

# 2006 JOINT SERVICES ENVIRONMENTAL MANAGEMENT CONFERENCE

## ENVIRONMENTAL DISPOSAL TECHNOLOGY INNOVATIONS FOR MEETING DEFENSE FORCE TRANSFORMATION NEEDS

By  
James P. Elliott  
General Atomics  
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# ENVIRONMENTAL DISPOSAL TECHNOLOGY INNOVATIONS FOR MEETING DEFENSE FORCE TRANSFORMATION NEEDS

Work Sponsored by:

Defense Ammunition Center,  
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# PRESENTATION TOPICS

- Who is GA & what does GA do?
- What is SCWO?
- Benefits to DoD
- Recent SCWO Developments
- SCWO Installations
- Summary



# GENERAL ATOMICS

**LOCATION:** San Diego, California  
**FOUNDED:** 1955 by General Dynamics  
**STATUS:** Privately held corporation  
**OWNERS:** Neal and Linden Blue  
**BUSINESS:** High technology research, design, manufacturing, and production for industry and Government in the U.S. and overseas

Very diverse company:

- Nuclear fusion & fuels
- Radar systems
- Unmanned aircraft
- Electronics
- Electromagnetic systems
- Materials development
- Space power systems



[WWW.GA.COM](http://WWW.GA.COM)



# SURVEILLANCE & RECONNAISSANCE

## LONG-ENDURANCE TACTICAL SURVEILLANCE AND SUPPORT SYSTEMS

I-GNAT



PREDATOR



PREDATOR B



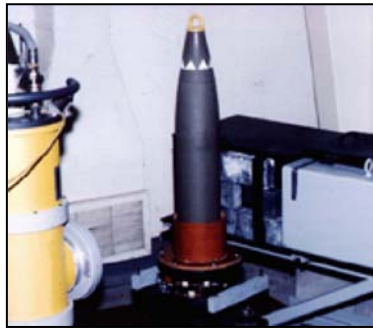
- Unmanned Air Vehicles
- Command and Control
- Defense
- Area Surveillance
- Scientific Research

