SEC Petition Evaluation Report
Petition SEC-00101

Report Rev #: 0 Report Submittal Date: February 4, 2009

Subject Expert(s):	James Mahathy
Site Expert(s):	N/A

Petitioner Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Petition A Receipt Date	DOE/AWE Facility Name
SEC-00101	83.14	November 1, 2007	Hood Building

NIOSH-Proposed Class Definition

All employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked in the Hood Building in Cambridge, MA, from May 9, 1946 through December 31, 1963, 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 SEC.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
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Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
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Evaluation Report Summary: SEC-00101, Hood Building

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

Within the EEOICPA facility description for the Massachusetts Institute of Technology (MIT), the Hood Building is designated as a Department of Energy (DOE) facility during the period from 1946 through 1963. The NIOSH-proposed class includes all employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked in the Hood Building in Cambridge, MA, from May 9, 1946 through December 31, 1963, 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 SEC.

Feasibility of Dose Reconstruction Findings

NIOSH lacks sufficient information, which includes dosimetry data, workplace monitoring data, and source term data, to allow it to estimate with sufficient accuracy the potential internal exposures to enriched uranium and thorium to which the proposed class may have been subjected.

NIOSH finds that it is likely feasible to reconstruct occupational medical dose for Hood Building workers with sufficient accuracy.

- Principal sources of internal radiation for members of the proposed class included exposures to uranium, enriched uranium, and thorium. Operations conducted at the Hood Building included metallurgical research with uranium and thorium, extrusion of uranium and thorium, disintegration studies involving radioactive tracers, studies of thorium alloys, and alloying of zirconium with uranium and thorium.

- NIOSH has obtained uranium bioassay results for some workers for 1952, 1955, 1957, and 1958 and breathing-zone air-monitoring results for less than twenty workers. NIOSH has also obtained limited urinalysis results for enriched uranium for the years 1957 and 1958 only. NIOSH has not obtained thorium bioassay results; nor has NIOSH obtained bioassay results measuring exposure to fission products for which exposure would have been limited to laboratory releases.

- NIOSH can likely reconstruct doses received from exposure to natural uranium metal. However, given the lack of monitoring data, doses received from potential intakes resulting from exposure to enriched uranium cannot be bounded given the lack of appropriate bioassay data and documentation of source term amounts and percentage enrichment.

- NIOSH cannot reconstruct doses received from potential intakes of thorium given the lack of personal monitoring data, workplace monitoring data, and complete source term data for thorium.

- Principal sources of external radiation for members of the proposed class included exposures to uranium, enriched uranium, and thorium which could have been received during operations at the Hood Building.

- NIOSH has identified external monitoring data for Hood Building workers for May 1947, and the period from 1951 through 1958.

- NIOSH considers it feasible to reconstruct external doses for individuals having personal external monitoring data. NIOSH has found sufficient film badge results and data supporting the processes to likely allow for development of external dose co-worker distributions for portions of the SEC period, if appropriate.

- 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 employees working in the Hood Building, NIOSH intends to use any internal and external monitoring data that may be available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Furthermore, NIOSH has determined that occupational medical dose for all workers can be reconstructed. Therefore, dose reconstructions may be performed using these data, as appropriate, for individuals with non-presumptive cancers or fewer than 250 days employment during the class period.

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 uranium and thorium and from direct exposure to radioactive materials. Therefore, 42 C.F.R. § 83.13(c)(3)(ii) requires NIOSH to specify that health may have been endangered for those 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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ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the Oak Ridge Associated Universities Team Lead Technical Evaluator: James Mahathy, Oak Ridge Associated Universities. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for employees who worked at a specific facility during a specified time. It provides information and analysis germane to considering a petition for adding a class of employees to the Congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH, with the exception of the employee whose dose reconstruction could not be completed, and whose claim consequently led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

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

2.0 Introduction

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

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioners and the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the

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

advice of the Board, the Director of NIOSH will propose a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.[2]

3.0 NIOSH-Proposed Class Definition and Petition Basis

The NIOSH-proposed class includes all employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked in the Hood Building in Cambridge, MA, from May 9, 1946 through December 31, 1963, 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 SEC. During this period, employees at this facility engaged in: (1) metallurgical research involving uranium, thorium, and beryllium; (2) movement of equipment to a new site in Concord, Massachusetts; and (3) building demolition.

The evaluation responds to Petition SEC-00101 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. This claimant was employed by the Massachusetts Institute of Technology as a Machinist from 1951 through 1954. NIOSH's determination that it is unable to complete a dose reconstruction for an EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations in the Hood Building from May 9, 1946 through December 31, 1963 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.

[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.

4.1 Operations Description

The DOE has assigned three classifications to its facility designation for the Massachusetts Institute of Technology (MIT). This report evaluates the DOE-covered period only (Item 3):

1. Atomic Weapons Employer (AWE) Site: From 1942 to 1946, MIT is classified as an AWE Site because of Manhattan Engineer District (MED) research in uranium extraction conducted in MIT locations other than the Hood Building.

2. Beryllium Vendor: From 1943 to 1946, MIT is also classified as a Beryllium Vendor because of research on beryllium metal and a beryllium-uranium alloy, and production of beryllium oxide crucibles.

3. DOE Facility: From 1946 though 1963, the Hood Building is classified as a DOE Facility because of research involving uranium, thorium, and beryllium performed by both MIT and Nuclear Metals, Inc. (NMI), personnel.

