



Assembled Chemical Weapons Assessment Program

Environmental Emissions Estimates for Neutralization/Biotreatment

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JH-1



Environmental Emissions

- ◆ Environmental emissions from the PH 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

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JH-2



Environmental Emissions Status

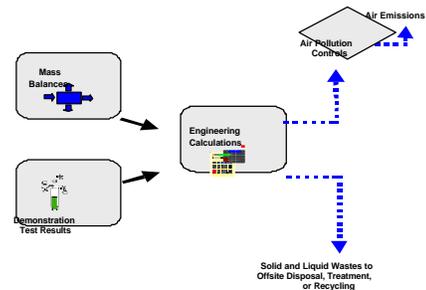
- ◆ Estimates presented here were prepared for the ACWA Environmental Impact Statement
- ◆ Throughput rates are specified by 1997 Request for Proposals
- ◆ Technology processes match 1999 final Demonstration Technical Reports
- ◆ Methodology will be used with updated information for permit estimates

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JH-3



General Approach Used to Estimate Environmental Emissions



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JH-4



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.

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JH-5



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).

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JH-6



SMB (Concluded)

- ◆ 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



PH Process Inputs

Materials Input (Lbs./Day)			
Agents		Subtotal, ACWA Materials	64158
munitions grade HD	6998		
munitions grade HT	162	Other Process Inputs	
		Air for biotreater	2022346
Energetics		sodium hydroxide	6999
Tetryl	304	water (in caustic solution)	6999
munitions grade Tetryl	51	sulfuric acid	245
lead azide	1	K ₂ HPO ₄	333
		MgCl ₂	125
Metal Parts		CaCl ₂	125
Steel	50391	(NH ₄) ₂ HPO ₄	624
Aluminum	188	ammonia	2498
Copper	1138	ferrous sulfate	42
Zinc	195	hydrogen peroxide	999
	
Dunnage		Total Process Inputs	2105492
Lumber	3784		
Iron	946		



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 Proposals



Process Feed Assumptions

- ◆ Estimated Distribution of PH Process Feed to Hydrolysis and the Metal Parts Treater (MPT)

Feed	Percentage to Hydrolysis*
Munitions HD	90%
Munitions HT	90%
Fuzes	90%
Explosives	90%

* Balance of feed is sent to Metals Parts Treater (MPT)

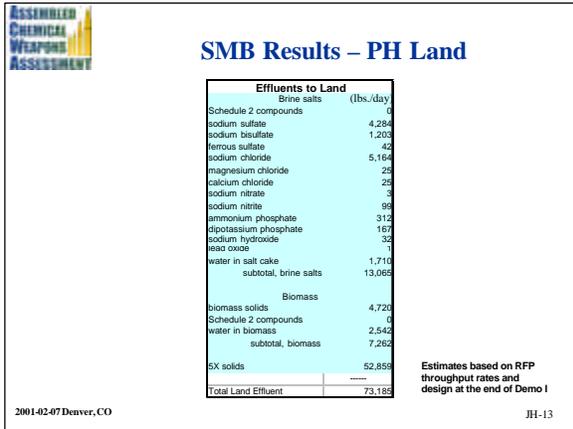


SMB Results - PH Air

Effluents to Air	
	(lbs./day)
nitrogen	1,597,665
oxygen	411,016
carbon dioxide	13,584
nitrous oxide	20
ammonia	45
water vapor	9,978

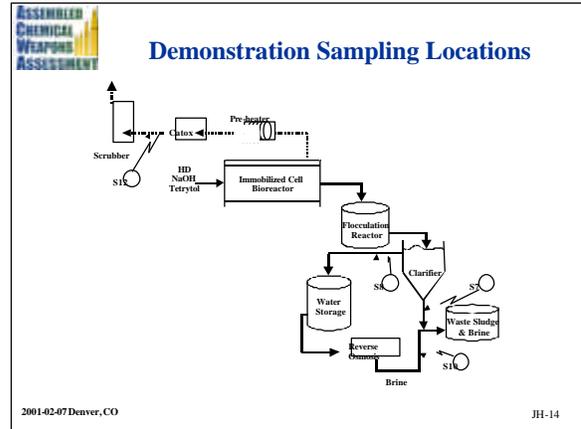
Total Air Effluent	2,032,307

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



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JH-13



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JH-14

- ### Demonstration Analytical Results
- ◆ Testing conducted in early 1999
 - ◆ Unit operations tested include
 - Immobilized Cell Bioreactor (ICB™)/Catalytic Oxidizer (CATOX)
 - Energetics Hydrolyzer
 - Metal Parts Treater (MPT)/Catalytic Oxidizer (CATOX)
 - ◆ The highest concentration of each analyte found in any test run was identified for each unit operation and each munition type

