SEC Petition Evaluation Report
Petition SEC-00185

Report Rev #: 1 Report Submittal Date: July 13, 2011

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

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00185	83.14	April 7, 2011	Ames Laboratory

NIOSH-Proposed Class Definition
All Department of Energy employees, its predecessor agencies, and its contractors and subcontractors who worked in any area of the Ames Laboratory at Iowa State University during the period from August 13, 1942 through December 31, 1970, 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 classes of employees included in the Special Exposure Cohort.

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

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

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SEC Evaluation Approved By:	[Signature on File] *Stuart L. Hinnefeld*	7/14/2011 *Date*

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Evaluation Report Summary: SEC-00185, Ames Laboratory

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

NIOSH-Proposed Class Definition

All Department of Energy employees, its predecessor agencies, and their contractors and subcontractors who worked in any area of the Ames Laboratory at Iowa State University during the period from August 13, 1942 through December 31, 1970, 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

NIOSH lacks sufficient information, which includes bioassay results, ambient air concentrations, or sufficient process information, to allow it to estimate with sufficient accuracy the potential internal exposures to radionuclides other than uranium to which the proposed class may have been subjected. NIOSH finds that it is not applicable to reconstruct occupational medical dose for site-name workers because medical X-ray procedures were performed at an off-site, non-EEOICPA-covered facility.

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

- Principal sources of internal and external radiation for members of the proposed class included exposures to uranium and thorium and their decay progeny during the production time periods; research quantities of radioactive materials used in the Hot Canyon within the Research Building; tritium and argon-41 from the Ames Laboratory Research Reactor during its operation; and gamma and neutron radiation from the Ames Laboratory Research Reactor during its operation.

- NIOSH previously determined in its evaluation of petition SEC-00038 that with the exception of uranium, the sum of information from the available resources was not sufficient to document or estimate the potential maximum internal and external exposure to members of the class. In 2006, the Department of Health and Human Services (DHHS) designated the following class for inclusion in the SEC:

  Department of Energy (DOE) employees or DOE contractor or subcontractor employees who worked at the Ames Laboratory in one or more of the following facilities/locations: Chemistry Annex 1 (also known as "the old women's gymnasium" and "Little Ankeny"), Chemistry Annex 2, Chemistry Building (also known as "Gilman Hall"), Research Building, or the Metallurgical Building (also known as "Harley Wilhelm Hall") from August 13, 1942 through December 31, 1954 for a number of work days aggregating at least 250 work days, or in combination with work days within the parameters (excluding aggregate work day

requirements) established for one or more classes of employees in the SEC, and who were monitored or should have been monitored (DHHS, 2006).

- NIOSH previously determined in its evaluation of petition SEC-00075 that it did not identify or collect internal or air data that were related to members of the proposed SEC class or their immediate work environments. In 2007, DHHS designated the following class for inclusion in the SEC:

  Sheet metal workers, physical plant maintenance and associated support staff (including all maintenance shop personnel), and supervisory staff who were monitored or should have been monitored for potential internal radiation exposures associated with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building) at the Ames Laboratory from January 1, 1955, through December 31, 1970, for a number of work days aggregating at least 250 work days or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort (DHHS, 2007).

- NIOSH previously determined in its evaluation of petition SEC-00166 that it did not locate sufficient data, including bioassay results, ambient air concentrations, or process information to estimate with sufficient accuracy internal exposures to radionuclides other than uranium for workers in one of the Ames Laboratory buildings (the Research Building (Spedding Hall)), which includes an area known as the Hot Canyon. In addition, the Cave within the Hot Canyon did not provide a degree of containment that precluded the release of radioactive materials into the air. The air within the Cave was shared by the workers outside of it. Ames Laboratory employment data do not associate individuals with specific buildings or rooms; therefore, NIOSH must extend the assessment of its inability to bound internal dose in the Research Building to all employees, contractors, and subcontractors at the Ames Laboratory facility. In 2010, DHHS designated the following class for inclusion in the SEC:

  All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area of the Department of Energy facility at the Ames Laboratory from January 1, 1955 through December 31, 1960, for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort (DHHS, 2010).

- Through the course of ongoing dose reconstruction and research, NIOSH has determined that, due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and a determination by the Department of Labor (DOL) that employment records do not indicate work locations, it is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH has found that a determination cannot always be made as to the specific area an employee worked in, or whether an employee should have been monitored for radiological exposures. Accordingly, NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class description and to expand the SEC class definition to include all areas of Ames Laboratory, and DOE employees, its predecessor agencies, and their contractors and subcontractors who worked at

Ames Laboratory at Iowa State University during the specified time period, regardless of monitoring.

- NIOSH found that external exposure could be reconstructed for all employees between 1942 and 1970, with the exception of external exposure to thorium and plutonium during the years from 1942 through 1952, as determined the evaluation of SEC-00038.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for 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, partial dose reconstructions for individuals employed at Ames Laboratory during the period from August 13, 1942 through December 31, 1970, 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 supplied by the petitioners or from other resources 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 workers in the class may have accumulated chronic radiation exposures through intakes of thorium and thorium progeny, as well as other radionuclides from research activities in the Hot Canyon. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been 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.

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SEC Petition Evaluation Report for SEC-00185

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Roger Halsey, Oak Ridge Associated Universities (ORAU). 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 advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary

[1] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at http://www.cdc.gov/niosh/ocas.

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 Department of Energy employees, its predecessor agencies, and its contractors and subcontractors who worked in any area of the Ames Laboratory at Iowa State University during the period from August 13, 1942 through December 31, 1970, 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 classes of employees included in the Special Exposure Cohort. During this period, employees at this facility were involved the separation and production of uranium metal (1942 to 1945); the separation and production of thorium metal (1943 to 1953); research on uranium, thorium, and fission products (1942 to 1970); and the operation of the Ames Laboratory Research Reactor (1965 to 1970) (ORAUT-TKBS-0055).

The evaluation responds to Petition SEC-00185 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).

There are currently three classes of Ames Laboratory workers associated with previous NIOSH evaluations of SEC petitions (SEC-00038, SEC-00075, and SEC-00166), for which the Secretary of DHHS has designated inclusion in the Special Exposure Cohort:

Class added to the SEC effective on September 7, 2006 (DHHS, 2006): *Department of Energy (DOE) employees or DOE contractor or subcontractor employees who worked at the Ames Laboratory in one or more of the following* ***facilities/locations: Chemistry Annex 1 (also known as "the old women's gymnasium" and "Little Ankeny"), Chemistry Annex 2, Chemistry Building (also known as "Gilman Hall"), Research Building, or the Metallurgical Building (also known as "Harley Wilhelm Hall")*** *from August 13, 1942 through December 31, 1954 for a number of work days aggregating at least 250 work days, or in combination with work days within the parameters (excluding aggregate work day requirements) established for one or more classes of employees in the SEC, and who were monitored or should have been monitored.*

Class added to the SEC effective on October 12, 2007 (DHHS, 2007): ***Sheet metal workers, physical plant maintenance and associated support staff (including all maintenance shop personnel), and supervisory staff who were monitored or should have been monitored for potential internal radiation exposures associated with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building)*** *at the Ames Laboratory from January 1, 1955, through December 31, 1970, for a number of work days aggregating at least 250 work days or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

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

Detailed information associated with the worker classes added to the SEC in 2006 and 2007can be found in the NIOSH evaluation reports, *SEC Petition Evaluation Report for Petition SEC-00038 and SEC Petition Evaluation Report for Petition SEC-00075, Ames Laboratory* (NIOSH, 2006; NIOSH, 2007). The associated SEC class designated by DHHS was based on the NIOSH determination at that time, based on the information at hand, that employee work locations would be sufficiently well known, such that an assessment could be made regarding whether or a not an employee received exposures from a specific work location or work activity.

