

# **Nuclear Metals Inc. Special Exposure Cohort Petition Evaluation Report**

**Samuel Glover, PhD**  
Research Health Scientist  
National Institute for Occupational Safety and Health  
Division of Compensation Analysis and Support

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# Brief Site Overview

- Nuclear Metals, Inc. (NMI) grew out of the special metallurgical operations conducted by Massachusetts Institute of Technology (MIT) for the Manhattan Engineer District which were later consolidated into the Hood Building at the perimeter of the MIT campus
- NMI took over the MIT operations at the Hood Building as a private company and in 1958, transferred the operations to Concord, MA

# Brief Site Overview—cont.

- NMI provided the AEC fabrication capabilities and metallurgical consulting services for uranium, thorium, and many alloys of these elements
- In the mid 1970s, NMI began large scale fabrication of depleted uranium munitions for the US military
- The covered period for NMI as an AWE facility is October 29, 1958 through 1990, Residual Radiation 1991 through March 1, 2011

# Petition Overview

- **October 20, 2011: petition received**
- **Petitioner proposed class definition:**
  - **All employees who worked in Buildings A, B, C, D, E, the Butler Building, external storage containers, and outside areas immediate to plant grounds at the Nuclear Metals, Inc. facility in West Concord, Massachusetts, during the period from January 1, 1970 through December 31, 1983.**
- **January 17, 2012: petition qualified for evaluation based on the potential for unmonitored internal radiation exposures**

# Petition Overview—cont.

- NIOSH expanded the time period and scope evaluated versus that requested by the petitioner
- NIOSH evaluated class:
  - All employees who worked at the Nuclear Metals, Inc. facility in West Concord, Massachusetts, during the period from January 1, 1958\* through December 31, 1983.

**\*It was later determined by the Department of Labor that the earliest covered period at NMI is October 29, 1958**

# Sources of Available Information

- ORAU Team Site Profiles and Technical Information Bulletins (TIBs) and Procedures
- NIOSH Site Research Database
- Existing claimant files
- Information from petitioner which included 9 affidavits with 23 supporting documents
- Worker interviews (9) as well as information from claimant telephone interview files (CATIs)
- ATL/ORAUT/NIOSH conducted three outreach meetings in Concord attended by approximately 50-60 former workers and company management (some of whom were present from day 1)

# Data Capture Efforts

- DOE Opennet (OSTI data base)
- Standard data base search (DDRS, NNSA, CEDR etc.)
- Internet search
- Various DOE locations (OSTI, Hanford, DOE Germantown, Legacy Management, Grand Junction, Morgantown, Sandia, Savannah river)
- HASL-EML
- Hagley Museum & Library
- NRC
- June 13 ORAU received 16,000 documents from MA Department of Environmental Protection

# Status of Claims

(as of August 7, 2012)

- Total number of claims submitted: 23
- Total number of claims who worked during proposed (SEC): 19
- Total number with a DR (at DOL): 16
- Total number claims with internal dosimetry records: 15
- Total number claims with external dosimetry records: 18

# Background

- NMI operated at the Hood Building (a DOE facility) next to the MIT campus until October 28, 1958
- NMI at Concord (the subject of the evaluation) was located at 2229 Main St, Concord MA on originally 30 acres of land, which was later expanded to 46.4 acres (in 1990)
- NMI began transferring operations to Concord after March 1958 and fully transitioned as of October 29, 1958 at which point DOL has determined it became an Atomic Weapons Employer (AWE) facility
- Workforce varied from 60 to over 650 workers during the time period under review (peaking in the early 1980s)

