Battelle
The Business of Innovation

The Acid Digestion Process (ADP) for Disposal of Sea Dumped Munitions

Presented by Mr. Dennis Wynne

Co-authors: Mr. Ed Groth and Mr. Chris Livingston

Battelle Memorial Institute

Outline of Briefing

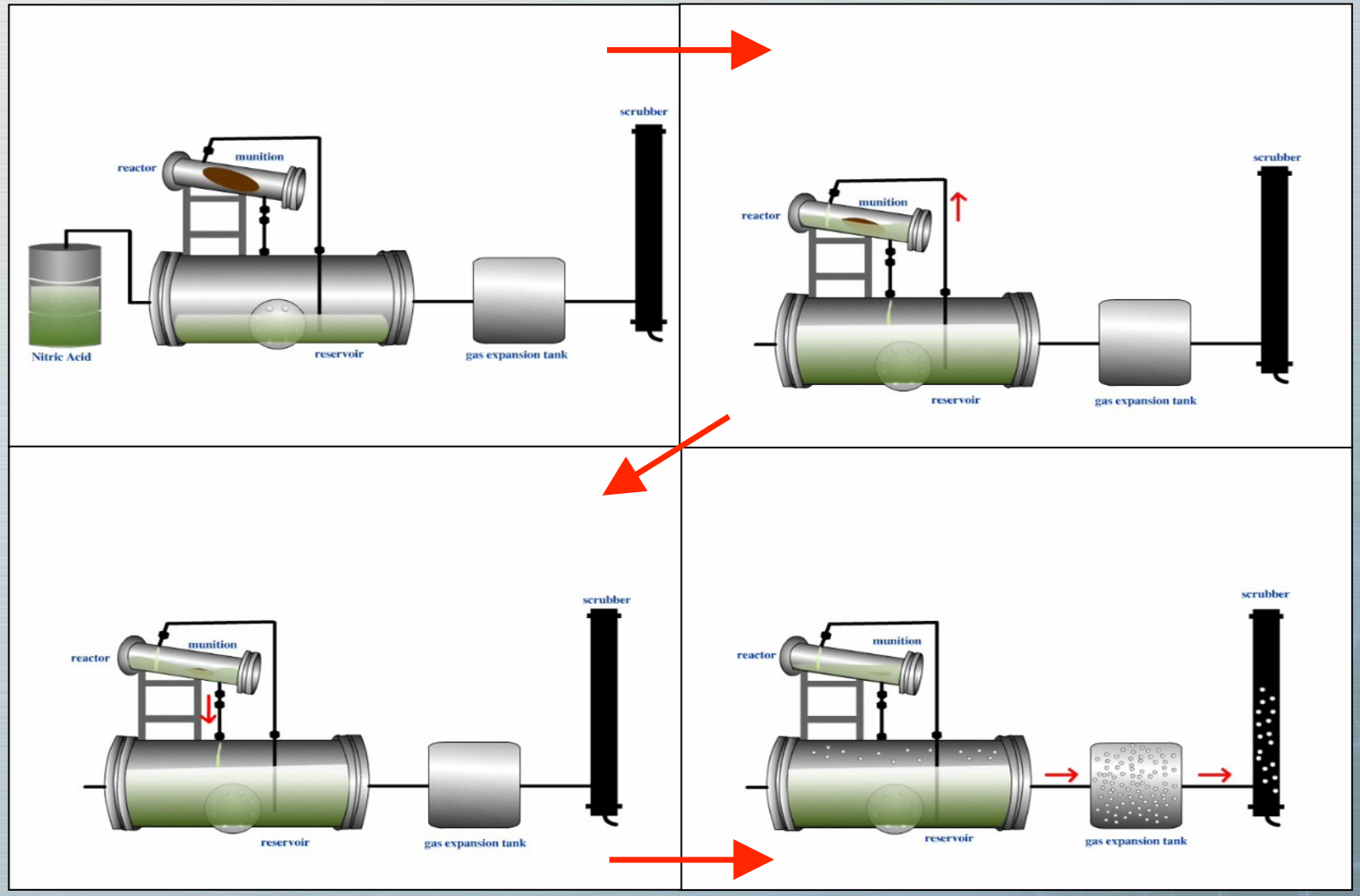
- Background Information
- Testing and Operations
- Breadth of Chemical Testing to Date
- Future Applications of ADP