Class added to the SEC effective on November 5, 2010 (DHHS, 2010):
All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked in any area of the Department of Energy facility at the Ames Laboratory from January 1, 1955 through December 31, 1960, for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

Detailed information associated with the worker classes added to the SEC in 2010 can be found in the NIOSH evaluation report, *SEC Petition Evaluation Report for Petition SEC-00166, Ames Laboratory* (NIOSH, 2010). The associated SEC class designated by DHHS was based on Ames Laboratory employment data not associating individuals with specific buildings or rooms; thus, it is not possible to specify whether employees did or did not work within specific buildings.

In the course of its on-going dose reconstruction and continued data capture efforts, NIOSH has determined that due to undocumented worker movements across the site, limited claimant-specific information pertaining to work locations, and a determination by DOL that employment records do not indicate work locations, NIOSH is unable to eliminate any specific worker from potential exposure scenarios based on assigned work location. NIOSH has found that a determination cannot always be made as to the location where an employee worked, or whether an employee should have been monitored for radiological exposures. Accordingly, NIOSH has determined that it is necessary to remove the area-specific and monitoring criteria from the class descriptions and expand the SEC class definition to include all areas of Ames Laboratory, and all employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked at Ames Laboratory during the specified time periods, regardless of monitoring or job location.

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at Ames Laboratory from August 13, 1942 through December 31, 1970 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.

Unless otherwise indicated, information for Section 4.0 and its subsections was obtained from *SEC Petition Evaluation Report for Petition SEC-00166, Ames Laboratory* (NIOSH, 2010).

4.1 Operations Description

This section summarizes the operations performed at Ames Laboratory that are relevant to the proposed SEC time period. Detailed information associated with the operations at Ames Laboratory can be found in the NIOSH evaluation reports, *SEC Petition Evaluation Report for Petition SEC-00038; SEC Petition Evaluation Report for Petition SEC-00075, Ames Laboratory; and SEC Petition Evaluation Report for Petition SEC-00166* (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010).

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. These buildings were 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), and the Ames Laboratory Research Reactor. The exact size of the facility is not as clearly defined as other Atomic Energy Commission (AEC) and DOE sites, as the Laboratory shared infrastructure with the University. For the period evaluated by NIOSH, the Ames Laboratory workforce began with a few dozen researchers in 1942 and grew to approximately 770 individuals in 1970 (Monitoring Results, 1970).

The precursor of the Ames Laboratory was the Ames Project, which was established in 1942 by a contract between the Metallurgical Laboratory at the University of Chicago and Iowa State College (the predecessor to Iowa State University). Ames Laboratory was established by the AEC in May 1947.

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

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

By November 1942, successful methods were developed and the Ames Project supplied approximately one-third of the uranium used in the Chicago pile. Between mid-1942 and August

1945, more than 1,000 tons of pure uranium metal was supplied to the Manhattan Project. The Ames Project was asked to turn over its process to industry in 1945.

Following bombardment experimentation in 1942, thorium was considered to be a potential alternative source of nuclear reactor fuel. Thorium production had been initiated at the "Little Ankeny" facility as early as 1943. Production and research activities continued at Little Ankeny until 1949, when they were moved to the newly-completed "Metallurgy Building," which was built by DOE for Ames Laboratory research. The Metallurgy Building was later renamed Harley Wilhelm Hall. Purified thorium was produced at Wilhelm Hall using a five-stage process:

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

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

Construction of 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 and its support facilities were about 1.5 miles northwest of the Iowa State University campus on a 200-acre site used by the Institute for Atomic Research (Ames, 1967). 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 (Ames, 1967; Voigt, 1981). Operation of the reactor ended in December 1977 and decontamination and decommissioning of the facilities was completed in 1981 (Voigt, 1981).

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.

4.2.1 Internal Exposure Potential

The primary source of internal radiation exposure at the site was inhalation and/or ingestion of uranium metal, uranium tetrafluoride, uranium decay products, thorium metal, thorium tetrafluoride, and thorium decay products generated during the production of uranium metal and thorium metal and the operation of the Ames Laboratory Research Reactor.

Uranium

The radiological hazard presented by uranium metal or compounds results primarily from alpha particles emitted by uranium-238 (4.15 MeV and 4.20 MeV) and its isotopes uranium-235 (4.37 MeV, 4.40 MeV, and 4.58 MeV) and uranium-234 (4.27 MeV and 4.77 MeV). Naturally-occurring uranium is 0.71% (by weight) uranium-235 and 0.0055 uranium-234. NIOSH assumes that uranium

tetrafluoride received at Ames was derived solely from naturally-occurring ores. This assumption is based on the knowledge that the uranium produced at Ames was fabricated into fuel for use in the Chicago pile, which only used uranium of natural enrichment. On an activity basis (i.e., dpm/gram) the uranium-235 will be present in negligible amounts at these enrichment levels, but the uranium-234 activity will be at a level that is essentially equal to uranium-238 due to its much shorter half-life (2.46 x 10^5 years for uranium-234, and 4.47 x 10^9 years for uranium-238).

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

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

Thorium

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

Thoron

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

Tritium

The Ames Laboratory Research Reactor produced tritiated heavy water during its operation. The Ames Laboratory Research Reactor was a 5-megawatt D2O (heavy water) moderated research reactor. Initially, the moderator-coolant contained a small amount of tritium, which increased with the operation of the reactor. Certain activities in the reactor area and in the waste disposal area had the potential to expose personnel to the tritiated heavy water. Plus, there was a possibility of exposure due to other sources of tritium that were occasionally present. These sources included spent targets, tritium gas in cylinders, and other tritiated compounds used at the laboratory (Voss, 1971).

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.

Photon

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

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

Table 4-1 provides the energies of the gamma emission from the primary isotopes of concern at the Ames Laboratory for those areas related to thorium and uranium production.

Table 4-1: Gamma Emissions of Primary Interest

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

Source: This table is Table 5-1 from NIOSH, 2010.

Beta

Exposure to beta sources for Ames Laboratory employees would have resulted principally from uranium and thorium decay products. In the uranium-series decay scheme, beginning with uranium-238, the short-lived isotope protactinium-234m emits the most energetic beta particle (2.28 MeV). It is this beta particle that accounts for the shallow-dose hazard associated with handling uranium and uranium tetrafluoride. Table 4-2 provides the energies of the beta emission from the primary isotopes of concern at the Ames Laboratory for those areas related to thorium and uranium production.

Table 4-2: Beta Emissions of Primary Interest

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

Source: This table is Table 5-2 from NIOSH, 2010.

The Ames Laboratory Research Reactor produced argon-41, a noble gas with a half life of 1.8 hours. This isotope decays by emitting a 2.49 MeV beta particle. Although the reactor released the gas at an annual rate of 15,000 curies, due to its short half-life, the maximum amount in the air at any one time was calculated to be 4.5 curies (Hull, 1973). As it is chemically inert, dose incurred from argon-41 may be considered an external exposure.

Neutron

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

There was a potential for neutron exposure from the Ames Laboratory Research Reactor. No documentation has been found to describe the levels that would have been encountered; however, film badge results include individuals identified as reactor personnel (Monitoring Results, 1959-1960). The dosimeter was a Kodak NTA film (Berg, 1969).

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 from 1942 through present. As presented in Section 3.0 of this report, in 2006, 2007, and 2010 DHHS designated that a class of Ames Laboratory workers be included in the SEC.

- August 13, 1942 through December 31, 1954 (2006 designation)
- January 1, 1955 through December 31, 1970 (2007 designation)
- January 1, 1955 through December 31, 1960 (2010 designation)

The start date of August 13, 1942, was selected for the 2006 designated class because that was the start date of Manhattan Engineer District operations at the site. The end date of December 31, 1970, was selected for the 2007 designated class because that was the end of or the renovation work relating to the exposures associated with the proposed worker class. The period of radiological operations associated with this evaluation encompasses all three of the time periods associated with the three previously designated classes for SEC-00038, SEC-00075, and SEC-00166. Accordingly, the time period for this evaluation report on Ames Laboratory exposures is from August 13, 1942 through December 31, 1970.

