1981 (Tritium Results, 1968-1975; Tritium Results, 1971; Tritium Results, 1971-1974; Tritium Results, 1975-1978; Tritium Results, 1977; Tritium Results, 1965-1981).

Other than tritium bioassay through 1981, 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 proposed class.

5.5 External Monitoring Data

As stated in Section 4.2.2, this evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by the DOL. External dose reconstruction is not addressed in this evaluation.

5.6 Workplace Monitoring Data

NIOSH has not located sufficient air monitoring data that would allow it to estimate airborne radioactivity concentrations in all buildings for the time period under evaluation, although there is evidence that some air monitoring did take place. Examples of gamma spectroscopy measurements of air monitoring samples from Spedding Hall and the ALRR stack have been found for years 1980-1982 (Air Data, 1981-1982). These data appear to be from quarterly environmental samples and are not necessarily representative of the workers' breathing air. Room air sample data from Spedding Hall and Wilhelm Hall, primarily for years 1986 through 1991, are also available (Air Data, 1986-2008). NIOSH cannot confirm that these samples are representative of the workers' breathing zones. Air sampling results in the vicinity of the Alpha Glovebox Facility plutonium gloveboxes, from 1983-1986 have been captured (Air Data, 1983-1986). These data include post-HEPA filter exhaust air monitoring and "breathing zone" samples. It is unclear whether these samples were taken under static conditions or during active operations. The Alpha Glovebox Facility is attached to the west side of the Waste Disposal Building located north of the Applied Science Center (Appraisal Report, 1990).

NIOSH has not located any air sampling data for tritium. Notes in bioassay logbooks indicate certain bioassay samples were commented as "RR H3 above MPC special samples" (Tritium Results, 1968-1975), indicating that those samples were collected after air concentrations associated with the research reactor exceeded maximum permissible concentrations. It is assumed that the trigger for theses samples was routine air monitoring, although such monitoring records have not been located.

Extensive smear data are available for the period under evaluation. These include, but are not limited to, post-remediation assessments, routine surveys of clean areas, assessment of known highly-contaminated items and areas, and release of items and areas for unrestricted use. Health physics smear survey data are available for Wilhelm Hall, with dates ranging from 1958-2014 (Wilhelm Surveys, 1958-2014). Similar data for the Metals Development Building are also available from 1971 through 1993 (Metals Development Surveys, 1971-1992). Health physics survey data for Spedding Hall are available for years 1966 through 1991 (Spedding Surveys, 1966-1991).

5.7 Radiological Source Term Data

Materials inventory reports are available for the site for the period December 1970 through December 1978, and for June 1981. These reports do not show details regarding the specific uses for each material, but they do summarize the on-site total inventories for thorium, enriched uranium, normal uranium, depleted uranium, and plutonium (Material Status, 1969-1974; Material Status, 1974-1978 and 1981).

The site thorium inventory remained constant from December 1970 through at least December 1978, at about 300 kg. The inventory in June 1981 was 389 kg, an increase of about 90 kg. The enriched uranium inventory was around 40 kg in 1970 and decreased over the next 10 years to only about 0.2 kg in 1980. The depleted uranium inventory remained reasonably consistent over this time period at between 350 and 390 kg. The plutonium inventory ranged between about 25 grams in 1970 to about 16 grams in 1981. The site has not been able to provide thorium inventory records for other years.

6.0 Feasibility of Dose Reconstruction for the Proposed Class

42 C.F.R. § 83.14(b) states that HHS will consider a NIOSH determination that there was insufficient information to complete a dose reconstruction, as indicated in this present case, to be sufficient, without further consideration, to conclude that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy.

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already determined that a dose reconstruction cannot be completed for an employee at the DOE or AWE facility. This determination by NIOSH provides the basis for the petition by the affected claimant. Per § 83.14(a), the NIOSH-proposed class defines those employees who, based on completed research, are similarly affected and for whom, as a class, dose reconstruction is similarly not feasible.

In accordance with § 83.14(a), NIOSH may establish a second class of co-workers at the facility for whom NIOSH believes that dose reconstruction is similarly infeasible, but for whom additional research and analysis is required. If so identified, NIOSH would address this second class in a separate SEC evaluation rather than delay consideration of the claim currently under evaluation (see Section 10). This would allow NIOSH, the Board, and HHS to complete, without delay, their consideration of the class that includes a claimant for whom NIOSH has already determined a dose

reconstruction cannot be completed, and whose only possible remedy under EEOICPA is the addition of a class of employees to the SEC.

This section of the report summarizes research findings by which NIOSH determined that it lacked sufficient information to complete the relevant dose reconstruction and on which basis it has defined the class of employees for which dose reconstruction is not feasible. NIOSH's determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions.

6.1 Feasibility of Estimating Internal Exposures

In its evaluation of SEC-00185, NIOSH defined a single class that included all Ames Laboratory workers from August 13, 1942 through December 31, 1970. That class combined the classes from three previous Ames Laboratory SEC evaluations in which NIOSH concluded that it is not feasible to estimate, with sufficient accuracy, certain internal exposures prior to January 1, 1971 (and certain external doses prior to 1953).

In its evaluation of SEC-00038, NIOSH determined that internal radiation doses from uranium can be reconstructed; however, NIOSH determined that internal radiation doses from thorium cannot be reconstructed from 1942 through 1954. In its evaluation of SEC-00075, NIOSH determined that internal radiation doses received by remediation workers in Wilhelm Hall for the time period from January 1, 1955 through December 31, 1970 could not be reconstructed with sufficient accuracy due to the lack of applicable bioassay data, air monitoring data, and source-term information for estimating thorium intakes.

