CHARACTERIZATION OF MINERAL PROCESSING WASTES AND MATERIALS

ENVIRONMENTAL PROTECTION AGENCY

1997

1. Introduction

In its January 25, 1996 Supplemental Proposed Rule, the Agency assumed that land-based storage units historically have been a significant part of the production process of the mining and mineral processing industries, primarily because of the large volumes of materials managed by the industry. EPA believed that the quantities of secondary materials were too large to be managed in anything other than land-based units.

Based on new data and further analysis, however, EPA has found that generation rates of wastes from the mineral processing industry are similar to other industrial wastes currently regulated under RCRA. Further, many of the newly identified wastes have concentrations of hazardous constituents that are similar to wastes currently regulated under the RCRA Subtitle C program. The Agency is presenting information indicating that land-based storage units are <u>not</u> necessarily an integral to the mineral processing industry. The Agency's information indicates that tanks, containers, and buildings, which provide greater environmental protection, can be used to store mineral processing secondary materials prior to recycling.

In the Supplemental Proposed Rule, the Agency also raised the issue of whether to allow mineral processing secondary materials to be recycled in units generating Bevill-exempt wastes. The Agency has found many cases in which environmental damages were caused by these Bevill-exempt wastes, including several cases in which non-Bevill feedstocks were being added to units generating the exempt waste. (See Damage Cases and Environmental Releases, EPA, 1997). Because of these cases, the Agency is concerned about the contribution of contaminants from non-Bevill feedstocks. Therefore, the Agency has compared desirable and undesirable contaminants in virgin Bevill unit feedstocks with secondary materials that might be used as alternative feedstocks to these units, and found that these secondary materials often have higher contaminant concentrations than the virgin feedstock.

2. Comparison of Waste Stream and Toxicity Data

This section first presents current waste stream data and then compares these data with the data used in the RIA accompanying the January 1996 Supplemental Proposed Rule. Finally, this section compares mineral processing waste streams with currently listed RCRA Subtitle C wastes in terms of generation volumes and toxicity..

January 1996 Data vs Data Provided in Public Comments

The Agency received many comments on its January 1996 proposed mineral processing rule that addressed the amounts and types of secondary materials generated. Based on a review of those comments, the Agency found that a number of waste streams either are no longer generated or are generated in different quantities than previously believed. In addition, one commenter suggested new waste streams should be added to the analysis.

Exhibit 1 lists all of the waste streams that: 1) have dropped out of the analysis; 2) have been added to the analysis; or 3) have been assigned a new average facility generation rate based on the review of new data. As seen in the exhibit, 32 waste streams have dropped out of the analysis because in most cases the Agency determined that these wastes are either non-hazardous or not stored in land-based units. Two waste streams, elemental phosphorous andersen filter media and furnace building washdown were added to the analysis because the Agency received comments suggesting they were hazardous. Two more waste streams, elemental phosphorous AFM rinsate and furnace scrubber blowdown were assigned new generation rates. Please note that average facility generation rates, rather than total sector generation rates, were used because the Bevill exclusion defines high volume streams based on average facility generation rates.

Exhibits 2 and 3 graphically present the old and new average facility generation rates for mineral processing secondary materials for those cases in which the current generation rates differ from those rates used in the December 1995 RIA supporting the January 1996 Supplemental Proposed Rule. In most cases, changes in generation rates resulted from the removal of waste streams from the analysis (hence the large numbers of "0s" in the exhibits). Exhibit 2 shows that facility generation rates for phosphorous andersen media filter and zinc WWTP solids (both solid wastes) rose because of their recent inclusion in the analysis. Exhibit 3 demonstrates that the facility generation rates for three liquid wastes, phosphorous furnace building washdown and furnace scrubber blowdown and AFM rinsate rose between December 1995. In two of the cases, wastes were added for the January 1997 analysis, while in the third case, commenters reported a change in generation rate.

In the January 1996 Supplemental Proposed Rule, 148 mineral processing secondary materials were identified that could be affected by the Phase IV LDRs. However, due to new information contained in public comment on the proposed rule, as well as other additional information, the Agency now believes 118 mineral processing secondary materials will be affected by the Phase IV LDRs. Of these streams, 61 are solid and 57 are liquid.

Current Volumes

Exhibit 4 presents average and maximum facility generation rates for all solid waste streams in the current data set in ascending order, while Exhibit 5 presents this information for liquid waste streams.[1] These figures were obtained from the mineral processing cost RIA cost model. Only three waste streams are generated in volumes above the high volume criterion (45,000 mt/yr for solid materials or 1,000,000 mt/yr for liquid materials) used in the 1990 Report

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[1] Please note that these generation rates have not been corrected to account for uncertainty in hazard characteristics, as was done in the cost model for the RIA.

