An Alternative Treatment Technology to Open Burning and Open Detonation of Energetic Hazardous Wastes

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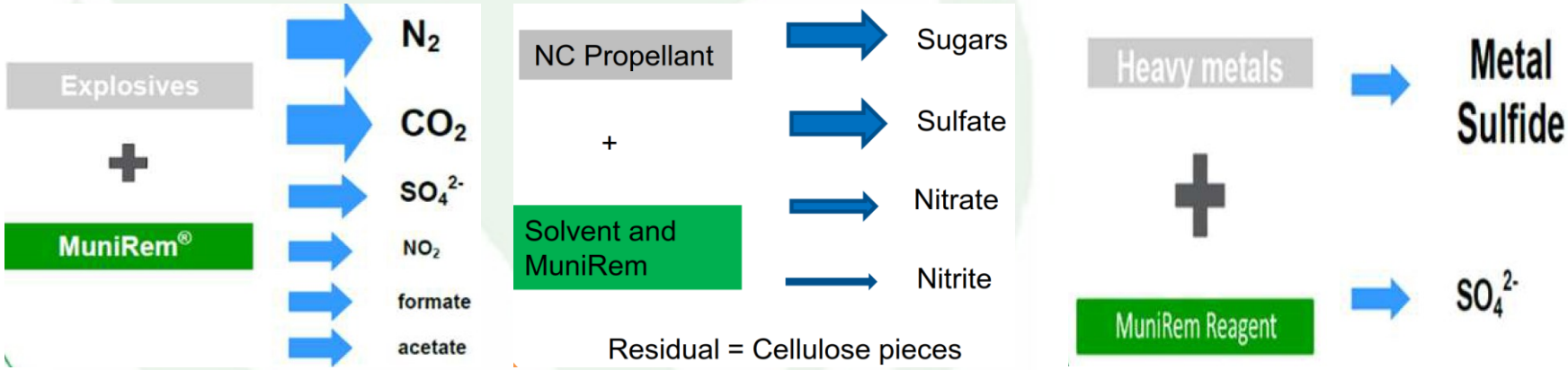
What is the Solution?

- A University of Georgia patented innovation commercialized under the Trademark MuniRem®
- Achieves near-instant neutralization and destruction of explosives and chemical warfare agents in an aqueous solution
- Invention based on reduction chemistry mediated by sulfur oxides and other enhancers
- Stabilizes metals as insoluble metal sulfides, thus used for heavy metals remediation
- End-product from reactions is non-hazardous waste
- Versatile and Scalable
- Exclusively licensed to MuniRem Environmental, LLC founded by the inventor at Univ. of Georgia

Unique Properties of the Chemical Reduction Reagent

End Products after chemical neutralization and destruction are **non-hazardous**



Commercial Product and Packaging: Types

Types

- MuniRem-R541E
- MuniRem-R532E
- MuniRem-R811E
- MuniRem-FE
- MuniRem-Foam
- MuniRem-BC

- All varieties available in deodorized versions (MuniRem-RxxxE-D) which mask the sulfur odor.
- Deodorized MuniRem products are provided upon Client's request.

Packaging

- 5 lb Pail, sold in packs of 4 (limited availability at present)
- 45 lb Pails (normally available ex-stock)
- 200 lb Drum (available to order)
- Portable Field Kit with 4 x 2 lb jars of different MuniRem Reagents

5 Lb (2.2 kg) pail

45 Lb (20.5 kg) pail

220 Lb (100 kg) Drum

Portable Field Kit

MuniRem Capabilities & Applications

Versatility of Chemical Reagent

Military Explosives
- C4
- HMX
- PETN
- RDX
- Semtex

Commercial Explosives
- ANAL
- ANFO
- Black Powder
- Dynamite
- Nitroglycerin
- Smokeless Powder
- TNT
- Urea Nitrate

Improvised Explosives*
– HMTD
– TATP

Other Contaminants
– Heavy Metals
– Reactive Aluminum
– Halogenated Organics

Applications

A. Demilitarization:
- Bulk explosives neutralization
- Demilitarization derived waste
- Recovered underwater munitions
- Humanitarian demining
- Neutralization of Fireworks/Flares