4.4 Site Locations Associated with Radiological Operations

Chemistry Building (Gilman Hall)

The initial Ames Project work was conducted in the Chemistry Building in early 1942. The process for purifying uranium metal and the methods and equipment for increasing production were developed in the Chemistry Building. 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. The chemical reduction component of the operations was moved to the Physical Chemistry Annex 1 by December. 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.

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 until 1953. Poor contamination control practices and poor ventilation contributed to contamination of the building. However, contamination levels have been reduced by mitigation, decontamination, remodeling, and renovation projects. 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, and were studied by 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 a 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. Although NIOSH has not located documents that would define which radionuclides were present in the Hot Canyon, what quantities were present, or the methods that were used to manipulate the materials, the *Site Profile for Ames Laboratory*, ORAUT-TKBS-0055, proposes a method to estimate the maximum amounts of radioactive materials that would have been present based on the design criteria of the Hot Canyon and the manipulation of 180-day cooled reactor fuel. Note that the calculations in ORAUT-TKBS-0055 are based on the release of materials through building filtration. 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 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.

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.

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. Operations ended in 1953. Iowa State College, the predecessor to Iowa State University, purchased the building in 1953 and converted it to a plumbing shop.

Ames Laboratory Research Reactor

Construction of 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 and its support facilities were about 1.5 miles northwest of the Iowa State University campus on a 200-acre site used by the Institute for Atomic Research (Ames, 1967). 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 (Ames, 1967; Voigt, 1981). Operation of the reactor resulted in airborne tritium concentrations in occupied spaces of the building (Voigt, 1981). 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 (Voigt, 1981). At the time operations ended, the heavy-water coolant contained approximately 1.7 Curies of tritium per liter (Voigt, 1981).

A component of the basis for the SEC class designated in 2006, was that employee work locations would be sufficiently well known, such that an assessment could be made regarding whether or not an employee received exposures while working *"… at the Ames Laboratory in one or more of the following facilities/locations: Chemistry Annex 1 (also known as "the old women's gymnasium" and "Little Ankeny"), Chemistry Annex 2, Chemistry Building (also known as "Gilman Hall"), Research Building, or the Metallurgical Building (also known as "Harley Wilhelm Hall")…"* A component of

the basis for the SEC class designated in 2007, was that employee work locations and whether or not an employee was monitored would be sufficiently well known, such as the assessment could be made regarding whether or not an employee received exposures while working as "*Sheet metal workers, physical plant maintenance and associated support staff (including all maintenance shop personnel), and supervisory staff who were monitored or should have been monitored for potential internal radiation exposures associated with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building)...*" NIOSH has since found that, due to undocumented worker movements across the site and because Ames Laboratory employment data do not associate individuals with specific buildings or rooms, it is not possible to specify whether employees did or did not work in a specific building or should have been monitored. NIOSH is therefore unable to define individual worker exposure scenarios based on specific work locations within the Ames Laboratory site during the period under evaluation.

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. This is because NIOSH has found no specific information associated with tracking the movement of personnel on site and therefore has decided that it cannot use job titles or duties to corroborate work in specific areas or associated radiological exposures. Based on this information, NIOSH has determined that the previously proposed SEC class definitions cannot be based or limited on job titles or duties.

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

Detailed information regarding NIOSH's data capture efforts for the Ames Laboratory site can be found in the related NIOSH evaluation reports for SEC-00038, SEC-00075, and SEC-00166 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010).

5.2 Worker Interviews

To obtain additional information in support of its 2006, 2007, and 2010 evaluation 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 deemed necessary, and were therefore not conducted.

5.3 Internal Personnel Monitoring Data

Ames Laboratory initially monitored employees for radiation exposure using medical testing to look for abnormalities in blood chemistry (Payne, 1992). This practice was discontinued in 1946 (Payne, 1992). No direct mention of radiological monitoring was identified in individual medical monitoring records. However, a specific code (the letter "r") appears to have been used to identify uranium blood test results for Ames Laboratory employees. This was a medical test that looked for abnormal albumin results as an indicator of exposure to uranium. The 1946 Myers correspondence reports that highly exposed employees were sampled monthly by urinalysis and other employees were sampled quarterly through 1945 (NIOSH, 2006). Only thirty-four uranium bioassay records have been found for Ames Laboratory employees for that time period. The thirty-four bioassay samples were collected by the Army Corps of Engineers in July, August, and September of 1944 and were analyzed for uranium ("X ion"). The analytical results ranged from 0 mg/l to 0.3 mg/l, but no information was provided on the method used to analyze these samples. The Army Corps of Engineers stated that at that time, no tolerance value had been established for the X ion, but that the report results were about the same as those obtained from other groups handling the same special materials (Tybout, 1944). In addition to these results, a uranium excretion study was performed at Ames Laboratory between 1943 and 1945 (Ferretti, 1951). This study was part of a Manhattan Engineer District (MED) study of 86 individuals exposed to different uranium compounds at Ames, Chicago, and Oak Ridge. Forty-eight men from Ames Laboratory were sampled. Exposure was determined to be mostly due to uranium tetrafluoride salt (green salt). The individuals in the test were put into one of four groups according to

their presumed exposure to uranium, with Group one (1) having the highest exposure potential and Group four (4) having the lowest. Results of the study for the four groups are described in the evaluation report for SEC-00038.

Current and historical internal dosimetry results are maintained at the Ames Laboratory. Some, but not all of these documents have been obtained by NIOSH through data capture efforts and through information supplied by claimants.

A review of all documents and data available to NIOSH identified some bioassay data for the period from August 13, 1942 through December 31, 2005. Only limited *in vitro* bioassay data have been found for the years 1942 through 1945.

NIOSH has identified 90 bioassay (urine) samples collected in March 1952 and analyzed for thorium by the AEC (Samples 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.

Urinalysis results for two individuals and nasal swipes for four individuals involved in a thorium spill incident have been located (Thorium Results, 1957). NIOSH has not identified any indication of a routine internal monitoring program for members of the class under evaluation or that is applicable for dose reconstruction for members of the class.

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 1978 (Tritium Results, 1968-1975; Tritium Results, 1971; Tritium Results, 1971-1974; Tritium Results, 1975-1978; Tritium Results, 1977).

In its evaluation of SEC-00038, NIOSH found that limited individual monitoring records were available for uranium exposures, and no individual monitoring records were available for thorium or plutonium exposures at Ames Laboratory from August 1942 through February 1952. Limited individual and area results for thorium and thoron sampling were available after that period but the data were not sufficient for internal dose reconstruction. As a result of those limitations and changes in processes and exposures prior to the 1952 monitoring, and with routine monitoring beginning in the 1954-1955 timeframe, NIOSH determined it could not establish a maximum internal exposure scenario that addresses all of the internal exposure potential for the petitioning class for the period from August 13, 1942 through December 31, 1954, and therefore could not estimate their internal doses with sufficient accuracy.

In its evaluation of SEC-00075, NIOSH found that internal radiation doses received by members of the SEC-00075 proposed class that included personnel who worked with the maintenance and renovation activities of the thorium production areas in Wilhelm Hall (i.e., the Metallurgy Building or "Old" Metallurgy Building) at the Ames Laboratory, 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. While secular equilibrium could have been reasonably assumed, NIOSH did not have sufficient information to quantify the amount of

thorium and progeny that was present in the contaminated areas of Wilhelm Hall that were later renovated by members of the proposed class. In addition, NIOSH could not reasonably assume particle sizes or airborne concentrations that were encountered in the contaminated areas of Wilhelm Hall.

In its evaluation of SEC-00166, NIOSH found that there were insufficient data, including bioassay results, ambient air concentrations, or process information to estimate internal exposures to radionuclides other than uranium for workers in the Research Building (Spedding Hall) including the Hot Canyon within the Research Building from January 1, 1955 through December 31, 1960. In addition, the Cave within the Hot Canyon did not provide a degree of containment that precluded the release of radioactive materials into the air. The air within the Cave was shared by the workers outside of it. Lacking bioassay data for these workers, air samples for the room, or detailed information on the materials being handled, NIOSH concluded that internal dose reconstruction for exposure to the research radionuclides used in the Hot Canyon was not feasible.

