Uranium and Beryllium Decontamination and Decommissioning in a Developed Neighborhood – 17494

Nelson Walter*, Jason Provencher*, Rod Pendleton* and John Hunt**
*Amec Foster Wheeler E&I, Inc., 511 Congress Street, Portland, ME 04101
–** ***de maximis, inc.***, 200 Day Hill Road, Windsor, CT 06095

ABSTRACT

In September 2008, the United States Environmental Protection Agency (EPA), Region 1, issued an Administrative Order by Consent (AOC) that required the completion of a Non-Time-Critical Removal Action for the Nuclear Metals, Inc. Site (Site), which is located in Concord, Massachusetts. The AOC required decontamination and demolition of the site buildings and structures. The Site was originally used for radiological research and production, and included foundry equipment for melting metals, extrusion presses and metal working equipment, pickling and etching tanks, and electroplating equipment. In the 1970s, Nuclear Metals, Inc. developed a large scale depleted uranium manufacturing, operation, which included the manufacturing of penetrators, or bullets, from depleted uranium (DU) as a defense contractor for the U.S. Army. Later operations included production of beryllium alloy materials. The Site included a two-story, five-section interconnected building, a tank house, a hydrogen peroxide tank house, two gas cylinder storage huts, and four "Butler" metal storage buildings, which had a combined footprint of approximately 17,000 square meters (185,000 square feet). The buildings were principally contaminated with DU and beryllium dust, along with asbestos, PCBs, lead and other constituents. The required removal action at the Site consisted of building stabilization activities to remove flammable materials, install temporary utilities and control dust to create a safe work environment within the buildings for site workers; removal of hazardous materials; demolition of all structures and equipment; and off-site disposal of waste materials. The Decontamination and Decommissioning (D&D) activities and highlights of some of the public involvement work required to complete building D&D work in a residential community are discussed.

BACKGROUND AND BRIEF HISTORY OF SITE

The Nuclear Metals, Inc. (NMI) Site is located on an 18.8 hectare (46.4-acre) parcel at 2229 Main Street in the western portion of the Town of Concord, Middlesex County, Massachusetts. The site buildings and structures are shown in Figure 1.