MIT began its work as an AWE site for the MED on August 13, 1942 when it was contracted to perform uranium extraction studies (DOE, 2009). MIT's mission was expanded in July 1944 with the establishment of the Raw Materials Development Laboratory (National Lead, 1954-59). In that role, MIT researched and tested processes for melting and casting uranium metal, and for extracting uranium from small quantities of low-grade ores. As research evolved, MIT deduced that uranium ore of a much lower grade required treatment in order to increase uranium production (National Lead, 1954-59). Consequently, the project was increasingly focused on the effective processing of relatively low-grade materials. As the scope of uranium production increased in variety and significance, routine uranium processing was moved in 1946 to the Watertown Arsenal in Watertown, Massachusetts (Watertown, unknown date; National Lead, 1954-59).

MIT's work as a Beryllium Vendor started on August 31, 1943 when it entered into MED contract W-7405-eng-175. The ensuing project studied the characteristics of beryllium metal and attempted to create a satisfactory beryllium-uranium alloy. This period also led to one of MIT's largest contributions to the MED effort: the design of a beryllium crucible that permitted plutonium to be reduced to metal without introducing light-element contaminants (DOE, 1997, pdf p. 15; Garrelick, 1995). The resulting crucibles were shipped to Y-12 and the Los Alamos Scientific Laboratory (MIT Shipping, 1946). In 1946, MIT's government-funded research of enriched uranium, uranium alloys, and thorium materials was continued by the newly-created Atomic Energy Commission (AEC) (AEC, Dec47, pdf p. 45; MIT, 1949; MIT MiscLetters, 1946; Gordon, 1948; Various authors, Mar63-Dec70).

MIT's work as a DOE Facility began in 1946. After a number of cases of beryllium disease at MIT, the AEC consolidated the activities described above into a single building. AEC purchased the Hood Milk Company building located at the intersection of Massachusetts Avenue and Albany Street (155 Massachusetts Avenue). NIOSH has found reference to a memo dated May 9, 1946 that addresses the "planned move of MIT to Hood Milk Co. Building" (Randall, 1947, pdf p. 137). The earliest indication found by NIOSH that MIT was working out of the Hood Building is a memo dated August 14, 1946 with a Hood Building return address (MIT MiscLetters, 1946, pdf p. 3). The Hood Building was designated Building 12 by MIT and adjoined another MIT building that housed an

instrumentation shop. Section 4.3 presents the NIOSH conclusions regarding the time period associated with radiological operations at the Hood Building.

From 1946 through 1963, employees at the Hood Building were involved with metallurgical research involving uranium (including uranium extrusion) and thorium, movement of equipment to a new site in Concord, Massachusetts, and demolition of the building. MIT also developed and manufactured extruded beryllium bars for use at Los Alamos (Garrelick, 1995). Beryllium crucible research and production continued under the AEC on the first and second floor of the Hood Building (Cammann, 1949; ORAU, 2008a). The Hood Building incorporated 300-pound and 1000-pound presses on the first floor to extrude both uranium and beryllium (ORAU, 2008a). In 1948, Hood Building staff (using a specifically-designed hood) experimented with powdered beryllium-natural uranium alloys (Belmore, 1948). Throughout the course of later operations in the Hood Building, the potential for beryllium exposure existed due to AEC activities.

Tracers were used in disintegration studies and organic property studies; radioactive tracers included Cd-95, Co-60, Cs-134, Na-24, Hf-181, I-131, Sc-46, and Zn-95 (MIT Requests, 1947-48).

In 1947, Hood workers extruded thorium powder obtained from Westinghouse into metal rods and performed studies of thorium alloys (MIT, no date; Santangelo, no date). In 1952, Hood Building staff performed tests, including heat extrusion, annealing and density checks, on thorium rods for use at the Savannah River Site (Hayes, 1952; Loewenstein, 1952). After receiving thorium from Fernald (AEC, 1954), work with thorium continued through at least 1955 (ORAU, 2008c).

On July 1, 1954, MIT and AEC privatized all work done at the Hood Building under contract to Nuclear Metals, Inc. The staff of 121 MIT employees at the Hood Building (Garrelick, 1995) became employees of NMI on that date. The following on-going activities were transferred to NMI (Klevin, 1954):

- Routine fabrication of beryllium crucible and stopper rods
- Reduction and purification of zirconium
- Alloying of zirconium with uranium and thorium
- Casting of thorium containing 2 weight percent uranium
- Extrusion cladding of uranium with zircalloy and cladding and scaling ends by co-extrusion
- Extrusion of uranium

MIT also conducted radiochemical analysis of AEC radium samples in the Hood Building from 1946 through 1953 under contract W-022-075eng013 (MIT, 1951; Rodden, 1952; MIT, 1953a). This analytical work was performed by MIT; however, this analytical work was not continued by NMI after MIT vacated the Hood Building.

Hood Building staff manufactured fuel elements for Savannah River, Hanford, and Idaho National Engineering and Environmental Laboratory, and later developed processes so that those sites could manufacture elements (ORAU, 2008a; ORAU, 2008b). Work was also performed for Brookhaven National Laboratory (ORAU, 2008b) using enriched uranium. Hood Building staff performed research of enriched uranium-beryllium alloys containing U-235 up to 10 percent weight (AEC, Dec47, pdf p. 52; Randall, 1947, pdf p. 24; Santangelo, no date). Alloy development work not

involving radioactive materials was conducted at the Hood Building as well as part of the fuel element research.