Additional information regarding the quantity and condition of the Ames Laboratory internal personnel monitoring data available to NIOSH, and the NIOSH evaluation of such data, can be found in the NIOSH evaluation reports for SEC-00038, SEC-00075, and SEC-00166 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010).

5.4 External Personnel Monitoring Data

Current and historical external dosimetry results are maintained at the Ames Laboratory. Some, but not all of these documents have been obtained by NIOSH through data capture efforts and through information supplied by claimants.

Ames Laboratory staff received regular film badge service beginning in 1953. NIOSH has located film badge results for over five hundred individual workers during the time period under evaluation (NIOSH, 2010). These records are biweekly results associated with named individuals and include gamma, beta, and in some cases, neutron exposure results.

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

In its evaluation of SEC-00038, NIOSH concluded that there may not have been a routine external radiation monitoring program at Ames Laboratory prior to March 1952. Records from 1953 indicate that about 166 workers were monitored with a total of about 3,200 results, most of which were reported as total dose. NIOSH found over 7,800 results for about 190 workers in 1954. Those results were reported in a mixed format with some having beta and gamma results and some being reported in total dose only. These data were collected at the beginning of a formal monitoring program at Ames and provide general film badge and direct reading (pocket chamber) results. Although some quality-check records were available, this documentation and data did not provide sufficient supporting information relating to the early operations that were performed during the time frame evaluated in SEC-00038.

Although NIOSH obtained neutron monitoring results for workers in the Ames Laboratory Research Building for part of 1953 and 1954, there was no documentation indicating that those workers were involved with thorium research or other AEC sponsored activities. NIOSH discovered no evidence of individual neutron monitoring, or the acknowledgement of potential neutron exposures, prior to 1953.

In its evaluation of SEC-00075, NIOSH concluded that while process-related external dosimetry data were not available for members of the SEC-00075 proposed class for the time period from January 1, 1955 through December 31, 1970, monitoring data did exist for other Ames Laboratory employees that were not covered under the proposed class. Radiation sources and activities that monitored workers were predominantly exposed to included the uranium and thorium production processes. Smaller numbers of workers were exposed to sources that included electron accelerators, electron beam welding, beta-ray spectrometers, X-ray and neutron diffraction spectrometers, plutonium chemistry, and a research reactor. NIOSH believes that external monitoring data obtained from workers associated with the aforementioned activities could be used to bound external exposures to members of the SEC-00075 proposed class.

A co-worker data study has been performed to permit dose reconstruction for individuals for which external monitoring data were unavailable or incomplete. The co-worker data study for Ames Laboratory includes all available dosimetry records from 1952 through 1981.

In its evaluation of SEC-00166, NIOSH concluded that reconstruction of external radiation dose was feasible for the SEC-00166 Ames Laboratory worker class, which included personnel who worked at the Ames Laboratory campus for the period from January 1, 1955 through December 31, 1960. Such reconstruction can be accomplished using co-worker data distributions and the bounding assumptions and applicable protocols specified in various complex-wide Technical Information Bulletins.

Details regarding the various analyses used and the associated minimum detectable activities are presented in SEC-00038, SEC-00075, and SEC-00166 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010).

5.5 Workplace Monitoring Data

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

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.

In its evaluation of SEC-00038, NIOSH found no evidence of any area monitoring that would specifically support internal or external exposure assessments at Ames Laboratory prior to March 1952. NIOSH did find that some thorium and thoron area air sampling was performed for a limited time frame after that period. However, the available information was not deemed sufficient to support the ability to bound dose or resolve the dose reconstruction issues for the proposed class defined in the SEC-00038 evaluation.

In its evaluation of SEC-00075, NIOSH identified some area monitoring data that would support reconstructing internal and external doses for Ames Laboratory personnel, as defined in ORAUT-TKBS-0055. These doses could be assigned to Ames Laboratory personnel for the applicable periods as defined for each Ames Laboratory location. However, the available information was not deemed sufficient to support the ability to bound dose or resolve the dose reconstruction issues for the proposed class defined in the SEC-00075 evaluation.

In its evaluation of SEC-00166, NIOSH described approaches to estimate exposures by estimating concentrations based on theoretical dispersions of various radionuclides based on maximum allowable activities, filtration efficiencies of the filter media used, and ratios of typical radionuclides. However, the available information was not deemed sufficient to support the ability to bound dose or resolve the dose reconstruction issues for the proposed class defined in the SEC-00166 evaluation.

5.6 Radiological Source Term Data

During the operational period for uranium refining between 1942 and 1945, workers may have been exposed to uranium and uranium decay progeny. During the operational period for thorium refining between1943 and 1953, workers may have been exposed to thorium and thorium decay progeny. Workers after those time periods may have been exposed to residues containing the same isotopes but in diminished quantities. During the operation of the Ames Laboratory Research Reactor between 1961 and 1977, workers may have been exposed to neutron and gamma radiation from the reactor.

Additional information regarding the Ames Laboratory source term data available to NIOSH can be found in the related Ames Laboratory evaluation reports for SEC-00038, SEC-00075, and SEC-00166 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010).

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

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.

The class defined in SEC-00038 included all laboratory workers between the years 1942 and 1954. The report stated that internal exposure due to thorium, plutonium, and thoron could not be reconstructed.

Potential exposures due to residual thorium contamination in the Metallurgy Building after 1954 was not monitored either through a bioassay program, air sampling, or though calculation and estimation of the amount that remained in air ducts and other relatively inaccessible areas. The bioassay records that have been reviewed were either related to production activities or to the Ames Laboratory Research Reactor.

The Metallurgy Building was assessed for residual thorium contamination in 1953 and again in 1998 (Ames, 1999). No surveys for the intervening years have been located.

The class defined in SEC-00075, which was added to the SEC, was based on thorium contamination in ductwork within the Metallurgy Building and was defined to include those workers "…who were monitored or should have been monitored for potential internal radiation exposures associated with the maintenance and renovation activities of thorium production areas in Wilhelm Hall (a.k.a. the Metallurgy Building or "Old" Metallurgy Building) at the Ames Laboratory from January 1, 1955 through December 31, 1970..."

Potential exposures to research materials handled in the Hot Canyon within the Research Building were not monitored through a bioassay program. NIOSH has not located records that would specify the types of radionuclides that were handled within the Hot Canyon or the amounts that were present. In addition, no records of ambient air sampling or of the methods used to manipulate these materials have been located. The Class defined in SEC-00166, which was added to the SEC, was based in part on the inability to estimate doses from this location.

A method for estimating uranium exposures due to residual contamination for the years between 1954 and 1974 in the Chemistry Building was included in the Evaluation Report for SEC-00166. This could be applied for workers who could be shown to have only worked within that building.

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 must extend its inability to bound exposures in any one building to all employees of the Ames Laboratory.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to thorium and thorium progeny, as well as other research radionuclides used within the Hot Canyon during the period of DOE operations. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to thorium and thorium progeny, as well as other research radionuclides and resulting doses for the class of employees covered by this evaluation.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from August 13, 1942 through December 31, 1970, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at Ames Laboratory during the period from August 13, 1942 through December 31, 1970, 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 to thorium and thorium progeny, as well as other radionuclides 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.

In its evaluation of SEC-00038, NIOSH determined that external exposure from operations involving uranium could be reconstructed for the time between 1942 and 1954. NIOSH found that, with the exception of 1953 and 1954, reconstruction of external exposure due to thorium and plutonium operations was not feasible. NIOSH also found that reconstruction of neutron exposure was not feasible. No documentation has been reviewed that would alter these conclusions.

In its evaluations of SEC-00075 and of SEC-00166, NIOSH found that for those classes of workers, all external exposure could be reconstructed. These two classes include all Ames Laboratory workers for the years between 1955 and 1970.