In its evaluation of SEC-00166, NIOSH determined that internal radiation doses from research work in Spedding Hall cannot be reconstructed due to the lack of sufficient data or process information for estimating intakes.

NIOSH has evaluated the available personnel and workplace monitoring data and source-term information and has determined that there are insufficient data for estimating internal exposures, as described below.

Other than tritium bioassay through 1981, NIOSH has not identified any indication of a routine internal monitoring program for members of the class under evaluation that is applicable for dose reconstruction for members of the proposed class. For ALRR workers with available tritium bioassay results, NIOSH may be able to reconstruct tritium intakes, but there are insufficient data to reconstruct potential intakes of fission and activation products.

Although air monitoring data have been identified that are applicable to the period under evaluation (as indicated in Section 5.6), NIOSH does not find these data sufficient to estimate internal exposures with sufficient accuracy for all workers during this period. The majority of the air monitoring data are from environmental sampling and are not necessarily representative of workers' breathing air. Although some "breathing zone" air samples were identified in the vicinity of the Alpha Glovebox Facility for a few years, it is unclear whether these samples were taken under static conditions or during active operations. NIOSH cannot assume that these air sample data represent the breathing air for all workers.

The available surface smear data include post-remediation assessments, routine surveys of clean areas, assessments of known highly-contaminated items and areas, and release of items and areas for unrestricted use. The post-remediation smears are not likely representative of surface contamination during remediation. Data from routine surveys of clean areas may not be representative of all potentially-contaminated areas. For the assessments in known highly-contaminated areas, workers would have likely taken some special precautions, such as wearing respiratory protection. In addition to these uncertainties, estimating intakes from surface contamination requires assumptions regarding resuspension factors, building-ventilation rates, uniformity of contamination, and occupancy times. NIOSH finds that sufficiently accurate intake estimates are infeasible given the uncertainties associated with all of these unknown variables.

The available source term data from December 1970 through December 1978, and for June 1981, suggest that sufficient quantities of various radioactive materials were present on-site during this time to pose a significant potential risk of worker exposure. Detailed information regarding the use of these inventories is unavailable. Inventories for the remainder of the period under evaluation (January 1979 through December 1989) are unavailable.

NIOSH has concluded that the available internal dose monitoring data, workplace monitoring data, and source term data are insufficient for dose reconstruction purposes.

NIOSH is continuing its evaluation of post-1989 operations at Ames Laboratory. It appears that the magnitude of radiological operations was limited during this time period. In a DOE Health Physics Appraisal Report dated April 17-21, 1989 (Appraisal Report, 1989), is the following statement:

> *There presently is only limited work involving radioisotopes at the Laboratory. The only major user of radioisotopes at this moment is the ICP (Inductively Coupled Plasma) operation.*

This ICP operation is the operation previously described in this document that took place in the Alpha Glovebox Facility. It involved depleted uranium solutions containing approximately one gram of uranium; approximately one gram of plutonium had been used in the facility from 1983 through 1989. Although this operation was identified during the April 17-21, 1989 appraisal as the "only major user of radioisotopes at this moment," it is evident that other operations involving radioactive materials were ongoing at this time and continued well into the 1990s and beyond. For example, according to a DOE environmental report from March 1989, high-purity metals (including depleted uranium and thorium) were being prepared in batches of up to 25 pounds. Small amounts of carbon-14 were being used for diffusion studies in metals. Machining of depleted uranium and thorium metals was being conducted (Environmental Survey, 1989).

The primary stated purpose of the 1989 DOE Health Physics Appraisal Report was to review the HP programs with respect to DOE Order 5480.11. The report concluded, among other things, that identification of controlled areas, radiation areas, and contamination areas had yet to be performed. The Order, effective January 1, 1989, required full compliance by January 1, 1990. The agenda for the Health Physics Appraisal included HP administration, exposure control, control of radioactive material, dosimetry, instrumentation, radiological operations, and training. NIOSH is continuing to evaluate the post-1989 period at Ames Laboratory for internal dose reconstruction feasibility as the Ames Laboratory Site Profile (ORAUT-TKBS-0055) is being revised. If additional dose reconstruction infeasibilities are identified during this revision process, NIOSH may recommend further expansion of the SEC class.

Although worker interviews indicated that few personnel worked in more than one location, there were no physical boundaries between the various buildings. Workers commuted freely between buildings. In addition, employment data do not associate individuals with specific buildings (Leiton, 2010). Therefore, NIOSH recommends that the SEC class definition include all employees and all areas of the Ames Laboratory.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from January 1, 1971 through December 31, 1989, 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). For example, if tritium bioassay data are available for a claimant who worked at the ALRR, those data may be used to reconstruct tritium intakes. Dose reconstructions for individuals employed at Ames Laboratory during the period from January 1, 1971 through December 31, 1989, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

6.2 Feasibility of Estimating External Exposures

This evaluation responds to a petition based on NIOSH determining that internal radiation exposures could not be reconstructed for a dose reconstruction referred to NIOSH by DOL. As noted above, DHHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report.

6.3 Class Parameters Associated with Infeasibility

DHHS has designated an SEC class for Ames Laboratory employees for the period from August 13, 1942 through December 31, 1970 (DHHS, 2011). Through the course of ongoing dose reconstruction and continued data capture efforts, NIOSH has determined that the inability to estimate, with sufficient accuracy, the total internal dose for Ames Laboratory employees extends through December 31, 1989. Therefore, NIOSH recommends that the NIOSH-proposed class include the period from January 1, 1971 through December 31, 1989.

