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Treatability Study for the Bench-Scale Solidification of Nonincinerable LDR Low-Level Mixed Waste

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ABSTRACT

The focus of this report is the solidification of nonincinerable, land disposal restricted (LDR) low-level mixed waste generated at the Idaho National Engineering Laboratory. Bench-scale solidification was performed on samples of this mixed waste, which was done under a Resource Conservation and Recovery Act treatability study. Waste forms included liquids, sludges, and solids, and treatment techniques included the use of conventional Portland cement and sulphur polymer cement (SPC).

A total of 113 monoliths were made under the experimental design matrix for this study; 8 of these were "blank" monoliths (contained no waste). Thus, 105 monoliths were used to solidify 21.6 kg of mixed waste; 92 were made with Portland cement systems, and 13 were made with SPC. Recipes for all monoliths are given, and suggested recipes (as based on the minimized leaching of toxic components) are summarized. In most cases, the results presented herein indicate that solidification was successful in immobilizing toxic metals, thereby transforming low-level mixed waste into low-level nonhazardous waste.

The ultimate goal of this project is to use appropriate solidification techniques, as described in the literature, to transform low-level mixed waste to low-level nonhazardous waste by satisfying pertinent disposal requirements for this waste. Disposal requirements consider the toxicity characteristic leaching procedure tests, a free liquids test, and radiological analyses. This work is meaningful in that it will provide a basis for the disposal of waste that is currently categorized as LDR low-level mixed waste.

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TABLES

Treatability Study for the Bench-Scale Solidification of Nonincinerable LDR Low-Level Mixed Waste

1. INTRODUCTION

This report covers the solidification of nonincinerable, land disposal restricted (LDR) low-level mixed waste generated at the Idaho National Engineering Laboratory (INEL). The objective of this document is to discuss the bench-scale solidification of samples of this mixed waste, which was done under a Resource Conservation and Recovery Act (RCRA) treatability study. Solidification was performed on several INEL wastes, where the treatment techniques included the use of conventional hydraulic-type cements (e.g., Portland cement) and a thermoplastic-type cement (sulphur polymer cement, SPC). Waste forms included liquids, sludges, and solids.

The ultimate goal of this project is to use appropriate solidification techniques,[a,b] to transform low-level mixed waste to low-level nonhazardous waste by satisfying pertinent disposal requirements for the treated waste. This work is meaningful in that it will provide a basis for the disposal of waste that is currently categorized as LDR low-level mixed waste.

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a. K. L. Gering, "Selection of Solidification Techniques for INEL Nonincinerable Mixed Wastes," EG&G Idaho, Engineering Design File Serial No. WROC-EDF-101, December 1991.

b. K. L. Gering, "Assessment of Solidification Treatment Methods for the Development of Solidification Waste Acceptance Criteria at WERF," EG&G Idaho, Engineering Design File Serial No. WERF-0129, July 1992.

2. WASTE DESCRIPTIONS

2.1 Waste Forms

The INEL mixed wastes that were investigated during this study are listed in Table 2-1; the waste generator, drum bar codes, and drum volumes are given. As this table indicates, most of these wastes are contained in 55-gal drums. Table 2-2 contains a more qualitative description of the physical waste form, as gained from visual observation; nine mixed waste samples are listed. It should be noted that there is more than one type of waste form (solid, liquid, or sludge) for two of the INEL wastes. The Babcock & Wilcox (B&W) sludge listed in Table 2-2 is an additional waste that was not included in the original experimental design matrix; however, a small, six-monolith matrix was performed for this waste.

2.2 Summary Information from Form EG&G-669s

Early characterization data for the mixed waste considered in this report come from two primary sources: Generator's Hazardous Waste Material Profile Sheets (Form EG&G-669), and the Controlled Mixed Waste Stream History Table for Year 1991.[1] Pertinent information from these sources have been summarized in Tables 2-3 and 2-4.

2.3 Waste Characterization Results

Early in this project, it was decided that the information given on EG&G-669 forms was insufficient to formulate a satisfactory characterization data base for the solidification of mixed waste. Thus, representative samples of the mixed waste given in Tables 2-1 through 2-4 were sent off site to undergo more analyses, namely toxicity characteristic leaching procedure (TCLP), percent moisture, and total dissolvable material (TDM) tests. In addition, radiochemical analyses were performed, where alpha-, beta-, and gamma-emitters were characterized for each mixed waste sample.

2.3.1 TCLP

TCLP is the criterion by which a sample is judged as hazardous or nonhazardous from a toxicity basis, and will be the primary focus of monolith analysis for this work. For a more detailed discussion of the above criteria, see *Sampling and Analysis Plan for Solidification of Nonincinerable LDR Mixed Wastes.*[c] According to RCRA guidelines (see Section 3), a waste is defined as toxic if a leachate of that waste contains a component(s) in an amount that exceeds a predefined limit. Hence, a waste sample is said to "fail" TCLP testing if the TCLP results indicate the presence of a toxic component at a concentration that exceeds the RCRA limit for that component. For the majority of this study, the toxic components of concern are heavy metals.

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c. K. L. Gering, *Sampling and Analysis Plan for Solidification of Nonincinerable LDR Mixed Wastes*, WROC-PROJ-0015115, April 1992.

Table 2-1. LDR nonincinerable mixed waste slated for solidification.[a]

INEL waste identification number	Waste description (generator)	Drum bar codes	Volume,[b] drums
124	TAN mercury concrete material (TAN)	560–563, 566, 573, 574, 577–582, 599–602, 624, 639–646, 681	27, 55 gal
128	Sludge with free liquids (TRA)	651, 652	2, 55 gal[c]
142	Radiation/lead-contaminated debris (PBF)	1472	1, 15 gal
153	Mercury-contaminated soil/sludge (TAN/IET)	556, 558, 559, 632, 658, 708–711, 922, 941	11, 55 gal
157(a)[d]	Warm waste pond sludge samples and debris (WEDF, TRA)	900–907, 1701	9, 55 gal
186	Solidified ash that failed test (WERF)	685, 686, 2759	1 B-25 bin 1, 85 gal 1, 55 gal

a. Inventory data for this table were taken from the WROC "Controlled Mixed Waste Stream History Table for Year 1991" (Reference 1).

b. "Volume" represents the internal volume of the container used to hold a given waste, and so may not be the actual waste volume. In many cases, the actual waste volume is much less than the indicated container size. The B-25 bin listed under waste 186 contains two 55-gal drums.

c. These drums contained several smaller glass and plastic containers, many of which were sampled.

d. Stream 157(a) is cross-referenced with WERF code identification number 23-91.

IET — Initial Engine Test (Facility)
PBF — Power Burst Facility
TAN — Test Area North
TRA — Test Reactor Area
WEDF — Waste Engineering Development Facility
WERF — Waste Experimental Reduction Facility
WROC — Waste Reduction Operations Complex.

Table 2-2. Waste form descriptions: nonincinerable LDR mixed waste.