In accordance with ORAUT-TKBS-0055, the X-ray equipment for examinations of Ames Laboratory staff members was located at the Iowa State Student Health Center/College Hospital. In accordance with the ORAU Technical Information Bulletin, *Guidance on Assigning Occupational X-Ray Dose*

Under EEOICPA for X-Rays Administered Off Site, ORAUT-OTIB-0079, occupational medical exposures are only included for medical examinations obtained at Ames Laboratory. There were no X-ray examinations performed onsite, therefore no occupational medical exposures were incurred.

6.3 Class Parameters Associated with Infeasibility

DHHS has designated three SEC classes for Ames Laboratory workers for the period beginning August 13, 1942 through December 31, 1970 (DHHS, 2006; DHHS, 2007; DHHS, 2010). The time period covered by this current report was selected to reconcile the three previous petitions, SEC-00038, SEC-00075, and SEC-00166, and encompasses all time periods previously designated by DHHS in 2006, 2007, and 2010. NIOSH therefore recommends that the class include the period from August 13, 1942 through December 31, 1970.

The class for SEC-00075 was defined too narrowly in that it assumed that personnel could be associated with specific buildings, which has since been determined by DOL to not be the case (Leiton, 2010). 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 therefore recommends that the class to include personnel having worked in any area of the Ames Laboratory.

The proposed class is not limited by job description. Potential exposures from thorium in the Metallurgy Building and from the Hot Canyon in the Research Building could have been incurred by any worker that was present. NIOSH therefore recommends that the class include all Ames Laboratory workers.

7.0 Summary of Feasibility Findings for Petition SEC-00185

This report evaluates the feasibility for completing dose reconstructions for employees at Ames Laboratory from August 13, 1942 through December 31, 1970. NIOSH determined that members of this class may have received radiation exposures from uranium, thorium and their progeny, tritium, argon-41, as well as from gamma and neutron exposures from the Ames Laboratory Research Reactor. NIOSH lacks sufficient information, which includes internal exposures to thorium contamination in the Metallurgy Building and undetermined exposures from materials that may have been used in the Hot Canyon in the Research Building 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.

Consistent with its findings associated with SEC-00038, SEC-00075, and SEC-00166 (NIOSH, 2006; NIOSH, 2007; NIOSH, 2010), NIOSH finds that it is not feasible to estimate, with sufficient accuracy, the internal radiation doses for the years between 1942 and 1970, and certain external radiation doses between the years 1942 and 1954, received by members of the proposed class of employees.

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 August 13, 1942 through December 31, 1970, 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-00185

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 workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has 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 residual thorium contamination in the Metallurgy building and from radionuclides handled in the Hot Canyon in the Research building. Additionally, information is lacking to associate workers with specific buildings. 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-00185

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all Department of Energy employees, its predecessor agencies, and its contractors and subcontractors who worked in any area of the Ames Laboratory at Iowa State University during the period from August 13, 1942 through December 31, 1970.

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 is 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-1970 period at the site. Research activities that occurred after this date are expected, but not proven, to involve relatively small amounts of radioactive materials. If necessary, an 83.14 evaluation will be performed to include additional years to the SEC.

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

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, 1999, *Characterization, Risk Assessment and Remediation of Harley Wilhelm Hall at Ames Laboratory*, Rev. 0; Ames Laboratory; December 1999; SRDB Ref ID: 18854

Berg, 1969, *Neutron Measurement Information*, correspondence to Milo Voss; Irwin Berg; March 11, 1969; SRDB Ref ID: 25817

DHHS, 2006, *DHHS Designation of Additional Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act for Ames Laboratory in Ames, Iowa (August 13, 1942-December 31, 1954)*; Department of Health and Human Services (DHHS); August 8, 2006; SRDB Ref ID: 94027

DHHS, 2007, *DHHS Designation of Additional Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act for Ames Laboratory in Ames, Iowa (January 1, 1955-December 31, 1970)*; Department of Health and Human Services (DHHS); September 12, 2007; SRDB Ref ID: 94028

DHHS, 2010, *DHHS Designation of Additional Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act for Ames Laboratory in Ames, Iowa (January 1, 1955-December 31, 1960)*; Department of Health and Human Services (DHHS); October 6, 2010; SRDB Ref ID: 94029

Dust Samples, May-Jun 1943, *Dust Sample Results Sheets for Iowa State College, Ames, Iowa*; various dates in May and June 1943; SRDB Ref ID: 8960

Dust Samples, Jul 1943, *Dust Sample Results Sheets for Iowa State College, Ames, Iowa*; samples taken July 15, 1943; SRDB Ref ID: 8969

Ferretti, 1951, *Uranium Excretion Studies*, Chapter 7 of the "Plutonium Project Record," Volume 20; R. J. Ferretti, G. R. Price, and Samuel Schwartz; SRDB Ref ID: 739, pdf. pp. 267-279

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*; Bruce W. Hokel, James H. Withers, W. Paul Waters, and Kenneth J. Ewing; April 1998; SRDB Ref ID: 18848

Hull, 1973, *Addition to ALRR Report No. 15, Argon-41 Concentrations*, correspondence to J. H. Norman; D. L. Hull; May 3, 1973; SRDB Ref ID: 25828, pdf. pp. 15-18

Klevin, 1952, *Ames Research Laboratory Occupational Exposure to Thorium and Beryllium*; Paul B. Klevin; July 14, 1952; SRDB Ref ID: 18942

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

Monitoring Results, 1959-1960, *Neutron Film Badge Exposure Reports*; reports for dates ranging from January 1959 through December 1960; SRDB Ref ID: 25898

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

ORAUT-OTIB-0079, *Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site*, Rev. 00; ORAU Team Dose Reconstruction Project for NIOSH; January 3, 2011; SRDB Ref ID: 89563

ORAUT-TKBS-0055, *Site Profile for Ames Laboratory*, Rev. 02; ORAU Team Dose Reconstruction Project for NIOSH; January 14, 2011; SRDB Ref ID: 91640

Payne, 1992, *The Ames Project: Administering Classified Research as a Part of the Manhattan Project at Iowa State College, 1942-1945*, Dissertation; Carolyn Stilts Payne; 1992; SRDB Ref ID: 18851

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

Thorium Results, 1957, *Thorium Bioassay and Sample Data regarding the July 9, 1957 Thorium Spill*; SRDB Ref ID: 25773

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

Tybout, 1944, *Urinalysis Conducted on Samples*, correspondence to F. H. Spedding, includes urinalysis results; Richard A. Tybout; November 21, 1944; SRDB Ref ID: 8959

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

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Attachment One: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Ames Laboratory

Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded to SRDB
Primary Site/Company Name: Ames Laboratory DOE; 1942-present [Name redacted], Industrial Safety [phone number redacted] Other Site Names: Iowa State Iowa State University Size of the workforce: 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. 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.	242-Pu-94 experiment in room 29 Spedding Hall, activity in reactor effluents, air sample data sheets, Ames Laboratory description, environmental reports, atomic space living on the Manhattan Project, bioassay procedure and results, bremsstrahlung doses from natural uranium ingots, design and operation of a pilot plant for purification of thorium, external dose records, film badge specifications, health physics aspects of the neutron generator, incident reports, neutron film badge data, radiation surveys, reactor effluent reports, results of indoor radon monitoring, survey of ISU medical X-ray machine, Th-232, U-238, beryllium contamination in Wilhelm Hall at Ames Laboratory, and X-ray machine monitoring including doses from chest X-rays.	03/14/2007	287
State Contacted: Iowa Department of Public Health [Name redacted], [Title redacted] Bureau of Radiological Health [phone number redacted]	No relevant data identified.	06/03/2010	0

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
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.	07/02/2010	10
Claimant	Miscellaneous Linde material, including a mention of medical records from Ames.	04/18/2005	1
Curtiss-Wright, Cheswick, PA	Methods of Separating U233 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, and operational reports.	12/30/2008	3
DOE Argonne National Laboratory	Organization of National Nucleonics Program.	04/02/2008	1
DOE Brookhaven National laboratory	Air monitoring parameters at Ames and a roster of Brookhaven personnel who worked at Ames.	10/21/2008	2
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	6
DOE Hanford	Ames waste management audits and reports, waste shipments, Commodity Irradiation Project, AEC planning for U-233 production, and the 1951 history and description of Ames Laboratory.	07/22/2010	33
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.	02/28/2011	61

