High Hazard Decommissioning Project
Nuclear Metals, Inc. Superfund Site
Concord, MA

Joint Efforts By:

History of Nuclear Metals, Inc.

- Nuclear Metals, Inc. (NMI) purchased undeveloped property in 1957 and the original laboratory facility was built the following year.

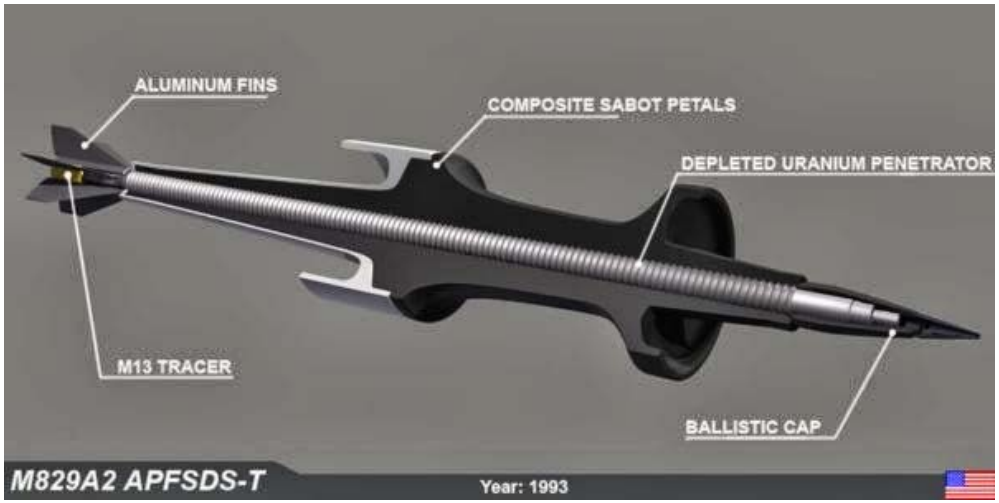
- Owners/Operators –

  - 1958-1972: two industrial entities sequentially own NMI, which performed specialty metals R&D, primarily for the US Army and the Atomic Energy Commission.

  - 1972: Employees purchase the company and incorporate as NMI – expand work to include production of depleted uranium (DU) penetrators under contract with US Army.

  - 1997: NMI changes to Starmet Corp, stops DU penetrator production and focusses on other manufacturing (metal powders, beryllium/aluminum alloys)

Depleted Uranium Munitions



History of Nuclear Metals, Inc. (continued)

- November 2011: Starmet and affiliated business abandon site and Massachusetts Deportment of Public Health-Radiation Control Program terminates Starmet's Radioactive Material License
- November 2011: Non-Time Critical Removal Action (NTCRA) for the removal of building contents and the demolition of the buildings is initiated.
- *de maximis, inc.* – Prime contractor implementing the NTCRA

NMI NTCRA Site Management

- Prime contractor implementing the RI/FS and NTCRA
- Radiation Protection Program Support and Specialty Decommissioning Projects
- Operations and Specialty Decommissioning Projects (formerly EQ Northeast)

High Hazard Project Overview

- Target Processes
  1. Pickling Area
  2. Acid Recycling Area
  3. DU Sludge Recycling Area
- Operational areas abandoned in 1997
- Little process knowledge was available
- Hazardous and radioactive materials were still present in process lines, tanks, equipment and on surfaces.
  - Acids – Hydrofluoric Acid, Sulfuric Acid, Hydrochloric Acid
  - Base – Sodium Hydroxide
  - Pyrophoric/radioactive DU metal sludge

Project Objective

- Remove and containerize hazardous solids and liquids
- Disassemble, size and neutralize process equipment
  - Direct spray application of neutralization solution
  - Submersion in dip tanks
- Neutralize remaining building surfaces
- Verify materials were properly neutralized prior to shipment for direct disposal

Hazards Associated With Work

- Heat stress due to elevated levels of PPE
- Radioactive material
  - Depleted Uranium
    - Total Contamination up to 5,000,000 dpm /100cm^2
    - Removable Contamination up to 200,00 dpm /100cm^2
- Pyrophoric DU powders
- Corrosive materials (HF, H_2SO_4, NaOH)
- Opening lines, vessels, ducts, and equipment containing hazardous materials
- Size reduction and disassembly of components

Work Area Radiological Hazards

- All areas had high levels of removable radioactive contamination present on work surfaces
- Acidic process solutions contained high concentrations of dissolved DU and heavy metals
- Existing ventilation systems were unfiltered and contained high levels of process residues

HF Specific Training

- HF was considered the most significant hazardous material present due to poor warning properties and risk of death from limited exposure.
- Brought in industry experts to train project personnel
- Trained local fire fighters and paramedics on HF treatment
- Coordinated treatment plans with local Hospital Emergency Room
- Provided HF specific treatment kits to project personnel and first responders