NMI continued metallurgical research and production of beryllium crucibles in the Hood Building until NMI vacated the Hood Building in 1958 and moved to a new facility in Concord, Massachusetts. Two hundred sixty-five employees worked for NMI at the time of the move to Concord (Garrelick, 1995). No additional AEC activities were performed in the Hood Building after 1958. The General Services Administration deeded the Hood Building to MIT by early 1963 for the purpose of MIT demolishing the building and constructing an educational facility (The Tech, 1963; MIT Press Releases, 1962-63). The building was demolished in 1963 by MIT and their contractor, P. R. Mallory (ORAU, 2008b). MIT paid the costs of demolition (MIT Press Releases, 1962-63).

4.2 Radiation Exposure Potential from Operations

The potential for external radiation dose existed in all locations of the Hood Building where radioactive materials were handled, used, or stored. Sources of potential external exposures included beta radiation and photon radiation from the decay of uranium and thorium daughters and from X-ray radiographic testing. Exposure to fission products may have resulted from the use of isotopic tracers and from the testing of radiation shielding and heat transfer conditions.

During Hood Building operations, potential radiological internal exposures resulted from operations using uranium ore and metals, enriched uranium, and thorium. Indications are that Hood Building operations also included exposures to some quantity of fission products. NIOSH has documentation to establish portions of the source terms for some radionuclides; however, there are insufficient data to reconstruct the total source term for any radionuclide, or to identify all chemical forms of radionuclides encountered at the Hood Building.

4.3 Time Period Associated with Radiological Operations

Per the DOE Office of Health, Safety and Security, the time period associated with DOE operations is from 1946 through 1963 (DOE, 2007). As discussed in Section 4.1, NIOSH has found reference to a memo dated May 9, 1946 discussing MIT's planned move to the Hood Building (Randall, 1947, pdf p. 137). The earliest indication found by NIOSH that MIT was working out of the Hood Building is a memo dated August 14, 1946 with a Hood Building return address (MIT MiscLetters, 1946, pdf p. 3). NIOSH has determined that the consolidation of AEC operations within the Hood Building likely occurred between May 9, 1946 and August 14, 1946. Because NIOSH has no information to confirm when during this period actual radiological operations began in the Hood Building, this evaluation report assumes that DOE operations in the Hood Building began on May 9, 1946 and continued through December 31, 1963 (the year Hood Building demolition was completed).

4.4 Site Locations Associated with Radiological Operations

The Hood Building was acquired by the AEC for use by MIT in performance of Metallurgical Project 6825. The Hood Building was constructed in the early 20th century and served as an ice cream plant and warehouse for the Hood Milk Company. The building was located at the intersection of Massachusetts Avenue and Albany Street (155 Massachusetts Avenue) in Cambridge. While the building was owed by AEC, MIT assigned Building Number 12 for identification. A photo of the building is provided in Figure 4-1.

Figure 4-1: The Hood Building at MIT

The Hood Building was constructed of brick and wood without reinforcement to support heavy loads. The foundry was located on the first floor which also supported 300- and 1000-pound presses in the extrusion area. During OCAS interviews, previous employees indicated that uranium was stacked in many accessible locations throughout the building (ORAU, 2008b). Worker interviews further indicated that the building did not contain mechanical ventilation systems other than some hoods that were added to limited areas and which vented to the roof; workers frequently vacuumed ash and dust from the roof as a consequence of the exhaust. Respirator use was based on the job being performed, but was sporadic according to the testimony of former workers. Although there was a lunch area on the second floor, former workers indicate that it was common practice to eat in the production areas. A layout of the Hood Building is provided in Figure 4-2.

