



# Assembled Chemical Weapons Assessment Program

## Environmental Emissions Estimates Neutralization/SCWO

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## Environmental Emissions

- ◆ Environmental emissions from the General Atomics (GA) pilot-plant operations for Pueblo have been estimated by combining two sets of data:
  - Technology-specific, site-specific stoichiometric mass balances.
  - Analyses of samples of selected unit operation process streams and effluents that were collected during demonstration tests

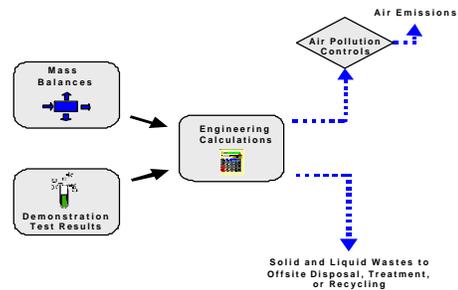


## Environmental Emissions Status \*

- ◆ Estimates presented here were prepared for the ACWA Environmental Impact Statement
- ◆ Throughput rates are specified by 1997 Request for Proposals
- ◆ Technology processes match 1999 final Demonstration Technical Reports
- ◆ Methodology will be used with updated information for permit estimates



## General Approach Used to Estimate Environmental Emissions



## Preliminary and Approximate \*

Because unit operations and predicted efficiencies may change as plant designs are finalized, estimates of emissions and wastes that are provided here should be considered to be preliminary and approximate indications of the types and quantities of emissions and wastes that might be expected. These estimates may need to be revised or refined as designs evolve and as more reliable estimates can be made regarding technologies and process efficiencies.



## Stoichiometric Mass Balances \*

- ◆ Technology-specific, site-specific stoichiometric mass balances (SMB)—which were initially developed for the ACWA Technical Evaluation Team during the preliminary evaluation phase of the technology demonstration—provide estimates of primary components in feeds, process, and effluent streams.
- ◆ Mass balances have been prepared to describe the processing of the complete ACW stockpile at Pueblo Chemical Depot (PUCD).



### SMB (Continued)

\*

- ◆ The mass balance provides estimates of the input from the stockpile, as well as process chemicals and the output of principal final reaction products that would be expected for the stockpile at PUCD.
- ◆ The balances focus on those unit operations that generate the bulk of the plant effluents associated with processing and chemical reaction.
- ◆ The SMB assumes that the reactions go to completion, carbon dioxide, water, etc.



### PUCD Stockpile

\*

- ◆ The maximum number of munitions that could be processed during pilot operations at PUCD:
  - 383,418 M360 105-mm HD projectiles
  - 299,554 M104 155-mm HD projectiles
  - 76,722 M2/M2A1 4.2-inch HD mortars
  - 20,384 M2/M2A1 4.2-inch HT mortars



### Neutralization/SCWO Process Inputs

GAT Materials Input			
	(lbs./day)	Dunnage	(lbs./day)
<b>Agents</b>		Lumber	3784
munitions grade HD	6998	Iron	946
munitions grade HT	162		
<b>Energetics</b>		<b>subtotal, ACWA Materials</b>	<b>64158</b>
Tetrytol	304		
munitions grade Tetryl	51	Other Process Inputs	
lead azide	1	Liquid nitrogen	52117
		Liquid oxygen	56737
<b>Metal Parts</b>		Water in caustic solution	9115
Steel	50391	Sodium hydroxide	7465
Aluminum	188	phosphoric acid	209
Copper	1138	Kerosene for SCWO	10630
Zinc	195	Air for SCWO and HDC	49
		<b>Total Process Inputs</b>	<b>200481</b>



### Stockpile Processing Rate

\*

- ◆ Entire stockpile could be processed in 731 days
  - 12-hour operating days
  - Feed Rates

Munition	Agent	Feed Rate
4.2-in mortar, M2/M2A1	HD	50
4.2-in mortar, M2/M2A1	HT	50
105-mm projectile, M360	HD	100
155-mm projectile, M104	HD	100