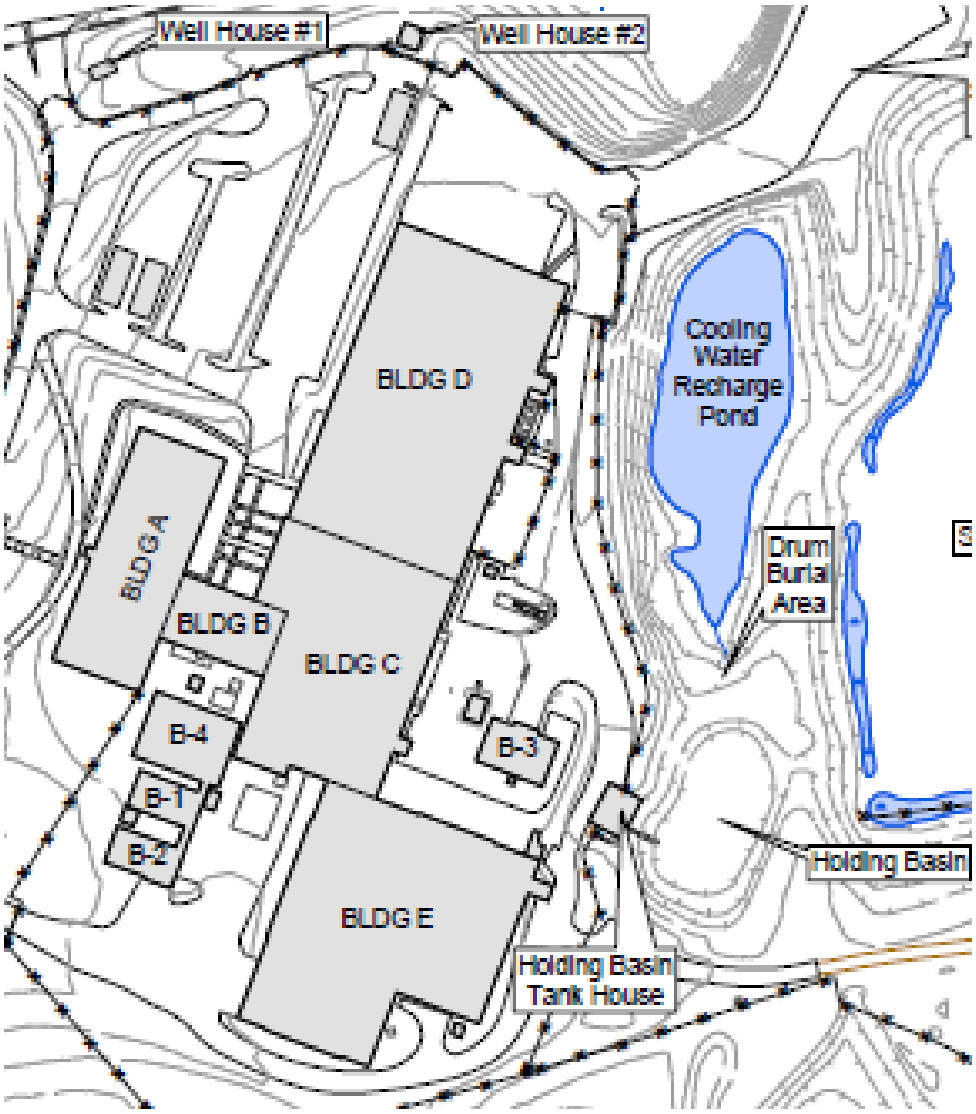

Figure 1 – Nuclear Metals, Inc. Site Buildings

The Site had five interconnected buildings with several smaller outbuildings, e.g., Butler buildings, well houses, storage sheds, etc. Most buildings had been vacant for some time prior to the removal action and were in disrepair. The footprint of all buildings at the Site was approximately 17,000 square meters (185,000 square feet). The Site is bordered by Main Street (Route 62) and several commercial and residential properties to the north, residential properties to the east, and woodland and commercial/ industrial properties to the west. The Assabet River is situated approximately 90 meters (300 feet) north of the Site.

Past operations at the Site involved research and development in physical metallurgy, chemical metallurgy, engineering and product development, fuel element development and manufacture, and high temperature materials. Most of the operations at the Site were conducted under contracts with the United States Atomic Energy Commission and the United States Department of Defense, along

with some private industry contracts. These operations included the investigation and development of materials for missiles, airframes, and other components.

The focus of site operations shifted from research and development to large-scale production in the mid-1970s. This included manufacture of DU shields, counter weights, and armor penetrators, manufacture of metal powders, beryllium and beryllium alloy parts production, and manufacture of specialty titanium parts. This coincided with the employees purchasing the company from prior owners (NMI) in 1972. NMI was renamed as “Starmet” in 1997.

Given the type of work performed, the quantity of production over time conducted within the buildings, and the lack of adequate controls, it was found that there was widespread DU and beryllium contamination in the manufacturing areas. The DU metallurgical processes created uranium oxide dust which accumulated in cracks and crevices and on horizontal surfaces within the buildings. In addition, the volume of DU material used and the numerous years of operation resulted in the accumulation of significant quantities of uranium in the production buildings. Beryllium powder operations also contributed to wide-spread contamination in the buildings.

Beginning in 2003, there were several regulatory actions attempting to phase out operations at the Site and have the Starmet owners vacate the buildings so that cleanup operations could begin. In the fall of 2011 the remaining businesses that occupied the buildings vacated the property and the Site was turned over to the responsible parties to begin cleanup actions.

Because Starmet was insolvent, decommissioning and remediation was performed and funded by the Responsible Parties, which included companies that had past ownership interest in the Site, and the Federal Government who had contracted for much of the production work at the Site.

The Site is located in a relatively densely populated area (Concord, Massachusetts is an affluent suburb of Boston) and there are residential properties in close proximity to the Site, which led to concerns of local residents about the contamination and impacts from remediation. In addition, two separate citizens’ groups had formed specifically directed toward cleanup of the Site. Their input was solicited on project plans and reports, and frequent meetings were held with the citizens’ groups and the public to keep them informed.

When Starmet vacated the Site, there was no attempt by them to achieve safe shutdown. Process chemicals and materials were left in place; the heating and electrical systems were not thought to be reliably safe; and the roof had deteriorated in places, causing concern for collapse from snow load should snow accumulate on the roof.

DECONTAMINATION AND DECOMMISSIONING PHASES

D&D of site structures was conducted in three phases. Priority was given to stabilizing the buildings, providing temporary heat and power, beryllium decontamination and removing higher risk and hazardous items from the buildings. Subsequent phases were designed to remove equipment and manufacturing systems, and finally demolish the structures. Though aspects of each of the three phases overlap, in general terms the three phases involved the following activities:

Phase 1: Removal of Higher Risk Items and Termination of Utilities

Phase 1 was designed to reduce the risk of chemical exposure and other dangers to workers as well as reduce the risk of fire in the buildings. Phase 1 included the following activities:

- Removal and/or abatement of “high hazard” materials was a priority to remove materials that could pose a significant potential risk to site workers, have a risk of explosion or initiating a fire.
- Utility decommissioning included electrical service, telephone and communication lines, gas, oil, water, and sanitary sewer.
- Removal of chemicals and some radiologically impacted wastes was conducted to reduce hazards and improve access for materials and equipment removal and demolition activities.
- Removal of combustible materials was completed to reduce fire hazards and to improve access for equipment removal and demolition activities. In addition, process ductwork and small equipment, machinery and tools were removed during the removal of combustible materials to improve access for Phase 2 and 3 work.