Mission/Need for Battelle's Acid Digestion Process™

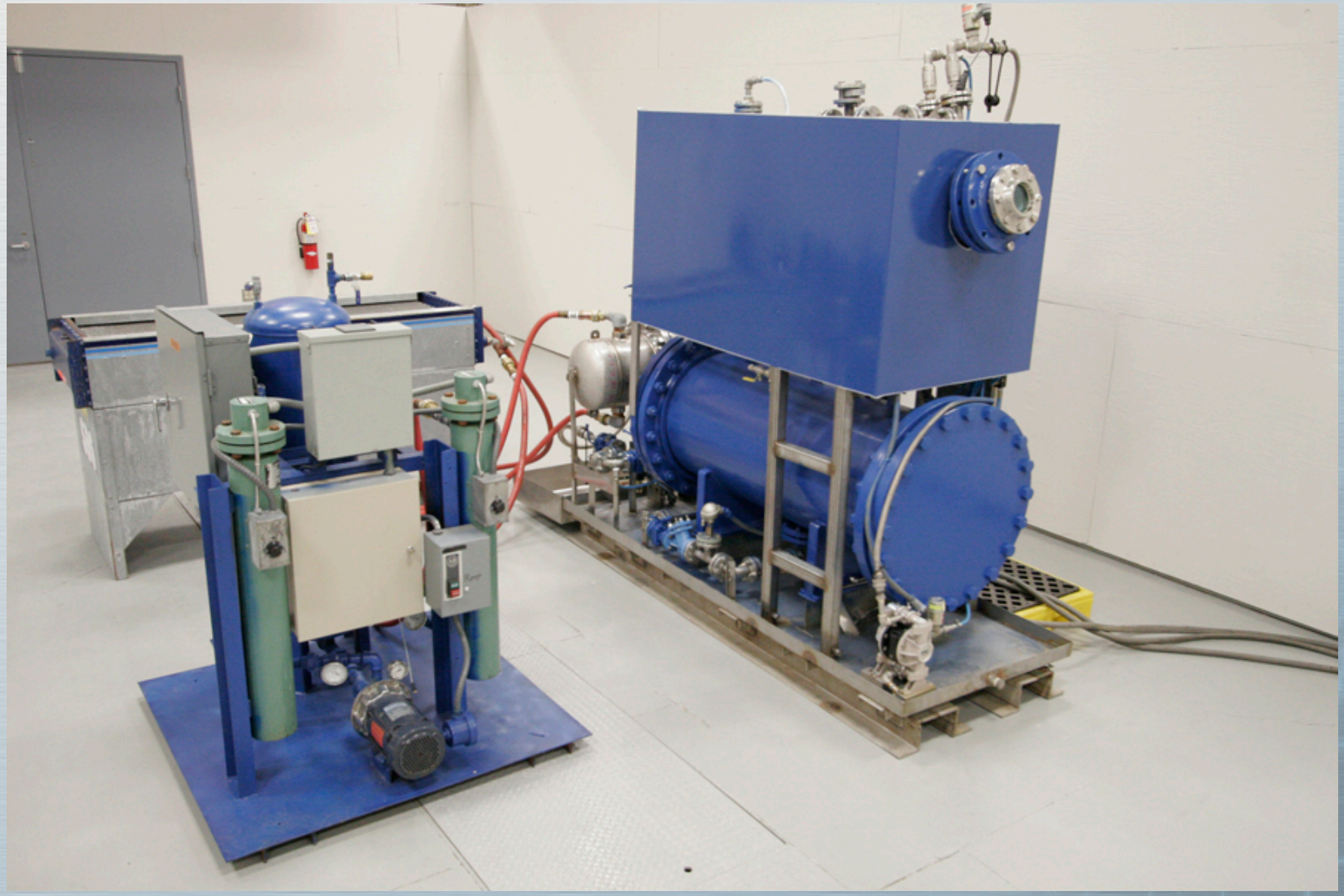
To establish an unexploded ordnance (UXO) disposal capability that:

- Eliminates public concern with open burning/open detonation (OB/OD).
- Treats a variety of munition types – explosive, chemical, biological, and miscellaneous without change of hardware.
- Complies with environmental requirements.
- Maximizes worker and public safety.
- Is simple enough to allow it to be mobile in the event munitions cannot be transported.
- Has multiple applications (recovered, stockpiled, unserviceable, and captured weapons/munitions).