Exhibit 1
Waste Streams Status Changes Since December 1995

Sector	Waste Stream	Waste Type	Action	Reason
Beryllium	Bertrandite thickener slurry	Liquid	Dropped Out of Analysis	Public comment indicate previous agency decision on beneficiation processing line
Beryllium	Beryl thickener slurry	Liquid	Dropped Out of Analysis	Public comment indicate previous agency decision on beneficiation processing line
Beryllium	Spent barren filtrate streams	Liquid	Dropped Out of Analysis	Public comment indicate previous agency decision on beneficiation processing line
Beryllium	Spent raffinate	Liquid	Dropped Out of Analysis	Public comment indicate previous agency decision on beneficiation processing line
Boron	Waste liquor	Liquid	Dropped Out of Analysis	Determined to be not-hazardous
Copper	APC dust/sludge	Solid	Dropped Out of Analysis	Not land stored
Copper	Process wastewaters	Liquid	Dropped Out of Analysis	Not land stored
Copper	Scrubber blowdown	Liquid	Dropped Out of Analysis	Believed to be same as acid plant blowdown, removed to prevent double counting
Copper	Spent bleed electrolyte	Liquid	Dropped Out of Analysis	Not land stored
Copper	Surface impoundment waste liquids	Liquid	Dropped Out of Analysis	Double counted (same as process wastewaters)
Copper	Tankhouse slimes	Solid	Dropped Out of Analysis	Not land stored
Copper	Waste contact cooling water	Liquid	Dropped Out of Analysis	Not land stored
Elemental Phosphorous	AFM rinsate	Liquid	Changed Generation Rate	Commenter provided data
Elemental Phosphorous	Andersen Filter Media	Solid	Added to Analysis	Commenter indicated this material is hazardous
Elemental Phosphorous	Dust	Solid	Dropped Out of Analysis	Commenter provided data
Elemental Phosphorous	Furnace Building Washdown	Liquid	Added to Analysis	Commenter provided data

Elemental Phosphorous	Furnace offgas solids	Solid	Dropped Out of Analysis	Not toxic
Elemental Phosphorous	Furnace scrubber blowdown	Liquid	Changed Generation Rate	Commenter provided data

Exhibit 1 (Continued)
Waste Streams Status Changes Since December 1995

Sector	Waste Stream	Waste Type	Action	Reason
Gold and Silver	Refining wastes	Solid	Dropped Out of Analysis	Generated at secondary smelter only
Gold and Silver	Slag	Solid	Dropped Out of Analysis	Not land stored
Gold and Silver	Spent Furnace Dust	Solid	Dropped Out of Analysis	Not land stored
Gold and Silver	Wastewater	Liquid	Dropped Out of Analysis	Generated at secondary smelter only
Gold and Silver	Wastewater treatment sludge	Solid	Dropped Out of Analysis	Generated at secondary smelter only
Lead	Acid plant blowdown	Liquid	Dropped Out of Analysis	Fully recycled, not land stored
Lead	Baghouse dust	Solid	Dropped Out of Analysis	Fully recycled, not land stored
Lead	Process wastewater	Liquid	Dropped Out of Analysis	Fully recycled, not land stored
Lead	Surface impoundment waste liquids	Liquid	Dropped Out of Analysis	No longer generated
Molybdenum	Molybdic oxide refining wastes	Solid	Dropped Out of Analysis	No longer generated
Rare Earths	Spent lead filter cake	Solid	Dropped Out of Analysis	Fully recycled, not land stored
Rare Earths	Waste solvent	Liquid	Dropped Out of Analysis	Fully recycled, not land stored
Rare Earths	Waste zinc contaminated with mercury	Solid	Dropped Out of Analysis	No longer generated
Titanium and Titanium Dioxide	Scrap detergent wash water	Liquid	Dropped Out of Analysis	Not hazardous
Titanium and Titanium Dioxide	Waste acids (Chloride process)	Liquid	Dropped Out of Analysis	Fully recycled/Treated, not land stored
Titanium and Titanium Dioxide	Waste ferric chloride	Liquid	Dropped Out of Analysis	Same as Wastes acids (chloride process)
Zinc	Spent surface impoundment solids	Solid	Dropped Out of Analysis	No longer generated
Zinc	Zinc-lean slag	Solid	Dropped Out of Analysis	This is a special waste
Zinc	WWTP solids	Solid	Added to Analysis	New information on management practices