- ◆ Throughput rates specified in 1997 Request for Proposal



### Process Feed Assumptions

- ◆ Estimated Distribution of Neutralization/SCWO Process Feed to Hydrolysis/ SCWO and Heated Discharge Conveyor (HDC)

Feed	Percentage to Hydrolysis/SCWO*
Munitions HD	>99.9
Munitions HT	>99.9
Munitions H	>99.9
Steel GB	>99.9
Aluminum GB	>99.9
Munitions VX	>99.9
Fuzes	90%
Explosives	>99.9
Propellant	>99.9

\* Balance of feed is sent to Heated Discharge Conveyor



### SMB Results – Neutralization/SCWO Air

Effluents to Air	
nitrogen	52,237
water vapor	28,713
carbon dioxide	47,669
excess oxygen	5,158
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<b>Total Air Effluent</b>	<b>133,778</b>

Estimates based on RFP throughput rates and design at the end of Demo I

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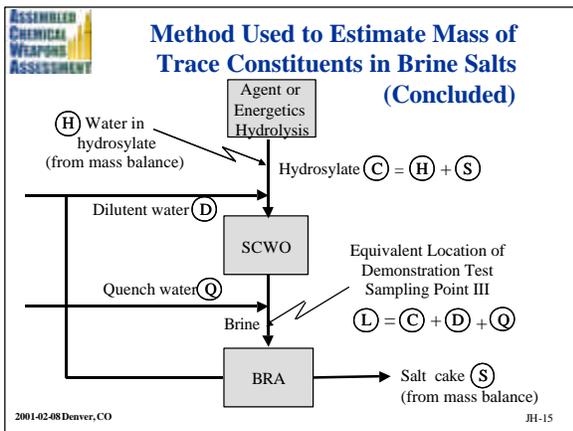
### SMB Results – Neutralization/SCWO Land

Effluents to Land	
Salts	
sodium sulfate	6,527
sodium chloride	5,164
sodium phosphate	349
lead	1
water in salt cake	1,804
Subtotal, Brine Salts	13,845
tramp metal from dunnage	946
5X metals	51,913
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<b>Total Land Effluent</b>	<b>66,703</b>

Estimates based on RFP throughput rates and design at the end of Demo I

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- ### Method Used to Estimate Mass of Trace Constituents in Brine Salts
- The following diagram shows the sampling locations from demonstration that were used to predict trace constituent levels in the brine salts exiting the brine reduction area.
  - It was assumed that all trace constituents detected in the brine liquids would accumulate in the dried salts.
  - SMB flow rates for the hydrolysate (H), the diluent water (D) and the Quench water (Q) were used to predict the flow at point L.
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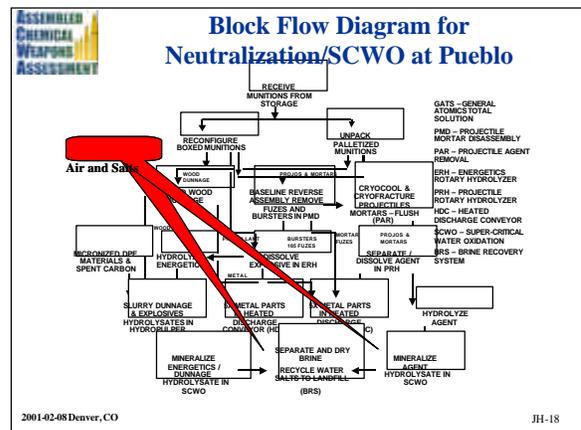
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- ### Demonstration Analytical Results
- Testing conducted in early 1999
  - Unit operations tested include
    - Supercritical Water Oxidation (SCWO)
    - Energetic Rotary Hydrolyzer (ERH)
  - The highest concentration of each analyte found in any test run was identified for each unit operation and each munition type
  - Results were used to estimate the trace constituent concentrations in the different air and waste streams
  - Results that were considered to not be representative of current design were eliminated from the data set.
    - Some qualified data
    - Test equipment did not adequately represent redesigned unit operations
    - Non-representative feedstocks
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### Full Scale Plant Diagram \*

- The following diagram shows the full scale plant layout and process streams. The red circles indicate corresponding process streams in the process to demonstration sampling locations.