Acid Digestion Process Concept



Battelle's Acid Digestion Process Demonstration Hardware



Previous Testing/Operations
Prototype Testing: SETH Processing

105 mm projectile before and after partial digestion

Previous Testing/Operations Additional Testing

Before and After

Before After

BLU -97B, bomblet with Comp-B

Before

After

1lb Phosgene cylinder

35mm HEI round

Previous Testing/Operations
Spring Valley Arsine Rounds

Recovered 75 mm Arsine Filled Projectiles Before and During Processing

Before

During

Recent Testing Operations
Fuze Testing

Testing conducted to determine if sensitizing of energetic materials occurs in a dilute nitric acid solution.

- Materials selected for testing included:
  - M700 time fuse.
  - M213 grenade fuze.
  - Winchester W209 shotgun shell primer.
  - #8 non-electric blasting cap.

The energetic materials tested were found to be less sensitive to ignition/detonation, following wetting with the nitric acid solution.

Recent Testing
Fuze Types Destroyed

WWI era fuzes

- Powder train time.
- Impact.
- Combination fuzes.
- “Super quick” fuzes – standoff.

Recent Testing
Recovered Chemical Weapons Treated

Munition	#	Suspect Fill	Comments
Unfuzed Projectiles	3	Arsine	
WWI era fuzes	3	Mercury Fulminate	Fuzes Only
Fuzed Projectiles	6	Phosgene (CG) Hydrogen Cyanide (AC) Arsenic Trichloride Oleum (FS) Mustard (H) Ethyl Iodoacetate (SK)	Actual recovered munitions
Unfuzed mortar	1	HBU 88B	Insensitive Munition

Recent Testing
Insensitive Munitions Testing

Difficulty in disposing of IM without OB/OD

- Cannot melt out explosives
- Cannot incinerate

ADP proposed dissolving munition body to recover explosives

- Digested a 120mm mortar containing HBU-88B in the ADP prototype unit.

120mm Mortar Prior to Acid Digestion

120mm Mortar Following Acid Digestion

Explosive contamination of liquid waste did not occur.

Recent Testing
White and Red Phosphorus

Conducted calorimeter testing with nitric acid and WP/RP

- Reaction products compatible with materials used for ADP prototype.
- Waste is predominantly phosphates and nitrates which are not reactive.
- Heats of reaction are well within the design basis.

Conclusion

- Safe to test full up munition in prototype.
- Waste potentially can be spread for use as fertilizer.

Summary
Compatibility of ADP with Various Fills

Energetic Material		Chemical Fills	
Lead styphanate	Pilot Scale	Diphosgene (DP)	Bench Scale
Lead azide		Tin tetrachloride (smoke)	
Mercury fulminate		Sulfur trioxide (smoke)	
Black powder		Chloropicrin (PS)	
Double base propellant		Nerve agents VX & G series	
Flash powder		Arsinöl	
Barium chromate/zirconium		Nitrogen Mustard (HN)	
TNT		White Phosphorus (WP) (smoke)	
RDX		Red Phosphorus (RP) (smoke)	
PETN		Hydrogen cyanide (AC)	Pilot Scale
Dinitrobenzene		Phosgene (CG)	
Hexanitrodiphenylamine		Mustard (HD)	
Picric acid		Oleum (FS)	
Dinitrotoluene		Arsenic trichloride (smoke)	
HBU-88B		Ethyl Iodoacetate (SK)	
PBXN-109	Bench Scale	Arsine (SA)	
AFX-757			