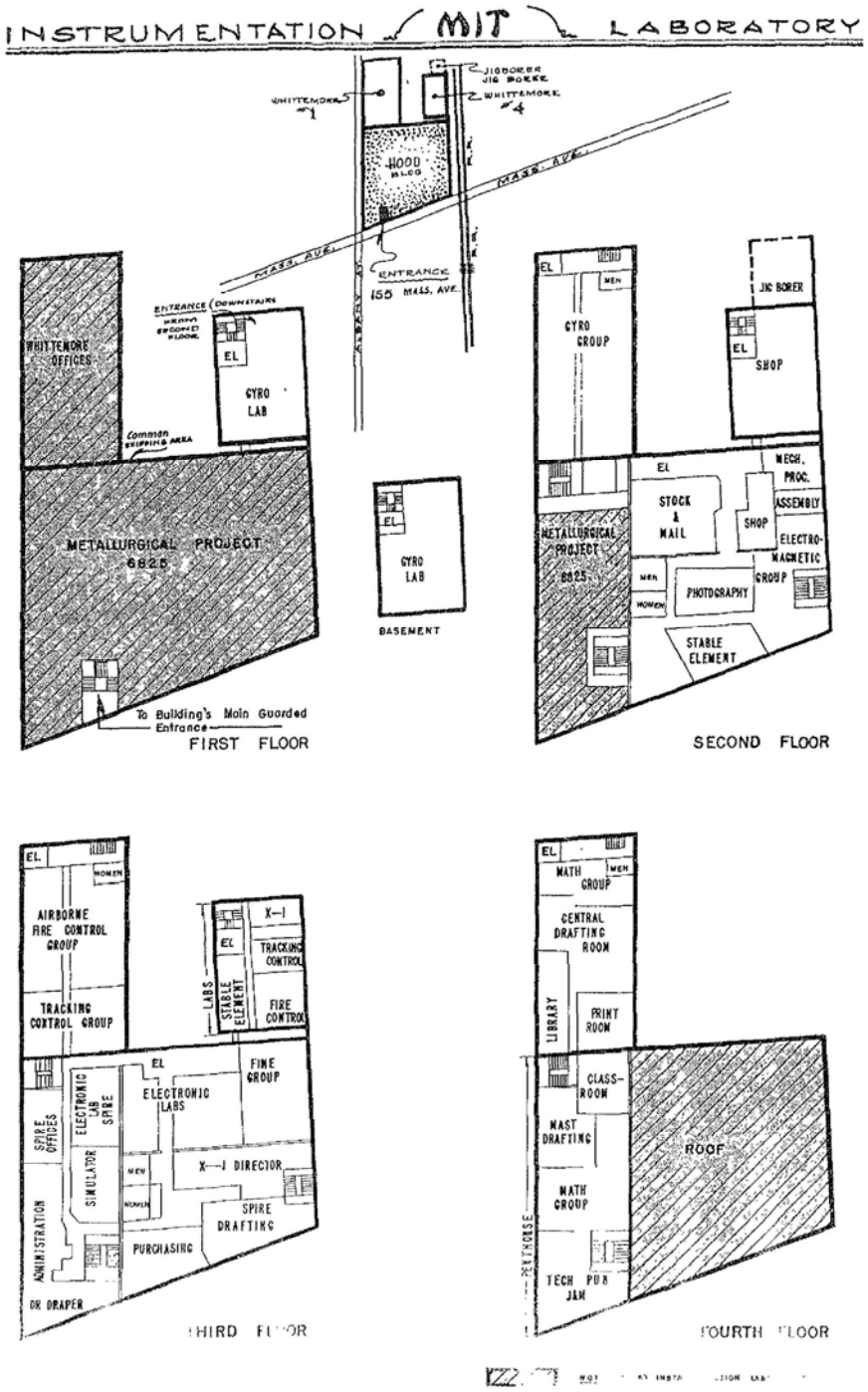

Figure 4-2: Layout of MIT's Hood Building

There was at least one recorded incident of an extrusion press expelling a piece of material through the wall of the Hood Building and into the MIT Instrumentation Lab next door. Workers have described those projectiles, and fires caused by the presses, as common occurrences (Santangelo, no date). In 1956, interviewees indicated that three hurricanes came through Cambridge and flooded the Hood Building. Water flowed through the elevator into the area where enriched uranium and thorium were stored, requiring the materials to be moved. Controlling the material was a major concern as well as the spread of uranium and thorium contamination. The storage area had already been flooded in 1954 though it is not clear if radioactive materials were present during that event (ORAU, 2008b).

In 1955, NMI was cited by the state of Massachusetts for the crowded condition of Hood Building work rooms which was a handicap to the control of health hazards (Elkins, 1955). There were 225 employees working at the Hood Building in September 1956 (Bavley, 1956). In 1956, NMI expanded operations into a second building about ¼ mile away at 224 Albany Street. This building was used to manufacture and ship fuel elements for use at Savannah River Site (SRS) (ORAU, 2008a; ORAU, 2008d). An SRS representative had an office in the 224 Albany Street Building (ORAU, 2008a). Materials were carried and trucked between the Hood Building and 224 Albany Street on a frequent basis. The current DOE Facility Description for MIT and the Hood Building does not include 224 Albany Street; therefore, exposures from that location are not considered in this evaluation report.

While worker testimony and Figure 4-2 established that some areas were office areas, stable metal areas, and laboratories, worker testimony and available documentation also have established that the spread of radioactive materials was not controlled and limited to certain areas. Consequently, the entire Hood Building is included in the proposed SEC class for the DOE operational period.

4.5 Job Descriptions Affected by Radiological Operations

NIOSH has limited documentation that associates job titles and/or job assignments with specific radiological operations. NIOSH has a roster of all people hired by Nuclear Metals, Inc., since July 1954 (NMI Employees, 1954-2004). From former worker interviews, NIOSH has established that poor controls were used to limit the spread of radioactive contamination in the Hood Building. Due to the lack of information regarding worker job descriptions, and lack of knowledge concerning worker movements within the Hood Building during the DOE operations period, NIOSH is not able to rely solely on worker job descriptions to determine the potential for DOE-period radiological exposure.

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

In addition to examining its Site Research Database (SRDB) to locate documents supporting the evaluation of the proposed class, NIOSH identified and reviewed numerous additional data sources, including worker interviews, to locate information relevant to determining the feasibility of dose reconstruction for the class of employees proposed for this petition. This included determining the availability of information on personnel monitoring, workplace monitoring, and radiological source term data.

NIOSH searched available DOE data to find source term, workplace monitoring, and personnel monitoring information pertaining to MIT and the Hood Building. NIOSH has completed six data capture campaigns in search of information relevant to MIT's covered activities at the Hood Building. During these data captures, NIOSH searched for records at: MIT, the state regulators, the Nuclear Regulatory Commission (the ADAM electronic records repository), the DOE (the OpenNet repository and the Office of Scientific and Technical Information), and the National Archives record centers. NIOSH has located limited documents detailing the Hood Building operations and some very limited area and personnel monitoring data. Attachment One contains a summary of MIT-related documents. The summary specifically identifies specific data capture details for each document retrieved.