Phase 2: Removal of Equipment and Manufacturing Systems

Equipment and systems that were not integral to building structures and which could be safely and cost-effectively removed prior to demolition were removed during Phase 2. Some equipment and systems were left for removal during Phase 3 where it was safer or more cost-effective for their removal to occur during demolition.

Phase 3: Demolition Activities and Placement of Temporary Cover

Phase 3 primarily consisted of demolishing the site structures and removing the resulting debris. Subsurface pits were filled as part of Phase 3, and a temporary cover was placed over the floor slabs. A future remedial action will remove the slabs and contaminated soils at the Site.

PRE-DEMOLITION ACTIVITIES

While some of the more urgent tasks (temporary power and heat systems and beryllium decontamination to make the facility safe for D&D workers) were being

implemented project plans were developed for the many specific tasks required as part of the D&D work.

Remedial Action Work Plan

A Remedial Action Work Plan was developed that described the overall framework of the activities to be performed under the NTCRA and included sections that described the site background, site security and maintenance activities, building sampling activities, construction submittals, demolition activities, and post-removal action site control. Certain plans were part of the Remedial Action Work Plan and described specific aspects of the D&D work in more detail:

- The Applicable or Relevant and Appropriate Requirements Implementation Plan identified the specific federal and state regulatory requirements that applied to the D&D work.
- Site Management and Security Plan described how various project aspects such as access, security, contingency procedures, management responsibilities, investigation-derived waste disposal, and data handling were to be managed. This plan also addressed termination of utilities and the supply of temporary and/or portable power sources, external heating systems, and water; as well as procedures to maintain the structural integrity of the structures.
- Health and Safety Plan established procedures designed to protect health, safety, public welfare and the environment during implementation of the work. The Health and Safety Plan also described measures to prevent exposure to widespread radiological contamination and potential beryllium contamination at the facility.
- The Emergency Response Plan described the procedures for responding to and mitigating fire and other emergency situations that may occur during the D&D work. The Plan described the actions personnel must take to respond to emergencies or unplanned releases at the Site during the D&D work, arrangements with local, state and federal emergency responders to coordinate emergency services, identification of the roles and responsibilities of the emergency coordinator and alternates, supply and maintenance of on-site emergency equipment, and stop work and emergency evacuation planning.
- The Field Sampling Plan described the technical approach and procedures to be used for Pre-Demolition Survey; waste characterization activities for development of Waste Acceptance Criteria (WAC); and sub-slab soil investigation to assess levels of contamination in soils located beneath the buildings to support the Remedial Investigation/Feasibility Study.
- The Quality Assurance Project Plan included discussion of chemical data quality objectives, laboratory analytical methods, Quality Control requirements, data management requirements, and assessments and response actions.
- The Community Relations Support Plan described the activities needed to establish and maintain effective community relations related to the D&D work.

Additional Project Plans

Additional specific plans were prepared for each major group of activities being conducted at the Site. Some examples of these include:

- A Utilities Decommissioning Plan which described the process for safely terminating and removing the existing facility utilities prior to the start of demolition.
- The Hazardous and Regulated Material Management Plan described the pre-demolition survey of hazardous and regulated material and the packaging and disposal of those materials.
- The Waste Management Plan addressed waste characterization, waste processing and staging areas, shipping dock locations, Resource Conservation and Recovery Act of 1976 (RCRA) waste consolidation and accumulation, disposal facilities, transportation options, manifests and record keeping, and the Waste Management Tracking Database.
- Materials Removal and Demolition Plans were prepared for each phase of the work and described the approach to remove higher hazard materials, abandoned chemicals, and combustible materials; removal of equipment and demolition of the buildings
- The Waste Processing and Loading Plans for each phase described the processing and loading of wastes prior to transportation and disposal, wastes classification for disposal, truck and container decontamination, transportation of wastes, traffic control, and spill contingency planning.

Structural Inspection

A Structural Roof Investigation was prepared to assess allowable snow loads on the site roofs until roof removal during D&D. A prior evaluation found that water penetration due to roofing failure had and continued to occur in most buildings, and that “It will be a matter of time before the loss of materials leads to structurally unsafe conditions which are a potential for partial roof collapse.” The Report recommended that the roofs not be accessed and worked on without using a system of walkways, planks, and work platforms; and that snow accumulations be limited to 30 centimeters (12 inches) maximum, which required heating the building in the winter to melt snow off the roofs.

PHASE 1 D&D WORK

The building, when vacated by Starmet, were left in an “as is” condition. Files and paperwork remained in offices; laboratories had a wide variety of chemicals and materials on lab benches and in full cabinets; production raw materials and partially finished and finished products were left in production equipment, in storage spaces and around the work areas; old and newer equipment filled production and shop areas. The primary activities in Phase 1 included activities to make the buildings safe to work in and included evaluation and assessment of what types of hazards were present. Hazards in the buildings included:

- Beryllium as a powder (dust) residue on surfaces and within ventilation systems

- Both fixed and removable radiological contamination throughout the buildings
- Deteriorated conditions in roofing and building structures in work areas
- Laboratory and process chemicals
- Flammable liquids
- Combustible materials
- Strong acids and corrosives, including hydrofluoric acid
- Oxidizers
- Reactive chemicals
- Mercury in drain line traps
- Metals, volatile organic compounds and semi volatile organic compounds as residue in drain lines
- Polychlorinated Biphenyls in oils and structural building materials
- Unlabeled chemicals and wastes;
- Asbestos
- Mold
- Biological hazards such as ticks, rats, and spiders

Utility decommissioning and removal and disposal of universal wastes, combustible materials, and manufacturing and smaller process equipment and machines were conducted in Phase 1.