B. Decontamination:
- Manufacturing equipment
- Former explosive manufacturing buildings
- Scrap metal & bomb casings
- Indoor Training Range Maintenance

C. Remediation
- Soil
- Groundwater and Wastewater
- Training Ranges

NEUTRALIZATION AND DISPOSAL OF BULK EXPLOSIVES

Case Studies:

Military Explosive – Composition D

Commercial Explosive – Dynamite

Options for Recovery of Bomb Fillers (Bulk Energetics)

- Water jet
- Water saw
- Milling
- Cryogenic Breaching

Projectile Casings

Breaching and Recovery of Bulk Energetics

Recovered Bulk Energetics

Custom Built Reactors for Instant Neutralization of Multiple 10 lb. (4.5 kg) Batches of Bulk Explosives

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Main Treatment Tank Reactor

Complete, instant and rapid neutralization in under 30 minutes

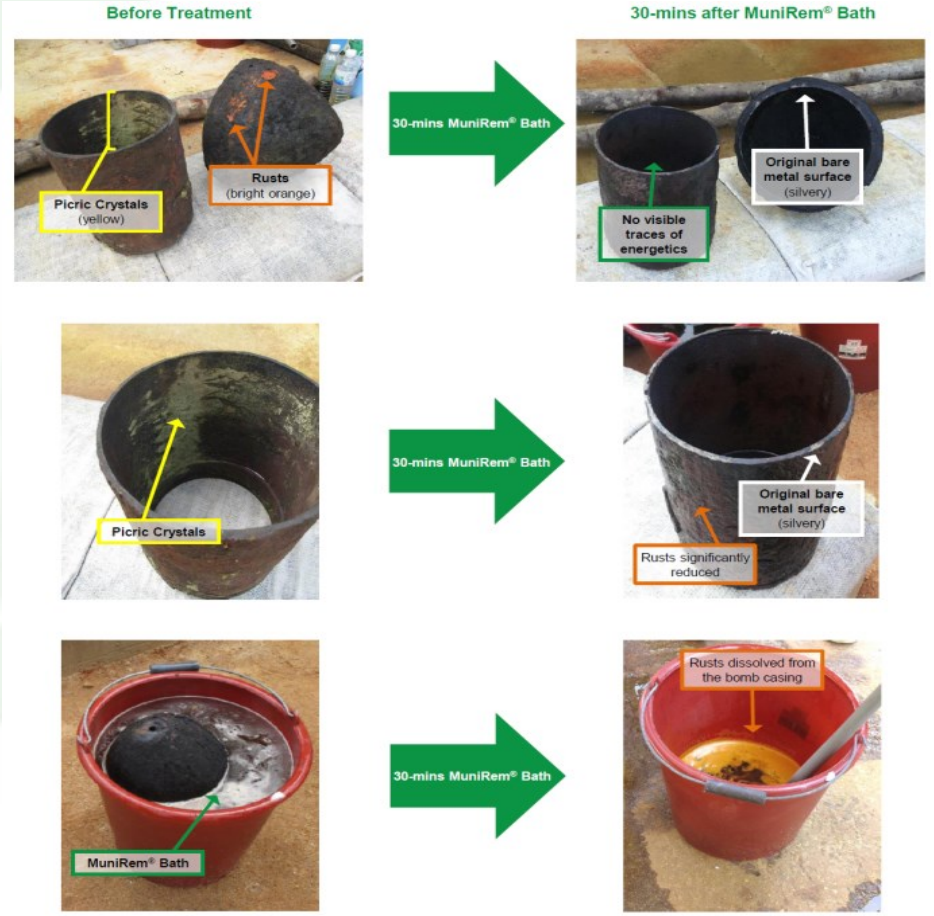
Effluent wastewater target of 2 ppm explosives achieved

Bomb casings registered no detectable explosive compounds or intermediate products after decontamination in MuniRem solution

Thermal Vs. Non-thermal Decontamination of Bomb Casings

Thermal Decontamination

MuniRem Bath Decontamination



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Chemical Neutralization and Destruction of Dynamite in Abandoned Magazines