INEL waste code	Description
124 (solids)	Moist solids with small bits of rock and gravel (generally $\leq$1/4-in. in size), and laced with larger pieces of white and gray clay-like material. This clay makes up roughly 20 to 35% of the waste by volume. Color: bulk material is brown/orange-brown. Approximate moisture content: 48% by weight.
128 (sludge)	Dark colored sludge with small pieces of rock, soil, and twigs. It was not easy to get representative samples of this sludge for the various monoliths. Color: bulk material is black. Approximate moisture content: 88% by weight.
128 (solids)	Light-colored, sandy-textured solid that appears somewhat crystalline or salt-like. Some grinding was required to reduce particle sizes. Contains small pieces of organic matter that looks like tiny plant roots. Dry. Color: bulk material is light-tan. Approximate moisture content: 2% by weight.
142 (solids)	Loosely packed gravel and rock, having an average particle size of 1/8 to 1/4 in. It resembles aquarium gravel, only the particles have a flint-like appearance. Color: bulk "wet" material is light-brown. Dried material has a low density of about 0.4 g/cc. Approximate moisture content: 49% by weight.
153 (solids)	Brown clay-like clumps covered/coated with a fine, brownish material that looks like ground-up peat moss. Approximately 60 to 80% of this mixed waste volume is clay-like material, and roughly 3 to 5% is small rocks. Moist material has a high density. May have to grind the clay clumps after they have undergone drying. Color: bulk material is dark brown. Approximate moisture content: 10 to 15% by weight.
157(a) (liquid)	Slightly amber, aqueous solution with brown-orange precipitate on the bottom of the waste container. The precipitate occupies $\leq$1% of the solution volume, and looks filmy/organic in form. Approximate moisture content: 98% by weight.
157(a) (solids)	Soil-like appearance; roughly 30% of the waste volume is small rocks or pebbles. Dry. Color: bulk material is gray to light-brown. Approximate moisture content: 2% by weight.
186 (solids)	Gray, ash-like material in chunks. The chunks contain black material (possibly ash that has not solidified properly). Had to grind this material to reduce the average particle size. The ground material was black/gray-black. Color: gray on exterior of particles (looks like old cement); black on the inside of the particles. Approximate moisture content: 20% by weight.
B&W chromate sludge	Dark (usually black) colored sludge containing very fine solids. Approximate moisture content: 85% by weight.

B&W — Babcock & Wilcox

Table 2-3. Physical and chemical analyses of nonincinerable mixed waste slated for solidification.

	Physical characteristics				Chemical characteristics		
INEL waste identification number	State	Free liquid	pH	Specific gravity	Total heavy metals (ppm)	Organics and PCBs	Radionuclides
124	Solid, semi-solid, bilayer	No	8.67 to 10.64	>1.7	Mercury 22.4	No organics No PCBs	Co-60 at 0.19 nCi/g, assuming a specific gravity of 1.9
128[a]	Solid, semi-solid, liquid	Yes	6.0	1.3 to 1.4	Arsenic: 50 Lead: 2,050 Barium: 460 Mercury: 150 Cadmium: 48 Silver: 195 Chromium: 10,800	See Table 2-4	MFP, MAP at 0.5 μCi/g
142[a]	Solid	No	N/A	1.5 to 1.7	Barium: 0.81 mg/L Cadmium: 0.59 Lead: 15 (via extraction procedure)	See Table 2-4	Cs-137 at 0.24 μCi/g
153[a]	Solid	No	4.1 to 6.9	>1.7	Mercury: 200	No organics No PCBs	Cs-137 at <0.1 mrem/hr at contact
157(a)[a]	Semi-solid	Yes, 10%	7.0	1.3 to 1.4	Arsenic: 13[b] Mercury: 37[b] Cadmium: 30[b] Silver: 18[b] Chromium: 3,950[b] Lead: 206[b]	No organics No PCBs	MFP at 70 μCi/g
186	Solid, multilayer	No	7.1 to 10.0	>1.7	Cadmium: 70 mg/L Lead: 15 (via extraction procedure)	No organics No PCBs	MFP at unknown levels

a. Waste may require segregation before solidification treatment.

b. Waste also contains copper and zinc.

MAP — mixed activation products
MFP — mixed fission products
PCB — polychlorinated biphenyl.

Table 2-4. Supplemental information: organic content of INEL wastes 128 and 142.[a]

Waste	Compound	Concentration (ppb)
128	Acetone	264
	Acrylonitrile	10
	Bis(2-ethylhexyl)phthalate	13,672
	Di-n-butylphthalate	3,888
	Di-n-octylphthalate	4,477
	Pentachlorophenol	34,197
	Total =	56,508
142	Bis(2-ethylhexyl)phthalate	7
	Unknown saturated hydrocarbon	14
	Alkane C_{20}	31
	Unknown steroid	14
	Unknown C_{20}	13
	Unknown C_{20}	8
	Unknown hydrocarbon	12
	Unknown alkane C_{20}	46
	Unknown steroid	55
	Unknown	43
	Unknown substituted aromatic	35
	Miscellaneous BNAs	< detection limit
	Total =	278

a. This information came directly from data submitted with the waste material profile sheets for this waste.

BNA — base neutral acid test for semivolatile organics.

TCLP results for toxic metals in the untreated samples, as determined by TCT-St. Louis laboratories, are provided in Table 2-5. The significant result that is seen in this table is that only two of the wastes listed have concentrations of a metal(s) that exceed the U.S. Environmental Protection Agency (EPA) limit, namely INEL waste codes 124 and 157(a)-liquids, where mercury and lead are the only metals that exceed their concentration limit. Thus, only these two wastes can be classified as hazardous as far as toxicity is concerned, and the remaining waste should be considered for reclassification as nonhazardous low-level waste. It should also be noted that the TCLP metals results in Table 2-5 differ markedly from the total heavy metals values seen in Table 2-3. It is believed that many of the waste in Table 2-5 that passed TCLP tests were mistakenly labeled as mixed waste because total heavy metals was used as a basis for toxicity instead of TCLP or another leaching procedure.

In addition, TCLP tests were done to check for semivolatile organic compounds, and the results indicate that concentrations of all such compounds are well below regulatory limits for the samples submitted for testing. The laboratory results for these compounds are given in Appendix B. These TCLP results for semivolatile organics differ from what is seen in Table 2-4, where there are some compounds in the parts-per-million range. This discrepancy could be explained by assuming that the representative sampling differed between the samples used to generate the results in Table 2-4 and the more recent results obtained by the TCT-St. Louis laboratories. Since semivolatile organics are not a concern for the untreated waste samples, TCLP analyses for these compounds will not be performed on the treated waste samples.

Table 2-5. TCLP results for LDR low-level mixed waste samples prior to solidification (in µg/L).

	INEL waste identification number								
Metals	124 (solid)	128 (sludge)	128 (solid)	142 (solid)	153 (solid)	157a (liquid)	157a (liquid)	186 (solid)	B&W (sludge)
Silver	42[a]	42[a]	42[a]	42[a]	42[a]	262	42[a]	42[a]	12.0[a]
Arsenic	140[a]	140[a]	140[a]	200	140[a]	665	140[a]	140[a]	120[a]
Barium	504	575	169	240	1,815	4,440	1,000	1,650	3,340
Cadmium	5[a]	94	5[a]	5[a]	211	208	9	5[a]	5[a]
Chromium	82	620	120	10[a]	10[a]	2,240	144	47	105,000[b]
Mercury	1,900[b]	0.15	0.1[a]	0.1[a]	95	920[b]	0.93	0.11	27.8
Lead	7,080[b]	425	100[a]	100[a]	100[a]	1,430	100[a]	2,930	246
Selenium	518[a]	518[a]	518[a]	518[a]	518[a]	518[a]	518[a]	518[a]	2[a]

a. This is a value at or below the shown detection limit for this metal. Detection limits for a given metal may vary according to the instrument detection limit (IDL) of analytical instruments used on a given set of samples.

b. This is a value that exceeds the EPA/RCRA disposal limit for this metal.

2.3.2 Percent Moisture

Percent moisture data are desired when a particular waste is to be solidified with a hydraulic cement, so that the total water content of the concrete monolith can be determined. In most instances, the percent moisture values obtained by TCT-St. Louis were verified by this study. All moisture data are given in Table 2-6.