NIOSH also examined the DOE records for the six MIT claimants in the NIOSH OCAS Claims Tracking System (NOCTS) and found limited urinalysis results for one of these claimants and external monitoring data for one other claimant.

5.2 Worker Interviews

To obtain additional information, NIOSH interviewed sixteen former Hood Building workers from October 6 through October 8, 2008 in Concord, Massachusetts. These workers described work processes, work conditions, materials used, and health and safety measures employed at the Hood Building. Two of the former workers were former officers of Nuclear Metals, Inc., and one was a former NMI medical director.

- Personal Communication, 2008, *Documented Communication with Process Knowledge Experts Discussing the Hood Building*; In-person interview by ORAU Team and NIOSH; October 6, 2008; SRDB Ref ID: 52732

- Personal Communication, 2008, *Documented Communication with Former Medical Director of Nuclear Metals, Inc.*; In-person interview by ORAU Team and NIOSH; October 6, 2008; SRDB Ref ID: 52733

- Personal Communication, 2008, *Documented Communication with Process Knowledge Experts Discussing the Hood Building*; In-person interview by ORAU Team and NIOSH; October 7, 2008; SRDB Ref ID: 52730

- Personal Communication, 2008, *Documented Communication with Process Knowledge Experts Discussing the Hood Building*; In-person interview by ORAU Team and NIOSH; October 7, 2008; SRDB Ref ID: 52731

- Personal Communication, 2008, *Documented Communication with Process Knowledge Experts Discussing the Hood Building*; In-person interview by ORAU Team and NIOSH; October 8, 2008; SRDB Ref ID: 52729

5.3 Internal Personnel Monitoring Data

The review of available monitoring records for the six NIOSH claimants having DOL-verified MIT employment revealed uranium urinalysis results for one of these claimants for 1952. NIOSH has obtained uranium fluorometric urinalysis results for 15 site workers in 1952 (AEC, Apr52-May52); 13 results were non-zero. NIOSH has obtained uranium fluorometric urinalysis results for 41 workers in 1955 (AEC, Nov55-Dec59); all 41 results were non-zero. NIOSH has obtained uranium fluorometric urinalysis results for more than 50 workers, some with multiple results, in 1957 and 1958; most of these results were non-zero (AEC, Nov55-Dec59). NIOSH has obtained results of about 70 urinalyses that were analyzed for enriched uranium in 1957 and 1958 (AEC, Nov55-Dec59). The enriched uranium urine results were reported in units of dpm/L and ranged up to about 200 dpm/L. NIOSH has obtained about twenty breathing zone air sample results obtained in 1952 analyzed for uranium by gross alpha determination (AEC, May52-Jun52).

5.4 External Personnel Monitoring Data

NIOSH has identified external monitoring data for some Hood Building workers, including results reported for two workers in May 1947 (MIT Film, 1947). Film badge data for many workers have been identified for 1951 through 1958 (MIT, Aug52-Dec53; Nucleonic Corporation, Apr57-Sep57; Film Badge Reports, 1956; Film Badge Listing, 1956-59; Film Badge Reports, 1957-58a; Film Badge Reports, 1957-58b; Film Badge Reports, 1958-59; Film Badge Reports, 1957; Film Badge Report, 1954-56; Film Badge Reports, 1956; Film Badge Readings, 1950s; Film Badge Listings, 1950s; Film Badge Reports, 1957-58c; Film Badge Reports, 1956-57b; AEC, Jan54-Jun57; Film Badge Reports, 1956-57c; MIT, Dec1955-Nov56; MIT, 1953b; MIT, 1955; MIT, 1954). In September 1956, 120 of 225 employees were being routinely monitored by film badge (Bavley, 1956).

NIOSH has not obtained occupationally-required medical X-ray data for Hood Building workers although NIOSH has obtained documentation on physical examinations that included requirements for pre-employment and annual medical exams (Bavley, 1956). NIOSH interviewed a former NMI physician who confirmed that X-rays were part of those medical exams (ORAU, 2008e)

5.5 Workplace Monitoring Data

NIOSH has identified some workplace surface monitoring and air monitoring results analyzed for gross-alpha activity, reported as uranium, and for non-radiological beryllium (AEC, Dec48; AEC, Dec48- Jan55; Bavley, 1956). NIOSH has not identified any air or surface monitoring results analyzed for thorium and fission product contamination for the Hood Building. Of the available air monitoring data, there about 250 uranium air results reported between 1948 and 1955, all taken for crucible operations in the Hood Building (AEC, Dec48; AEC, Dec48- Jan55; AEC, Apr50-Dec51). Summary gross alpha air monitoring data for the Hood Building are reported for 1956, 1957 and 1958 (Liberty Mutual, 1964; Elkins, 1955; Bavley, 1957a; Bavley, 1957b; Bavley, 1957c; Bavley, 1958). Air monitoring was dependent on the operation and was not routine (ORAU, 2008d).