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
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.	02/03/2011	88
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.	06/18/2008	17
DOE Los Alamos National Laboratory	Los Alamos uranium metallurgy technical series and wartime reports mentioning purification work at Ames.	08/22/2007	3
DOE Oak Ridge Operations Vault and Holding Area.	List of papers written on uranium and researcher notes.	12/10/2010	2
DOE Office of Scientific and Technical Information (OSTI)	Report on survey of irradiation facilities, thorium slugs produced at Ames, and thorium rod measurements.	08/02/2010	3
DOE Pacific Northwest National Laboratory (PNNL)	GENII version 2 user's guide.	03/12/2007	1
DOE Savannah River Site	Production of thorium at Ames, trip report including thorium meeting division of research, and thorium slugs for irradiation program.	07/22/2008	3
[Name redacted] Personal Files	Memorandum of understanding with the Metallurgical Laboratory for Dr. Spedding's services.	11/24/2009	1
Federal Records Center (FRC) - Kansas City	Film badge reports.	10/16/2008	4
Federal Records Center (FRC) - San Bruno	Summaries of fuels and materials development programs.	01/31/2006	1
Hagley Museum and Library	References to Ames' wartime PUREX work with DuPont at Hanford and the Deepwater Works.	09/29/2010	8
Internet	References to Ames' development of the PUREX process.	04/08/2011	1
Internet - Ames Public Library	No relevant data identified.	06/18/2010	0
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	03/20/2010	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Monthly Report Hanford Atomic Products Operation for April 1953.	03/20/2010	1
Internet - DOE Legacy Management Considered Sites	Monthly progress report, authority review for MED operations conducted at Ames Laboratory, interim overview and certification activities report, research reactor facility, production of thorium metal, uranium contained in the Iowa State College dump, and a Tonawanda area progress report.	04/18/2010	9
Internet - DOE OpenNet	Semiannual reports of the Atomic Energy Commission, Manhattan District History, Book I - General, Volume 7 - Medical Program, summary history of the nuclear weapons program, and activation test results of samples.	09/01/2010	9

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
Internet - DOE OSTI Energy Citations	The Ames reactor training program, thorium chemistry research, descriptions of the POLLY system, bubble chamber work, the Tiger Team assessment of Ames, environmental reports, quarterly progress reports, and thorium metallurgy. NOTE: These documents were ordered through OSTI.	01/11/2011	54
Internet - DOE OSTI Information Bridge	Analysis of enriched and depleted uranium oxide powders, annual site environmental report, effects of temperature on mechanical properties or normal uranium dingot, in-situ monitoring of actinides and rare earth elements, low enrichment fuel conversion, neutron scattering studies, Nuclear Science and Technology extracts from Journal of Metallurgy and Ceramics, performance assessment modeling of high level nuclear waste forms from the pyroprocess fuel cycle, performance testing of multi-metal continuous emissions monitors, plutonium contamination monitoring, quarterly reports, radiological survey, sputtering of vanadium and niobium under 14.1 Mev neutron impact, uranium enrichment using plasma centrifuges, X-ray K-edge analysis of drain lines in Wilhelm Hall, counting laboratories intercalibration, radioactive waste reports, a 1950 survey of air cleaning, and a summary of environmental dose models. NOTE: 9 documents were added by previous research or site association.	04/15/2011	90
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, and a Manhattan Engineer District organization chart and history. NOTE: 13 documents were added by previous research or site association.	04/11/2010	57
Internet - HP Journal	No relevant data identified.	06/14/2010	0
Internet - Iowa State University Library	No relevant data identified.	06/18/2010	0
Internet - Journal of Occupational and Environmental Health	No relevant data identified.	06/14/2010	0
Internet - National Academies Press (NAP)	No relevant data identified.	03/20/2010	0

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	03/20/2010	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	Annual operations report on Iowa State University's UTR- 10 Reactor, final status survey report for the Iowa State University UTR-10 Reactor, termination of facility operating license No. R-59 for the UTR-10 research reactor, notification of reactor operator license cancellations, request for license amendment, shipment of uranium fuel, an inspection report, and information on Iowa's Agreement State Program. NOTE: 2 documents were added by previous research or site association.	04/14/2010	21
Internet - US Army Corps of Engineers	No relevant data identified.	04/18/2010	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	03/20/2010	0
Mound Museum	Preparation of powdered thorium.	02/13/2008	1
National Archives and Records Administration (NARA) - Atlanta	Accountability reports of source and fissionable materials, acid treatment of thorium metal, air sampling results, breakdown of finished metal into green salt lots, comparison of yields from Mallinckrodt and Harshaw feed material, crushing brown oxide pellets, description of work done at Ames, instructions for billet production, Madison Square area monthly accountability reports, myrnalloy production - Iowa, procedures for handling by-product materials, proposed research program of Iowa, reactor development, receiving report receipts at Ames of thorium, trip report, requirements for x-slugs, semi-monthly reports, shipments of materials, thorium accountability report, thorium bearing residues, indoor radon study volumes 1 and 2, and urine results.	05/14/2010	136
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.	08/19/2010	38
National Archives and Records Administration (NARA) - Kansas City	Information on Oak Ridge facility decontamination history.	03/30/2005	1
National Institute of Occupational Safety and Health (NIOSH) (DCAS Website)	Special Exposure Cohort Petitions Evaluation Reports and class designation documents.	04/19/2011	6
National Technical Information Service (NTIS)	Summary of environmental emissions including equipment, facilities, and economic evaluations.	06/08/2010	1
NIOSH/SC&A	Highly enriched uranium working group reports.	02/16/2006	3

Table A1-1: Data Capture Synopsis for Ames Laboratory			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
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.	01/14/2011	21
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
Sandy Cohen & Associates (SC&A)	TR-119 to attend the research materials coordination and planning meeting and a report showing Ames shipments to Fernald.	07/02/2008	2
Southern Illinois University	Disposal of radioactive wastes in the metropolitan St. Louis area.	10/08/2008	2
Unknown	Air samples, Blockson Chemical Company and other FUSRAP site information, semi-annual report of the Atomic Energy Commission, location of HP medical records - Mancuso Study, occupational exposure to thorium and beryllium, radiological hazards and controls for uranium operations, results of the DOE indoor radon study, site history information, urine, air dust, and slag sample results, and records from sites involved in thorium work with Ames.	10/18/2004	43
TOTAL			**1041**

Table A1-2: Databases Searched for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded To SRDB**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called "Ames Laboratory Rev 01 (83.14) 04-27-11"			
Ames Public Library www.Catalogue.amespubliclibrary.org COMPLETED 06/18/2010	See Note above	0	0
DOE CEDR http://cedr.lbl.gov/ COMPLETED 03/20/2010	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 03/20/2010	See Note above	2	1
DOE Legacy Management Considered Sites http://csd.lm.doe.gov/ COMPLETED 04/18/2010	See Note above	9	9
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 09/01/2010	See Note above	66	9
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 01/11/2011	See Note above	12,319	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 04/15/2011	See Note above	4,718	81
Google http://www.google.com COMPLETED 04/11/2010	See Note above	127,347	44
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 06/14/2010	See Note above	43	0
Iowa State University Library www.primofe-1.lib.iastate.edu COMPLETED 06/18/2010	See Note above	0	0

Table A1-2: Databases Searched for Ames Laboratory			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded To SRDB**
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 06/14/2010	See Note above	30	0
National Academies Press http://www.nap.edu/ COMPLETED 03/20/2010	See Note above	2,288	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 03/20/2010	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 04/14/2010	See Note above	550	19
USACE/FUSRAP http://www.lrb.usace.army.mil/fusrap/ COMPLETED 04/18/2010	See Note above	1	0
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 03/20/2010	See Note above	0	0