# Background—cont.

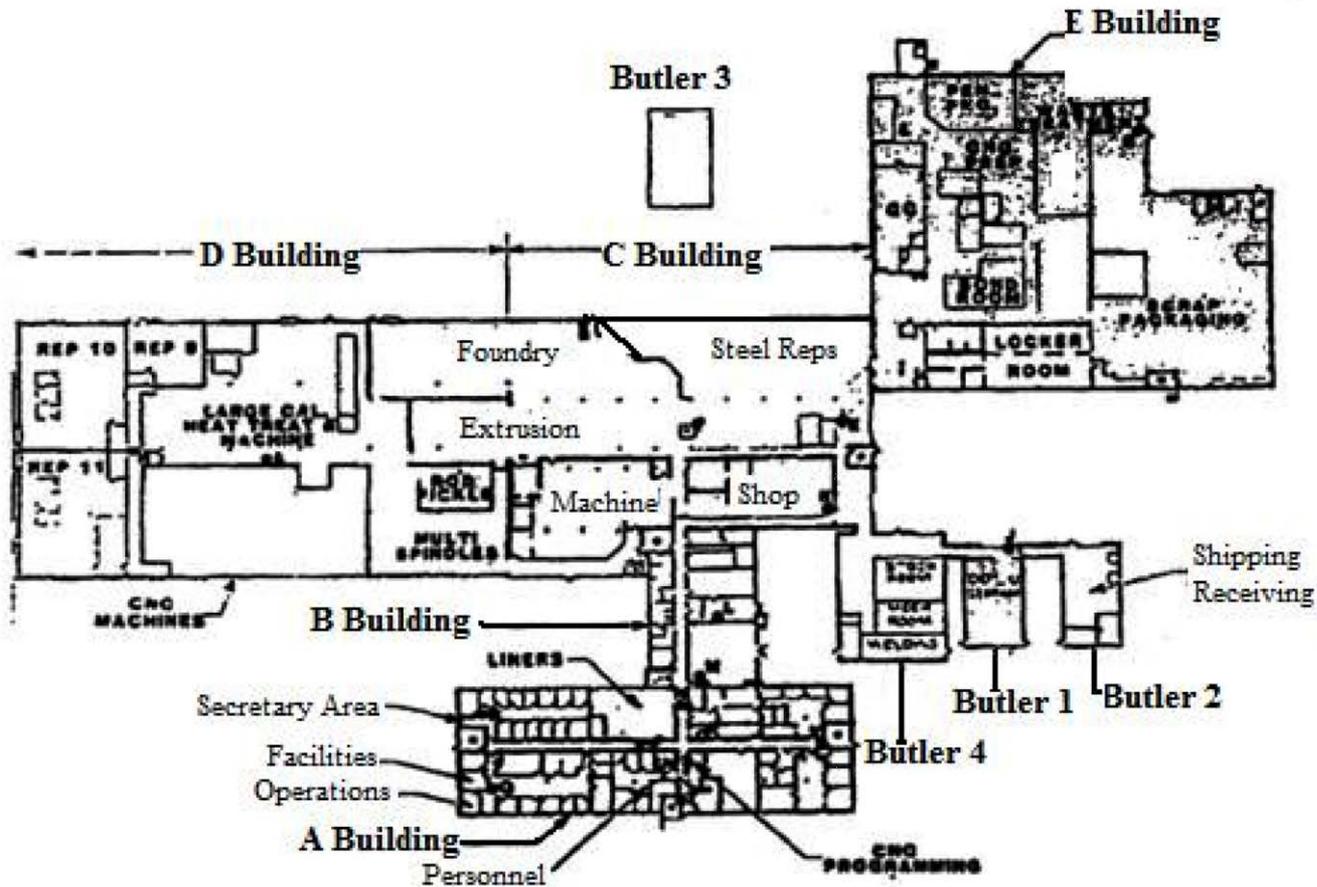
- **Original facility consisted of three buildings**
  - **Building A containing office space and research laboratories (analytical, x-ray equipment, vacuum furnaces)**
  - **Building B contained services (e.g., cafeteria, electrical switch room, lockers, etc) and sometimes used as needed to hold radioactive materials.**
  - **Building C was the main production facility and included equipment for melting metals, extrusion, metal working, pickling and etching, and electroplating**

# Background—cont.

- **Additional buildings added over time**
  - **Building D (1978) built to expand the production space**
  - **Building E (1983) production area for wet processes (pickling, coolant recovery, waste treatment)**
  - **Butler Buildings (BB) were added over time and used for storage and sometimes pressed into service as needed**
    - **BB 1 (1958): Primarily non-DU related but over time packing and storage of DU components occurred here**
    - **BB 2 (1960) unrestricted access, non-DU purposes**
    - **BB 3 (1976) used for storing DU components**
    - **BB 4 (1977) unrestricted access, non-DU purposes**