Personnel Preparation

- Site and Activity Specific Training
  - Radiation Protection Training
  - Mandatory Respirator Use
  - Hazardous Material Handling Training
  - Line Breaking
  - HAZWOPER Training
  - Emergency Response
- Integrated the requirements of Job Safety Analysis (JSAs) and Radiation Work Permits (RWPs) to designate proper PPE ensembles
- Acclimatization Schedule for Workers
  - Body Weight and Temperature Monitoring

PPE: Coveralls

Tychem SL Coveralls

PPE: Extremities Protection

- Hands
  - 2 layers of inner gloves
    - nitrile gloves

  - 2 layers of outer gloves
    - Chemtek Butyl outer gloves are for barrier purposes
    - Abrasion resistant for handling sharp edged materials
  - Seal both layers of gloves with each layer of coveralls with ChemTape

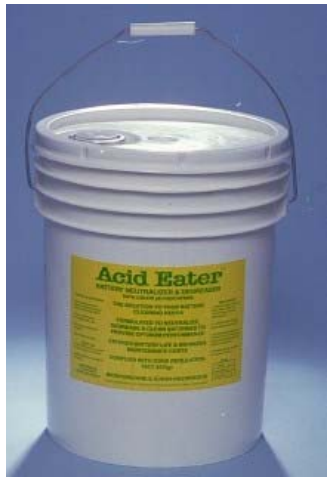
  - High density PVC steel toe boots

PPE: Powered Air Purifying Respirator (PAPR)

- Pictured to the right:
  - 3M Versaflo Hooded Shroud
  - 3M GVP-443 Cartridge
  - 3M GVP-100 Motor Blower
  - 3M GVP-122 Breathing Tube
  - 3M GVP-111 Battery Pack
- Assigned Protection Factor = 1,000

Neutralization of HF and Sulfuric/ Hydrochloric Acid Residues

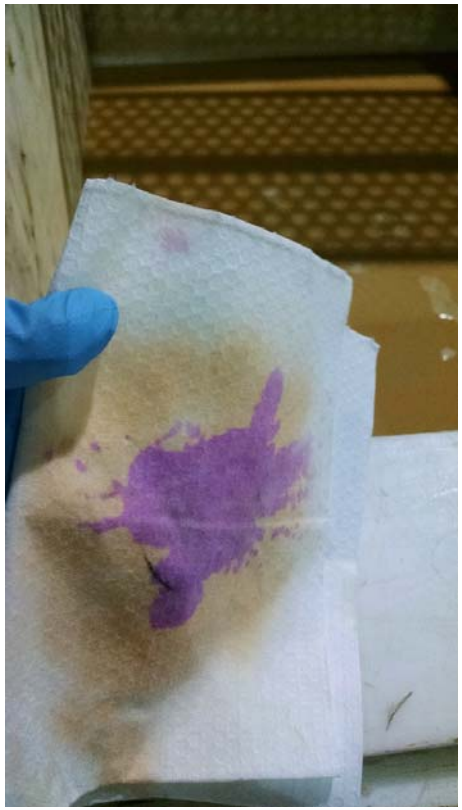
- Cliff Industries Products
  - HF Acid Eater
    - Non-Hazardous
    - Color Indication in the presence of HF (bright pink)
    - Color indication when fully neutralized (tan)
    - Specific to HF only does not work on other acids
  - Acid Eater
    - Non-Hazardous
    - Same color indication
    - Does NOT work on HF acid