Pre-demolition Survey

Concurrent with development of the project plans and the initial Phase 1 D&D activities, a pre-demolition survey was conducted to identify, characterize and quantify hazardous and regulated materials within the buildings scheduled for future demolition, and transportation to and disposal at licensed facilities. The hazardous and regulated materials include:

- Radionuclides;
- Polychlorinated Biphenyl-containing materials;
- Asbestos-containing materials;
- Lead paint and leaded materials;
- Chemical constituents;
- Universal Wastes;
- Additional hazardous/regulated materials; and
- Oils.

Classification for demolition was conducted to identify materials which require abatement prior to demolition, special handling, and/or controlled demolition.

Utility Decommissioning

Utility decommissioning included a controlled shutdown of the previously existing electrical service in accordance with an Electrical Termination Plan. Deactivation efforts included physical disconnects of electrical services within the buildings, disconnection of mechanical equipment, and discharging of capacitors. Temporary electrical service was installed to provide service for lighting, tools, the fire alarm system, temporary heating units, and field offices.

The low and high pressure natural gas service within the building structures were terminated at the service meter. The existing natural gas service continued to be used as a fuel source for the three heating units providing heat to the buildings during the D&D work. Two additional heaters, fueled by propane, were installed to heat buildings without natural gas service.

Interior gas systems included a low and high pressure natural gas system, a hydrogen storage and piping system, a compressed air system, a helium storage and piping system, an argon storage and piping system, and a vacuum system. These systems were deactivated in accordance with the Natural Gas Piping and Hydrogen Piping Purge and Depressurization of the Compressed Air, Helium, and Argon Systems Plan.

The contents of the No. 4 heating oil tanks were removed from the site's heating oil underground storage tanks using a vacuum truck.

A single catch basin was decommissioned during the site improvements work for container storage. The remainder of the storm sewer system was left in place.

Municipal water service was used as the water supply for D&D activities and also services the fire protection system. The potable water supply to site buildings and structures was taken out of service and locked out. Remaining water services and fire protection water services were decommissioned during Phase 3.

Universal Waste

Universal Waste that were removed included batteries, pesticides, thermostat ampoules, mercury thermometers and switches, electronics (computers, computer monitors, computer equipment, small electronics, televisions, refrigerators, and small electrical control panels), equipment and telephones with electronic circuit boards, and fluorescent lamps. Freon gas refrigerants were reclaimed from air conditioning units, chillers, refrigerators and equipment with compressors. Refrigerant oils were collected and sent off-site for recycling.

Combustible Materials

Combustible materials were removed during Phase 1 to reduce fire hazards and to improve access for equipment removal and demolition activities. Phase 1 combustible material removal included office contents, non-stationary combustible solid materials and Heating, Ventilation, and Air Conditioning ductwork, aboveground storage tanks oils, flammable liquids, paper wastes, and stockpiled wooden wastes. Stockpiles generated from the removal of combustible materials in Buildings A and B were mixed with heavier masonry debris to optimize waste container volumes and densities for shipping.

Hydraulic Oils, Oils and Fuels, Chemicals and Solvents

Hydraulic oils, machine oils, fuel oils, and solvents that were stored in containers on the premises (that did not need to be drained from equipment) were removed during Phase 1 in conjunction with the Laboratory Package Chemical (LPC) removal activities. Hydraulic oils, radiologically contaminated laboratory chemicals and radiologically contaminated organic acid/base waste streams were segregated and prepared for disposal.

Removal of Chemical and Radiological Impacted Wastes

The majority of smaller manufacturing equipment and machines were dismantled and disposed of as debris during Phase 1 activities. Manufacturing equipment and machines that were easily dismantled and moved were removed during Phase 1.

Removal of Dust Control and Filtration Systems

The majority of interior process and exhaust ducts were removed during Phase 1. Appropriate monitoring and contamination controls were implemented for worker safety during removal of the process and exhaust duct systems and components. Decontamination, encapsulation, and sealing of the process and exhaust duct systems and components were performed for worker safety, waste transport, and disposal.

Removal of Furnaces, Ovens, and Burners

Furnaces, ovens and burners were removed in Phase 1 with the exception of the large plant boilers and large ovens used in production processes, which were removed with larger equipment in Phases 2 and 3.