Table A1-3: Cincinnati Public Library Documents Ordered for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: NA OSTI ID: 85990 Ref ID: 81050	In-Situ Characterization Technique for Screening Contaminated Soils from Journal of Environmental Engineering, Vol 121(7):521-526, July 1995	05/04/2010	05/04/2010
DOC Number: NA OSTI ID: 4351662 Ref ID: 81221	Reduction of Uranium With Magnesium, Metal Progress, Vol 69(3):81-88, Mar 1956	05/04/2010	05/04/2010
DOC Number: NA OSTI ID: 5268990 Ref ID: 81220	Waste Fuel Mix Saves University $41,600 Yearly from Energy User News Vol 7(23):5, Jun 7, 1982	05/04/2010	05/04/2010
DOC Number: CONF-890604 OSTI ID: 6757028 Ref ID: 81219	The Role of the Iowa State University Research Reactor in Nuclear Engineering Education from Transactions of the American Nuclear Society, Vol 59, Annual Meeting of the American Nuclear Society, 4-8 Jun 1989	05/04/2010	05/05/2010
DOC Number: CONF-690312 OSTI ID: 4150845 Ref ID: 81286	Instructions in Applications of Nuclear Devices at Iowa State University from Education for Peaceful Uses of Nuclear Explosives from Symposium on Education for the Peaceful uses of Nuclear Explosives Pp 281-283, Jan 1970	05/04/2010	05/10/2010
DOC Number: CONF-660630; IS-1379 OSTI ID: 4509093 Ref ID: 81752	Uranium Metal by Carbon Reduction of Uranium Oxide in Vacuum from Vacuum Metallurgy Conference, Jun 14, 1966	05/04/2010	05/25/2010
DOC Number: NA OSTI ID: 4663051 Ref ID: 81288	Environmental Trace Element Survey at a Heavy Metals Refining Site, Nuclear Methods in Environmental Research from Meeting on Nuclear Methods in Environmental Research, Pp 172-185, Jan 1971	04/28/2010	05/11/2010
DOC Number: NA OSTI ID: 381792 Ref ID: 81287	Full-Scale Technology Demonstration of a Polyethylene Encapsulation Process for Radioactive, Hazardous, and Mixed Wastes from Journal of Environmental Science and Health, Part A: Environmental Science and Engineering, Vol 31(7):1767-1780, Aug 1996	04/28/2010	05/11/2010
DOC Number: UNI-SA-103; CONF-821005-4 OSTI ID: 5115872 Ref ID: 82903	Decommissioning of the Ames Laboratory Research Reactor from DOE International Decommissioning Symposium, Oct 10, 1982	04/28/2010	07/02/2010

Table A1-4: OSTI Documents Requested for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-4789 OSTI ID: 5402590 Ref ID: 25824	Decommissioning of the Ames Laboratory Research Reactor. Final Report, Dec 1981	04/28/2010	04/28/2010
DOC Number: IS-4798 OSTI ID: 5304492 Ref ID: 25429	Environmental Monitoring Summary for Ames Laboratory: Calendar Year 1981, Apr 1982	04/28/2010	04/28/2010
DOC Number: IS-1098 OSTI ID: 4641828 Ref ID: 25884	Survey of Environmental Radioactivity (Cy 1963?), December 1964	04/28/2010	04/28/2010
DOC Number: PB-274552 OSTI ID: 6812936 Ref ID: 81261	Evaluation of the Ames Solid Waste Recovery System. Part I. Summary of Environmental Emissions: Equipment, Facilities, and Economic Evaluations. Interim Report 5 Feb 76--4 Feb 77, Nov 1977	04/28/2010	06/08/2010
DOC Number: CC-2401 OSTI ID: 4365563 Ref ID: 87894	A Method of Recovering Thorium from Slag Materials. Problem Assignment No. 16, Mar 23, 1945	04/28/2010	09/15/2010
DOC Number: WASH-149 OSTI ID: 4360605 Ref ID: 87863	Air Cleaning Seminar, Ames Laboratory, September 15-17, 1952, Mar 1954	04/28/2010	09/15/2010
DOC Number: ANL-7934? OSTI ID: 4638706 Ref ID: 87918	Ames Laboratory Holly Programming System, January 1972	04/28/2010	09/15/2010
DOC Number: ANL-7934? OSTI ID: 4650114 Ref ID: 87924	Ames Laboratory Interactive Hardware Programmed Polly, January 1972	04/28/2010	09/15/2010
DOC Number: IS-4955 OSTI ID: 6617260 Ref ID: 87966	Ames Laboratory Quarterly Report, October 1, 1987--December 31, 1987, Feb 1988	04/28/2010	09/15/2010
DOC Number: IS-3483 OSTI ID: 4249469 Ref ID: 87799	Ames Laboratory Reactor Operator Training Program, Aug 1974	04/28/2010	09/15/2010
DOC Number: IS-1500, Sect E OSTI ID: 4530066 Ref ID: 88270	Annual Summary Research Report in Engineering, Oct 31, 1966	04/28/2010	09/15/2010
DOC Number: AECU-1817 OSTI ID: 4394686 Ref ID: 87900	Backscattering of Beta-Rays In Windowless Geiger-Muller Counters, Oct 31, 1952	04/28/2010	09/15/2010

Table A1-4: OSTI Documents Requested for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: AECD-3249 OSTI ID: 4399591 Ref ID: 87901	Compounds of Thorium with Transition Metals I. The Thorium-Manganese System, Aug 24, 1951	04/28/2010	09/15/2010
DOC Number: M-4585 OSTI ID: 4365308 Ref ID: 87892	Corrosion of Thorium and Related Materials, Oct 31, 1956	04/28/2010	09/15/2010
DOC Number: IS-T-1555 OSTI ID: 10140375 Ref ID: 87970	Encapsulation of Hazardous Wastes into Agglomerates, Jan 28, 1992	04/28/2010	09/15/2010
DOC Number: DOE/EA-0434 OSTI ID: 7043259 Ref ID: 87969	Environmental Assessment for US Department of Energy Support of an Iowa State University Linear Accelerator Facility at Ames, Iowa, May 1990	04/28/2010	09/15/2010
DOC Number: IS-4734 OSTI ID: 5309715 Ref ID: 87944	Environmental Monitoring at Ames Laboratory: Calendar Year 1979, Apr 1980	04/28/2010	09/15/2010
DOC Number: IS-4844 OSTI ID: 6681447 Ref ID: 87967	Environmental Research and Development Measurement and Dosimetry. Quarterly Report, April 1, 1983-June 30, 1983, Oct 1983	04/28/2010	09/15/2010
DOC Number: IS-4869 OSTI ID: 6011268 Ref ID: 87965	Environmental Research and Development: Measurement and Dosimetry. Quarterly Report, April 1-June 30, 1984, Sep 1984	04/28/2010	09/15/2010
DOC Number: ANL-7934? OSTI ID: 4626725 Ref ID: 87916	General Description of the Ames Laboratory Polly, January 1972	04/28/2010	09/15/2010
DOC Number: IS-4818 OSTI ID: 5722416 Ref ID: 87961	Health and Environmental Research. Quarterly Report, April 1-June 30, 1982, Nov 1982	04/28/2010	09/15/2010
DOC Number: IS-4791 OSTI ID: 5171787 Ref ID: 87937	Health and Environmental Research. Quarterly Report, October 1-December 31, 1981. [Health And Environmental Effects of Waste and Biomass to Energy Processes], Apr 1982	04/28/2010	09/15/2010
DOC Number: IS-4841 OSTI ID: 5534946 Ref ID: 4841	Identification and Characterization of Pollutants. Quarterly Report, January 1-March 31, 1983, Jun 1983	04/28/2010	09/15/2010
DOC Number: ISC-653 OSTI ID: 4362480 Ref ID: 87865	Kinetics of the Reaction Between Thorium and Water Vapor, Jun 1955	04/28/2010	09/15/2010