Exhibit 2

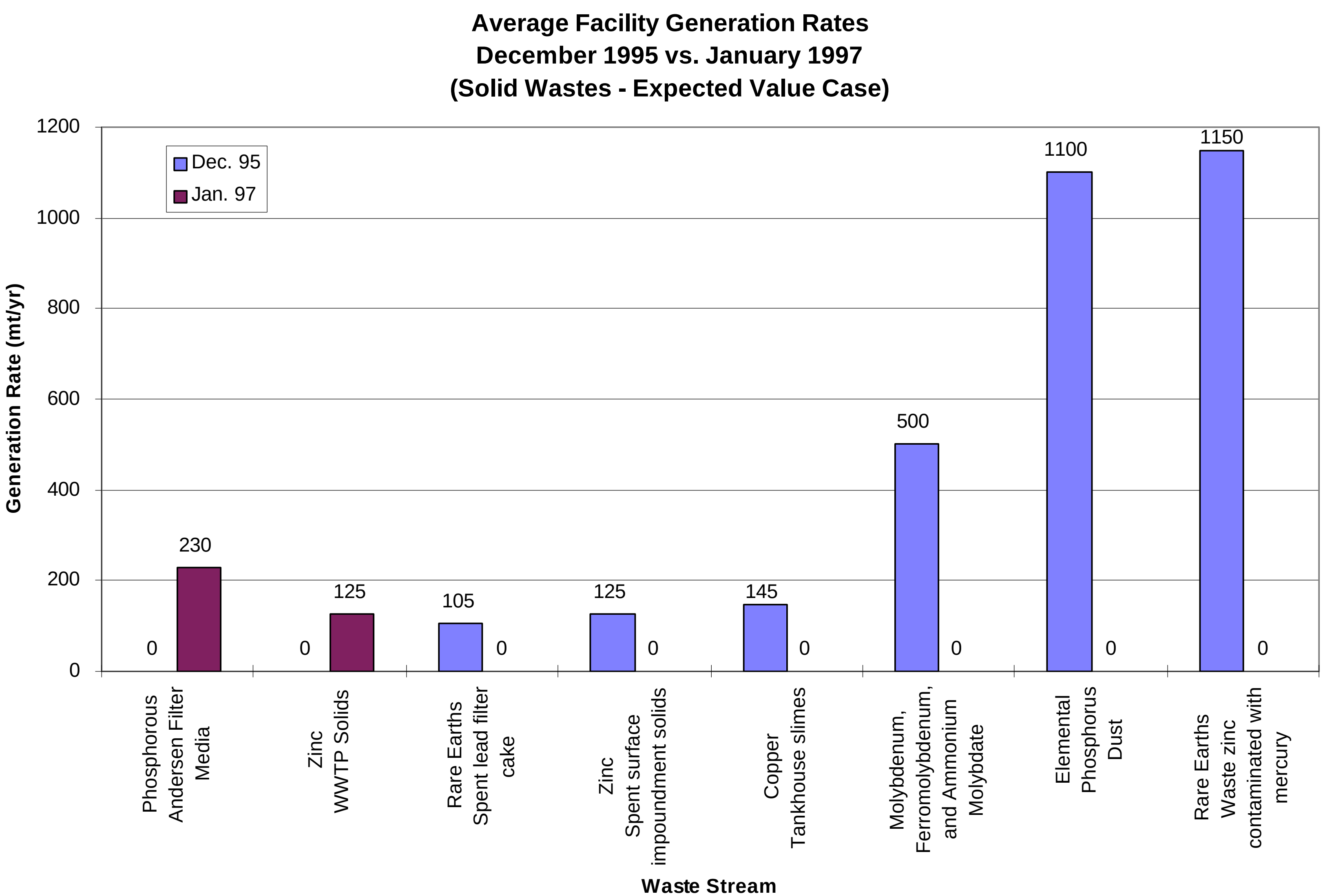
Average Facility Generation Rates
December 1995 vs. January 1997
(Solid Wastes - Expected Value Case)
Dec. 95
Jan. 97
Generation Rate (mt/yr)
1200
1000
800
600
400
200
0
230
125
105
125
145
500
1100
1150
Phosphorous Andersen Filter Media
Zinc WWTP Solids
Rare Earths Spent lead filter cake
Zinc Spent surface impoundment solids
Copper Tankhouse slimes
Molybdenum, Ferromolybdenum, and Ammonium Molybdate
Elemental Phosphorus Dust
Rare Earths Waste zinc contaminated with mercury
Waste Stream