Dust Control

The integrity of the building exterior envelope was maintained during Phases 1 and 2. Dust controls were specified in the site-specific Air Monitoring Procedure for those activities which could potentially generate significant quantities of dust. Examples of these types of activities include the removal of dust control and filtration systems, and removal of process sludges, tailings and sediments from beneath removed equipment. Dust suppression was implemented through the selection of equipment and methods and by the use of fixative agents, water sprays, misting systems, and High Efficiency Particulate Air (HEPA) vacuuming. During Phase 1 and 2 activities, waste was loaded into 24.5 cubic meter (32 cubic yard) containers within the envelope of the buildings. Before equipment and items were loaded into containers, removable contamination on exterior surfaces was either decontaminated or locked down to prevent the potential for air emissions outside the buildings.

Sampling locations where beryllium concentrations exceeded 3.0 µg/100 square centimeters were HEPA vacuumed and treated with fixative material to prevent the

release of beryllium dust and other particulate during removal operations. Action levels corresponding to occupational exposure limits for these parameters were established for the Site in the Health and Safety Plan and were maintained throughout the duration of the D&D work. As a precautionary measure, it was assumed that all materials were radiologically contaminated.

Interior Air Monitoring

During all three phases of work, temporary air monitoring station(s) were placed on moveable stands and set at breathing zone height (approximately 1.5 meters or five feet above the ground surface) in active work areas. These monitors were operated during the time that activity was conducted in the work area and served as the primary measurement to evaluate airborne concentrations of both radiological and chemical contaminants. Personal air sampling was also performed to better assess potential worker exposures during invasive activities that had the potential to generate airborne levels at 20% or greater of the derived air concentration (DAC) for radionuclides or 50% or greater of the applicable exposure limit for chemical contaminants.

Control of particulate emissions (dust) within the work areas was maintained in order to not exceed the uranium and beryllium action levels at the work area perimeter. If airborne emissions exceeded an action level within the work area, operations were suspended and dust control measures reviewed and modified in an effort to prevent recurrence. The source of the elevated dust was identified and immediate steps were taken to reduce dust levels.

PHASE 2 D&D WORK

Equipment and systems that were not integral to building structures and which could be safely and cost-effectively removed prior to demolition were removed during Phase 2.

Gas Cylinders

Compressed gas cylinders with known contents were handled in accordance with the procedures in the Compressed Gas Cylinder Removal Plan. Empty cylinders were cold cut into pieces using a reciprocating saw or other equipment and disposed of as debris. Compressed gas cylinder containers that required off-site disposal were evaluated for radiological and beryllium contamination and decontaminated to allow unrestricted release for processing and disposal following the procedures and guidelines established in the Regulated and Hazardous Material Assessment and Segregation Plan.

High Hazard Material Removal and Demolition

The High Hazards Materials Removal and Demolition activities included the removal of tanks and equipment from the Hydrofluoric Acid Area (HFA) in Building E, the

Pickling Area in Building D, and the Acid Recycling Area in Building E, as well as the decommissioning of a Hydrogen Peroxide System in Buildings C and E. Acids and other liquids and loose solids were removed from tanks and piping and neutralized. Tanks, piping and ventilation systems were rinsed to remove residual acids. Neutralized tanks, piping and ventilation systems were then disassembled and removed. Tanks and equipment removed during this work were cut into manageable pieces and packaged in disposal containers.

Removal of Fluids from Machines and Equipment

Hydraulic and other fluids contained in machines or equipment were drained prior to removal of the machines or equipment from the process floor. Drained oils and fluids were segregated and containerized for disposal. Given the number and types of equipment at the Site, not all oils or cutting fluids could be characterized during the Pre-Demolition Survey. Remaining uncharacterized oils and cutting fluids were characterized prior to being treated and disposed of in accordance with all state and federal regulations. Due to the hazardous constituents identified in the oils characterized during the Pre-Demolition Survey and the potential for radiologic contamination, oils were sent off for incineration at a facility permitted or licensed to receive radioactive material. Removed refrigerants gasses were packaged for recycling during the LPC removal activities.

Phase 2 Equipment and Machine Removal

Manufacturing equipment and machines that were easily dismantled were for the most part removed during Phase 1. Large equipment, such as the Birdsboro 1,400 ton extrusion press, two boilers and the Sonodyne Unit, which required structural demolition for removal, were left in place for removal during Phase 3.

Removal of Rooftop Equipment and Systems

Removal of roof top equipment and systems commenced during Phase 2 activities in accordance with the Rooftop Systems Removal Work Plan. This work plan described the methods for removal of contaminated ventilation systems from the roofs and the administrative and engineering controls to be used to control potential particulate emissions (DU and beryllium) during the removal of ventilation system components.

Overhead Crane Assemblies

Overhead crane assemblies were removed from the Buildings during Phase 2. Oils from overhead crane assemblies were containerized and characterized prior to transportation and disposal.

Removal of Piping Systems

All piping systems, with the exception of the fire suppression system piping, throughout the buildings were removed during Phase 2 activities.