Based on the information available to NIOSH, it cannot associate Ames Laboratory personnel with specific buildings. There were no barriers between the buildings and certain personnel, such as maintenance personnel, may have worked in more than one building. NIOSH is unable to define individual employee exposure scenarios based on specific work locations within the Ames Laboratory. Therefore, NIOSH recommends that the proposed class definition include all areas of Ames Laboratory during the specified time-period.

NIOSH has also found insufficient documentation associating job titles and/or job assignments with specific radiological operations or conditions. Without this information, NIOSH is unable to define the proposed SEC class based on job descriptions. NIOSH therefore recommends that the proposed class include personnel having worked in any area of the Ames Laboratory and include all job descriptions.

7.0 Summary of Feasibility Findings for Petition SEC-00245

This report evaluates the feasibility for completing dose reconstructions for employees at Ames Laboratory from January 1, 1971 through December 31, 1989. NIOSH determined that members of this class may have received radiation exposures from uranium, thorium, fission and activation products, tritium, and various other radionuclides used in research and development. NIOSH lacks sufficient information, such as internal dose monitoring, air monitoring, source term, and contamination monitoring data that would allow it to estimate the potential cumulative internal exposures to which the proposed class may have been exposed.

NIOSH has documented herein that it cannot complete the dose reconstructions related to this petition. The basis of this finding demonstrates that NIOSH does not have access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate.

NIOSH finds that it is not feasible to estimate, with sufficient accuracy, the internal radiation doses received by members of the proposed class of employees from January 1, 1971 through December 31, 1989. With the implementation of DOE Order 5480.11, improvements to the site internal dose assessment programs were likely after 1989. NIOSH is continuing to evaluate the post-1989 period.

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, 1971 through December 31, 1989, 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-00245

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. §83.14(b) and §83.13(c)(3). Pursuant to these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulations require 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 employees who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has determined that members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of uranium and thorium (and their progeny), and other radionuclides as well as direct exposure to radioactive materials.

Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH-Proposed Class for Petition SEC-00245

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked in any area at the Ames Laboratory in Ames, Iowa, during the period from January 1, 1971 through December 31, 1989, 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 included in the Special Exposure Cohort.

10.0 Evaluation of Second Similar Class

In accordance with §83.14(a), NIOSH may establish a second class of co-workers at the facility, similar to the class defined in Section 9.0, for whom NIOSH believes that dose reconstruction may not be feasible, and for whom additional research and analyses are required. If a second class is identified, it would require additional research and analyses. Such a class would be addressed in a separate SEC evaluation rather than delay consideration of the current claim. At this time, NIOSH has not identified a second similar class of employees at the Ames Laboratory for whom dose reconstruction may not be feasible. NIOSH will continue to review dose reconstructions and associated approaches for Ames Laboratory for the post-1989 period at the site. Operations that occurred after this date appear to have involved relatively small amounts of radioactive materials. In addition, with the implementation of DOE Order 5480.11, improvements to the internal dose assessment programs were likely after 1989. NIOSH is continuing to evaluate the post-1989 period. If necessary, an 83.14 evaluation will be performed to include additional years in the SEC.

This page intentionally left blank

11.0 References

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

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

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

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

Air Data, 1981-1982, *Composite Air Samples: Spedding Hall and ALRR,* Ames Laboratory; various dates and names in 1981-1982; SRDB Ref ID: 167091

Air Data, 1983-1986, *Air Sample Data Sheets: Alpha Facility Plutonium Glovebox,* Ames Laboratory; various dates in 1983-1986; SRDB Ref ID: 167144

Air Data, 1986-2008, *Air Sample Data Sheets: Wilhelm Hall,* Ames Laboratory; various dates in 1986-2008; SRDB Ref ID: 146744

Ames, 1967, *Ames Laboratory - Iowa State University 25th Year Open House*; U.S. Atomic Energy Commission, Iowa State University, Ames Laboratory; April 7-8, 1967; SRDB Ref ID: 18830

Ames, 1973, *Whole-Body Internal Dose Assessments of Tritium and Tritium Dose Calculation Procedures*; Ames Laboratory; December 12, 1973; SRDB Ref ID: 25454, pdf pp. 2-5

Ames Brochure, undated, *Iowa State University Institute for Atomic Research*, Ames Laboratory; undated but likely early 1960s from context; SRDB Ref ID: 18856

Ames Facilities, 2009, *Historical & Architectural Survey & Evaluation: Facilities of the Ames Laboratory, U.S. Department of Energy, Iowa State University Campus,* AKAY Consulting, Boone, Iowa for Section 110 of the National Historic Preservation Act Compliance Project; June 1, 2009; SRDB Ref ID: 80590, PDF p. 97

Ames History, 1979, *History and Current Radiological Condition of the Ames Laboratory*, Ames Laboratory; December 3, 1979; SRDB Ref ID: 18840

Ames History, 1986, *The Building of the Ames Laboratory,* Ames Laboratory; October 1986; SRDB Ref ID: 18860

Appraisal Report, 1982, *Health Protection Appraisal Report, Ames Laboratory; Ames, Iowa*; U.S. Department of Energy, Chicago Operations Office; November 15, 1982; SRDB Ref ID: 167125

Appraisal Report, 1984, *Health Physics Appraisal Report, Ames Laboratory; Ames, Iowa*; U.S. Department of Energy, Chicago Operations Office; June 1, 1984; SRDB Ref ID: 167126

Appraisal Report, 1989, *Health Physics/Emergency Preparedness Appraisal Report, Ames Laboratory; Ames, Iowa*; U.S. Department of Energy, Chicago Operations Office; June 13, 1989; SRDB Ref ID: 167113