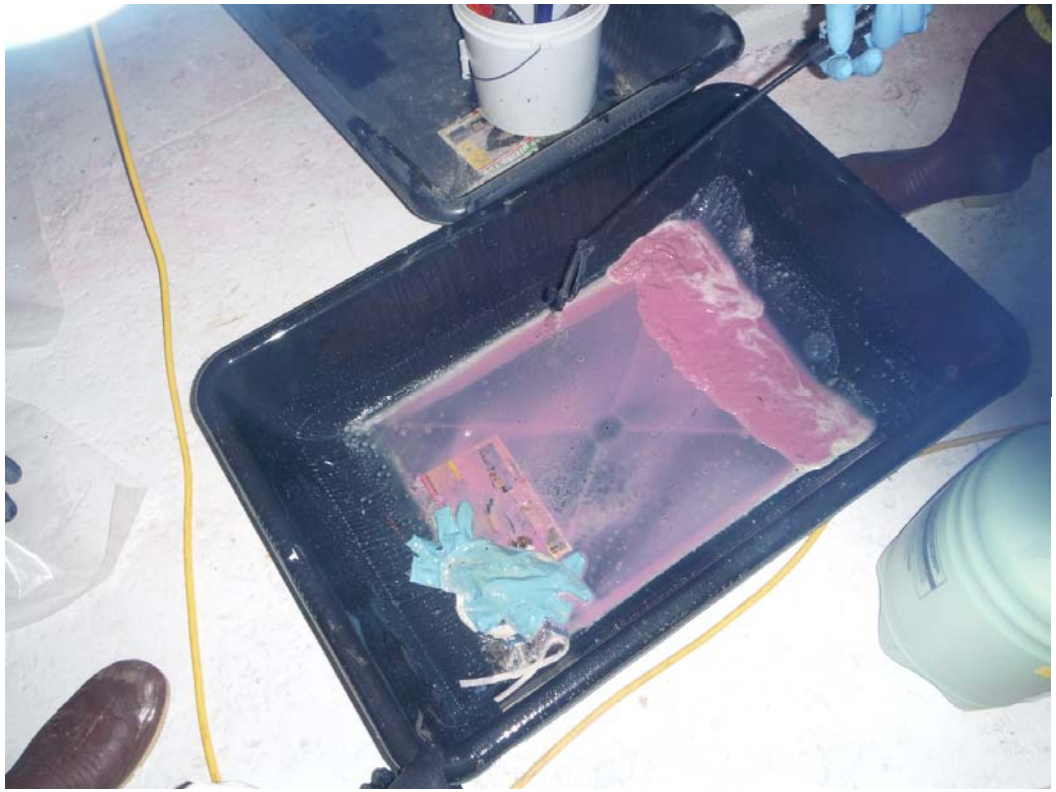
Multi-Stage Neutralization Process

- Neutralization of Personnel
  - Wipe-down with neutralization solution(s) when exiting the Exclusion Zone.
- Neutralization of Process Equipment
  - Direct application on large surfaces (tanks, floors, walls)
  - Piping, pumps and equipment were disassembled and dipped in neutralization tanks.
- Neutralized materials retested after two weeks to verify no leaching of corrosive materials had occurred