Hazard is highly unstable nitroglycerine sweating out of the dynamite sticks

Chemical Neutralization and Destruction of Dynamite Abandoned in Storage Magazine

Storage Magazine Before Doors Opened

Contents of Explosive Storage Magazine

>40 Years Old

Abandoned Explosive Magazine

Chemical Neutralization and Destruction of Dynamite Abandoned in Storage Magazine

Dynamite Soaked with MuniRem Solution to Allow for Safe Recovery

Recovered Dynamite in Plastic Tub and Soaked in MuniRem Solution

Chemical Neutralization and Destruction of Dynamite Abandoned in Storage Magazine

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Destruction of Dynamite in MuniRem Reagent Solution

Packaging Left from Destruction of Dynamite

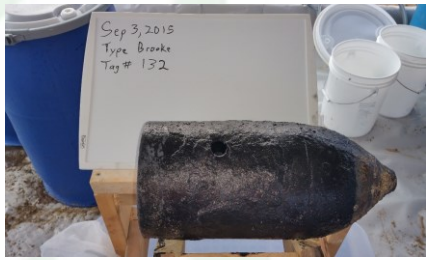
Open Detonation vs. Chemical Neutralization of Underwater Munitions

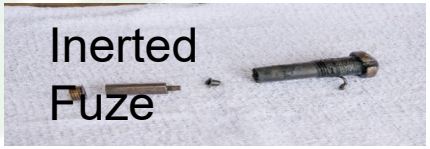
Unexploded Ordnance Clearance at Mappleton Beach by Open Detonation
https://ceobs.org/blast-fishing-how-abandoned-ordnance-is-destroying-coral-reefs/

Breaching and Chemical Neutralization of Recovered Underwater Munitions

Chemical Neutralization of Munitions

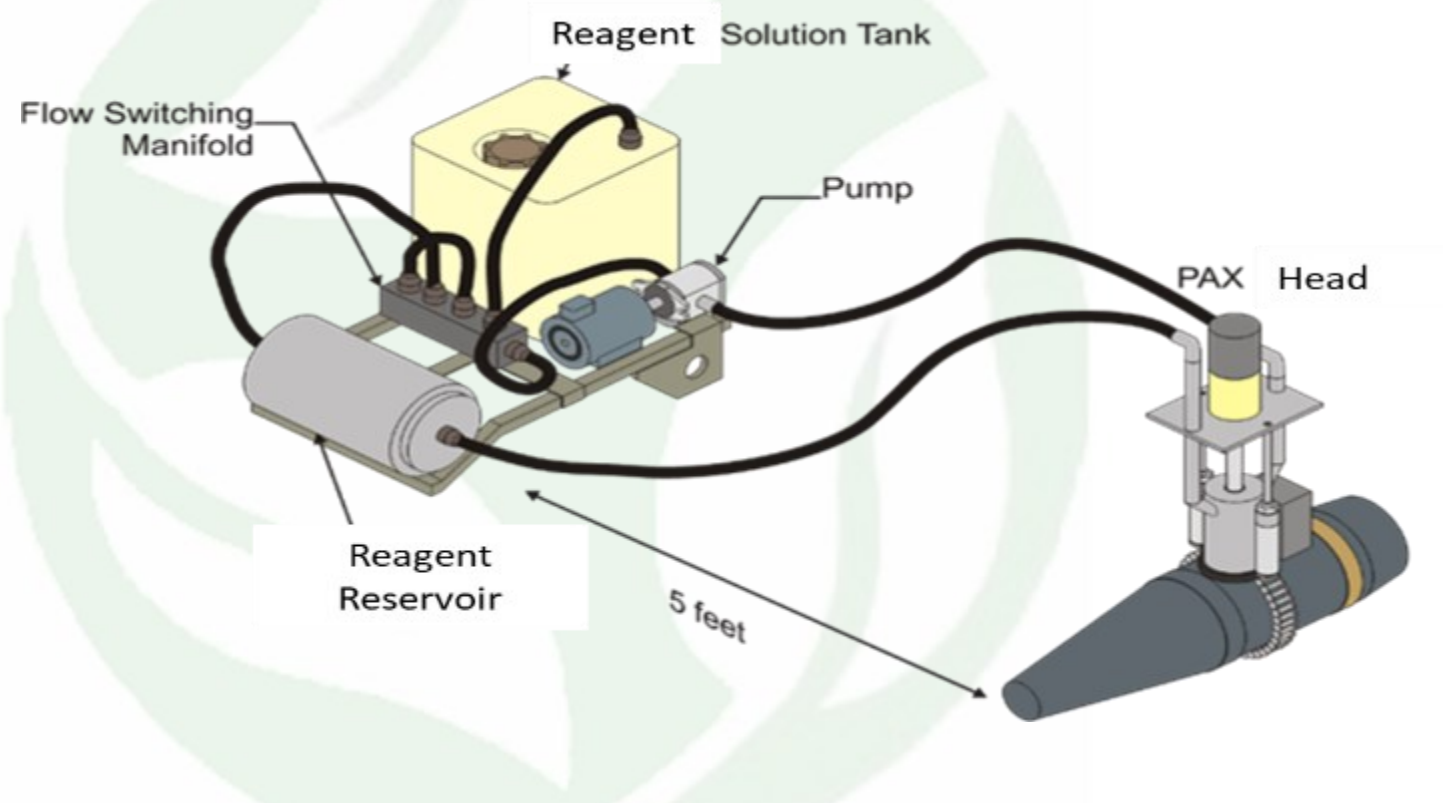
End Products: Empty Bomb Casings and Non-hazardous Wastewater