# Background—cont.

## Diagram of NMI in 1994



# Background—cont.

- **Partial listing of operations conducted pre-1972**
  - Principally fundamental metallurgy, physical metallurgy, chemical metallurgy, engineering and product development, fuel element development and manufacture, and manufacture of high temperature materials.
- **Operations 1972-1979**
  - Shifted towards large scale production including the manufacture of depleted uranium (DU) shields, counter weights, armor penetrators, metal powders, beryllium and beryllium alloys, and specialty titanium parts
- **Post 1979**
  - Operations continued, but this period has been reserved for further review

# Health Physics Program

- NMI had no trained Health Physics staff until 1981
- The program transferred from the Hood Building in 1958
- The programs were research in nature and thus the staff was often unaware of new hazards which may be encountered
- Program evolved over many years, and may have periods of lapses into poor practices
  - Mid-1960s reports describe significant uranium spills and contamination which were left unreported
  - Inspection reports from the mid-1970s emphasize this lack of contamination controls and monitoring

# Health Physics Program—cont.

- Improvements in the radiation protection program coincided with the growth of the company in the late 1970s and 1980s and emphasis to becoming a production program
- While the period after 1979 will be described in a future report improvements included
  - Access controls enforced
  - Increased air monitoring program
  - Air and swipe sample analysis brought in-house to reduce delays
  - Employee radiation safety training provided by full time training specialists as part of orientation
  - Increased health physics coverage for all three work shifts
  - Large increase in the amount of bioassay samples collected

# Sources of Internal Exposure

- NMI's research and production activities involved numerous sources of exposure
- Amounts changed over time (up and down)
- Some NMI activities and materials remain classified
- Sources of internal dose included
  - Uranium (depleted, natural, enriched) in many physical forms and as the result of fires and explosions
  - Thorium (oxides, powders and metal)
  - Uranium and thorium progeny
  - Recycled uranium components

# Thorium

- Thorium was transferred from the Hood building at the start of operations (approximately 1 ton)
- In the 1960s NMI extruded thorium rods for British and French companies
- Converted thorium rods to powder
- Extruded thorium powder
- NMI cast thorium to billet size followed by machining, jacketing, extrusion, pickling and machining
- Given the limitations on records, NIOSH has identified a persistent and radiologically significant thorium source term over the operating history of NMI for which no monitoring exists for the period 1958 through 1979

# Sources of External Exposure

- Processing of depleted/natural/enriched uranium and thorium metal
- Submersion in contaminated air and exposure to contaminated surfaces
- Concentration of progeny during metal working and separation processes enhanced radiation
- X-ray sources
  - Two industrial X-ray units (by the mid 1960's there were five units)
  - 40 mCi unencapsulated Ir-192 source and 45 Ci of Ir-192
  - 100 kV medical X-ray machine

# External Monitoring Programs and Data Availability

- Personnel monitoring program in place prior to relocation of operations to Concord
- In the late 1950s, film badges were issued to all uranium processing employees
- In the 1960s, all personnel wore film badges (according to documents)
  - Processed every 6 ½ weeks
  - Clerical personnel badges processed annually

# External Dose Monitoring Programs and Data Availability—cont.

Nuclear Metals, Inc. Dosimeter Results Summary

YEAR	Number of Badges	SRDB Reference	YEAR	Number of Badges	SRDB Reference
1958	98 <sup>a</sup>	25034	1971	604	25046
1959	341 <sup>b</sup>	25034; 28468	1972	364	25046; 25054
1960	1424	28468	1973	433	25054
1961	1196	25038	1974	451	25054
1962	1071	25037	1975	368	25054
1963	828	25037	1976	462 <sup>e</sup>	25054
1964	979 <sup>c</sup>	25037	1977	811	25054; 25072; 113268; 113279
1965	1284	25037; 29184	1978	942	25054; 25055
1966	902	25045	1979	2615	25054; 25058
1967	617	25045	1980	4230	25054; 29132; 113198
1968	312 <sup>d</sup>	25045; 28465	1981	5422	28481; 28483
1969	622	25040	1982	1970	28582; 28584
1970	688	25046	1983	7739	29151; 29154