Appraisal Report, 1990, *Environmental Protection Appraisal Report, Ames Laboratory; Ames, Iowa*; U.S. Department of Energy, Chicago Operations Office; May 11, 1990; SRDB Ref ID: 167115

Changing Scene, 1974-1975, *Changing Scene Highlights, 1974-1975*, Ames Laboratory, the U.S. Energy Research and Development Administration (ERDA), and the Energy and Mineral Resources Research Institute at Iowa State University, Ames, Iowa; 1976; SRDB Ref ID: 167078

DHHS, 2011, *HHS Designation of Additional Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000: Designating a Class of Employees from Ames Laboratory at Iowa State University, Ames, Iowa*, U.S. Department of Health and Human Services; October 18, 2011; SRDB Ref ID: 141455

DOE, 1988, DOE Order 5480.11, *Radiation Protection for Occupational Workers*, U.S. Department of Energy, Office of Health, Safety and Security; December 21, 1988; SRDB Ref ID: Publicly available: https://www.directives.doe.gov/directives-documents/5400-series/5480.11-BOrder

Environmental Report, 2010, *Annual Site Environmental Report, Calendar Year 2010*, IS-5197, UC-20e, Ames Laboratory; 2010; SRDB Ref ID: 166858, PDF p. 35

Environmental Survey, 1989, *Environmental Survey Preliminary Report, Ames Laboratory, Ames, Iowa*, U.S. Department of Energy, Washington, DC; Environment, Safety and Health Office of Environmental Audit; March 1989; SRDB Ref ID: 166866

Fact Sheet, 1977, *Fact Sheet: Ames Laboratory Research Reactor*, Ames Laboratory; June 15, 1977; SRDB Ref ID: 167076

Fact Sheet, 1994, *Fact Sheet: Ames Laboratory Research Reactor*, Ames Laboratory; January 24, 1994; SRDB Ref ID: 167079

Final Survey, 1982, *Final Survey: 37-38 Gilman Hall*, Ames Laboratory; December 13, 1982; SRDB Ref ID: 146718, PDF pp. 12-14

Hokel, 1998, *An Assessment of the Causes, Mitigation Efforts, and Current Status of Th-232, U-238, and Beryllium Contamination in Wilhelm Hall at Ames Laboratory*, B. W. Hokel. J. H. Withers, W. P. Waters, and K. J. Ewing; Ames Laboratory; April 1998; SRDB Ref ID: 18848

Industrial Medicine, 1951, *Industrial Medicine on the Plutonium Project: Survey and Collected Papers*, National Nuclear Energy Series, Manhattan Project Technical Section; Division IV – Plutonium Project Record, Volume 20; U.S. Atomic Energy Commission; 1951; SRDB Ref ID: 739. PDF pp. 267-279

Leiton, 2010, *Proposed SEC Class Definition for Ames Laboratory*, correspondence to Stuart Hinnefeld, OCAS; Rachel P. Leiton, Department of Labor; July 20, 2010; OSA Ref ID: 112217

Material Status, 1969-1974, *U.S. Atomic Energy Commission Material Status Reports*, completed by Ames Laboratory; various dates in 1969-1974; SRDB Ref ID: 167168

Material Status, 1974-1978 and 1981, *U.S. Atomic Energy Commission Material Status Reports*, completed by Ames Laboratory; various dates in July 1974-1978, and April 1 - June 30, 1981; SRDB Ref ID: 167166

Metals Development Surveys, 1966-1974, *Health Physics Surveys of the Metals Development Building*, Ames Laboratory; various surveyor names and dates ranging from 1966 to 1974; SRDB Ref ID: 146608

Metals Development Surveys, 1971-1992, *Health Physics Surveys of the Metals Development Building*, Ames Laboratory; various surveyor names and dates ranging from 1966 to 1974; SRDB Ref ID: 146677

Monitoring Program, 1974, *Personnel Monitoring Program – 1974*, Ames Laboratory; 1974 SRDB Ref ID: 25769

Monitoring Results, 1970, *Annual Summaries of Radiation Exposures*; radiation exposure summaries for calendar year 1970; SRDB Ref ID: 13801

NIOSH, 2006, *SEC Petition Evaluation Report for Petition SEC-00038, Ames Laboratory*; National Institute for Occupational Safety and Health (NIOSH); April 9, 2006; SRDB Ref ID: 94024

NIOSH, 2007, *SEC Petition Evaluation Report for Petition SEC-00075, Ames Laboratory*; National Institute for Occupational Safety and Health (NIOSH); May 9, 2007; SRDB Ref ID: 94026

NIOSH, 2010, *SEC Petition Evaluation Report for Petition SEC-00166, Ames Laboratory*; National Institute for Occupational Safety and Health (NIOSH); July 26, 2010; SRDB Ref ID: 94025

NIOSH, 2011, *SEC Petition Evaluation Report for Petition SEC-00185, Ames Laboratory*; National Institute for Occupational Safety and Health (NIOSH); June 7, 2011; SRDB Ref ID: 99020

ORAUT-TKBS-0055, *Site Profile for Ames Laboratory*, Rev. 03, Oak Ridge Associated Universities; January 3, 2012; SRDB Ref ID: 106103

Peterson, 1979, *Thorium Metal Preparation*, D. T. Peterson; Ames Laboratory; December 11, 1979; SRDB Ref ID: 167137

Press Packet, 1960, *Information for Press, Radio & TV: Construction of Metals Process Development Building*, Ames Laboratory; January 25, 1960; SRDB Ref ID: 167171, PDF p. 35