Removal of Heating, Ventilation, and Air Conditioning Mechanical Components

All remaining interior Heating, Ventilation, and Air Conditioning duct systems were removed during Phase 2. The interior Heating, Ventilation, and Air Conditioning intake and exhaust mechanical components were removed, transported, and disposed. Because of the widespread presence of DU and beryllium dust, mechanical components, when necessary, were cleaned, sealed and/or containerized for transport and disposal. Breaches in the building envelope created by removal of the interior Heating, Ventilation, and Air Conditioning mechanical components were re-sealed to maintain dust and rain water control.

Non-Load-Bearing and Non-Structural Wall and Floor Removal

The non-loading bearing and non-structural walls (e.g., masonry, concrete, partition, etc.) in all buildings were removed during Phase 2 Activities. Prior to removal, a structural engineering review was performed of interior walls to verify that the walls were non-load-bearing, non-structural, and their removal would not compromise the integrity of the building.

Interior Asbestos Abatement

Interior asbestos abatement was performed in accordance with the Interior Asbestos Abatement Work Plan. Asbestos-containing materials abatement was performed in compliance with Occupational Safety and Health Administration and Massachusetts requirements by a Massachusetts-licensed asbestos contractor. Interior asbestos abatement included:

- Pipe insulations;
- Mud fittings on piping;
- Transite laboratory hoods and table tops;
- Boiler and tank insulations;
- Transite cement board walls;
- Door caulking;
- Floor tile, floor sheet covering, and floor mastics; and
- Floor leveling compounds.

PHASE 3 WORK

Phase 3 primarily consisted of demolishing the site structures and removing the resulting debris. Subsurface pits were filled as part of Phase 3, and a temporary cover was placed over the floor slabs.

Filling and Capping of Slab Penetrations

In accordance with a Filling and Capping of Slab Penetrations Plan, slab penetrations, roof drains, sumps, pits, and trenches were located and recorded on drawings to assist in temporary cover and sub-slab investigation activities. Penetrations were inspected prior to filling and the type and extent of the

penetration documented. Where a penetration extended completely through the slab, soil samples beneath the slab were collected and analyzed. Pipe penetrations, expansion joints, cracks and drains were filled with non-shrinking grout. Sumps were filled with gravel and then capped with concrete.

Surficial Cleaning and Lock Down of Dust on Building Interior

One of the most significant concerns from the public was a concern about contaminated dust emissions during the Building demolition work. Prior to the Phase 2 rooftop systems removal activities and Phase 3 work, virtually all work had been completed inside the building envelope limiting the potential for airborne contamination.

To reduce the fugitive dust that could be liberated during building demolition, contaminated interior building surfaces with visible dust, including but not limited to, walls, trusses, beams, and window sills, were cleaned using a HEPA vacuum to collect loose material. Subsequent to cleaning, accessible interior building surfaces with residual loose contamination were encapsulated to prevent the release of dust that might contain beryllium or uranium. Encapsulation techniques included spraying the surfaces with paint or other fixatives.

Exterior Asbestos Abatement

Exterior Asbestos-containing materials (ACM) identified during the Pre-Demolition Survey was abated during Phase 3 prior to the demolition of site structures. An Exterior Asbestos Abatement Work Plan identified the abatement and monitoring procedures used in the removal of exterior ACM, which included several types of roofing materials, perimeter waterproofing behind exterior brick walls; and transite exterior wall panels.

Due to the unsound and structurally compromised state of the building roofs, abatement of the asbestos containing roofing on Building A, B, C, and connector roofs separating Butler Buildings B1, B2, B4 were performed utilizing heavy equipment. Waterproof mastic located behind the brick veneer of Building E, was also removed using heavy equipment. The work was performed in compliance with Non-Traditional Asbestos Abatement provision of 310 CMR 7.15.

Removal of Processing, Mechanical, and Manufacturing Equipment

Radiological decontamination was performed to remove or lock down surface contamination, and removal of more highly contaminated materials to allow the equipment to meet disposal facility WAC. Remaining hydraulic or other fluids in machines or equipment was drained prior to removal of the machines or equipment. As part of the removal process for the equipment and machines, residual materials or sediments in the equipment were sampled for worker safety and disposal characterization, and then removed and containerized for transport and disposal. Equipment and machines were disassembled where possible, or sized using shears, saws or burn bars and packaged in accordance with transportation

and disposal requirements. Equipment was decontaminated and fixative applied where needed for shipping and disposal. After removal of the equipment and machines, metal process residues and aqueous liquids were removed from accessible sumps and the sump surfaces cleaned prior to filling and capping.

Removal of Temporary Electrical Systems

The majority of the original facility electrical equipment and components were removed during Phase 1. Electrical equipment such as motor control centers, switchgear, capacitors, and disconnects were removed in Phase 2. Temporary Electrical Systems installed as part of the D&D work were de-energized, gapped and demolished during building demolition in Phase 3.