# External Monitoring Programs and Data Availability

- Weekly smear sampling program began in 1958
  - Only limited results available to this point
- AEC inspectors remarked (9/18/1969) on contamination smears not being taken as required
- Other inspection reports (5/16/1973) indicate direct measurement surveys were not recorded on log sheets as required

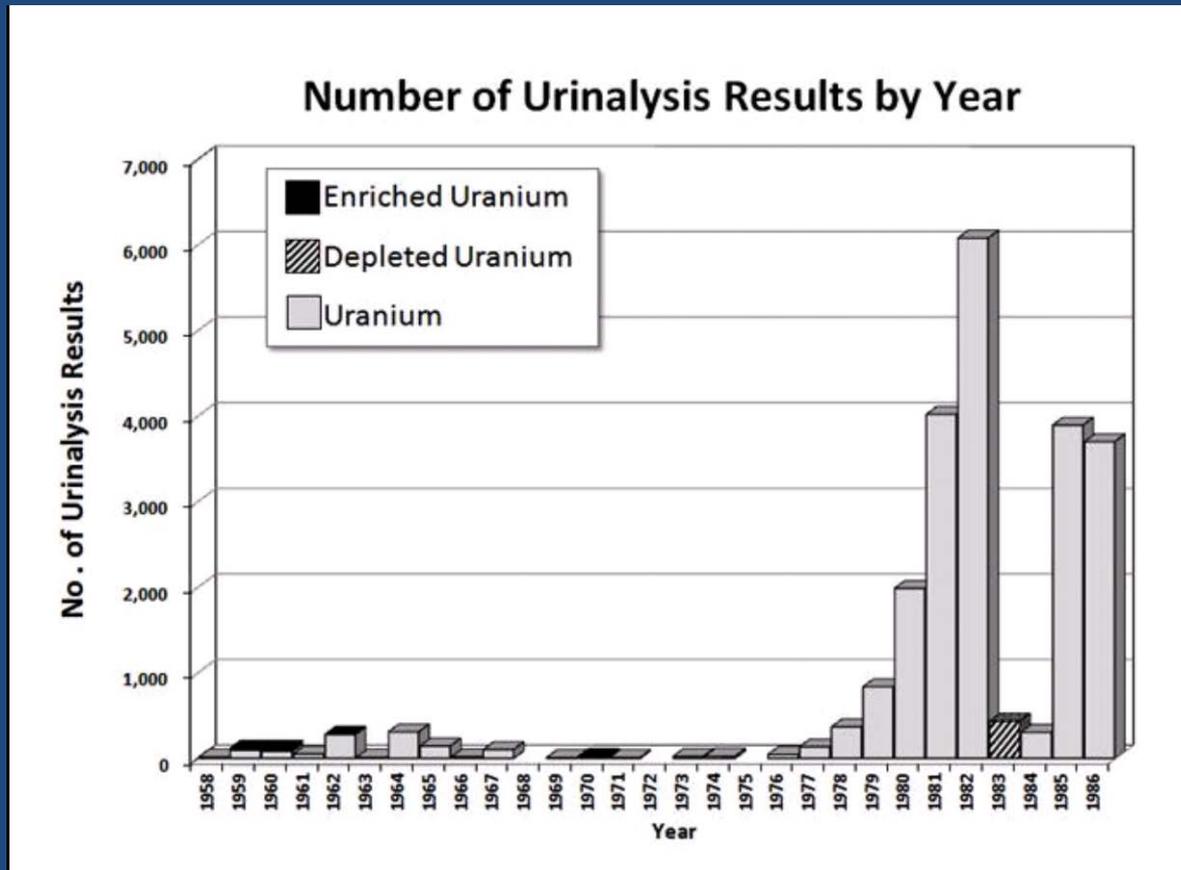
# Internal Dose Monitoring Programs and Data Availability