Exhibit 2 (Continued)

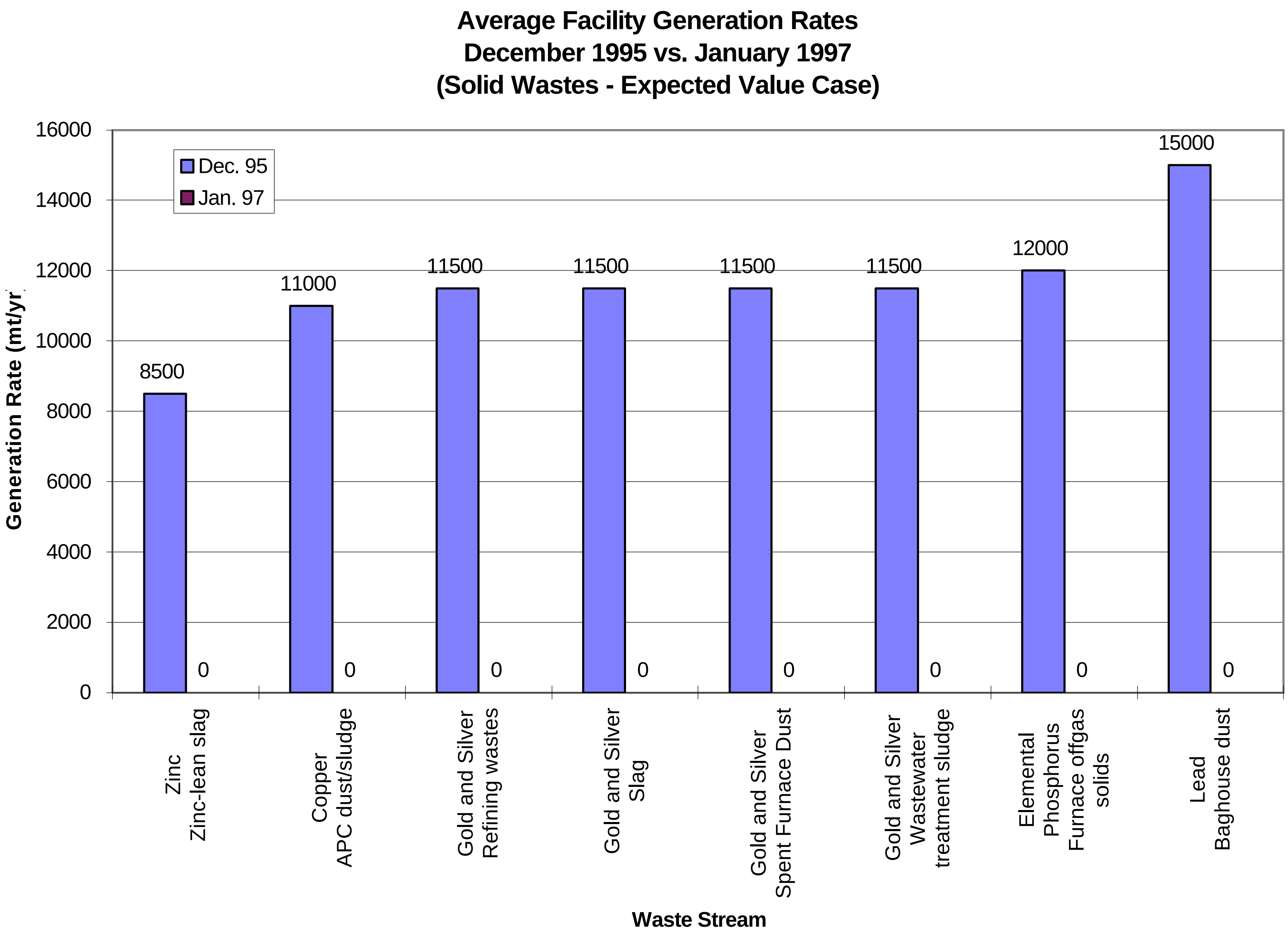

Exhibit 3

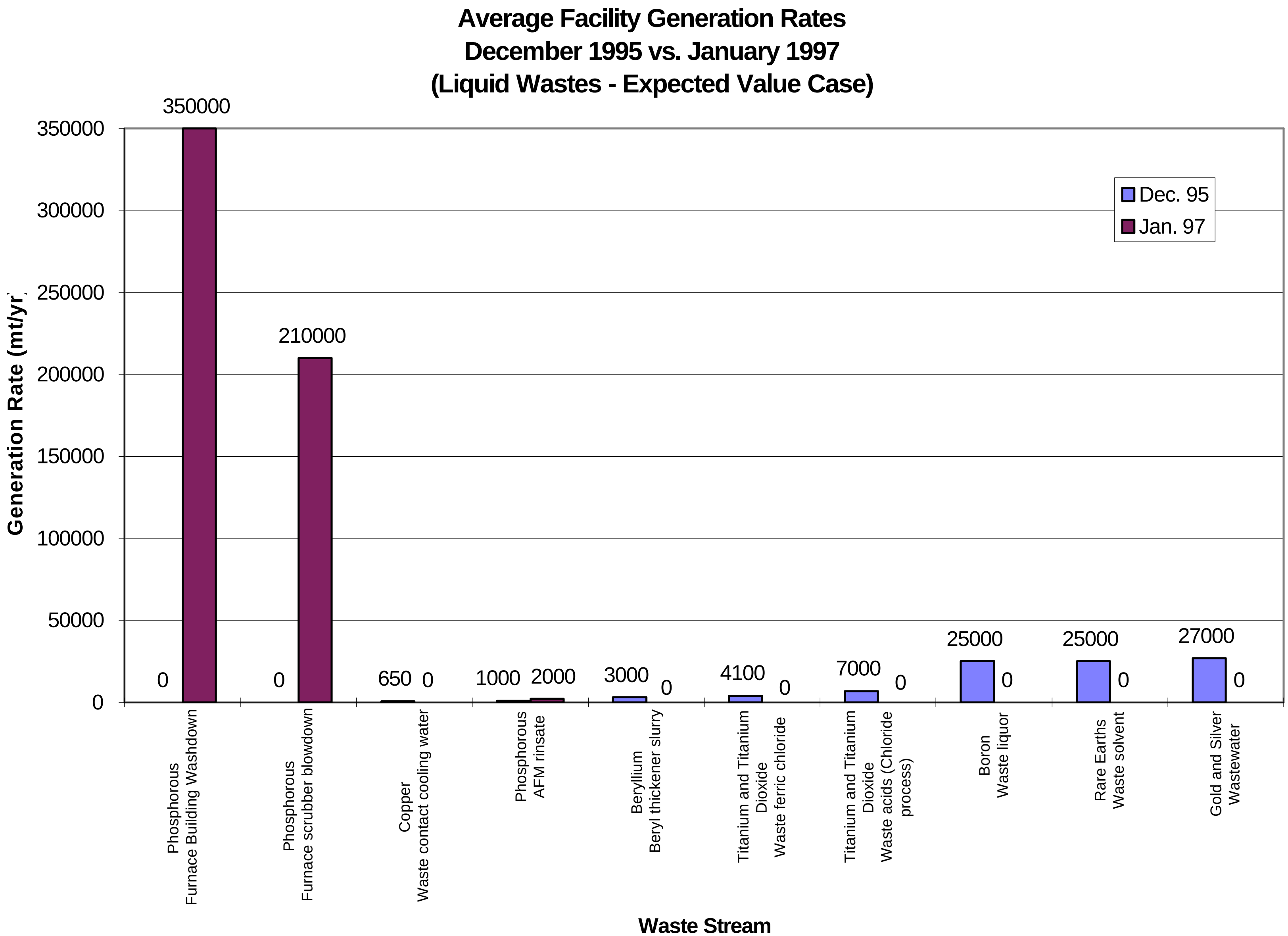
Average Facility Generation Rates
December 1995 vs. January 1997
(Liquid Wastes - Expected Value Case)
Generation Rate (mt/yr)
350000
300000
250000
200000
150000
100000
50000
0
Dec. 95
Jan. 97
0
350000
0
210000
650
0
1000
2000
3000
0
4100
0
7000
0
25000
0
25000
0
27000
0
Phosphorous Furnace Building Washdown
Phosphorous Furnace scrubber blowdown
Copper Waste contact cooling water
Phosphorous AFM rinsate
Beryllium Beryl thickener slurry
Titanium and Titanium Dioxide Waste ferric chloride
Titanium and Titanium Dioxide Waste acids (Chloride process)
Boron Waste liquor
Rare Earths Waste solvent
Gold and Silver Wastewater
Waste Stream

Exhibit 3 (Continued)