5.6 Radiological Source Term Data

Some information on the quantities of uranium ore and thorium received and/or used at the Hood Building has been identified; however, the total amounts of uranium and thorium, and the forms of these isotopes, are unknown. License No. C-03429 was issued to NMI on December 2, 1955. It authorized possession of up to 100 pounds of natural uranium for use in the development of new fuel elements. Subsequent amendments to the license added enriched uranium and natural thorium (ORNL, 1998). One report shows maximum quantities of uranium and thorium permitted to be handled at the Hood Building as allowed by the State of Massachusetts in 1958 (DOL, 1958). NIOSH has identified some documentation that discusses the processes and equipment developed and/or used at the Hood Building by MIT and NMI. However, without additional documentation, NIOSH cannot make assumptions about particular radionuclides, quantities, or forms of source materials that may have been used.

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.

NIOSH has obtained uranium bioassay for some workers for 1952, 1955, 1957, and 1958 and breathing-zone air-monitoring results for less than twenty workers. NIOSH has also obtained some urinalysis results for enriched uranium for 1957 and 1958. NIOSH has not obtained thorium bioassay results; nor has NIOSH obtained bioassay results sufficient to estimate exposures to uranium progeny or fission products for which exposure would have been limited to laboratory releases. AEC production operations ceased in the Hood Building by December 31, 1958 and the building was empty until it was demolished in 1963 (MIT Press Releases, 1962-63). NIOSH has not found information to define the amount of any radioactive contamination that existed after uranium or thorium operations ceased, or any data collected during building demolition.

NIOSH can likely reconstruct doses received from exposure to natural uranium metal. However, given the lack of monitoring data for most workers for most of the class period, and the lack of documentation of source term amounts and percentage enrichment, the doses received from potential intakes resulting from exposure to enriched uranium cannot be bounded. NIOSH cannot reconstruct doses received from potential intakes of thorium given the lack of personal monitoring data, workplace monitoring data, and complete source term data for thorium.

NIOSH does not have access to sufficient personnel monitoring, workplace monitoring, or source term data to estimate potential internal exposures to enriched uranium and thorium during the period of DOE operations in the Hood Building. Consequently, NIOSH finds that it is not feasible to estimate, with sufficient accuracy, internal exposures to enriched uranium and thorium 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 proposed class, 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 the Hood Building, but not qualifying 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 enriched uranium and thorium could not be reconstructed for a dose reconstruction referred to NIOSH by the Department of Labor (DOL). As noted above, HHS will consider this determination to be sufficient without further consideration to determine that it is not feasible to estimate the levels of radiation doses of individual members of the class with sufficient accuracy. Consequently, it is not necessary for NIOSH to fully evaluate the feasibility of reconstructing external radiation exposures for the class of workers covered by this report.

NIOSH considers it feasible to reconstruct external doses for individuals having personal monitoring data. NIOSH has found sufficient film badge results and data supporting the processes to likely allow development of external dose co-worker distributions for portions of the SEC period, if appropriate. NIOSH considers adequate reconstruction of medical dose for MIT workers likely to be feasible by using claimant-favorable assumptions as well as the applicable protocols in the complex-wide TBD *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006).

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any 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 the Hood Building, but not qualifying for inclusion in the SEC, may be performed using these data, as appropriate.

6.3 Class Parameters Associated with Infeasibility

Per the DOE Office of Health, Safety and Security facility description for the Massachusetts Institute of Technology, the time period associated with DOE operations in the Hood Building is from 1946 through 1963. NIOSH has found indications that MIT was planning the move to the Hood Building as early as May 9, 1946. Because NIOSH has no information to define exactly when actual radiological operations began in the Hood Building, NIOSH recommends that the class include the period from May 9, 1946 through December 31, 1963.

The acquisition of the Hood Building was specifically executed to consolidate many different types of radiological work. Due to the lack of knowledge concerning worker movements within the building, and because NIOSH has established that poor controls were used to limit the spread of radioactive contamination, NIOSH recommends that the class definition include all areas of the Hood Building during the specified time period.

Due to the lack of information regarding worker job descriptions, limited documentation that associates job titles and/or job assignments with specific radiological operations, and lack of knowledge concerning worker movements, NIOSH is unable to rely solely on worker job descriptions to determine the potential for DOE radiological exposure in the Hood Building. NIOSH therefore recommends that the class include all Hood Building workers.

7.0 Summary of Feasibility Findings for Petition SEC-00101

This report evaluates the feasibility for completing dose reconstructions for employees who worked in the Hood Building in Cambridge, MA, from May 9, 1946 through December 31, 1963. NIOSH determined that members of this class may have received radiation exposures from internal and external sources. NIOSH lacks sufficient information, which includes biological monitoring data, sufficient air monitoring information, and radiological source information, that would allow it to estimate the potential internal exposures to enriched uranium and thorium to which the proposed class may have been exposed.

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

NIOSH has determined that it can likely reconstruct with sufficient accuracy internal doses received from potential exposure to natural uranium metal. NIOSH considers it feasible to reconstruct external doses for individuals having personal monitoring data. NIOSH considers adequate reconstruction of medical dose for MIT workers likely to be feasible by using claimant-favorable assumptions as well as the applicable protocols in the complex-wide documents.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal or 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 the Hood Building, but not qualifying for inclusion in the SEC, may be performed using these data, as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00101

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

9.0 NIOSH-Proposed Class for Petition SEC-00101

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked in the Hood Building in Cambridge, MA, from May 9, 1946 through December 31, 1963, 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 SEC.