- The bioassay program consisted of urinalysis samples and lung counts
- Bioassay program evolved over time due to the AEC (NRC) inspection reports
  - In 1977, bioassay sampling started increasing
  - In 1983, program reportedly consistent with Regulatory Guide 8.11
  - NIOSH currently has identified 2,600 urine bioassay samples for uranium between 1958 and 1979 and 12,500 samples for the period 1980 through 1983
  - No urine samples located to date for 1968, 1972, and 1975

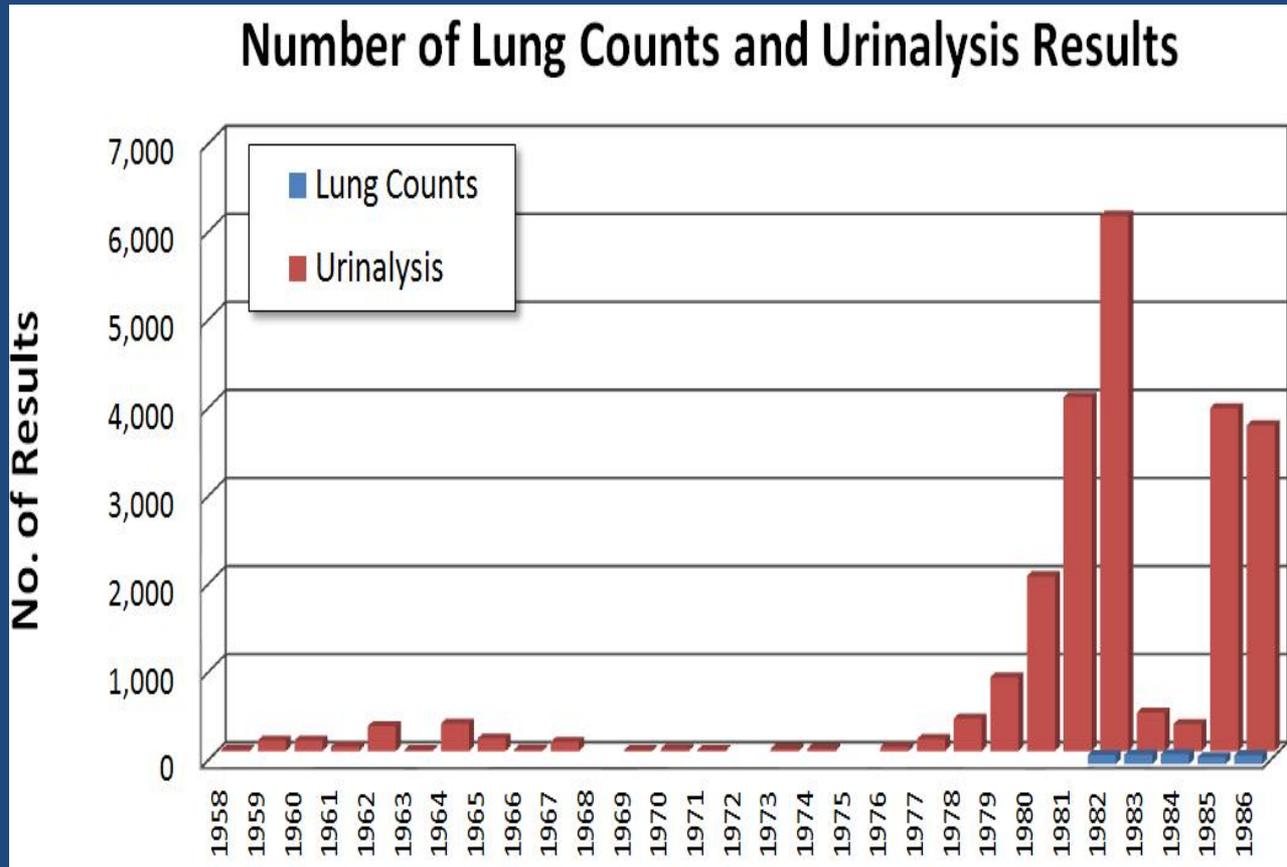
# Internal Dose Monitoring Programs and Data Availability—cont.