2.3.3 Total Dissolvable Material (TDM) Results

The amount of dissolvable material present in a waste can impact the performance of a hydraulic cement used to solidify that waste. Generally speaking, total dissolvable material (TDM) results are an indicator of the amount of electrolytes (salts) that are present in a waste. Most hydraulic cements do not perform favorably when there is a high salt concentration in the concrete matrix. TDM results for the wastes of interest are provided in Table 2-6. Note that TDM is different from total dissolved solids (TDS), which is typically reserved for liquids analyses.

2.4 Gamma Ray Analysis

Gamma ray analysis was performed by the Radiation Measurements Laboratory (RML) at the INEL, and the results are reproduced in Table 2-7. Although there are some samples that contain transuranic components, their activity is sufficiently low enough to enable the waste samples to be classified as low-level mixed waste, not transuranic mixed waste.

2.5 Alpha Analysis

Gross spectrometric alpha analyses of the mixed waste samples were done at the INEL, and are summarized in Table 2-8. Most notable in this table is the presence of transuranium radionuclides (e.g., Pu-239, Cm-244), and the presence of highly enriched uranium in INEL waste code 153. The activity of the alpha-emitters in Table 2-8 is very low, where values are generally in the low, single-digit pCi/g range.

Table 2-6. Percent moisture and TDM results for LDR low-level mixed waste.

	INEL waste identification number								
Parameter	124 (solid)	128 (sludge)	128 (solid)	142 (solid)	153 (solid)	157a (liquid)	157a (solid)	186 (solid)	B&W (sludge)
Percent moisture (wt%)	49.4	87.8	1.6	49.0	10.5	98.0	2.2	20.2	85.0
Total dissolvable material (mg/gm)	6.0	5.3	940	76.3	2.4	—[a]	—[a]	119	—[a]

a. Sample not tested.

Table 2-7. Gamma ray results for LDR low-level mixed waste samples.

INEL waste code	Sample identification	RML identification	Manmade radionuclides	Activity(T) (pCi/g)
124 solids	WERF124ABG1	A1041492035	Co-60	(5.9 ± 0.7) E+1
128 solids	WERF128ABG1	A2041092042	Co-60	(5.6 ± 0.4) E+2
			AG-108m	(2.2 ± 0.3) E+0
			Cs-134	(5.3 ± 0.4) E+0
			Cs-137	(1.90 ± 0.13) E+3
			Eu-152	(3.3 ± 0.4) E+0
			Eu-154	(6.4 ± 0.6) E+0
			Am-241	(8.5 ± 1.4) E+0
128 sludge	WERF128ABG2	A1041092034	Co-60	(3.8 ± 0.6) E+3
			Ag-108m	(9 ± 2) E+0
			Cs-134	(1.6 ± 0.3) E+1
			Cs-137	(5.7 ± 0.9) E+3
			Eu-154	(1.5 ± 0.3) E+1
128 liquid	WERF128ABG3	A2041092033	Co-60	(3.7 ± 0.6) E+3
			Cs-134	(5.0 ± 0.9) E+1
			Cs-137	(1.22 ± 0.19) E+4
			Eu-154	(3.2 ± 0.6) E+1
142 solids	WERF142ABG	D3041492022	Cs-137	(1.17 ± 0.14) E+0
153 solids	WERF153ABG	A1041092039	Co-60	(5.0 ± 0.5) E-1
			Cs-137	(6.2 ± 0.4) E+1
			U-234	(3.1 ± 0.8) E+2
			U-235	(1.62 ± 0.12) E+1
153 solids	WERF1532ABG	A4041092043	Co-60	(5.1 ± 0.7) E-1
			Cs-137	(7.7 ± 0.6) E+1
			U-235	(9.9 ± 0.7) E+0
157(a) solids	WERF157AABG1	A4041492024	Co-60	(1.48 ± 0.11) E+2
			Ag-108m	(2.4 ± 0.2) E+0
			Cs-134	(8.1 ± 1.7) E-1
			Cs-137	(5.6 ± 0.4) E+2
			Eu-152	(7.8 ± 0.7) E+0
			Eu-154	(2.2 ± 0.3) E+0
157(a) liquid	WERF157AABG2	A1041592024	Co-60	(1.5 ± 0.2) E+2
			Ag-108m	(1.00 ± 0.16) E+1
			Cs-134	(8.3 ± 1.8) E-1
			Cs-137	(4.2 ± 0.7) E+2
			Eu-152	(1.8 ± 0.3) E+0
			Eu-154	(8.2 ± 1.8) E-1
			Am-241	(1.2 ± 0.3) E+0
186 solids	WERF186ABG	A1041492023	Co-60	(5.9 ± 0.4) E+1
			Sb-125	(8.5 ± 0.7) E+0
			Cs-134	(8.8 ± 0.6) E+0
			Cs-137	(7.6 ± 0.5) E+2
			Eu-154	(6.8 ± 1.1) E-1
186 solids	WERF186ABGD	A4041492037	Co-60	(5.8 ± 0.4) E+1
			Sb-125	(1.02 ± 0.10) E+1
			Cs-134	(8.9 ± 0.6) E+0
			Cs-137	(7.5 ± 0.5) E+2
			Eu-154	(4 ± 2) E-1

Table 2-8. Alpha-emitter results for LDR low-level mixed waste samples.

INEL waste identification number	Nuclide present	Activity
124 (solid)	Am-241 and/or Pu-238	4.1 ± 0.5 E-1 pCi/g
	U-238	4.8 ± 0.6 E-1 pCi/g
	U-234	6.5 ± 0.7 E-1 pCi/g
128 (sludge)	Am-241 and/or Pu-238	2.81 ± 0.18 E 1 pCi/mL
	Pu-239	1.41 ± 0.1 E 1 pCi/mL
	U-238	3.3 ± 0.4 E 0 pCi/mL
	U-234	2.5 ± 0.3 E 0 pCi/mL
	Cm-244	7.4 ± 0.6 E 0 pCi/mL
128 (solid)	Am-241 and/or Pu-238	4.9 ± 0.3 E 0 pCi/g
	Pu-239	2.22 ± 0.17 E 0 pCi/g
	Cm-244	1.27 ± 0.12 E 0 pCi/g
142 (solid)	Th-232	6.0 ± 0.8 E-1 pCi/g
	Th-230	7.9 ± 0.9 E-1 pCi/g
	Th 228	5.6 ± 0.7 E-1 pCi/g
153 (solid)	U-238	2.9 ± 0.2 E 0 pCi/g
	U-234	4.03 ± 0.21 E 2 pCi/g
	U-235	1.52 ± 0.09 E 1 pCi/g
157(a) (liquid)	Am-241 and/or Pu-238	6.1 ± 0.5 E 0 pCi/mL
	Pu-239	9.3 ± 0.7 E 0 pCi/mL
157(a) (solid)	Am-241 and/or Pu-238	5.0 ± 0.4 E 0 pCi/g
	Pu-239	2.2 ± 0.18E 0 pCi/g
	U-238	6.4 ± 0.9 E-1 pCi/g
	U-234	1.52 ± 0.14 E 0 pCi/g
	Cm-244	1.18 ± 0.12E 0 pCi/g
	Th-232	1.05 ± 0.11 E 0 pCi/g
	Th-230	1.42 ± 0.14 E 0 pCi/g
186 (solid)	Am-241 and/or Pu-238	7.2 ± 0.5 E 0 pCi/g
	U-238	1.14 ± 0.1 E 0 pCi/g
	U-234	1.94 ± 0.15 E 0 pCi/g

2.6 Beta Analysis

Beta-emitter analyses of the mixed waste samples were performed at the INEL, and the results are given in Table 2-9. The beta results in Table 2-9 are from gross analysis, where the gross activity from beta-emitters is seen to range from approximately 20 pCi/g (INEL waste code 142, solids) to 20,000 pCi/mL (INEL waste code 128, sludge). These activity values represent beta radiation that is relatively low level.