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. The NIOSH-proposed class already includes all employees of the DOE, its predecessor agencies, and their contractors and subcontractors who worked in the Hood Building; therefore, NIOSH has not identified a second similar class of employees at the Hood Building in Cambridge, Massachusetts for whom dose reconstruction may not be feasible.

11.0 References

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for the Hood Building and MIT

Data Capture Information	General Description of Documents Captured	Completed	Uploaded
Primary Site/Company Name: Massachusetts Institute of Technology AWE 1942-1946, BE 1943-1946, DOE 1946-1963 Other Site Names: N/A [Name Redacted], RSO, and [Name Redacted], General Counsel's Office, have been contacted numerous times between 03/05/2007 and 10/14/2008	Hood Building floor plan, Hood Building line drawings and photographs.	10/15/2008	3
State Contacted: A letter was sent on 01/09/2007. On 01/23/2007 [Name Redacted], the Director of the MA Department of Public Health Radiation Control Program responded with an e-mail stating that he had no records for MIT from the covered period.	No records were captured.	01/23/2007	0
Argonne National Laboratory - East	ANL monthly reports.	04/19/2005	1
ORAU Team	Data Completeness Verification.	05/10/2007	1
Comprehensive Epidemiologic Data Resource (CEDR)	No relevant documents identified.	04/02/2008	0
Concord, MA Town Hall	Pamphlet describing the formation of MNI, including MIT connection, received during process knowledge expert interview.	10/07/2008	1
DOE Feed Materials Production Center (FMPC)	NYOO Health and Safety Division reports, May-June, 1951 and FY 1953.	08/14/2003	2
DOE Germantown	1948 air sample data, beryllium sampling data and hazards analyses, beryllium reports, injury reports, and uranium flow sheets.	01/28/2005	5
DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant documents identified.	04/02/2008	0
DOE Legacy Management Considered Sites Database	Winchester Engineering and Analytical Center 1954-1959 summary report including an index of MIT related topical reports.	10/04/2007	1
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	K-65, thorium, and radium shipment and process information, K-65 sludge assays and laboratory intercomparison.	03/08/2007	52
DOE Mound Laboratory	Shipping papers for EU shipments from MIT to FMPC.	04/09/2008	1
DOE Office of Scientific & Technical Information (OSTI) Energy Citations	No relevant documents identified.	04/17/2008	0
DOE Office of Scientific& Technical Information (OSTI) Information Bridge	Stannard's "Radioactivity and Health", oral history of C. J. Maletskos, uranium heat treatment, ORNL site summary.	04/02/2008	4

Table A1-1: Data Capture Synopsis for the Hood Building and MIT

Data Capture Information	General Description of Documents Captured	Completed	Uploaded
DOE OpenNet	AEC monthly summary, NYOO monthly status reports, reference to MIT in the Lovelace history.	04/02/2008	8
EML/HASL	Hood Building inspection.	03/08/2005	1
General Atomics	Nuclear materials transfer report.	11/02/2005	1
Google	Overview of the history of MIT's Department of Nuclear Science and Engineering.	04/11/2008	1
Interlibrary Loan	Book documenting the formation of NMI from MIT's Metallurgical Project.	05/15/2008	1
MIT Online Archive	1963 newspaper article reporting the planned demolition of the Hood Building.	04/29/2008	1
NARA - Atlanta	Trip reports, safety and health safeguards, extracting Pu from urine and feces, radioactive hazards analysis, shipment records, results of metallurgic spectrographic determinations, beryllium research, inventories, thorium project requests and shipments, irradiation requests for byproduct material and reports, breath samples, and the Hood Bldg. ventilation upgrade.	05/22/2008	55
National Academies Press (NAP)	No relevant documents identified.	04/02/2008	0
National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	04/17/2008	0
NRC Agencywide Document Access and Management (ADAMS)	License SNM-986 renewal material and historical material regarding MIT and the Watertown Arsenal.	04/02/2008	3
Nuclear Metals, Inc.	Health and Safety Program.	06/28/2006	1
ORO Vault	1947 film badge data.	05/13/2004	1
RMIS	Reducing oxidation losses by rolling uranium at lower temperatures.	07/19/2005	1
SAIC	AEC exposure summaries including MIT for 1960, 1961, 1964, 1970, 1972, 1973.	09/02/2004	6
Savannah River Site	Thorium metal working and irradiation.	07/22/2008	3
Unknown	Beryllium uses and practices, NYOO monthly reports, beryllium surveys and cases, NYOO H&S reports, beryllium shipments, beryllium air samples, accelerator fire, urine samples, film badge report, air sample reports, and thorium R&D.	10/08/2004	37
Washington State University (United States Transuranium and Uranium Registries)	No relevant documents identified.	04/02/2008	0
Washington University Library - St. Louis	Uranium extraction form phosphates and 396-5 ore.	04/26/2007	5

Table A1-1: Data Capture Synopsis for the Hood Building and MIT			
Data Capture Information	**General Description of Documents Captured**	**Completed**	**Uploaded**
TOTAL			196