Neutralization Reaction Personnel Exiting EZ

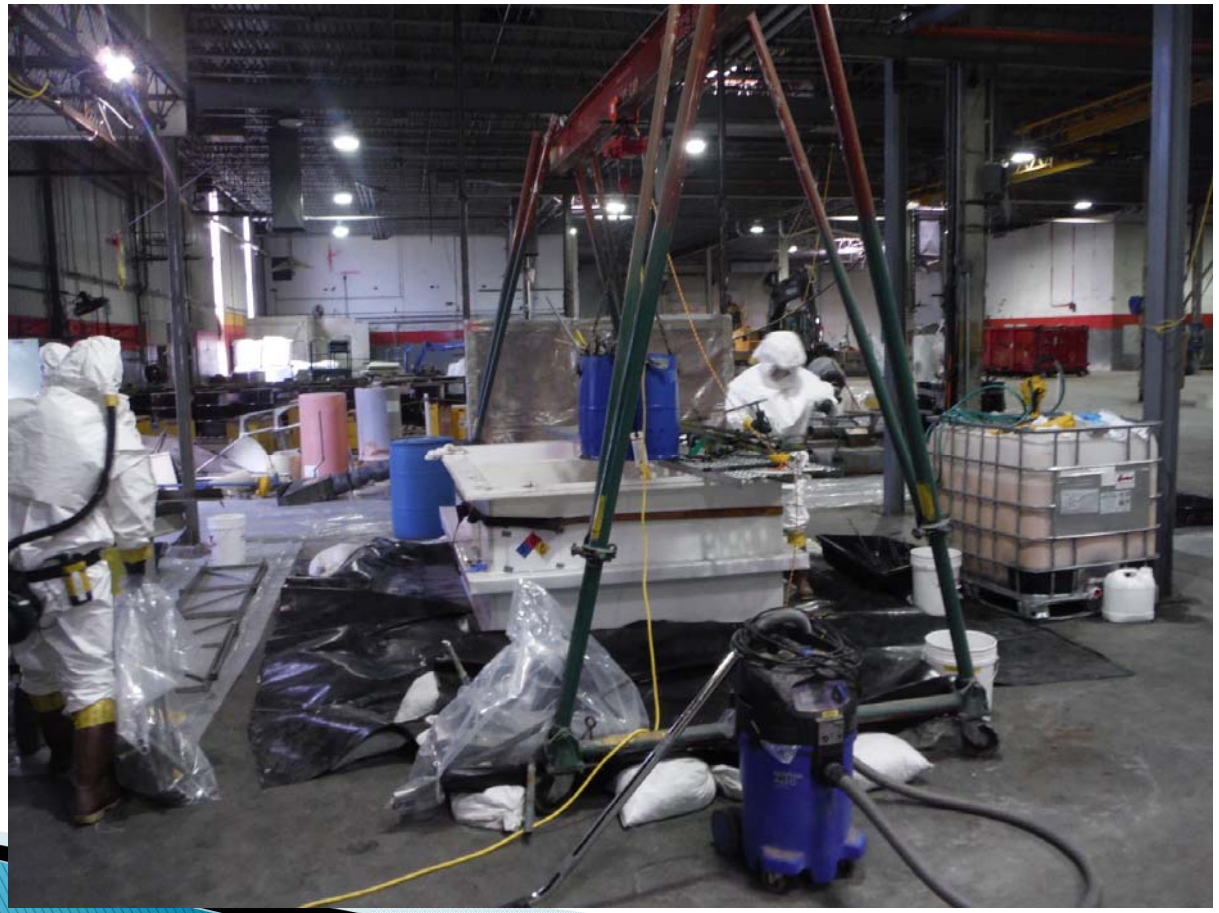


Spot Neutralization



Progressive Neutralization of Surfaces

Neutralization Tank



Neutralization Tank

Process #1 – Pickling Area

- DU billets had to be clad in copper jacketing to prevent ignition during the extrusion process.
- The copper clad DU billets were submerged in a heated concentrated acid bath to remove copper prior to machining.
- Finished penetrators and bullets were also dipped in a variety of acids to alter the metal surface properties.
- Spent acid solutions were sent through a closed piping system to the Acid Recycling Area for either regeneration or disposal.

Pickling Area

Line Breaking and Acid Recovery

Concentrated Acid with Dissolved DU

Pickling Area Trench Cleanout

Neutralized Surfaces of the Pickling Area

Process Area #2 – Acid Recycling

- Used Acids were accumulated in the High Copper Tank
- Two electroplating tanks were used to remove copper from the used acid solutions as the first step in regeneration.
- Once the copper was removed the solution was sent to the Low Copper Tank where concentrated acids were added to regenerate the solution.
- Solutions that could not be regenerated were sent to the Uranium Precipitation Tank where the pH was adjusted drop out the metals from the solution.
- A filter press was then used to remove the solids (DU and other metals) from solution.

Acid Recycling Area

Copper Plating Tanks

Copper Plating Electrodes

Uranium Precipitation Tank and Filter Press

Process Area #3 – DU Sludge Recycling

- The process was designed to convert DU sludge into Uranium Tetrafluoride (UF_4)
- Finely devised DU sludge was washed, rinsed, and mixed in an acidic soliton.
- 70% HF was reacted with this solution creating UF_4 which then precipitated in the reaction vessel
- A filter press was used to remove the UF_4 from the solution
- UF_4 could the be further reprocessed to make DU metal again

DU Sludge Recycling

Uranium Tetrafluoride Recovery

Radiological Protection Program Controls

- Most areas had fixed contamination routinely exceeding 1.5 million dpm/100cm^2.
- Negative pressure HEPA containment of work areas and use of local ventilation were required.
- Use wet control methods to control airborne emissions.
- Both high volume area and personal breathing zone samples were required for each job category.
  - Two day delay in interpreting results for DU.
  - 10% of all samples were analyzed for RCRA 8 Metals + Be
- DU concentrations were tracked using DAC hours with a target of 8 DAC hours per day.

Air Sample Summary

U-238 Class Y Derived Air Concentration (DAC) 2.0 E^{-11} µCi/mL

- 99 High Volume Area Air Samples Taken
  - Highest Sample Value 20.7 DAC hrs
  - Average Sample Value 1.24 DAC hrs
- 121 Low Volume Personal Air Samples Taken
  - Highest Sample Value 52.12 DAC hrs
  - Average Sample Value 5.17 DAC hrs
- 10% of all samples also analyzed for RCRA 8 Metals + Be
  - All results <10% of PEL

All samples are in units of DAC hrs/per shift without credit for respiratory protection

Radiological Protection Program Controls

- Employee exposure hours tracked using RWP entry logs
- Decontamination required when exiting the EZ
- Additional decontamination and survey of respiratory protection and reusable PAPR hoods in CRZ
- Full body frisk required upon exit of the CRZ
- Weekly removable contamination surveys were performed in the CRZ and at the boundary of the work zone
- Routine audits of work practices and doffing were performed to assure compliance with established procedures

Industrial Hygiene Controls

- Heat Stress
  - Training
  - Buddy system
  - Acclimatization
  - Internal temperature monitoring
  - Employee water loss tracking
  - Regimented hydration
  - Progressive reduction in stay times during the work shift
- Real-time monitoring for HF concentrations

Questions and Answers

Depleted UF6 Cylinder Storage Yard

Each cylinder contains 10 tons of UF6