- Lung counts for uranium annually on representative sample of employee population (approximately 100 per year)
  - Approximately 500 lung counts are available for the period 1982 through 1986

# Internal Dose Monitoring Programs and Data Availability—cont.



# Internal Dose Monitoring Programs and Data Availability—cont.



# Internal Dose Monitoring Programs and Data Availability—cont.

Table 6-4: Lung Count Results by Year (1982-1986)

Year	No. of Lung Counts	DU (mg)				U-235 (µg)			
		Max	Min	Ave.	STD DEV	Max	Min	Ave.	STD DEV
1982	103	154.3	1.7	7.5	15.4	83.0	0.0	16.1	23.7
1983	106	11.0	2.0	4.6	1.9	63.0	0.0	5.4	15.2
1984	114	10.3	1.7	4.4	1.8	54.0	0.0	8.1	17.3
1985	78	8.6	2.0	4.6	1.4	74.0	0.0	5.9	17.2
1986	100	32.2	1.9	4.9	3.3	69.0	0.0	1.3	8.8

# Internal Dose Monitoring Programs and Data Availability—cont.

- NMI maintained an air monitoring program from the earliest years
- NIOSH obtained some of the monthly reports for the pre-1980 years (31 of 255) with summary data which provide average, minimum and maximum concentration data
  - Described as having 12 fixed air samplers located throughout the plant (increased later)
  - 1959 report says that operations involving enriched uranium or special jobs of uranium were to have air sampling (results not available if implemented)
  - 1974 inspection report specifically observed that the fixed head air sampling did not approximate worker's breathing zones
  - New data available to NIOSH consists of approximately 28,000 breathing zone and work area samples (1980-1983)

# Summary of Monitoring Gaps

## ■ External

- No neutron monitoring (although limited exposure potential) but methods exist which may be suitable for estimating dose

## ■ Internal

- The early bioassay program (pre 1980) results are often sparse and NIOSH can not verify they represent the worst case exposures
- Early air sample data limited and not equivalent to breathing zone sampling
- Prior to late 1970s' difficult to determine if bioassay results included incidents
- No results for thorium operations (urine or air)
- No results for radon/thoron sources

# NMI SEC Petition 195

- **Why the class?**
  - Workers were potentially exposed to enriched uranium, thorium, uranium progeny, and thorium progeny who were not monitored nor does a suitable dose reconstruction method exist.
  - Decision was based on lack of adequate biological monitoring data, sufficient air monitoring information, and/or sufficient process and radiological source-term data to reconstruct dose with sufficient accuracy.

# NMI SEC Petition 195—cont.

- **Why everyone?**
  - **Based on reports by the AEC and facility layout, the process areas were not isolated from the non-process areas and no barriers to access were in place.**

# NMI SEC Petition 195—cont.

- **What about employees not included in the SEC?**
  - **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 dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Nuclear Metals, Inc. during the period from October 29, 1958 through December 31, 1979, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.**
  - **Furthermore, NIOSH intends to estimate doses from medical x-rays using information from employee medical records and claimant favorable medical dose reconstruction assumptions and methods.**

# NMI SEC Petition 195—cont.

- **Why stop in 1979?**
  - **Because the continuing analysis affects only post-1979, NIOSH has determined that it is appropriate to proceed with the pre-1980 feasibility evaluation while continuing to analyze the impact that newly obtained data have on post-1979 dose reconstruction. NIOSH is therefore reserving its full assessment of the available post-1979 data and will continue to evaluate the feasibility of sufficiently accurate dose reconstruction for the period from January 1, 1980 through December 31, 1983.**

# Health Endangerment

- The evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of radionuclides and direct exposure to radioactive materials.
- Consequently, NIOSH is specifying 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.

# Proposed Class

All Atomic Weapons Employees who worked at the facility owned by Nuclear Metals Inc. (or a subsequent owner) in West Concord, Massachusetts during the period from October 29, 1958 through December 31, 1979, 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.

# Recommendation

- For the period October 29, 1958 through December 31, 1979, NIOSH finds that radiation dose estimates cannot be reconstructed for compensation purposes

Class	Feasibility	Health Endangerment
October 29, 1958 – December 31, 1979	No	Yes