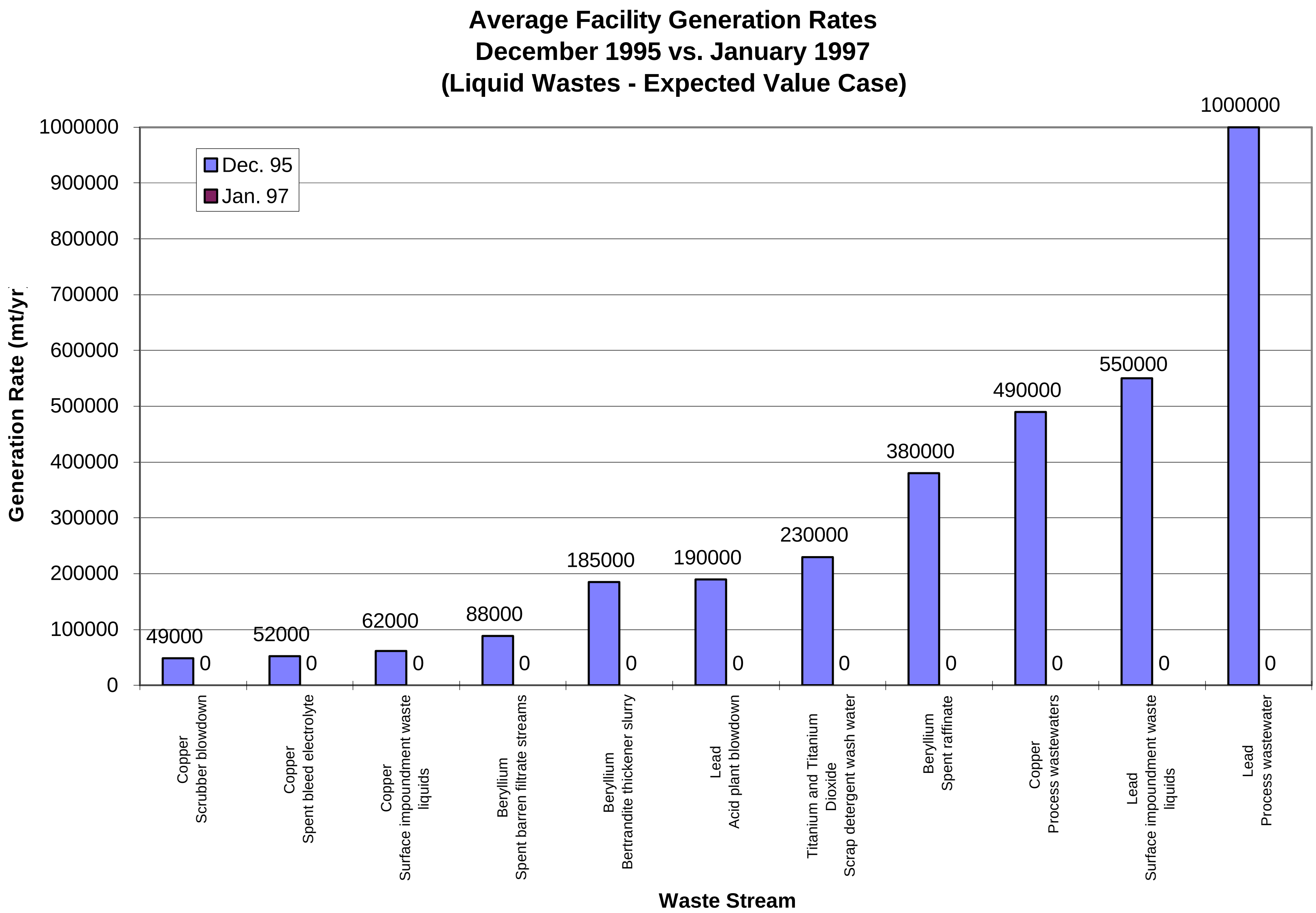

Exhibit 4
Average Facility Waste Generation Rates (mt/yr)
Solid Wastes

Commodity	Waste Stream	Expected	Maximum
Mercury	Dust	1	1
Germanium	Leach residues	2	3
Mercury	Furnace residue	6	11
Platinum	Slag	8	150
Bismuth	Electrolytic slimes	10	200
Calcium	Dust with quicklime	20	40
Zinc	Spent cloths, bags, and filters	25	50
Germanium	Chlorinator wet air pollution control sludge	27	100
Germanium	Hydrolysis filtrate	27	100
Germanium	Waste still liquor	27	100
Antimony	Stripped anolyte solids	48	95
Lead	Solid residues	65	130
Uranium	Uranium chips from ingot production	75	200
Selenium	Spent filter cake	85	1,700
Selenium	Slag	85	1,700
Selenium	Tellurium slime wastes	85	1,700
Selenium	Waste solids	85	1,700
Zinc	WWTP Solids	125	250
Phosphorous	Andersen Filter Media	230	230
Uranium	Slag	250	1,000
Copper	WWTP sludge	300	600
Lead	Spent furnace brick	330	330
Rare Earths	Electrolytic cell caustic wet APC sludge	350	7,000
Magnesium	Cast house dust	380	7,600
Cadmium	Copper and lead sulfate filter cakes	475	9,500
Cadmium	Copper removal filter cake	475	9,500
Cadmium	Iron containing impurities	475	9,500
Cadmium	Lead sulfate waste	475	9,500
Cadmium	Post-leach filter cake	475	9,500
Cadmium	Zinc precipitates	475	9,500
Bismuth	Slag	500	10,000
Tantalum	Digester sludge	500	500
Tellurium	Slag	500	4,500
Tellurium	Solid waste residues	500	4,500
Zinc	Discarded refractory brick	500	1,000
Aluminum	Cast house dust	830	830
Lead	Baghouse incinerator ash	1,000	10,000
Tantalum	Spent raffinate solids	1,000	1,000
Rare Earths	Solvent extraction crud	1,150	4,500
Aluminum	Electrolysis waste	1,250	2,500

Exhibit 4
Average Facility Waste Generation Rates (mt/yr)
Solid Wastes

Commodity	Waste Stream	Expected	Maximum
Bismuth	Alloy residues	1,500	6,000
Bismuth	Lead and zinc chlorides	1,500	6,000
Bismuth	Metal chloride residues	1,500	3,000
Antimony	Slag and furnace residue	1,750	3,500
Lead	Slurried APC Dust	2,300	2,300
Lead	Acid plant sludge	2,350	4,700
Titanium	Spent surface impoundments solids	2,550	5,100
Zinc	Spent goethite and leach cake residues	5,000	5,000
Zinc	Spent synthetic gypsum	5,300	5,300
Zinc	Waste ferrosilicon	8,500	17,000
Titanium	Smut from Mg recovery	11,000	23,000
Beryllium	Filtration discard	11,500	45,000
Molybdenum	Flue dust/gases	11,500	45,000