Project Summaries, 1975, *Brief Summaries of Individual Projects at Ames Laboratory*, Ames Laboratory; various authors and dates in 1975; submitted to the Smithsonian Institution Science Information Exchange on October 28, 1975; SRDB Ref ID: 167128

Rad Surveys, 1967-1970, *Health Physics Survey Reports for the Chemistry Building, 1967-1970* , Ames Laboratory; various dates and names from 1967 to 1970, SRDB Ref ID: 146718, PDF pp. 2-11

Rad Surveys, 1978-1991, *Radiological Survey Results from the Metals Development Building*, Ames Laboratory; various dates from 1978 to 1991, SRDB Ref ID: 167142

Samples Results, 1952-1953, *Various Urine, Air Dust, and Slag Samples (1952-1953) for Ames Laboratory*; sample dates ranging from March 1952 through May 1953; SRDB Ref ID: 8966

Site Profile Review, 2013, *Review of the NIOSH Site Profile for the Ames Laboratory*, SCA-TR-SP2013-0044, Rev. 0, S. Cohen & Associates for the Advisory Board on Radiation and Worker Health, National Institute for Occupational Safety and Health; August 14, 2013; SRDB Ref ID: 168134

Spedding Surveys, 1966-1991, *Health Physics Survey Reports for Spedding Hall*, Ames Laboratory; various surveyor names and dates ranging from 1966 to 1991; SRDB Ref ID: 46681

Tritium Results, 1965-1981, *Ames Laboratory Internal Dose Records 1965-1981*, Compilation of Ames data by Oak Ridge Associated Universities completed in 2006; SRDB Ref ID: 29232

Tritium Results, 1968-1975, *Tritium Urine Data Results (1968-1975) and Bioassay Procedure*; samples taken from 1968 through 1975; SRDB Ref ID: 25456 and 25167

Tritium Results, 1971, *Tritium Urine Data Results (1971)*; samples counted from April 1971 through November 1971; SRDB Ref ID: 25454, pdf pp. 6-10

Tritium Results, 1971-1974, *Tritium Results (1971-1974)*; results for 1971 through 1974; SRDB Ref ID: 25103

Tritium Results, 1975-1978, *Tritium Bioassay Results (1975-1978)*; results for 1975 through 1978; Ref ID: 25458

Tritium Results, 1977, *Tritium Urine Data Results (3rd Quarter of 1977)*; results for 1977, 3rd Quarter; SRDB Ref ID: 25463

Voigt, 1981, *Final Report-Decommissioning of the Ames Laboratory Research Reactor*; Adolf F. Voigt; December 1981; SRDB Ref ID: 25824

Voss, 1971, *Health Physics Memorandum-Bioassay-Program for Monitoring Personnel for Tritium with Sources of Tritium at the Ames Laboratory*; M. D. Voss; September 1, 1971; SRDB Ref ID: 25796

Wilhelm Surveys, 1958-2014, *Wilhelm Hall Radiological Survey Reports, 1986-2014*, Ames Laboratory; various locations and dates in 1958-2014; SRDB Ref ID: 151843

Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB 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 [name redacted], CSP, CHMM, Manager Environmental, Safety, Health and Assurance [phone number redacted] Other Site Names: Iowa State Iowa State University Physical Size of the Site: The three major buildings of the Ames Laboratory had approximately 2.4 million square feet under roof, in addition to two smaller waste storage buildings. The Ames Laboratory Research Reactor, situated on 44 acres, had 40,800 square feet under roof. The waste storage area comprises approximately two acres. Site Population: The total number of Ames personnel varied greatly over the years. During the Manhattan Engineer District period 102 people were monitored for radiation exposure. In 1973, 648 personnel were employed by the Ames Laboratory, of whom 139 were monitored for radiation exposure. Additionally, there were 671 visitors to the laboratory in 1973. In 1985, there were 403 employees of the laboratory of whom 160 were monitored for radiation exposure. In 1991, 107 personnel were monitored for radiation exposure. In 2000, 122 personnel were monitored for radiation exposure.	Personnel dosimetry data, radiation protection plan, internal audit corrective actions, plutonium experiment in Spedding Hall, radiological surveys, radiochemistry manual, air sample data, facility floor plans, Ames Laboratory historical and descriptive documentation, incident reports, remarks on the hydrates of thorium tetrafluoride, diffraction units and the monitoring of personnel using these units (1959-1960), radioactive waste deposit to Hanford, research reactor decommissioning progress reports 1978-1981, Ames Laboratory research reactor radionuclide concentrations in sludge and concrete, site annual environmental reports 1974-2004, specifications for film badge service contract 1965, thorium production methods, status of TH-232, U-238, health physics aspects of the neutron generator, application for license to possess and store only special nuclear materials in the form of fuel plates, bioassay analysis results, bioassay procedure and results for tritium, cesium from pollucite by aluminum reduction, change in film badge MDA and summary 1957, chemistry research reports, criticality safety committee requirements, design and operation of a pilot plant for purification of thorium, development of uranium metal, Gilman Hall radiological survey reports 1983-2015, hand film dosimetry, hazards associated with thorium metallurgy, health physics activities reports, activities of the plutonium project, internal dosimetry 1966-1970, technical basis documents, Landauer exposure reports, letters written by Milo Voss 1950-1961, magnesium-uranium system, x-ray machine exposure reports, neutron film badge data, personnel listing and exposure summary data, Ames photographs, Pu hot cell surveys, radiation dose from residual tritium, reactor operations monthly reports, sewer contamination incident report, shipments of normal uranium as uranyl nitrate and thorium as oxalate, soil survey, Spedding Hall radiation incidents, history of Ames Laboratory, state of the laboratory reports, thorium metal preparation, tritium bioassay results, whole body internal dose assessments of tritium, Wilhelm Hall surveys, and an x-ray exposure incident report.	06/16/2017	701