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Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: DOE/ER/75360-2 OSTI ID: 5374102 Ref ID: 87947	Low Enrichment Fuel Conversion for Iowa State University, Aug 1990	04/28/2010	09/15/2010
DOC Number: IS-4718 OSTI ID: 5585528 Ref ID: 87959	Office of Health and Environmental Research. Quarterly Report, April 1, 1979-June 30, 1979. [Ames Municipal Solid Waste Recovery System], Oct 1979	04/28/2010	09/15/2010
DOC Number: IS-2600 OSTI ID: 4691951 Ref ID: 87933	Physics Division, January 1971	04/28/2010	09/15/2010
DOC Number: CC-2962 OSTI ID: 4365562 Ref ID: 87893	Precipitation of Thorium Oxalate from Nitric Acid Solutions. Problem No. 117, Oct 1945	04/28/2010	09/15/2010
DOC Number: ISC-135 OSTI ID: 4409518 Ref ID: 87910	Progress Report in Physics for the Period July 1, 1950, to December 31, 1950, Mar 15, 1951	04/28/2010	09/15/2010
DOC Number: IS-4740 OSTI ID: 5375416 Ref ID: 87948	Quarterly Report, 1 January-31 March 1980, May 1980	04/28/2010	09/15/2010
DOC Number: IS-4735 OSTI ID: 5267734 Ref ID: 87941	Quarterly Report, 1 October-31 December 1979, Mar 1980	04/28/2010	09/15/2010
DOC Number: IS-4707 OSTI ID: 5829597 Ref ID: 87964	Quarterly Report, January 1-March 31, 1979, Jul 1979	04/28/2010	09/15/2010
DOC Number: ISC-69 OSTI ID: 4337900 Ref ID: 87801	Quarterly Summary Research Report for April, May, and June 1949, Nov 28, 1949	04/28/2010	09/15/2010
DOC Number: AECD-4023 OSTI ID: 4360181 Ref ID: 87821	Quarterly Summary Research Report for July, August, and September 1951, Nov 15, 1951	04/28/2010	09/15/2010
DOC Number: AECD-3929 OSTI ID: 4366878 Ref ID: 87897	Quarterly Summary Research Report for October, November, and December 1950, Jan 30, 1951	04/28/2010	09/15/2010
DOC Number: ISC-642 OSTI ID: 4364249 Ref ID: 87872	Quarterly Summary Research Report in Engineering for April, May, June 1955, Nov 23, 1955	04/28/2010	09/15/2010

Table A1-4: OSTI Documents Requested for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: ISC-487 OSTI ID: 4363962 Ref ID: 87871	Quarterly Summary Research Report in Physics for January, February, and March 1954, Jun 26, 1954	04/28/2010	09/15/2010
DOC Number: ISC-533 OSTI ID: 4382994 Ref ID: 87899	Quarterly Summary Research Report in Physics for July, August, and September 1954, Dec 21, 1954	04/28/2010	09/15/2010
DOC Number: IS-900 OSTI ID: 4643927 Ref ID: 87920	Reactor Division, Oct 31, 1965	04/28/2010	09/15/2010
DOC Number: CONF-641207-5 OSTI ID: 4643940 Ref ID: 87921	Regulations and Control for Radiation Protection. Paper No. 64-819 From American Society of Agricultural Engineers, Winter Meeting, Dec 31, 1965	04/28/2010	09/15/2010
DOC Number: AECD-4046 OSTI ID: 4360180 Ref ID: 87806	Semi-Annual Progress Report in Metallurgy for The Period October 1, 1950- March 31, 1951, May 1951	04/28/2010	09/15/2010
DOC Number: ISC-757 OSTI ID: 4358865 Ref ID: 87804	Semi-Annual Summary Research Report in Chemistry for January-June 1956, Oct 12, 1956	04/28/2010	09/15/2010
DOC Number: ISC-834 OSTI ID: 4368061 Ref ID: 87898	Semi-Annual Summary Research Report in Chemistry for July-December 1956, Mar 15, 1957	04/28/2010	09/15/2010
DOC Number: ISC-760 OSTI ID: 4366223 Ref ID: 87895	Semi-Annual Summary Research Report in Engineering for January-June 1956, Oct 1, 1956	04/28/2010	09/15/2010
DOC Number: ISC-836 OSTI ID: 4366534 Ref ID: 87896	Semi-Annual Summary Research Report in Engineering for July-December 1956, Mar 15, 1957	04/28/2010	09/15/2010
DOC Number: ISC-463 OSTI ID: 4361723 Ref ID: 87864	Solubility of Carbon in Thorium, Feb 18, 1954	04/28/2010	09/15/2010
DOC Number: AECD-3206; ISC-102 OSTI ID: 4408189 Ref ID: 87905	Some Studies on the Uranium-Thorium-Zirconium Ternary Alloy System, June 1950	04/28/2010	09/15/2010
DOC Number: IS-1523 OSTI ID: 4439008 Ref ID: 87911	Survey of Environmental Radioactivity (Cy 1966?), January 1967	04/28/2010	09/15/2010

Table A1-4: OSTI Documents Requested for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: IS-2154 OSTI ID: 4768629 Ref ID: 87935	Survey of Environmental Radioactivity for Period January 1, 1969 to June 30, 1969, Jan 1969	04/28/2010	09/15/2010
DOC Number: IS-1924 OSTI ID: 4486804 Ref ID: 87914	Survey of Environmental Radioactivity for Period January 1--June 30, 1968, Jan 1968	04/28/2010	09/15/2010
DOC Number: ISC-14 OSTI ID: 4338203 Ref ID: 87803	The Chelate Compounds of Plutonium (Thesis), May 25, 1946	04/28/2010	09/15/2010
DOC Number: IS-986 OSTI ID: 4649643 Ref ID: 87922	The Creep of Thorium Near Room Temperature, Sep 1964	04/28/2010	09/15/2010
DOC Number: ISC-417 OSTI ID: 4406585 Ref ID: 87903	The Determination of Mesothorium in Thorium Nitrate, Nov 1953	04/28/2010	09/15/2010
DOC Number: AECD-3544; ISC-391 OSTI ID: 4408551 Ref ID: 87908	The Niobium-Thorium Alloy System, Aug 13, 1953	04/28/2010	09/15/2010
DOC Number: ISC-48 OSTI ID: 4363430 Ref ID: 87869	Thorium Alloys--The Thorium-Bismuth System, Jul 12, 1950	04/28/2010	09/15/2010
DOC Number: DOE/EH-0264 OSTI ID: 10154495 Ref ID: 87939	Tiger Team Assessment of the Ames Laboratory, Mar 1992	04/28/2010	09/15/2010
DOC Number: IS-900 OSTI ID: 4666506 Ref ID: 87925	Annual Summary Research Report of Chemistry, Engineering, Metallurgy, Physics And Reactor Divisions, July 1, 1963-June 30, 1964, Sep 1964	04/28/2010	09/15/2010
DOC Number: IS-1500, Sect M OSTI ID: 4518493 Ref ID: 88270	Annual Summary Research Report in Metallurgy, Oct 31, 1966	04/28/2010	09/23/2010
DOC Number: IS-1500, Sect P OSTI ID: 4508143 Ref ID: 88270	Annual Summary Research Report in Physics, Oct 31, 1966	04/28/2010	09/23/2010
DOC Number: AECD-4001 OSTI ID: 4360182 Ref ID: 88269	Progress Report in Metallurgy, April 1, 1949 to September 30, 1949, Nov 15, 1949	04/28/2010	09/23/2010

Table A1-4: OSTI Documents Requested for Ames Laboratory			
Document Number	**Document Title**	**Requested Date**	**Received Date**
DOC Number: TSC-700 OSTI ID: 4357623 Ref ID: NA	The Stress-Strain Characteristics of Uranium, Dec 1955	04/28/2010	OSTI Doesn't have
DOC Number: IS-1647 OSTI ID: OSTI ID: 4275110 Ref ID: NA	Survey of Environmental Radioactivity for Period, January 1, 1967--June 30, 1967, Jan 1967	04/28/2010	OSTI Doesn't have