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## ACWA Demonstration

- ◆ Demonstration Runs
  - Agent SCWO ran with HD for approximately 8 hours
  - Approximately 26,000 analytical results collected

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## Environmental Emissions Assumptions \*

- ◆ Estimates of environmental emissions associated with the pilot operations are provided on an average daily basis by taking the predicted total emissions for the four campaigns and dividing by the number of days during which pilot operations will be conducted.

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## Estimates of Representative Effluents \*

- ◆ The finally selected demonstration data for each analyte concentration were then merged with the mass balance data to provide conservative estimates of the quantities of trace constituents that might be expected in certain effluents and waste streams.

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## Fugitive Emissions \*

- ◆ Fugitive emissions will be kept to a minimum by
  - Employing redundant, state-of-the-art processing and pollution control technologies
  - Implementing a well-designed operating and maintenance (O&M) program
  - Enclosing all processes with any emissions sent to building HVAC system

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## Building HVAC Systems

- ◆ All emissions will be treated by a HEPA filter, six carbon filters in series, and a second HEPA filter
  - Overall particulate/metals removal efficiency for the HEPA filters is estimated to be 99.999991 percent (assuming 99.97 percent efficiency for each filter)
  - Overall organics removal efficiency for the six carbon filters is estimated to be 99.999998 percent (assuming 95 percent efficiency for each filter)
- ◆ It is important to note that emissions estimates do not reflect addition reductions associated with any condensers or scrubbers that may be employed.

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## Estimated Air Emissions: GA

Pollutant	Steam Boilers		Diesel Generators		Process Emissions	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
CO	4	6	10	3	ND	ND
NO <sub>x</sub>	6	10	48	14	0.04	0.03
SO <sub>2</sub>	0.03	0.04	3	1	0.01	0.01
PM <sub>10</sub>	0.3	0.6	3	1	1.E-09	1.E-09
VOC	0.2	0.4	4	1	1.E-10	8.E-11
Pb	2.E-05	0.07	0	0	2.E-12	2.E-12
HAPs	0.1	0.1	9.E-04	3.E-04	6.E-11	5.E-11

Argonne National Laboratory estimate
Mitretek estimates based on Demo Test data  
 Emission estimates based on RFP throughput rates and design at the end of Demo I

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### Process/Non-Process Wastes: GA

Waste Stream	Daily	Annual	Units
<b>Process Wastes</b>			
Brine Salts	7	900	tons
Tramp Metal from Dunnage	0.5	70	tons
5X Solids	30	4,000	tons
<b>Non-Process Wastes</b>			
Sanitary Wastes		4,100,000	gallons
Other Nonhazardous Solid Wastes		1,600	cubic yards
Recyclable wastes		640	cubic yards

Argonne National Laboratory estimate      Mitrotek estimates based on Demo Test data

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### Hazardous Air Pollutants

2-Methylphenol (o-Cresol)	Lead
4-Methylphenol (p-Cresol)	Manganese
Acetaldehyde	Mercury
Antimony	Methyl Ethyl Ketone
Chromium	m-Xylene
Cobalt	Nickel
Ethyl benzene	Phosphorus
Formaldehyde	

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### Dioxins/Furans

- ◆ There were no congeners of dioxins or furans detected.
- ◆ Therefore, the Toxic Equivalency Quotient (TEQ) for dioxins and furans is assumed to be zero.

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### Neutralization/SCWO Unit Operations

- ◆ Baseline Reverse Assembly
- ◆ Cryofracture
- ◆ Dunnage Shredder and Hydropulper System (DSHS)
- ◆ Projectile Rotary Hydrolyzer (PRH)
- ◆ Energetics Rotary Hydrolyzer (ERH)
- ◆ Projectile/Hardware Heated Discharge Conveyor
- ◆ Super Critical Water Oxidizer (SCWO)
- ◆ Brine reduction Area (BRA)

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**ASSEMBLED CHEMICAL WEAPON ASSESSMENT**