## STATE-OF-THE-ART GROUND CONTROL STATION



# GA's DEMILITARIZATION TECHNOLOGIES

**Munitions Inspection Systems**



**Cryofracture and Robotics**



**Solid Rocket Motor Washout and Hydrolysis**



**Energetics Incineration**



**CAD Hydrolysis**



**Supercritical Water Oxidation**



**Dunnage Shredding**



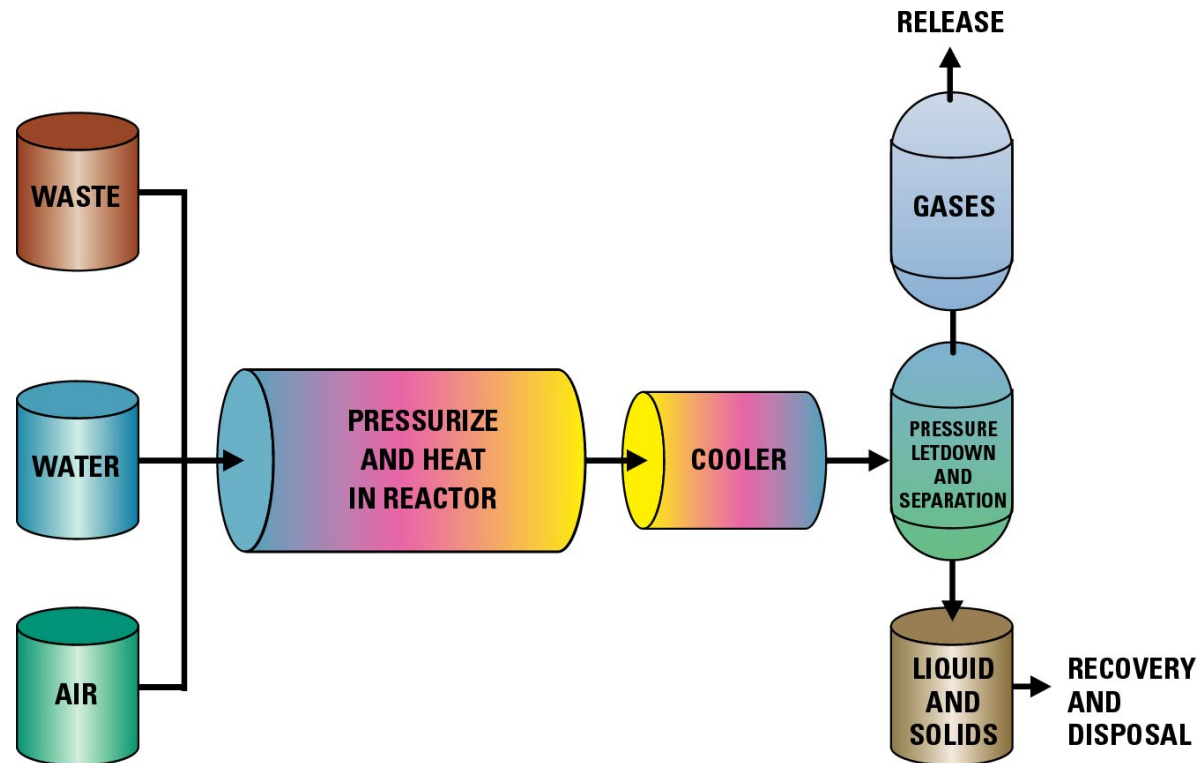
**Heavy Metals Removal**



**Cryocycle**



# WHAT IS SUPERCRITICAL WATER OXIDATION (SCWO)?



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*SCWO is a safe, simple process for waste treatment*



# SCWO HAS A VARIETY OF UNIQUE PROPERTIES

- Behaves similar to an organic solvent – typical organics are miscible in SCW
- Polar species are nearly insoluble in SCW – salts will precipitate, so salts management is extremely important
- Combustion gases (e.g., CO<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, etc.) are miscible in SCW
- Higher densities than typical gases (0.06g/cc vs 0.0004 for typical combustion gases); gas-like properties
- Very high Reynolds number relative to gas or liquid leads to high turbulence and good mixing
- High corrosion rate near transition point (when corrosive species such as salts, acids, and bases are present)
- No surface tension





# ADVANTAGES OF SCWO

- SCWO oxidizes organic wastes
  - Oxidation of a combustible material at temperatures and pressures above the critical point of water, 374°C and 22.1 MPa (3200 psi)
  - Complete oxidation to CO<sub>2</sub>, H<sub>2</sub>O, and inorganic acids (or salts) for most organic feeds
  - No acid gases, dioxins, furans, or particulates discharge
  - Minimal Gas Discharge - Low NO<sub>x</sub>, SO<sub>x</sub>, CO, and TOC
  - Destruction of organic wastes occurs very quickly
- Process stability
  - Fully automated, easy & safe operation

*Ultra clean, environmentally friendly  
waste processing technology*



# SCWO - PERMIT FRIENDLY

## Comparison with Incineration - Typical Effluent Limits

Pollutant	Incinerator Limit	SCWO	Cleanliness Improvement
CO	100 ppm	0.1 ppm	1000 x
NO <sub>x</sub>	130 ppm	1 ppm	130 x
Dioxins and furans, TEQ	15 ng/dscm	<0.006 ng/dscm	>2500 x
Polycyclic Aromatic Hydrocarbons	150 mg/dscm	0.2 mg/dscm	750 x

**SCWO does not require post treatment of gaseous effluent**

*SCWO systems have an excellent history with RCRA permitting*



# HISTORY OF SCWO

- GA and the AFRL has been designing SCWO systems since 1992
- GA has tested a variety of military wastes streams in SCWO systems, including:
  - Energetics (explosives and propellants)
  - Dunnage
  - Energetics processing waste streams
  - Hazardous wastes
- SCWO has >18,000 hours of operation

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*If it can be pumped, it can be processed by SCWO*



# SCWO DEMIL APPLICATIONS

- **Propellants**
  - CYH, M28, UDMH
- **Explosives**
  - Tetrytol, Tetryl, TNT, Comp B, RDX, HMX, NG, NC
- **Dunnage**
  - Wood pallets
  - Plastic DPE suits, butyl rubber gloves/boots, carbon
- **Hazardous Wastes**
  - VX, GB and HD chemical agent hydrolysates and surrogates
  - Navy wastes, including paints, motor oils, hydraulic fluids, grey water, black water, photo solutions, TCA, PCTFE, glycol, MoS<sub>2</sub>
  - Pink water, red water and PCB sludges
- **Other Wastes**
  - Municipal sewage sludges (primary and secondary)
  - Fluorinated organics