Pyrobitumens	Still bottoms	11,500	45,000
Magnesium	Smut	13,000	13,000
Synthetic Rutile	APC dust/sludges	15,000	30,000
Lead	Stockpiled miscellaneous plant waste	22,000	45,000
Rhenium	Spent rhenium raffinate	22,000	44,000
Synthetic Rutile	Spent iron oxide slurry	22,500	45,000
Titanium	WWTP sludge/solids	60,000	60,000
Lead	WWTP sludges/solids	95,000	95,000

Exhibit 5
Average Facility Waste Generation Rates (mt/yr)
Liquid Wastes

Commodity	Waste Stream	Expected	Maximum
Coal Gas	Multiple effects evaporator concentrate	-	65,000
Tungsten	Spent acid and rinse water	-	3,500
Zirconium	Spent acid leachate from Zr alloy prod.	-	430,000
Zirconium	Spent acid leachate from Zr metal prod.	-	800,000
Rhenium	Spent barren scrubber liquor	25	100
Bismuth	Waste acids	50	200
Uranium	Waste nitric acid from UO2 production	75	200
Zinc	TCA tower blowdown	125	250
Titanium	Spent surface impoundment liquids	245	960
Molybdenum	Liquid residues	250	500
Germanium	Waste acid wash and rinse water	275	1,000
Germanium	Spent acid/leachate	275	1,000
Uranium	Vaporizer condensate	275	1,000
Uranium	Superheater condensate	275	1,000
Scandium	Spent acids	280	1,000
Scandium	Spent solvents from solvent extraction	280	1,000
Platinum	Spent acids	285	1,000
Platinum	Spent solvents	285	1,000
Tungsten	Process wastewater	370	1,500
Titanium	Pickle liquor and wash water	450	1,100
Cadmium	Caustic washwater	475	9,500
Cadmium	Spent leach solution	475	9,500
Cadmium	Spent purification solution	475	9,500
Cadmium	Scrubber wastewater	475	9,500
Cadmium	Spent electrolyte	475	9,500
Tellurium	Waste electrolyte	500	10,000
Phosphorous	AFM rinsate	2,000	2,000
Antimony	Autoclave filtrate	2,250	9,000
Fluorspar	Off-spec fluosilicic acid	2,500	15,000
Pyrobitumens	Waste catalysts	2,500	10,000
Titanium	Scrap milling scrubber water	2,500	6,000
Bismuth	Spent caustic soda	3,050	12,000
Bismuth	Spent electrolyte	3,050	12,000
Bismuth	Spent soda solution	3,050	12,000
Bismuth	Waste acid solutions	3,050	12,000
Mercury	Quench water	5,500	60,000
Rare Earths	Process wastewater	7,000	7,000
Tellurium	Wastewater	10,000	20,000
Zirconium	Leaching rinse water from Zr alloy prod.	10,500	26,000
Rare Earths	Spent ammonium nitrate processing solution	14,000	14,000
Synthetic Rutile	Spent acid solution	15,000	30,000