Removal of Transformers

Five large oil-filled transformers were located on-site, exterior to the buildings and were removed during Phase 3. The Polychlorinated Biphenyl concentrations in the transformer oils varied from non-detectable to 4.5 parts per million, and the five transformers were considered non- Polychlorinated Biphenyl transformers for removal, transportation and disposal.

Building Demolition

A Building Demolition Work Plan was developed describing the means and methods for completing the Phase 3 demolition and removal activities, and included site preparation and installation of temporary facilities, air monitoring and dust suppression, hazardous and regulated materials abatement, removal of equipment and materials, removal of electrical transformers, building structure demolition, installation of a water treatment system for dust suppression water and precipitation water that contacts the building floor slabs, and installation of the temporary cover system.

After the Phase 3 pre-demolition activities were completed, the actual building demolition was conducted in a manner that controlled dust and protected the building slabs from free-falling building material that could further deteriorate the condition of the concrete slabs. A temporary fixative sealant was applied to contaminated building surfaces prior to demolition to minimize dust generation during demolition activities. Dust suppression techniques (e.g., water spray and foggers) were also used to inhibit dust during the demolition work.

In general, the building demolition equipment consisted of excavators, front end loaders, and skid steers. The excavators were equipped with shears to cut apart building components, grapples to grip and pull down structural components of the building, and buckets for moving building materials and for loading debris into containers. A front end loader and skid steer were used to stockpile and stage materials for loading.

Temporary Cover System

After completion of building demolition, a temporary cover system was installed over the building floor slabs to prevent exposure to areas of contamination in accordance with the Temporary Cover System Design. Following completion of building demolition activities, the building floor slabs were prepared by applying leveling compounds where necessary to provide an acceptable surface for installation of the cover system. Preparation of the building floor slabs and subsequent installation of the geosynthetic cover system proceeded in a sequential manner as demolition of sections of the buildings were completed to minimize the surface area of building slab that was exposed to the weather at any given time and minimize the potential for dust or contaminated rainwater runoff. The temporary cover system consisted of a geotextile applied directly to the slab as a cushion layer prior to installation of a 45-mil Ethylene-Propylene-Diene Monomer geomembrane. The geomembrane was mechanically anchored to the building slabs with sealed seams.

Water Treatment System

A water treatment system was installed and operated to manage waste water generated during the Phase 3 activities and to treat dust suppression water, decontamination water and precipitation that comes in contact with the building materials and building floor slabs. The water treatment system included and influent tank for flow equalization, particulate filtration for solids removal, granular activated carbon for organics removal, and effluent tanks for batch operation and pre-discharge sampling.

Dust Control

A Dust Control Plan was developed to control the interior work area particulate emissions (dust) to levels that were below the uranium and beryllium action levels at the work area perimeter; control particulates to below the exterior action limit of 75 milligrams per cubic meter during the building demolition activities; and minimize visible dust emissions.

The following activities were performed to minimize the potential emission of beryllium or uranium particulates during Phase 3 demolition activities:

- During Phase 2 and 3 activities, when the building envelope was intact, all remaining interior non-load bearing concrete and masonry walls, as well as second floor concrete floors (to the extent practical), were demolished and disposed;
- Prior to demolition, all contaminated interior building surfaces (floors, walls, and roofs) were coated with a fixative to minimize particulate emissions;
- Wetting techniques were used during building demolition; and
- All rooftop Heating, Ventilation, and Air Conditioning and Process System Collection Units were removed prior to building demolition.

During Phase 3 demolition activities, the demolition subcontractor was required to use the following dust control measures:

- Potable water was used for dust control;
- Wet sweeping machines were used periodically to remove dust from high traffic areas;
- Debris piles were placed on concrete ground slabs, paved surfaces or polyethylene;
- Dust suppression methods were used for all operations which had the potential to generate dust;
- Minimizing or ceasing dust generating activities during periods of sustained high winds [greater than 9 meters per second (20 miles per hour)];
- Implementation of local air monitoring stations at work areas;
- Implementation of perimeter air monitoring stations;
- Stop work and make dust suppression adjustments to reduce airborne particulate matter concentrations below action levels;
- No wrecking balls or explosives were used for demolition;
- Enforcement of low speed limits for vehicular traffic.

Perimeter Air Sampling

During Phases 2 and 3, permanent perimeter real-time air monitoring was performed using data-logging detectors that measure particulate matter of less than 10 microns (PM-10). High volume air sampling was also conducted for uranium and beryllium particulate. The fixed perimeter air monitoring stations were located in the north, east, south, and west directions at the perimeter of the Site in accordance with the site's Air Monitoring Plan. Exceedances of criteria required temporary shutdown of operations while the exceedance was investigated. In all cases, the exceedance was a result of ambient conditions and not caused by the demolition activities.