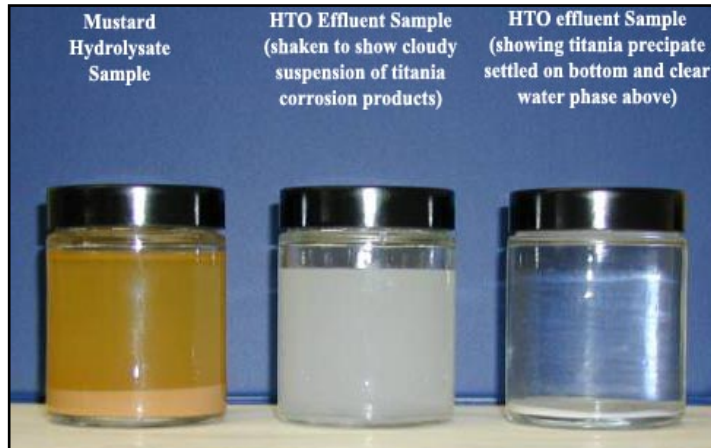
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*SCWO completely destroys organic wastes*



# 500-HR SCWO TESTS OF CHEMICAL WEAPONS WASTE FEED AND EFFLUENT APPEARANCE

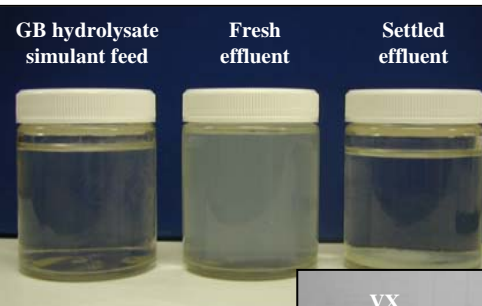
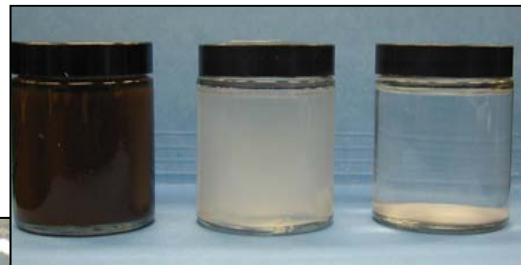
## Mustard Hydrolysate



## Tetrytol Hydrolysate/ Dunnage Slurry

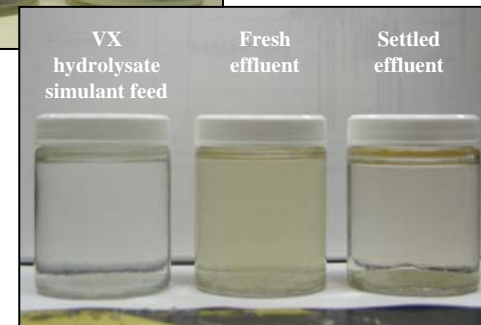


## M28/Cyclotol Hydrolysate/ Dunnage Slurry



## GB Hydrolysate Simulant

## VX Hydrolysate Simulant



# HIGH DESTRUCTION REMOVAL EFFICIENCIES (DRE's)



Motor oil (high heat value with zinc)

***DRE > 99.998%***



Paint (maximum solids)

***DRE > 99.997%***



Glycol (maximum antioxidant)

***DRE > 99.997%***

*Almost 100% pure/clean effluent*

## BENEFITS TO DOD

- Deploys a state-of-the-art hazardous waste treatment technology developed by the Air Force to solve DoD waste problems
- Reduces liability and environmental risk from storage and shipment of hazardous wastes
- Provides cleaner, less expensive, more compact, and mobile waste treatment throughout the military at home and abroad
- Provides onsite waste treatment reducing the military's dependence on outside contractors and waste haulers

*Processing waste onsite increases self sustainability leading to increased base security*

# RECENT SCWO DEVELOPMENTS

## iSCWO Design

- Objectives
- Configuration
- Energy recovery



*SCWO has been around for over a decade; however recent developments have made the technology more affordable*