Table 2-9. Beta-emitter results for LDR low-level mixed waste samples.

INEL waste identification number	Activity (gross)
124 (solid)	4.6 ± 0.7 E 1 pCi/g
128 (sludge)	1.7 ± 0.3 E 4 pCi/mL[a]
128 (solid)	1.7 ± 0.3 E 3 pCi/g
142 (solid)	2.2 ± 0.3 E 1 pCi/g
153 (solid)	9.5 ± 1.5 E 1 pCi/g
157(a) (liquid)	3.3 ± 0.5 E 2 pCi/mL
157(a) (solid)	1.2 ± 0.2 E 3 pCi/g
186 (solid)	4.4 ± 0.7 E 2 pCi/g

a. Weighted average (mass-based) for the solid and liquid components of the sludge.

3. REGULATORY LIMITS FOR HAZARDOUS CONSTITUENTS

3.1 D-Listed Waste

The INEL mixed waste investigated in this work is considered characteristic hazardous waste because it is believed to possess one or more toxic characteristics, which are denoted by a D-listed EPA code. Being such, it must conform to EPA treatment standards (according to RCRA) before it can be disposed of as nonhazardous waste. A summary of the treatment standards for the toxic metals considered herein is provided in Table 3-1.

Table 3-1. EPA treatment standards for toxic metals.

Constituent	EPA limit (mg/L)
Silver	5.0
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Mercury	0.2
Lead	5.0
Selenium	5.7

4. SOLIDIFICATION BACKGROUND

4.1 General Information

This bench-scale study used the technology screening performed in the references in Footnotes a and b as a basis for choosing solidification methods used on the aforementioned INEL waste samples. Summary information from these references is given in Tables 4-1, 4-2, and 4-3. Early in this project, the solidification techniques provided in Table 4-1 were evaluated using the following seven selection criteria (see Footnote a):

- Compatibility with waste pH
- Compatibility with waste moisture content (wet versus dry)
- Compatibility with waste heavy metals content
- Compatibility with waste organics content
- Compatibility with waste homogeneity
- Treatment cost per unit volume of waste
- Final waste volume (impacts disposal costs).

These criteria were used for technology screening because they make the best use of the available waste characterization data, reflect the overall compatibility of a solidification technique with a given waste, and give a qualitative comparison of treatment and disposal costs.

Table 4-3 contains the recommended solidification techniques for the INEL wastes of interest, as obtained from the preliminary technology screening. The first and second choices are shown for each mixed waste. The results of this study indicate that hydraulic-type cements and sulfur polymer thermoplastic "cements" are the most feasible means of solidifying most of the mixed wastes considered herein. Although organic polymer systems are listed, they were not seen as practical for bench-scale applications. It should be noted that the actual, specific solidification treatments that are used may depend on the type of required pretreatment (e.g., segregation, pH neutralization, sorption of free liquids, drying), and the final full-scale solidification treatments chosen may certainly depend on the cost of pretreatment options.

4.2 Hydraulic Systems

4.2.1 Portland Cement

The Portland cement used for this work was a Type I and II, low alkali formulation produced by Ash Grove Cement West Incorporated, which came in 94-lb bags. Approximately 130 lb of this cement was required for the entire bench-scale solidification effort. This type of cement were used to solidify liquid, solid, and sludge waste samples.

Table 4-1. Candidate techniques for treatment by solidification.

Technique	Advantages	Disadvantages
Hydraulic cement-based systems For example: — Portland cement — Portland cement plus flyash — Portland cement plus sodium silicate — Portland cement plus lime — Lime plus flyash	• Low cost • Proven stability • Safe chemical ingredients • Simple equipment • Variety of formulations available • Low concentrations of some organic materials (e.g., oils) can be treated • Suited for wet waste	• Volume increase of final waste form • Mass increase of final waste form • Not well-suited for waste having high concentrations of salts and/or organic solvents
Polymerization systems	• Can have a small volume increase of final waste form • Very low permeability • Quick setting/hardening compared to typical cement-based systems • May be suited for waste containing water, organic solvents, or oils	• High cost • Some chemicals used are hazardous • Possible biodegradation • Possible attack by ultraviolet sources • Complex equipment compared to typical cement-based systems
Organic polymer thermoplastic systems	• Can have a small volume increase of final waste form • Very low permeability • Quick setting/hardening compared to typical cement-based systems • High strength	• High cost • Some chemicals used may be hazardous • Possible biodegradation • Possible attack by ultraviolet sources • Heating unit needed • Complex equipment • Not well-suited for wet waste
Sulphur polymer thermoplastic systems	• Able to incorporate high concentration of salts into final waste • Very low permeability • Quick setting/hardening • Less waste volume increase compared to typical cement-based systems • High strength	• Unproven long-term performance • Moderate to high cost • Heating unit needed • Complex equipment compared to typical cement-based systems • Not well-suited for wet waste

Table 4-2. Recommended solidification methods for various waste categories.

Waste category	Recommended solidification method(s)	References[a]	Recommended pretreatment
Dry waste:			
Ash	HC; TPMic (SPC)	4, 5, 8, 9, 10, Footnote a on page 1	Mix/blend
Soils	HC; TPMic (SPC)	4, 8, 9, 10, 12	Mix/blend
Powders/residues	HC; TPMic; P/C	2, 4, 6, 7, 13	Mix/blend
Evaporator salts	TPMic (SPC); TPMac	4, 6, 8, 9, 10, 17	Dry; mix/blend
Nonhomogeneous	TPMac for large items; HC for smaller items	2, 4, 6, 7, 11, 17	Segregate if possible
Wet waste:			
Sludges	HC; ASet; PSet	2, 4, 6, 7, 16, 19, Footnote a on page 1	Adjust pH; mix/blend
Moist solids	HC; P/C	2, 4, 6, 7, 11, 12, 13, Footnote a on page 1	Mix/blend
Free liquids (aqueous)	HC; ASet; ASet II	2, 4, 6, 7, 11, 19	Adjust pH; ppt; mix/blend
Special waste:			
Organic-laden	PSet II; HC; P/C	4, 13, 15, 19	Mix/blend
Salt-laden	TPMic (SPC); ASet II; TPMac	6, 8, 9, 10, 19	Dry; mix/blend
Debris-laden	TPMac; TPMic (poly)	2, 3, 4, 6, 11, 17	Segregate if possible
Multi-hazard	HC; TPMac	2, 4, 6, 11, 17	Neutralize acids and reactives; mix
High-level, radioactive mixed	TPMac; Vit	17, 18	Primary containment

a. See Section 8, except where indicated.

ASet — Aquaset (Fluid Tech, Inc.)
ASet II — Aquaset II (Fluid Tech, Inc.)
HC — hydraulic cements (e.g., Portland cement)
P/C — polymer/copolymer systems
poly — organic polymer systems
ppt — chemical precipitation
PSet — Petroset (Fluid Tech, Inc.)
PSet II — Petroset II (Fluid Tech, Inc.)
SPC — sulfur polymer cement
TPMac — thermoplastic macroencapsulation
TPMic — thermoplastic microencapsulation
Vit — vitrification.

Table 4-3. Summary of recommended solidification techniques.