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JH-15

- ### Demonstration Analytical Results (concluded)
- ◆ 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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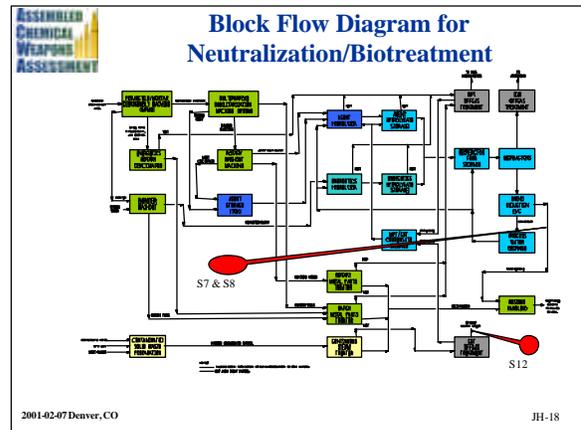
JH-16

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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JH-17



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JH-18



ACWA Demonstration

- ◆ Demonstration Runs
 - Bioreactor ran with HD for approximately 40 days
 - Metal Parts Treater (MPT) had 7 different feeds (3 runs/feed)
- ◆ >57,000 analytical results



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.



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.



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



Building HVAC Systems

- ◆ All emissions (except ICB) 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.



Estimated Air Emissions: PH

Pollutant	Steam Boilers		Diesel Generators		Process Emissions	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
CO	2	4	10	3	ND	ND
NO _x	4	7	48	14	0.6	3
SO ₂	0.02	0.03	3	1	0.01	0.06
PM10	0.2	0.4	3	1	3.E-05	1.E-04
VOC	0.2	0.3	4	1	2.E-01	1.E+00
Pb	1.E-05	0.05	0	0	1.E-13	5.E-14
HAPs	0.1	0.4	9.E-04	3.E-04	8.E-03	4.E-02

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



Process/Non-Process Wastes: PH

Waste	Daily	Annual	Units
Process Wastes			
Biomass (includes 15% water)	4	500	tons
Brine Salts (includes 15% water)	5	700	tons
5X Solids	30	4,000	tons
Non-Process Wastes			
Sanitary wastes		4,100,000	gallons
Other Nonhazardous Solid Wastes		1,600	cubic yards
Recyclable Wastes		640	cubic yards

Argonne National Laboratory estimate

Mitretek estimates based on Demo Test data

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JH-25



Hazardous Air Pollutants

1,1,1-Trichloroethane	Ethyl benzene			
1,2-Dichloroethane	Formaldehyde			
1,2-Dichloropropane	Glycol ethers (2-Butoxy ethanol)			
1,4-Dichlorobenzene	Lead			
3/4-Methy phenol	m,p-Xylene			
Acetaldehyde	Manganese			
Benzene	Mercury			
bis (2-Chloroethyl) ether	Methyl Ethyl Ketone			
bis (2-Ethylhexyl) phthalate	Methylene chloride			
Bromomethane	Naphthalene			
Carbon Disulfide	Nickel			
Carbon Tetrachloride	o-Xylene			
Chlorobenzene	Phenol			
Chloroethane	Phosphorus			
Chloroform	Polycyclic Organic Matter (Fluorene)			
Chloromethane	Propanal			
Chromium	Selenium			
Cobalt	Styrene			
Diethylphthalate	Tetrachloroethene			
Dimethylphthalate	Toluene			

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JH-26



Dioxins/Furans

- ◆ Immobilized Cell Bioreactor
 - 5 X 10⁻¹⁵ ng TEQ/m³
 - Probably due to contamination in test feed
- ◆ Metal Parts Treater
 - 7 X 10⁻¹⁵ ng TEQ/m³

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JH-27