In-Place Demilitarization of Munitions

Equipment developed and demonstrated by SRI & ARA, Inc

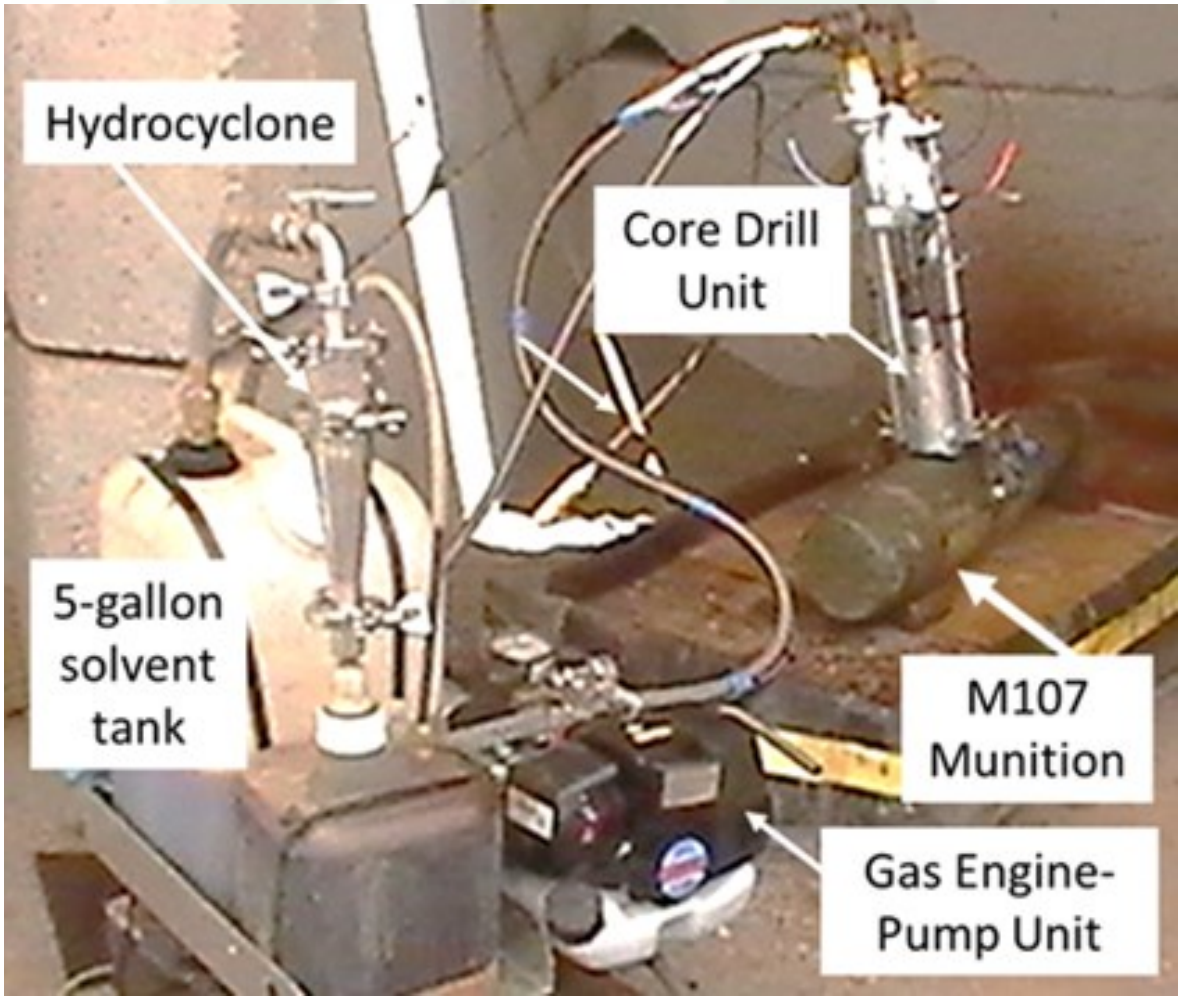


Mature, low-risk technology for fast field destruction of toxic liquid chemicals, and safe remote breaching of chemical ordinance shell.

Extensively tested

Energy-efficient, fluidized bed, multi-arc reactor CWA elimination system (US Patent 8,465,809 B2, 2013)

In-Place Breaching, Dissolution and Destruction of Bomb Fillers in M107 Munition Item



PAX/MuniRem technology is packaged as a transportable system carried on board of a trailer pulled by a jeep to destroy stockpiles of toxic materials and/or destroy tens of munitions in a matter of hours.

In-Place Demilitarization of Munitions

Equipment developed and demonstrated by SRI & ARA, Inc

In-Situ Remediation of Explosives in Soil at a DoD BRAC Site in the USA

MuniRem® is directly tilled into the soil for treatment

Blackened soil: neutralization of explosives in hotspot areas

MuniRem Technology Rating

No.	Criteria	Rating
1	Maturity	Already applied at full scale to demilitarize discarded military munitions and neutralize bulk explosives Compliments other demilitarization technologies
2	Process Efficacy	Demonstrated and validated at bench, pilot and full scale
3	Process Throughput	10s to 100s pounds per hour. Determined by breaching and neutralization method
4	Process Safety	**Very safe**. Near instant neutralization of most energetics