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
State Contacted: Iowa Department of Public Health [name redacted], Chief Bureau of Radiological Health [phone number redacted]	No relevant data identified.	06/03/2010	0
Albany Research Center	Quarterly summary research reports in metallurgy for 1952 and 1955, metallography of thorium, separation of Ra-228 in thorium metal production, production and separation of U-233, thorium-carbon alloys, quarterly summary research reports in chemistry 1952-1955, semi-annual summary research reports in chemistry for 1955 and 1957, uranium-zinc system, and progress reports in metallurgy 1949 and 1950.	03/21/2013	34
Argonne National Laboratory-East	Grade of thorium for materials testing reactor and the National Nucleonics program organization.	06/11/2013	2
Battelle-King Avenue	Source and fissionable material balance reports, explosion of extruded thorium metal, and solid radioactive waste burial.	01/11/2013	5
Brookhaven National Laboratory	Radiation exposures at accelerator, personnel who have worked on other Atomic Energy Commission projects, and ambient air monitoring parameters.	11/14/2008	3
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, uranium metal by carbon reduction of uranium oxide in vacuum, and a presentation on the decommissioning of the Ames Research Reactor.	02/10/2011	12
Claimant Provided	Miscellaneous Linde material including a mention of medical records from Ames.	04/18/2005	1
Curtiss-Wright, Cheswick, PA	Methods of separating U-233 from thorium.	06/18/2008	1
Department of Labor/Paragon	Draft background and resurvey recommendations for the Atomic Energy Commission portion of the Lake Ontario Ordnance Works, uranium compounds, operational reports, low-level mixed waste inventory characteristics, and a facility assessment for treatment, storage, and disposal alternatives.	01/23/2012	6
DOE Environmental Management Consolidated Business Center (Denver)	Rocky Flats thorium shipment receipts.	02/12/2014	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, Forest Hills location designation change and addition to covered facility list along with supporting documentation, and the DOE reasonable search protocol.	03/07/2011	11

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
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, transmittal of invoices and receiving reports, the site radiological resurvey program, an order for D-29 from DuPont, metal production for the Manhattan Engineer District, raw materials, and production reports.	07/22/2013	108
DOE Legacy Management - Morgantown	Recycled uranium reports showing Ames shipments, Fernald reports with receipts from and shipments to Ames, the Ames accountability station symbol, QA reports, evaluations of Ames uranium and thorium scrap, environmental evaluations, a Materials Management and Safeguards System status report, and thorium production at Ames.	01/11/2016	91
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	A review of the Ames thorium process, processing and inspection of Ames thorium at Fernald, a DOE capsule review of Ames, and complex-wide waste management and shipping issues, Mound notebook index, and a recommendation for preparation of thorium metal.	02/01/2012	26
DOE Oak Ridge Operations Records Holding Task Group	Ames laboratory inventory report, Clinton Engineering Works account monthly accountability reports, list of papers written on uranium, Manhattan District thorium accountability, metal requirements thorium development, monthly production, status and progress reports, notes and discussions on processes, request for 1,000 pounds of thorium metal, survey of production of fast feed, thorium program for Savannah River, and thorium requirements and requests.	08/12/2015	29
DOE Office of Scientific and Technical Information (OSTI)	Fabrication of thorium tubes, paper on early methods for casting uranium at Iowa State College, paper on practices in the uranium foundry at Iowa State College, direct pouring of liquid metal from the reduction bomb, report on explosion of extruded thorium metal, report on survey of irradiation facilities, stable isotope and heavy element inventories 1964, documentation involving thorium oxide, thorium rod measurements, trip report, restoration, and waste management site maps.	05/22/2015	27
Energy Technology Engineering Center	Annual review of radiological controls 1987.	11/03/2005	1
Federal Records Center (FRC) - Kansas City	Film badge reports.	10/16/2008	4
Federal Records Center (FRC) - Lee's Summit	Nuclear waste materials characterization reports.	04/20/2016	1
Federal Records Center (FRC) - San Bruno	Summaries of fuels and materials development programs.	01/31/2006	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Hagley Museum and Library	References to Ames' wartime PUREX work with DuPont at Hanford and the Deepwater Works and history of X metal plant development.	10/01/2010	9
Hanford	Ames waste management audits and reports, waste shipments, Commodity Irradiation Project, AEC planning for U-233 production, 1951 history and description of Ames Laboratory, metal hydrides data, trip report, ion exchange process, post exposure examination of thorium, and an accountable material survey and report.	03/14/2013	46
Idaho National Laboratory	Analytical Chemistry Branch procedures manual, health and safety personnel and functional representatives, progress reports 1964-1969, and radioactive material shipment records for exotic radionuclides.	01/08/2015	36
Interlibrary Loan	References to Ames' development of the PUREX process, uranium ore processing, incineration conference, and a journal of Glenn Seaborg.	05/29/2012	5
Internet - Defense Technical Information Center	Compatibility studies of several molten uranium and thorium alloys in niobium, tantalum, and yttrium, intense pulsed neutron source progress report, report on the determination of impurity elements in Ames thorium billet.	08/24/2016	5
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	03/20/2010	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Monthly Hanford Atomic Products operation report, trip reports, and Hanford experience with thorium.	06/06/2013	8
Internet - DOE Legacy Management	Complex-wide review of radioactive waste management, occupational radiation exposure reports, former worker medical screening program annual report, and a Legacy Management strategic plan comment resolution legend.	06/05/2017	9
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, remedial action performed at Ventron site, and an interim mixed waste inventory report.	04/24/2012	11
Internet - DOE Noncompliance Tracking System (NTS)	Price-Anderson noncompliance reports related to personnel training, instrument calibration, and seal source program.	07/13/2017	7
Internet - DOE Occurrence Reporting and Processing System (ORPS)	Occurrence reports on radiological and beryllium contamination, violation of procedures, and sealed sources.	07/13/2017	12