# iSCWO OBJECTIVES

- **Capital cost reduction**
  - Reduce costs of major equipment items (reactors, gas-liquid separators) by standardizing designs and improving manufacturing techniques
- **Maintain effectiveness and reliability from previous SCWO generations**
- **Operating cost reduction**
  - Energy recovery
  - Automation to reduce labor costs

*Goal: lower cost systems that are net power generators*



# iSCWO CAPITAL COST SAVINGS

- Simplified design targeted at specific applications
- Simplified control system reduces instrumentation requirements without loss of stability or reliability
- Easy & quick fabrication
- Easy deployment & installation
- Small foot print
- Suitable for 7/24 operation
- Compatible with future energy conversion, HMRS or special feed prep modules

*Reduction in capital cost without sacrificing the effectiveness or reliability*



# iSCWO EQUIPMENT LAYOUT



*Systems can fit on the back of a semi-truck*



# iSCWO OPERATING COST REDUCTION

- Recover energy in hot, moderate pressure effluents
  - Generate power thru gas expansion
  - Use power to drive air compressor and pumps or to generate electricity for re-introduction into the local power grid
  - Utilize residual waste heat in the SCWO process (e.g. pre-heating of low btu SCWO waste feeds)
- Fully automated operation
  - Control system monitors temperature, pressure, and feed rates
  - No operator input required

*Reduction in operating costs make SCWO cost competitive with traditional waste disposal technologies*



## iSCWO & ENERGY RECOVERY WORK STATUS

- Completed commercial design of 2 GPM and 10 GPM iSCWO systems
- GA installing a 2 GPM iSCWO system at TEAD and PENCO, and a 10 GPM system at BGAD
- Crane and Letterkenny seeking funding for iSCWO systems to process energetics
- Energy recovery design studies underway



*Reduction in costs has made SCWO an economical technology for waste processing*

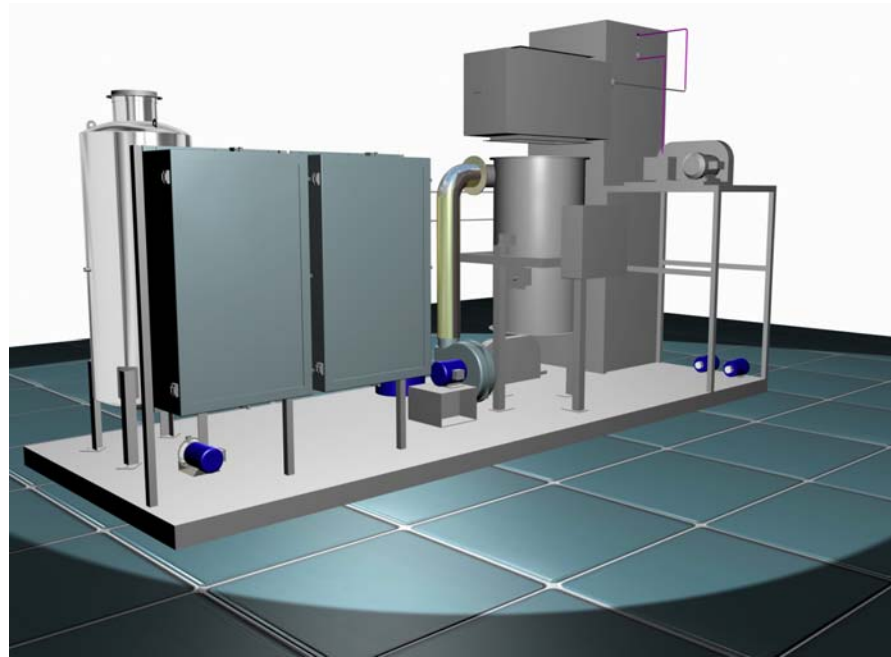


# SUMMARY

- SCWO is an effective, reliable waste destruction technology
- SCWO provides the DoD a technology that can process waste at the source of generation reducing the military's dependence on the local community
- Recent technology developments have reduced the cost of SCWO, making it affordable and cost competitive compared to traditional technologies



# GENERAL ATOMICS POINT OF CONTACT



**Jim Elliott**

**Program Manager/Business Development**

**(541) 382-2545**

**[Jim.Elliott@gat.com](mailto:Jim.Elliott@gat.com)**