Best Management Practices

Best Management Practices for storm water and erosion control were implemented during Phase 2, and continued into Phase 3. The Surface Water Pollution Prevention Plan and Erosion and Sedimentation Control Plan describe Best Management Practices implemented during Phase 2 and 3 and included the following measures:

- Direct truck traffic away from unpaved areas when possible;
- Avoid operating equipment on sloped areas;
- Mulch all bare soils and exposed soils as soon as possible to prevent erosion by rainwater;
- Stabilize, seed and mulch cleared and grubbed areas;
- Redirect any clean water that may run on to the Site;
- Do not perform exterior work during periods of heavy or extended rainfall; and
- Inspect and repair erosion controls on a weekly basis, after any significant rainfall and during prolonged rainfall.

WASTE TRANSPORTATION AND DISPOSAL

The primary waste processing activity was the segregation of materials associated with the removal and dismantling of the equipment and building structures. These wastes were segregated and packaged so that they met the waste disposal criteria for the disposal facility in terms of total DU concentration, chemical characterization and weight limitations.

Incoming waste containers were screened using handheld instrumentation for total and removable contamination levels to prevent off-site radiological contamination from being introduced into wastes to be transported from the Site for disposal. If a vehicle was required to enter a radiologically controlled area, radiological monitoring of the vehicle was conducted prior to entering the area and before release from the Site. Outgoing loads were covered as required to meet U.S. Department of Transportation transportation requirements. A truck scale installed at the Site was used to weigh outgoing shipments. Prior to its departure from the Site, each container was surveyed for radiological activity. The majority of the waste shipments were sent by truck to a rail transfer station and then to the final disposal location by truck from the destination rail station.

During the three phases of work, a total of 912 24.5 cubic meter (32 cubic yard) intermodals were shipped off-site for land disposal at US Ecology Idaho, totaling 10648 metric tons (11,738 tons). Of this total, the building structure volume consisted of 6800 metric tons (7,495 tons) and was transported off-site in 479 intermodal containers during Phase 3 Demolition activities. The transportation of the final intermodal containers containing building debris occurred on September 6, 2016.

All hazardous materials were properly manifested, packaged, and transported to EPA-approved disposal facilities. A listing of hazardous/manifested materials and associated quantities over the three phases of work is presented in Table I below:

TABLE I - Hazardous/Manifested Materials

Material	Quantity and/or Mass
Bulk Lead Waste (Solids)	7 Intermodals; 155 cubic meters (203 cubic yards)
Bulk RCRA Liquids	4 Tankers; 56,565 liters (14,943 gallons)
Bulk Non-RCRA Liquids (Low Activity)	3 Tankers; 45,160 liters (11,930 gallons)
Waste Oils/Fuel/Sludges	20,060 liters (5,300 gallons)
Underground Storage Tank Waste Fuel Oil	1 Tanker; 10,600 liters (2800 gallons)
Low-level Radioactive Waste	24 Drums; 3,625 kilograms (7,991 pounds)
RCRA Caustic Waste	11 Containers; 2.088 kilograms (4,603 pounds)
RCRA Acidic Waste	31 Containers; 6,249 kilograms (13,777 pounds)
Labpacks (Multiple)	Various Containers; 2,211 kilograms (4,875

Material	Quantity and/or Mass
	pounds)
Compressed Gas Cylinders	52 Gas Cylinders
Liquids Polychlorinated Biphenyls >than 50 parts per million	83 liters (22 gallons)
Debris / Solid Polychlorinated Biphenyls >than 50 parts per million	950 kilograms (2,096 pounds)
Polychlorinated Biphenyl /Suspect Polychlorinated Biphenyl Light Ballast	7 drums; 2,284 kilograms (5,036 pounds)
Non- Polychlorinated Biphenyl Light Ballast	17 drums, 4,793 kilograms (10,567 pounds)
Crushed Fluorescent Bulbs	12 drums; 2,330 kilograms (5,137 pounds)
Mercury Containing Articles	1 drum; 24 kilograms (52 pounds) (2 kilograms (5 pounds) Hg items)
Recycled Bulbs (mercury and sodium Lamps)	5 Bags; 16 kilograms (35 pounds)
Tungsten-Thorium Welding Rods & Tips	2 drums; 174 kilograms (384 pounds)
Nickel-cadmium, nickel-metal hydride, and Lithium Ion Batteries	Various; 242 kilograms (534 pounds)
RCRA Metal Solids	Drums/Sacks; 1787 kilograms (3940 pounds)
RCRA Volatile Organic Compound and Semi-Volatile Organic Compound Wastes	11 Units; 263 kilograms (580 pounds
Non- Polychlorinated Biphenyl Transformers	24 Units; 2,516 kilograms (5,549 pounds)
Asbestos Containing Materials	360 Units; 8,807 cubic meters (11,520 cubic yards)

NEXT STEPS

The Site has now entered into the Post Removal Site Control phase, which consists of activities necessary to ensure the effectiveness and integrity of the removal action for the time period between the completion of the Non Time-Critical Removal Action and the start of the implementation of the final remedy at the Site. Future remedial actions will address the building floor slab removal, removal of contaminated soils and sediments, physical containment of a former sludge impoundment and treatment of groundwater contamination.