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE OpenNet	Semiannual reports of the Atomic Energy Commission, Manhattan District History Book I - General, volume 7 - Medical Program, summary history of the nuclear weapons program, activation test results of samples, summary of trips by Hanford representatives during 1952 on behalf of fuel element development program, financial report, information on fuel element development program, source and special nuclear materials balance reports, history of the activities of the Manhattan District Research Division, normal uranium machining at Y-12, advantages of briquetting reactants in bomb reductions, nuclear weapons program historical summary, and a trip report related to Hanford fuel element development program.	05/25/2017	28
Internet - DOE OSTI	Interim report on metallurgy of thorium.	11/02/2006	1
Internet - DOE OSTI / SC&A	Summary of accidents involving radiation in atomic energy activities.	02/21/2007	1
Internet - DOE OSTI Energy Citations	The Ames reactor training program, thorium chemistry research, bubble chamber work, the Tiger Team assessment of Ames, environmental reports, quarterly progress reports, thorium metallurgy, and occupational exposure data.	02/01/2013	60
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 ingot, 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, X-ray K-edge analysis of drain lines in Wilhelm Hall, counting laboratories intercalibration, radioactive waste reports, a 1950 survey of air cleaning a summary of environmental dose models, and a performance evaluation of disposal of mixed low-level waste.	01/19/2013	129

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - DOE OSTI SciTech Connect	Report to Congress on long-term stewardship, annual report on the state of the DOE national laboratories, annual site environmental reports, review of the DOE research and development facilities, compliance certification application for the Waste Isolation Pilot Plant, innovative technology summary report, nuclear reactors built, being built, or planned 1991, optical assay technologies for nuclear safeguards quarterly report, reactor development program progress reports, retirement of Hallam Nuclear Power Facility, status and future requirements for the uranium-233 power reactor program, transuranic waste inventory, and a DOE summary of 2012 occupational radiation exposure.	05/23/2017	24
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, a waste minimization/pollution prevention plan, a complex-wide cleanup report, the sixteenth annual DOE exposure report, a Manhattan Engineer District organization chart and history, annual transuranic waste inventory report, Atomic Energy Commission and the secret city of Oak Ridge, development of radiological profiles for DOE low-level mixed wastes, occupational radiation exposure reports, enhanced surveillance program accomplishments, final report properties of radioisotope heat sources, cleanup to stewardship, Iowa State University physics building floor plans, site environmental report, and a Waste Isolation Pilot Plant disposal phase final supplemental environmental impact statement.	06/06/2017	115
Internet - Health Physics Journal	No relevant data identified.	06/22/2017	0
Internet - International Journal of Occupational and Environmental Health	No relevant data identified.	06/22/2017	0
Internet - National Academies Press (NAP)	Frank Spedding biographical memoirs.	08/19/2013	1
Internet - National Institute of Occupational Safety and Health (NIOSH)	Report on residual radioactive and beryllium contamination at atomic weapons employer facilities.	08/31/2015	6
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	06/22/2017	0
Internet - National Service Center for Environmental Publications (NEPIS)	No relevant data identified.	06/05/2017	0