INEL waste identification number	Waste description	Recommended solidification techniques (top two choices)
124	TAN mercury concrete material	1. Hydraulic cement 2. Polymerization
128[a]	Sludge with free liquids	1. Polymerization 2. Sulfur polymer thermoplastic
142[a]	Radiation/lead-contaminated debris	1. Organic polymer thermoplastic 2. Sulfur polymer thermoplastic
153[a]	Mercury-contaminated soil/sludge	1. Sulfur polymer thermoplastic 2. Hydraulic cement
157(a)[a]	Warm waste pond sludge samples and debris	1. Sulfur polymer thermoplastic 2. Hydraulic cement
186	Solidified ash that failed test	1. Hydraulic cement 2. Polymerization

a. Waste may require segregation before solidification treatment.

4.2.2 Portland Cement Plus Sodium Silicate

Sodium silicate pentahydrate ($Na_2SiO_3 \cdot 5H_2O$) from Spectrum Chemical Manufacturing Incorporated (Item S1433, 25-lb bucket) was used in some monoliths as an curing accelerator additive. This was done by adding enough of the pentahydrate salt to the concrete recipe to achieve a concentration of 8 wt% Na_2SiO_3. *Concrete* is defined here as the mixture of Portland cement, water, waste, and any additives.

4.3 Thermoplastic System (Sulfur Polymer Cement)

The sulfur polymer cement (SPC) used for this work sells under the trade name CHEMENT 2000, and arrived in bulk in a 55-gal drum. This material was in the form of flakes having a thickness of approximately 1/8 in., and is composed of approximately 95% sulfur and 5% additives. SPC was used to solidify dry waste only; mixed waste samples typically had to undergo a drying pretreatment.

5. BENCH-SCALE EXPERIMENTAL CONSIDERATIONS

5.1 Equipment and Materials List

Primary pieces of equipment and instrumentation used for this study were as follows:

- Waage Melting Pot (model WP8A-19-1), 115 Vac, 1,000 watts, 0–500°F, for use with thermoplastic cements
- Cole-Parmer "Stir-Pak" Laboratory Mixer (model 4554-10), variable speed, with forward/reverse switch
- Acculab Electronic Balance (model 5001), 5-kg capacity, 1-g graduation
- Thermometers
- Relative humidity indicator (hygrometer)
- 1/2-in. stainless steel sieve, for waste sizing
- Large mortar and pestle.

5.2 Location

Bench-scale solidification studies were performed at the Test Reactor Area (TRA), Building 661, Room 129. The Radioactive Materials Storage Area (RMSA) in TRA-604 was the location used for temporary mixed waste sample storage.

5.3 Sampling and Testing Schedules

Mixed waste drum sampling took place at the Waste Experimental Reduction Facility (WERF) during April 1992.[d] The sampling strategy that was used is given in Table 5-1.

Solidification of the mixed waste samples started in June 1992 and continued through August. This three-month period encompassed the time needed for monolith formation, curing, initial inspection, duplication of specific monoliths (if needed), and the start of representative sampling of the cured monoliths. This schedule did not include the time needed to perform leaching tests (TCLP) and other tests needed to satisfy disposal criteria; these additional tests were performed during August through November 1992.

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d. K. L. Gering, *Sampling and Analysis Plan for Supplemental Waste Characterization of Nonincinerable LDR Mixed Wastes*, WROC-PROJ-0015114, March 1992.

Table 5-1. Sampling strategy for LDR nonincinerable mixed waste.[a]

INEL waste identification number	Waste description	Sampling strategy: number of drums sampled	Total drums	Sampling amount taken[b] (±10%)
124	TAN mercury concrete material	4 random drums	27	4 L
128	Sludge with free liquids	All drums (2)	2	3 L
142	Radiation/lead-contaminated debris	All drums (1)	1	4 L
153	Mercury-contaminated soil/sludge	3 random drums	11	4 L
157(a)[c]	Warm waste pond sludge samples and debris	3 random drums	9	6.5 L
186	Solidified ash that failed test	All drums (3)	3	4 L
TOTAL VALUES:		16 drums	53 drums	25.5 L

a. Inventory data for the above table were taken from the WROC *Controlled Mixed Waste Stream History Table for Year 1991* (Reference 1).

b. Amount shown is for bench-scale solidification only; additional smaller amounts may have been taken for waste characterization.

c. Waste 157(a) is cross-referenced with WERF Code identification number 23-91.

5.4 Experimental Parameters and Design Matrix

There are two types of cements that were investigated for use on the INEL wastes considered herein: hydraulic and nonhydraulic. The variables that were investigated for each type of cement are discussed below. For further details concerning the statistically based experimental design matrix that was used for monolith formation, refer to *Sampling and Analysis Plan for Solidification of Nonincinerable LDR Mixed Wastes* (see Footnote c).

5.4.1 Experimental Design Matrix

When considering the experimental design matrix for monolith formation, there are essentially two separate experiments: one for hydraulic cement and another for nonhydraulic (sulfur polymer) cement. Of the nine wastes listed in Table 2-2, seven were solidified with

hydraulic cements and the remaining two were treated with SPC. The purpose of the matrix-based study is to determine the most effective monolith "recipe" for each of the waste types.

There are two steps to setting up the study, which can be improved with the use of statistics. First, there is the experimental design, which (for each waste type) defines the number and nature of the treatments (combinations of factor levels or "recipes") to be used, and the number of replications for each treatment. Second, there is the process of obtaining and assigning specimens (experimental units) to these treatments, often called a sampling plan. The experimental design is the focus of this section.

The number of monoliths that are produced during a treatability study should be minimized so that the time and money expended on laboratory analyses of the monoliths can be decreased, and so that the disposal requirements of failed monoliths will be diminished. In an effort to minimize the number of monoliths while maintaining satisfactory data, this bench-scale study used the method of fractional factorials as a statistical approach toward reducing the total number of monoliths produced.

5.4.1.1 Hydraulic Cements. The wastes assigned to the hydraulic cement part of the study are defined by INEL waste identification numbers 124, 128, 157a, and 186, according to the recommendations given in the reference in Footnote a. These wastes have various forms ranging from solids to liquids. The TCLP response of interest may differ from waste to waste and from monolith to monolith for a given treated waste.

A summary of the factors for the hydraulic cement portion of the study is provided in Table 5-2, where design factors A, B, and C are represented by cement formulation, total water content of concrete mixture, and waste to dry cement weight ratio, respectively. For the most efficient estimation of curvature effects, the levels of factor C have been equally spaced when possible.

There are 12 ($2 \times 2 \times 3$) possible treatments (recipes) for each waste type, using the full factorial design with no replication. With this experimental design matrix, all main effects and two-way interactions could be estimated. However, for analysis purposes we would have to assume the three-way interaction between factors A, B, and C to be negligible. This may be an inaccurate assumption and, therefore, the design is partially replicated. Replication increases the ability to quantify the curvature for factor C. Table 5-3 lists the treatments to be used along with the required number of monoliths for each treatment. Since partial replication exists, the total number of monoliths is 15 for each waste type. This design matrix was used for the waste types in Table 2-2 that were slated for treatment with hydraulic systems, with the exception of the B&W sludge, which was solidified under a scaled-down matrix. A value of 0.5 for factor C in Table 5-2 was used instead of 0.6 for liquids and sludges that had a very high water content, so that the waste to Portland cement ratio could be attained without exceeding the desirable percentage of water in the concrete.

5.4.1.2 Nonhydraulic Cements. The two wastes assigned to the nonhydraulic cement portion of the study are defined by INEL waste identification numbers 142 and 153. A summary of the factor for the nonhydraulic cement portion of the study is provided in Table 5-4. There are three

Table 5-2. Factor descriptions for the hydraulic cement portion of the study.

Factor	Factor definition	Factor type	Number of levels	Factor levels	Level code
A	Cement formulation	Qualitative, fixed	2	Portland cement: Without additive With additive	 - +
B	Total water content of concrete mixture	Quantitative, fixed	2	30% by weight 36% by weight	- +
C	Waste to dry cement weight ratio	Quantitative, fixed	3	0.20 0.40 0.60 (0.50)	1 2 3

Table 5-3. Design matrix for each waste in the hydraulic cement portion of the study.