Summary
Conceptual Scale Up of ADP

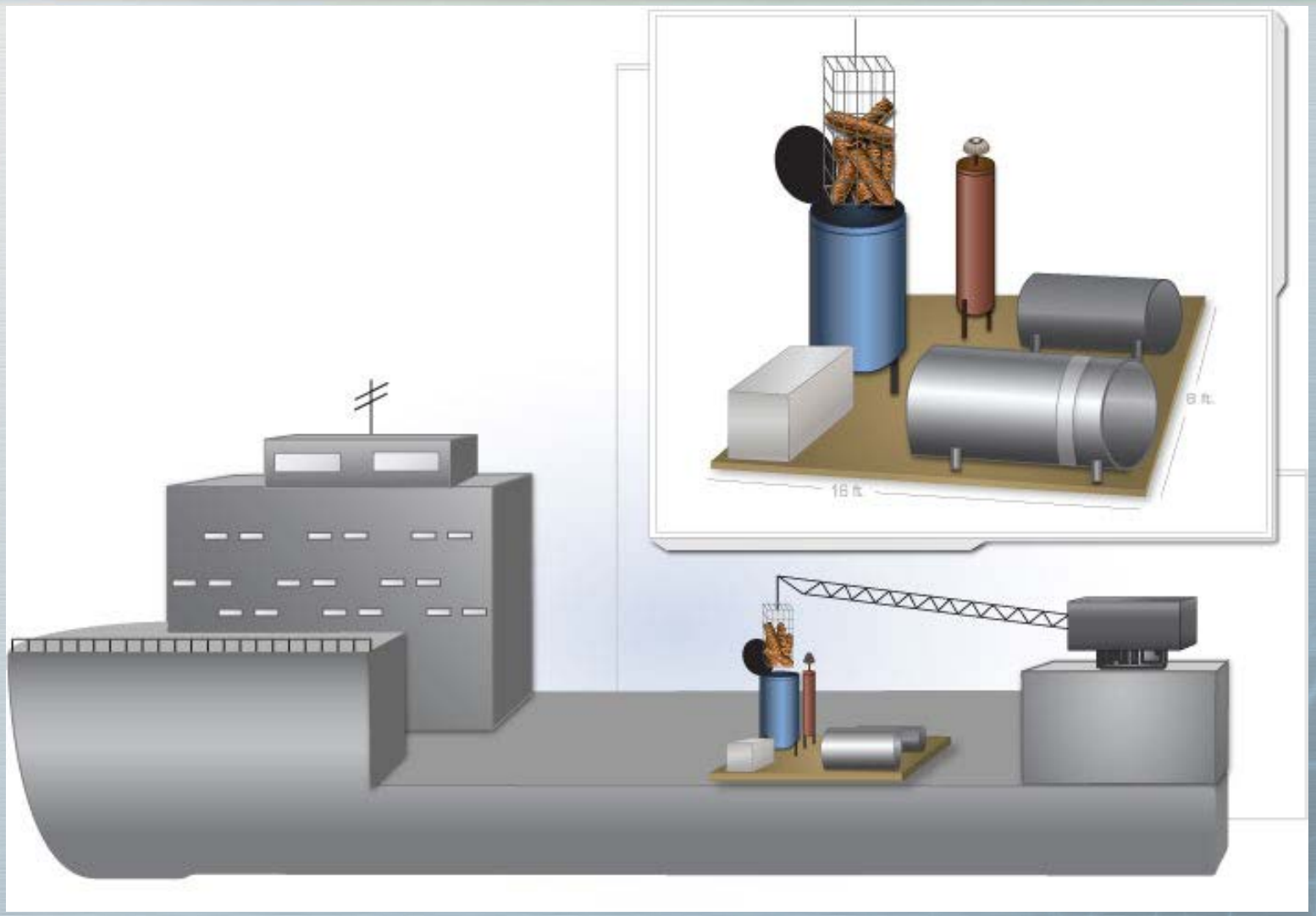
Preliminary design prepared for:

- Digestion of Containers weighing up to 2 tons
- Treating up to 5 RCWM at one time.

Concept prepared for:

- Continuous process reactor
- Skid mounted equipment for processing at sea

Conceptual ADP at Sea



Summary ADP Capabilities

- Flexibility of ADP minimizes need for characterization.
- Scale up of process uses readily available materials and equipment.
- Throughput is only limited by the digestion rate of steel.
- Recovery and reuse of acid using commercially available equipment will minimize costs.
- Use of waste products as fertilizer will allow waste to stay on the military reservations.

Conclusion

- ADP eliminates need for open detonation or open burning of munitions.
- The simplicity allows for:
  - Scalability
  - Mobility
  - Operability
  - Maintainability
- Other potential applications:
  - Demilitarization of munitions dumped at sea
  - Recovery and reuse of explosives, precious metals, or segregation of waste
  - Disposal of Biological Weapons
  - Treatment of range scrap

Points of Contact

Dennis J. Wynne

Battelle Eastern Science and Technology Center

1204 Technology Drive

Aberdeen, Maryland 21001

Telephone: 410-306-8614

E-mail: wynned@battelle.org

Edward Groth

Battelle Eastern Science and Technology Center

1204 Technology Drive

Aberdeen, Maryland 21001

Telephone: 410-306-8647

E-mail: grothe@battelle.org