Exhibit 5
Average Facility Waste Generation Rates (mt/yr)
Liquid Wastes

Commodity	Waste Stream	Expected	Maximum
Titanium	Waste acids (Sulfate process)	20,000	39,000
Beryllium	Chip treatment wastewater	25,000	1,000,000
Selenium	Plant process wastewater	33,000	33,000
Tantalum	Process wastewater	75,000	75,000
Zinc	Acid plant blowdown	130,000	130,000
Phosphorous	Furnace scrubber blowdown	210,000	210,000
Titanium	Leach liquor and sponge wash water	240,000	290,000
Rare Earths	Wastewater from caustic wet APC	250,000	1,000,000
Zirconium	Leaching rinse water from Zr metal prod.	250,000	1,000,000
Phosphorous	Furnace Building Washdown	350,000	350,000
Zinc	Wastewater treatment plant liquid effluent	435,000	870,000
Rare Earths	Spent scrubber liquor	500,000	1,000,000
Copper	Acid plant blowdown	530,000	530,000
Zinc	Spent surface impoundment liquids	630,000	630,000
Lead	WWTP liquid effluent	880,000	880,000
Zinc	Process wastewater	1,700,000	1,700,000

to Congress on Special Wastes from Mineral Processing in the expected volume case. These streams, which are described in more detail below, are:

- Wastewater treatment plant sludges and solids from the titanium sector,
- Wastewater treatment plant sludges and solids from the lead sector, and
- Process wastewater from the zinc sector.

Exhibit 6 is a histogram of average facility solid waste generation rates for all streams presently in the analysis. As can be seen in this exhibit, 48 of the 61 wastes streams have average facility generation rates at or below 5000 mt/yr. Exhibit 7 provides a more detailed look at the distribution of these 48 lower volume waste streams. Of these 48 "low volume" waste streams, 35 are generated at rates at or below 500 mt/yr. Exhibit 8 presents a histogram of average facility liquid waste generation rates. As can be seen in this exhibit, 31 of the 51 waste streams, are generated at average rates of less than 5,000 mt/yr. Exhibit 9 presents a more detailed look at these wastes. Of these 35 "low volume" waste streams, 22 are generated at rates at or below 500 mt/yr. In summary, the Agency found that of the 118 waste streams, 115 (97 percent) were generated in quantities lower than the respective high volume Bevill cutoffs for solids and liquids. Even more demonstrative is that 79 (48 solid wastes and 31 liquid wastes) of these 118 wastes steams (67 percent) are generated in quantities less than 5000 tons per year.

High Volume Streams

The three wastes streams that exceed the high volume thresholds are described below,[2] because they may require special consideration in determining appropriate storage practices. These streams exceed the thresholds in all three cases, because they are generated by commingling numerous other waste streams, either directly in the case of process wastewater from the zinc sector or as a result of treatment operations (i.e., the two WWTP sludge streams).

<u>Titanium - Wastewater Treatment Plant Sludge/Solids</u>

Wastewater treatment plant (WWTP) sludge/solids, a post-mineral processing waste, consists of sludges and solids resulting from the treatment of the wastewater treatment plant liquid effluent. Sludge/solids are disposed in on- or off-site landfills. Approximately 420,000 metric tons are generated annually by the entire sector. Titanium waste may exhibit the characteristics of toxicity (chromium).

<u>Lead - WWTP Sludges/Solids</u>

Wastewater treatment sludges and solids consist of solid materials that settle following lime neutralization of influent wastewaters. The sludges and solids typically are recycled to the sinter feed preparation operation. For example, at the Doe Run Herculaneum facility, a thickener serves as the final collection point for solids in the WWTP. Thickener solids are dewatered using a filter press and

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[2] US EPA, "Identification and Descriptions of Mineral Processing Sectors and Waste Streams," December 1995, pp. 401, 711, and 792.

then shipped by rail car to the sinter plant. Approximately 380,000 metric tons of WWTP sludges and solids