Level of A	Level of B	Level of C	Number of monoliths
-	-	1	1
-	-	2	2
-	-	3	1
-	+	1	1
-	+	2	1
-	+	3	2
+	-	1	2
+	-	2	1
+	-	3	1
+	+	1	1
+	+	2	1
+	+	3	1

Table 5-4. Factor description for the nonhydraulic cement portion of the study.

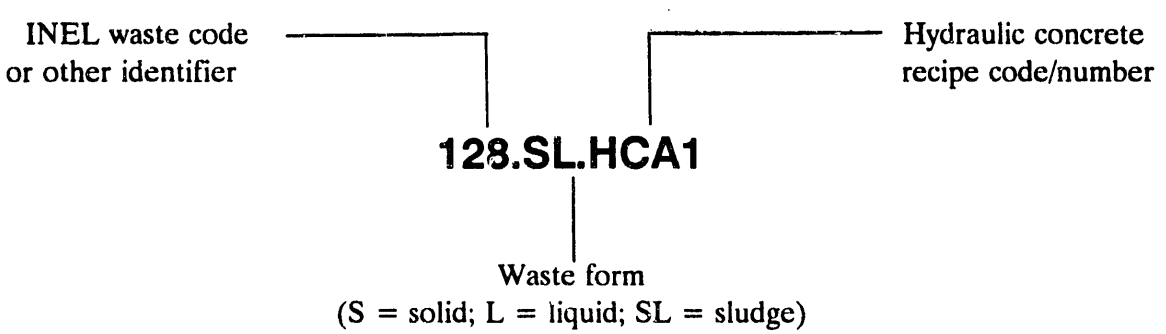
Factor	Factor definition	Factor type	Number of levels	Factor levels	Level code
C	Waste to SPC weight ratio	Quantitative, fixed	3	0.25 (0.15) 0.50 (0.25) 0.75 (0.50)	1 2 3

possible treatments (recipes) for each waste type. Using this single factor design with no replication for both waste types would require a total of 6 (3 × 2) monoliths. It is crucial to completely replicate in this case, since there is only one factor in the model and estimating curvature is desirable. The values for factor C in Table 5-4 that are in parentheses (0.15, 0.25, 0.50) were used for INEL waste code 142 because this waste had a low density (approximately 0.4 g/mL), resulting in a large volume of material per unit of mass of waste that had to be wetted by the SPC; thus, the ratio of waste to SPC had to be reduced to accommodate favorable mixing conditions. Table 5-5 provides the design matrix to be used for each of the three waste types. Notice that there is complete replication that doubles the total number of monoliths to 12 (six for each waste type).

For each waste type, the homogeneity of the specimens assigned to the different solidification treatments was maximized through drum sample compositing, which was accomplished during sampling activities. Consistent preparation methods were achieved throughout the production of monoliths, which was largely due to having well established laboratory procedures at the onset of the study.

5.4.2 Actual Monolith Recipes

The actual recipes that were used for the monoliths produced under this study are given in Appendix C, where a specific concrete formulation is quantified for a given monolith identification code. The monolith identification system used in Appendix C is explained as follows, using an actual monolith identification:



where the hydraulic concrete recipe code/number portion may have an "HC" for hydraulic concrete (Portland cement), or an "HCA" for hydraulic concrete with an additive (Portland cement plus sodium silicate).

Table 5-5. Design matrix for each waste in the nonhydraulic cement portion of the study.

Level of C	Number of monoliths
1	2
2	2
3	2

5.4.3 Additional Solidification Not Included in Experimental Design Matrix

There was a small number of monoliths produced in addition to those made under the experimental design matrix. These additional monoliths solidified secondary end-of-process waste, such as rinsing waste generated during the cleaning of mixing equipment, and leftover sample material. Since these secondary wastes are not involved in the determination of optimal concrete recipes according to the design matrix specified above, discussion of them will not be included in the main body of this report. Rather, solidification of these wastes is discussed in Appendix D.

5.5 Technical Procedures

The chronological sequence of activities for bench-scale solidification of LDR mixed waste was as follows:

1. Waste sample retrieval
2. Pre-bench-scale waste characterization
3. Procurement of bench-scale equipment and materials*
4. Laboratory preparation at TRA*
5. Waste sample pretreatment*
6. Waste sample monolith formation and curing*
7. Analysis of monoliths (e.g., TCLP, free liquids)
8. Interpretation of results*
9. Interim storage of monoliths
10. Disposal of monoliths.

Those items denoted by an asterisk (*) are or were the responsibility of the author/performer. The remaining items were coordinated in part by the author, but not necessarily performed by the author.

5.5.1 Pretreatment of Waste Samples

Waste pretreatment may include one or more of the following: segregation, drying, mixing, neutralization, flocculation of free liquids, surfactant addition, etc. Pretreatment may be necessary to make a waste more compatible with a given solidification technique by increasing waste homogeneity and through canceling the inhibitive effects of particular waste constituents (e.g., acids, salts, or organic solvents). For this bench-scale study, pretreatment was primarily comprised of segregation/screening, size reduction of larger particles, mixing, and drying, and depended on the waste type and planned solidification treatment.

Segregated material larger than 1/2 in. that was representative of a given waste sample (dirt clods or clumps, rocks, etc.) was reduced in size by crushing it with a mortar and pestle. Mixing of the sample material prior to solidification was typically done in the original sample container or in a glass or plastic beaker. Drying of sample material was accomplished by placing the material in a large beaker or an aluminum-lined tray, which was then set on a hotplate overnight. The degree of dryness was checked by noting the weight change of the sample per unit of time.

Pretreatment was not treated as a systematic test parameter; however, it was viewed as an important consideration in the overall solidification process. Table 5-6 contains the pretreatment steps that were performed for each of the wastes listed in Table 2-2.

5.5.2 Laboratory Procedures

The methodology for this work involves the use of straightforward solids-handling and solidification techniques for low-level mixed waste, which includes sample retrieval and transport, waste pretreatment, monolith formation, monolith sampling, monolith storage, and monolith disposal. Since sample retrieval, transport, and sampling were done by auxiliary personnel other than the author, these tasks will not be discussed in this document.

Table 5-6. Pretreatment of the wastes in Table 2-2.

INEL waste identification number	124 (solid)	128 (solid)	128 (sludge)	142 (solid)	153 (solid)	157a (liquid)	157a (solid)	186 (solid)	B&W (sludge)
Segregation/screening	X	–	X	–	X	–	X	X	–
Size reduction	X	–	X	–	X	–	–	X	–
Drying	–	–	–	X	X	–	–	–	–
Mixing/blending	X	X	X	X	X	X	X	X	X
pH adjustment (raise pH to ≥7)	–	–	–	–	–	–	–	–	X
Precipitation of free metals	–	–	–	–	–	–	–	–	X
Surfactant addition	–	–	–	–	–	–	–	–	–

Bench-scale solidification was accomplished under controlled, supervised, and monitored conditions. The monoliths were formed inside containers (casts) that have an internal volume of approximately 1 L. For hydraulic-type concretes, monolith containers were made of high-density polyethylene (HDPE), whereas metal casts were used for SPC concretes. The use of metal containers is recommended for thermoplastic systems because of the higher temperatures that are encountered.

Solidification took place in situ, where the cement and waste were mixed and cast in the same container, forming a homogeneous concrete mixture. This practice helped to reduce waste generation during bench-scale studies. Mixing procedures for hydraulic and nonhydraulic systems are given below.