5	Public & Regulatory Acceptance	Already approved on multiple State and Federal projects
6	Secondary Waste Issue	Not a concern
7	Destruction Verification Capacity	Available and Rapid. EXPRAY Test Kits and similar commercially available wet chemistry explosives sensors
8	Process Flexibility	Very scalable and adaptable. Easily transportable for on-site demilitarization. Fixed facility not a requirement for application

Increasing Capacity by Building Government and Industry Partnerships Worldwide

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Country	Private Industry	Government
Australia	X	X
Canada	X	X
Israel	X	X
Lebanon	X	X
Mexico	X	0
Saudi Arabia	0	X
South Africa	X	0
United Kingdom	0	X
United States	X	X

New partnerships coming up in Bosnia, Greece, Netherland/Germany

Conclusions

We have a safe solution to destroy dynamite and other explosives without polluting our air, soil and water.

We have a solution to mitigate the world's explosives remnants of wars faster and safely.

This invention is also beneficial for combating weapons of mass destruction and humanitarian demining.

An underwater munition dump site. According to the DoD, there are at least 32,000 tons of chemical weapons dumped in U.S. coastal waters. (Photo: Courtesy of the International Dialogue on Underwater Munitions)

MUNIREM IS A SAFE AND PROVEN TECHNOLOGY THAT SHOULD BE IN THE TOOLBOX FOR EXPLOSIVES AND OTHER HAZARDOUS WASTE REMEDIATION