### MTS Air Estimates

Unit Operation	Type of Emissions	Stoichiometric Mass Balance	Demonstration Testing	Comments
Supercritical Water Oxidation (SCWO)-Agent Hydrolyzase	Offgases	Yes	Yes	Emissions have been estimated. Any hazardous air pollutants (HAP) emissions will be captured in the building ventilation system and sent to high-efficiency particulate air (HEPA) and activated carbon filters.
Supercritical Water Oxidation (SCWO)-Energetics/Dunnage Hydrolyzase	Offgases	Yes	Yes	Any hazardous air pollutant (HAP) emissions will be captured in the building ventilation system and sent to high-efficiency particulate air (HEPA) and activated carbon filters.
Baseline Reverse Assembly Components	None	No	No	Emissions were not estimated. Because no thermal or chemical processing occurs, emissions are expected to be minimal. Also, HEPA and activate carbon filters will limit any emissions.
Projectile Rotary Hydrolyzer (PRH)	None	No	Yes, but configuration differs significantly from likely pilot plant unit.	Emissions have not been estimated, but are expected to be minimal and will be controlled by two condensers, a scrubber, and activated carbon filters.
Dunnage Shredder/Hydropulper System (DSHS)	None	No	Yes, but configuration differs significantly from likely pilot plant unit.	Emissions were not estimated. Because no thermal or chemical processing occurs, emissions are expected to be minimal. Building HEPA and activate carbon filters will limit any emissions.

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**ASSEMBLED CHEMICAL WEAPON ASSESSMENT**

### MTS Air Estimates (concluded)

Unit Operation	Type of Emissions	Stoichiometric Mass Balance	Demonstration Testing	Comments
Cryofracture	Offgases	Yes	No	Nitrogen emissions were estimated. Other emissions are expected to be minor due to the low operating temperature (321°F) and the fact that any emissions would be sent to the building HEPA and activated carbon filters.
Energetics Rotary Hydrolyzer(ERH)	Offgases	Yes	Yes, but configuration differs significantly from likely pilot plant unit.	Nitrogen emissions have not been estimated. HAPs emissions have not been estimated but will be controlled by condensers, a scrubber, and activated carbon filters.
Heated Discharge Conveyor (HDC)	Offgases	Yes	No	Emissions were not characterized, but should be negligible because resistance heat is used in an inert atmosphere to process metal parts and other solid wastes that have already been processed through the ERH, The PRH, and the DSHS.
Brine Reduction Area (BRA)	None	No	No	Emissions were not estimated; however, this unit is not expected to be a significant source of HAPs or other air pollutants.
Plant-wide	Fugitives	No	No	Emissions have not been estimated but are expected to be negligible because of redundant process controls and containment. Also, the equipment will be located in a sealed building under negative pressure, so any emissions-escaping process controls will be sent to the building carbon filters and HEPA filters.

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## MTS Process Waste Estimates

Unit Operation	Wastes Sent OffSite	Stoichiometric Mass Balance	Demonstration Test Data	Comments
Heated Discharge Conveyor (HDC)	5X metals, solids	Yes	No	Includes 5X metals and solids produced during processing of munition metal parts and fragments in HDC. 5X solids are produced during processing of other non-shreddable solids.
Brine Reduction Area (BRA)	Dried Salts	Yes	Yes (Agent and Energetics SCWO hydrolyzate liquids)	Analyses of hydrolyzate liquids were extrapolated assuming all trace constituents will eventually collect in the BRA wastes
Baseline Reverse Assembly Components	None			All material (other than any air emissions) will be processed further in PRH or ERH units.
Damage Shredder/Hydropulper System (DSHS)	None			All material (other than any air emissions) will be processed further in MPF or SCWO units.
Cryofracture	None			All material (except any air emissions) will be processed further in HDC or SCWO units.
Projectile Rotary Hydrolyzer (PRH)	None			All material (other than any air emissions) will be processed further in HDC or SCWO units.
Energetics Rotary Hydrolyzer (ERH)	None			All material (except any air emissions) will be processed further in HDC, MPF, or SCWO units.
Agent SCWO and Energetics/Damage Hydrolyzate	None			All material (other than any air emissions) will be processed further in the BRA.