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Internet - NRC Agencywide Document Access and Management (ADAMS)	Annual operations report and a final status survey report for the Iowa State University's UTR-10 Reactor, termination of facility operating license No. R-59 for the UTR-10 Reactor, notification of reactor operator license cancellations, request for license amendment, shipment of uranium fuel, an inspection report, and information on Iowa's Agreement State program, classification of byproduct material from Iowa State University for disposal at Ambrosia Lake, and additional license material.	05/25/2017	37
Internet - Oak Ridge National Laboratory Library (ORNL)	Aircraft nuclear propulsion project quarterly progress report, Metallurgy Division quarterly progress reports, Operations Division monthly report, ORNL status and progress reports, stable Isotope Research and Production Division quarterly progress reports, Radioisotope program progress report, and thorium alloys preliminary corrosion tests.	12/18/2012	44
Internet - US Army Corps of Engineers	Ames Laboratory beryllium survey report.	06/01/2017	1
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	03/20/2010	0
Iowa State University Library	Dr. Frank Spedding interview.	09/18/2013	1
Kansas City Plant	MC-633 returned to plant for rework with completion schedules.	10/09/2013	1
Los Alamos National Laboratory	Los Alamos uranium metallurgy technical series and wartime reports mentioning purification work at Ames Laboratory.	08/22/2007	3
Mancuso Collection	List of related Manhattan Project groups and contractors and names of personnel who worked with thorium at Ames Laboratory.	01/10/2017	3
Missouri Department of Natural Resources	Plutonium working group report.	10/01/2008	3
Mound Museum	Preparation of powdered thorium and a thorium plant operations report.	07/06/2008	2
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, urine results, and organizational charts.	09/02/2015	144
National Archives and Records Administration (NARA) - Chicago	Argonne National Laboratory Radiological Division monthly summary.	06/09/2015	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
National Archives and Records Administration (NARA) - College Park	Correspondence from 1947-1950, researcher notes from the review of classified documents, thorium program documents including research, production, fabrication, program costs, and metallurgy, material inventories, radex reports, and wartime activities.	03/12/2014	59
National Archives and Records Administration (NARA) - Kansas City	Information on Oak Ridge facility decontamination history, history of Electromet Company, and facilities used by Atomic Energy Commission between 1942 and 1957.	03/30/2005	3
National Archives and Records Administration (NARA) - Seattle	Radioactive material shipment records.	12/07/2014	1
National Technical Information Service (NTIS)	Summary of environmental emissions including equipment, facilities, and economic evaluations.	06/08/2010	1
Nevada Test Site	Final environmental impact statement.	10/01/2003	1
New York State Archives	Waste disposal at Lake Ontario Ordnance Works, weekly and monthly progress reports, and Process Development Branch minutes and reports.	03/21/2012	5
NIOSH	History of the United States Atomic Energy Commission, Monsanto's contribution to the atomic bomb, ICRP 1990 recommendations for neutron radiation weighting factors, semiannual report of the Atomic Energy Commission, annual report to Congress, and a review of a NIOSH site profile.	11/02/2017	23
NIOSH / SC&A	Highly enriched uranium working group reports.	02/16/2006	3
Oak Ridge Library for Dose Reconstruction	Operations monthly reports, Oak Ridge National Laboratory history, Feed Materials semi-annual report, and a statistical breakdown of incidents at Oak Ridge National Laboratory.	05/02/2011	5
Oak Ridge National Laboratory	Oak Ridge National Laboratory homogeneous reactor program, Metallurgical project information, plutonium contaminated uranium, radioisotope customers and volume of sales for each radioisotope, Operations Division monthly report, isotopic power materials development progress report, Analytical Chemistry quarterly report, and plutonium isotope separation information.	03/21/2014	24
Oak Ridge Reading Room	Thorium shipment information.	04/08/2011	1
Ohio Department of Health	Environmental restoration and waste management information.	11/03/2008	1
ORAU Team	Default assumptions and methods for atomic weapons employer dose reconstructions, occupational environmental doses for Ames Laboratory, U and Th operations, processing uranium products, the Ames Site Profile, documented communications with process knowledge sources and early occupational exposure experiences in uranium processing, and guidance on assigning occupational x-ray dose.	06/16/2017	31
Pacific Northwest National Laboratory	GENII version 2 user's guide.	03/12/2007	1

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Rocky Flats Plant	Litigation files of health hazards in handling thorium.	07/14/2006	1
S. Cohen & Associates (SC&A)	TR-119 to attend the research materials coordination and planning meeting, a report showing Ames shipments to Fernald, incident cases, and Isotopes Development Center planning meeting information.	06/13/2011	7
Savannah River Site	Production of thorium at Ames, trip report including thorium meeting division of research, thorium slugs for irradiation program, monthly progress reports, thorium metal program production, and thorium metal requirements.	02/08/2012	13
SC&A / Pinellas Plant	Waste generation and waste minimization annual progress report.	06/24/2010	1
Science Applications International Corp (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	9
Southern Illinois University	Disposal of radioactive wastes in the metropolitan St. Louis area.	10/21/2008	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, urine, air dust, and slag sample results, records from sites involved in thorium work with Ames, and an analysis of accident sequences.	02/10/2011	54
Unknown / SC&A	Results of indoor radon study.	10/09/2003	1
Y-12	Y-12 cultural resources survey and historical evaluation.	02/21/2008	1
TOTAL	Not applicable	Not applicable	**2066**

Table A1-2: Database Searches for Ames Laboratory

Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
Defense Technical Information Center (DTIC) COMPLETED 06/27/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	4,779	0
DOE Comprehensive Epidemiologic Data Resource (CEDR) COMPLETED 03/20/2010	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	0	0
DOE Hanford Declassified Document Retrieval System (DDRS) and Public Reading Room COMPLETED 05/25/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	0	0
DOE Legacy Management Considered Sites COMPLETED 06/05/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	508	17
DOE National Nuclear Security Administration (NNSA) - Nevada Site Office COMPLETED 06/22/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	0	0
DOE Noncompliance Tracking System COMPLETED 07/13/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	9	7
DOE Occurrence Reporting Processing System (Credentials Required) COMPLETED 07/13/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	12	12
DOE OpenNet COMPLETED 05/25/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	4,429	18
DOE OSTI Energy Citations COMPLETED 03/20/2010	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	12,319	0
DOE OSTI Information Bridge COMPLETED 03/20/2010	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	3,855	83
DOE OSTI SciTech Connect COMPLETED 05/23/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	101,713	9
Google COMPLETED 06/06/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	1,578,324	38
Health Physics Journal COMPLETED 06/22/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	151	0
International Journal of Occupational and Environmental Health COMPLETED 06/22/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	0	0
National Academies Press COMPLETED 05/31/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	78,079	0
National Service Center for Environmental Publications (NEPIS) COMPLETED 06/05/2017	Database search terms are available in the Excel file called "Ames Laboratory Rev 02, (83.14) 11-06-17"	2,661	0

Database/Source	Keywords / Phrases	Hits	Uploaded to SRDB
NRC ADAMS Reading Room COMPLETED 05/30/2017	Database search terms are available in the Excel file called “Ames Laboratory Rev 02, (83.14) 11-06-17”	1,501	20
United States Army Corps of Engineers (USACE) COMPLETED 06/01/2017	Database search terms are available in the Excel file called “Ames Laboratory Rev 02, (83.14) 11-06-17”	3,894	1
U.S. Transuranium & Uranium Registries COMPLETED 05/31/2017	Database search terms are available in the Excel file called “Ames Laboratory Rev 02, (83.14) 11-06-17”	30	0