Table A1-2: Internet Database Searches for the Hood Building and MIT			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
CEDR http://cedr.lbl.gov/ COMPLETED 04/02/2008	Massachusetts Institute of Technology	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 04/02/2008	MIT Massachusetts Hood building Massachusetts Institute of Technology	258	0
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 04/02/2008	Massachusetts Institute of Technology Nuclear Metals, Cambridge	165	8
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 04/02/2008	Massachusetts Institute of Technology Nuclear Metals, Cambridge	5	4
National Academies Press http://www.nap.edu/ COMPLETED 04/02/2008	"producing uranium" and "uranium metal"	6	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 04/02/2008	Nuclear Metals, Cambridge Massachusetts Institute of Technology - Uranium Metal SNM-0065 SNM-986	99	3
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 04/02/2008	MIT	4	0

Table A1-2: Internet Database Searches for the Hood Building and MIT			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
Google http://www.google.com COMPLETED 04/11/2008	AEC, americium, Am241, Am-241, Am 241, 241Am, 241-Am, 241 Am,	95,509	1
	AEC, ionium, Th230, Th-230, Th 230, 230Th, 230-Th, 230 Th		
	neptunium, Np237, Np-237, Np 237, 237Np, 237-Np, 237 Np, palm, Palmolive		
	polonium, Po210, Po-210, Po 210, 210Po, 210-Po, 210 Po		
	AEC thorium, thoria, Th232, Th-232, Th 232, 232Th, 232-Th, 232 Th, Z metal, Z-metal, myrnalloy, chemical 10-66, chemical 1066, chemical 10 66, chemical 18-12, chemical 1812, chemical 18 12, chemical 10-12, chemical 1012, chemical 10 12, UX1, UX2, Th-234, Th234, Th 234, 234-Th, 234Th, 234 Th		
	tritium, H3, H-3, mint, HTO		
	uranium, U233, U-233, U 233, 233U, 233-U, 233 U, U234, U 234, U-234, 234U, 234-U, 234 U, U235, U 235, U-235, 235-U, 235U, 235 U, U238, U 238, U-238, 238-U, 238U, 238 U, U308, U 308, U-308, 308-U, 308U, 308 U		
	black oxide, brown oxide, green salt, orange oxide, yellow cake, UO2, UO3, UF4, UF6, C-216, C-616, C-65, C-211, U3O8		
	uranium extraction, uranium dioxide, uranium hexafluoride, uranium tetrafluoride, uranium trioxide		
	plutonium, Pu-238, Pu238, Pu 238, 238Pu, 238-Pu, 238 Pu, Pu-239, Pu239, Pu 239, 239Pu, 239-Pu, 239 Pu, Pu-240, Pu240, Pu 240		
	radium, Ra-226, Ra226, Ra 226, 226-Ra, 226Ra, 226 Ra, Ra-228, Ra228, Ra 228, 228Ra, 228-Ra, 228 Ra		
	radon, Rn-222, Rn222, Rn 222, 222Rn, 222-Rn, 222 Rn		
	thoron, Rn-220, Rn220, Rn 220, 220Rn, 220-Rn, 220 Rn		
	protactinium, Pa-234m, Pa234m, Pa 234m, 234mPa, 234m-Pa, 234m Pa		
	strontium, Sr-90, Sr90, Sr 90, 90-Sr, 90Sr, 90 Sr		
	uranium dioxide, OR "uranium tetrafluoride", OR "uranium trioxide"		
	uranium contamination		
	Hood building		
	radioactive air dust, OR "air filter", OR "airborne test"		

Table A1-2: Internet Database Searches for the Hood Building and MIT			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
	"belgian congo ore", OR bioassay, OR bio-assay, OR beta, OR body burden, 1942-1963		
	contamination, OR collimation, OR curie, OR denitration, OR "denitration pot" 1942-1963		
	dose, OR dosimeter, OR DAC, OR "derived air concentration" 1942-1963		
	dosimetric, OR dosimetry, OR electron, OR environment 1942-1963		
	exposure, OR "exposure investigation", OR "radiation exposure"		
	"F machine", OR fecal, OR "feed material", OR femptocurie, OR fission, OR fluoroscopy		
	Formerly Utilized Sites Remedial Action Program, OR FUSRAP, OR gamma-ray, OR "gas proportional", OR "gaseous diffusion"		
	health physics, OR "highly enriched uranium", OR HEU		
	"low enriched uranium", LEU, OR "lung count"		
	maximum permissible concentration, OR MPC, OR metallurgy, OR microcurie, OR millicurie		
	"nuclear fuels", OR "nuclear track emulsion"		
	"occupational radiation exposure", OR "ore concentrate",		
	"radiation work permit", OR "safe work permit", OR "special work permit", OR RWP, OR SWP		
	Pitchblend		
	picocurie, OR photofluorography, OR pitchblende, OR "pocket ion chamber		
	radiation, OR radioactive, OR radioactivity, OR radiological		
	"Radiological Survey Data Sheet", OR "RSDS", OR radionuclide, OR raffinate		
	"Radiological Survey"		
	"retention schedules", OR roentgen		
	"air sample", OR "dust sample", OR "general area air sample"		
	building survey, OR "routine survey", OR "special survey", OR "technical basis"		
DOE Energy Citations http://www.osti.gov/energycitations/ COMPLETED 04/17/2008	Massachusetts Institute of Technology	1	0

Table A1-2: Internet Database Searches for the Hood Building and MIT			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 04/17/2008	MIT Massachusetts Institute of Technology	18	0

Table A1-3: OSTI Documents Requested for the Hood Building and MIT			
Document Number	**Document Title**	**Requested**	**Received**
No documents requested.			