5.5.2.1 Hydraulic-Type Cements. These type of cements were used first since they require the longest curing time, which is usually at least 28 days for a "full" cure. The primary concern for these type of systems is attaining the optimal ratios of water to total solids and waste to cement. Although the literature gives some guidance for these ratios, optimal values are sometimes derived through trial and error.

For hydraulic systems, the general mixing procedure is summarized as follows. First, predetermined amounts of dry Portland cement and sodium silicate (if specified in the recipe) are weighed into a monolith container and mixed. Next, an appropriate amount of water is added to the container, and the resultant mixture is mixed by hand two to three minutes to an even consistency. A measured amount of each waste is then incrementally added to the cement mixture in the container while it is being mixed thoroughly with a heavy-duty laboratory stirrer. The entire concrete mixture is then mixed with the laboratory stirrer at 150–250 rpm for approximately 8 to 10 minutes. The procedure is finished by sealing the container, and then labeling and storing the container for the curing phase.

5.5.2.2 Sulfur Polymer Cement. Since SPC literally cures "overnight," its use was scheduled after the hydraulic cements. SPC handling and mixing procedures are provided in Appendix A. For large-scale applications, the equipment required for the SPC system is anticipated to be the most complicated of the cements considered here, as it is likely to involve the use of a specialized heated mixing vessel and heated monolith casts. Additionally, there is more safety concerns tied to the sulfur polymer thermoplastic system because of the danger associated with the heated material, and the potential liberation of small quantities of hydrogen sulfide (H_2S) gas at temperatures exceeding 300°F.[e] Levels of H_2S gas were monitored at the edge of the ventilation hood for two days during SPC monolith production, and no detectable amounts of this gas were recorded. The results of the H_2S monitoring are given in Appendix E.

5.5.3 Sequence of Waste Samples to be Solidified

The logical order in which the samples were solidified is based on the sequence of monolith curing discussed earlier in this section. That is, the monoliths were formed in the order: hydraulic cement systems, thermoplastic system. Relating this order to the wastes in Table 2-2,

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e. Personal communication with Wes Aldrich, EG&G Idaho, January 16, 1992.

the sequence of waste samples treated was as follows: INEL waste code 157(a) liquid, 128 sludge, B&W sludge, 124 solids, 128 solids, 186 solids, 157(a) solids, 142 solids, and 153 solids.

5.6 Monolith Curing, Storage, and Disposal

5.6.1 Monolith Curing

The ambient temperature and humidity of the monolith storage area was kept as near to room conditions as possible during the monolith curing phase, and these conditions were measured and recorded in the project notebook at regular intervals. Generally, the room temperature was between 68 and 80°F, and the relative humidity was between 15 and 60%. The monoliths were kept as undisturbed as possible for the duration of the curing phase.

Hydraulic concrete monoliths were allowed to cure at least 28 days before they were sampled. Monoliths made with SPC required only an overnight cure time, although there was typically at least a five-day period between SPC monolith production and sampling.

5.6.2 Monolith Storage

The overall storage requirements for the solidified monoliths are short term, which will be defined here as less than six months. Storage intervals can be described as follows:

- **Storage during curing.** Depends on the solidification system used. At least 28 days are required for most hydraulic systems to reach a "full" cure. However, it may be desirable to wait longer than 28 days for selected monoliths, since mechanical and chemical properties of hydraulic concretes generally improve with time.[4] Thermoplastic systems take far less time to cure than this.

- **Storage during analyses (TCLP, etc.).** Up to three months; this storage period depends on who will be doing the TCLP analyses and whether these analyses are performed on site or off site the INEL.

- **Storage for those monoliths that failed analyses.** Depends on how soon these monoliths can be re-treated, which has been estimated at less than six months from the time that the TCLP test results are determined.

5.6.3 Monolith Disposal

The monoliths that pass the disposal criteria tests will be reclassified from LDR mixed waste to low-level nonhazardous waste. Treated waste that meets disposal criteria will be disposed of via a low-level waste disposal facility such as the Radioactive Waste Management Complex (RWMC) at the INEL. Those monoliths that fail to meet the disposal criteria will be kept in an approved temporary low-level mixed waste storage area, and re-solidified or encapsulated at a later date.

5.7 Secondary Waste Management

Small amounts of secondary waste were generated during the course of bench-scale work, and were generally in the form of rinsing waste and contaminated paper towel waste. Near the end of this project, these wastes were divided into two categories: waste to be treated with Portland cement, and waste to be treated with SPC. These secondary wastes were solidified according to the treatment plan given in Table 5-7. The resultant monoliths were subjected to the same testing criteria as the monoliths produced under the experimental design matrix.

5.8 Scale-Up Considerations

One primary concern in scaling up the bench-scale methodology is to be able to duplicate the extent of mixing that was achieved during bench-scale work. Full-scale operations run the risk of not providing thorough enough mixing techniques to ensure that the concrete ingredients are truly homogeneous prior to the onset of the curing phase. Thus, an effort should be made to verify that intimate mixing is being achieved during full-scale mixing. The process notes given in the next section (see Table 6-1) should be reviewed during the design of the full-scale system.

Another concern for scale-up is the containment of radioactive particles that could become airborne during routine waste handling operations. During bench-scale solidification, airborne particulate matter was controlled through the use of ventilation hoods. However, since ventilation hoods are impractical for full-scale systems, secondary containment will need to be seriously considered for full-scale solidification of the mixed wastes investigated herein.

Table 5-7. Treatment plan for secondary mixed waste.

Secondary waste	Approximate amount	pH	Treatment	Estimated treated volume
Rinsing waste	1 L	11	Portland cement	3 L
Rinsing waste	1 L	8	Portland cement	3 L
Paper waste (rags)	800 mL, compressed	—	SPC macroencapsulation	
SPC waste	200 mL	—	SPC macroencapsulation	2 L
		TOTAL TREATED VOLUME:		8 L (2 gal)

NOTE: The rinsing waste was solidified into a single container, a 5-gal bucket that has a sealable lid. The SPC macroencapsulation was done using two 1-L metal cans.

6. RESULTS

6.1 General Observations

Overall monolith production for this project is summarized as follows. A total of 113 monoliths were made according to the experimental design matrix; 8 of these were "blanks" (contained no waste). Thus, 105 monoliths were used to solidify 21.6 kg of mixed waste; 92 were made with Portland cement systems, and 13 were made with SPC. Recipes for all monoliths are given in Appendix C. In addition, there were a small number of additional monoliths that solidified supplemental waste not included in the design matrix; recipes for these monoliths are also given in Appendix C, and the solidification results are discussed in Appendix D.

Of the wastes solidified during this study, two proved to be difficult to solidify, either during the mixing phase or the curing phase. These two wastes were INEL waste codes 128 (solids) and 142 (solids), and are discussed below.

INEL waste code 128 caused swelling in the Portland cement-based monoliths it was incorporated into; 2 of 15 monolith containers split because of the swelling. This may have been due to the high percentage of soluble solids that are present in this waste (see Table 2-6). Perhaps the swelling could be avoided by using SPC instead of Portland cement. However, SPC is not compatible with some salts (especially oxidizers), so a chemical analysis should be performed to determine the predominant cations and anions in this waste. It should be noted that the Portland cement-based monolith recipes for this waste that included 8% Na_2SiO_3 did not swell as much as the monoliths using no added Na_2SiO_3.

INEL waste code 142 appears to be better suited for Portland cement systems than SPC. There are two main reasons for this. First, this waste is roughly 50% water, so it is time- and energy-intensive to dry it prior to solidification with SPC. If solidified with Portland cement, this mixed waste would require no pretreatment aside from mixing and blending. Second, the dried waste has a relatively low density (about 0.4 g/cc), which tends to make it float to the top of molten SPC. This floating problem could be eliminated by using a Portland cement system with a higher viscosity than molten SPC.

In addition, INEL waste code 153, as sampled, contained a small amount of elemental mercury that apparently caused the solidified monoliths for this waste to exceed the RCRA limit for mercury. This elemental mercury was seen at the bottom of the container that was used to hold this waste during the drying pretreatment step, prior to solidification with SPC. Regardless of the full-scale solidification technique that will be used on this mixed waste, a pretreatment step should be used wherein the elemental mercury is effectively removed from the waste matrix. A gravity-based separation technique would be a good candidate for such a pretreatment step.

6.2 Process Considerations

Table 6-1 contains notes for each waste that detail difficulties or significant observations pertaining to the bench-scale processing of the waste listed in Table 2-2. These notes should be applicable to scale-up considerations.

Table 6-1. Bench-scale process notes for nonincinerable LDR mixed wastes.

INEL waste code	Special process notes
124 (solids)	Because of the clay content (roughly 20–35% of waste is clay-like material), it is recommended that the waste be granulated to smaller than 1/4 or 1/2 in. before solidification to decrease the size of the clay particles (as was done for bench-scale testing). This material is sometimes gummy, and mixing equipment should be self-cleaning if possible. The monolith formulation having the highest ratio of waste to cement and the lowest percentage of water was unworkable because of insufficient "free" water for mixing.
128 (sludge)	Because of the physical form of this waste (heavy solids in a liquid), process methods should be used that will prevent the solids from settling to the bottom portion of the concrete prior to curing. This can be accomplished by using upward mixing (moving material from bottom to top), and by using a concrete formulation that has a lower water content, which will result in a higher concrete viscosity. Because of the high moisture content of this waste (approximately 88% water by weight), some of the higher waste to cement ratios that were planned could not be attained without exceeding an upper limit of total percent water. This resulted in the deletion of 2 of 15 monolith formulations from the experimental design matrix.
128 (solids)	This mixed waste caused swelling of the monoliths that was incorporated into, most noticeably in monoliths having high percentages of both mixed waste and water. Two of the 15 monolith containers used for solidification of this waste split from the swelling. Since it is a high priority to choose concrete formulations that will not jeopardize the integrity of the containers that hold them, it is suggested that future monoliths made with this mixed waste be made with low percentages of mixed waste and/or low percentages of water. Also, this may be a good candidate for SPC if the mixed waste does not fracture the concrete matrices when it has opportunity to absorb water. This material had to be ground with a mortar and pestle to reduce the average particle size.

Table 6-1. (continued).

INEL waste code	Special process notes
142 (solids)	In hindsight, this waste would have been a perfect candidate for hydraulic-type systems rather than SPC. The relatively high moisture content of this material (approximately 49% water by weight) would have been acceptable for hydraulic concretes, where as it is a liability for SPC systems. Drying this mixed waste is both time- and energy-intensive, as it must be heated for a prolonged time (at least three to four hours for bench-scale applications). Another problem that arose was caused by the low density of this mixed waste, which caused it to rise to the top of the molten SPC; this problem could have been avoided by using a thicker, more viscous hydraulic-type cement.
153 (solids)	Because of the clay content (roughly 60–80% of waste is clay-like material), it is recommended that the waste be granulated to smaller than 1/4 or 1/2 in. before solidification to decrease the size of the clay particles (as was done for bench-scale testing). This material is sometimes gummy, and may tend to clog or stick to process equipment if used with hydraulic cement systems; thus, such equipment should be self-cleaning if possible. If used with SPC, the material should be dried thoroughly before or after the granulation step.
157(a) (liquid)	Because of high moisture content of this waste (approximately 98% water by weight), some of the higher waste to cement ratios that were planned could not be attained without exceeding an upper limit of total percent water. This resulted in the deletion of 2 of 15 monolith formulations from the experimental design matrix.
157(a) (solids)	At least 25–30% of the volume of this mixed waste was composed of rocks and pebbles that were larger than 1/2 in., which could not be processed through the bench-scale equipment. However, these larger rocks would not be a problem for full-scale solidification equipment. The low moisture content of this mixed waste (2% by weight) makes it a candidate for SPC.
186 (solids)	This material had to be ground with a mortar and pestle to reduce the average particle size.
B&W chromate sludge	No problems were encountered with the solidification of this mixed waste. It appears to be a good candidate for hydraulic-type cements.

6.3 Toxicity Characteristic Leaching Procedure (TCLP) Test Results

All waste-bearing monoliths were subjected to TCLP testing after they had undergone a curing period. TCLP data were generated by TCT-St. Louis Laboratories of St. Louis, Missouri, and were unvalidated and unqualified at the time this report was written.[21] Data validation and qualification will be performed according to project needs.

Of the six INEL waste codes listed in Table 2-2, two had toxic metals that exceeded their EPA/RCRA concentration limit [INEL codes: 124 solids and 157(a) liquids], where mercury and lead are the toxic metals of concern according to TCLP analyses of the raw waste. Thus, much of the treated, solidified sample material was tested only for lead and mercury during TCLP analysis. Recall from Table 3-1 that the EPA/RCRA treatment standards for lead and mercury are 5,000 and 200 μg/l, respectively. Table 6-2 contains the summary results for the TCLP analyses of the untreated and solidified monolithic waste material. The "After" results given in this table correspond to the concrete recipes (see recipe codes) that produce no free liquids, and that lower the leachability of toxic metals to the greatest extent while allowing the ratio of waste to Portland cement to remain high. Although their choice is somewhat subjective, those recipes indicated in Table 6-2 are the best recipes deduced by this study as far as leachability and free liquids are concerned.

The results in Table 6-2 indicate that solidification via Portland cement is a very effective means of immobilizing toxic metals, where monolith recipes having higher amounts of waste (waste/Portland cement=0.5 to 0.6) generally performed as well as those having lesser amounts (waste/Portland cement=0.2), using TCLP as a criterion. Such results infer that it may be possible to load the concrete with greater amounts of waste while passing TCLP tests and satisfying disposal criteria.

There were also a small number of monoliths that failed TCLP tests, wherein their concentrations exceeded the limits imposed by RCRA. Given the relatively broad experimental design matrix described in Tables 5-2 through 5-5, it should not be unexpected that some of the monoliths would fail one or more disposal criteria. The monolith recipes that failed TCLP are given in Table 6-3, where three monoliths for waste code 153 failed TCLP for mercury, and three monoliths for waste code 186 failed TCLP for cadmium. The results seen in Table 6-3 are unusual in that the untreated wastes for INEL waste codes 153 and 186 passed TCLP by a good margin, and yet the treated wastes for these codes produced some monoliths that failed TCLP. Such results are unexpected and counter-intuitive, as there seems to be no clear explanation for them.

However, there are a few possible explanations for why some of the monolith samples for INEL waste codes 153 and 186 failed TCLP tests while the untreated wastes passed. First, the laboratory results or procedures for the analysis of the metals of concern could be in error. Second, the concrete ingredients may have caused a chemically favorable environment for the leaching of the indicated metals in Table 6-3. Lastly, the pretreatment step(s) used for INEL waste codes 153 and 186 may have altered the waste matrix and caused it to be more susceptible to the effects of leaching. Pretreatment of INEL waste code 153 involved drying the moist waste over a hot plate at 300–350°F overnight, followed by size reduction to less than 1/2 in. via mortar

Table 6-2. Best TCLP results (μg/L) for LDR low-level mixed waste samples.

Metal		INEL waste identification number								
		124 (solid)	128 (sludge)	128 (solid)	142 (solid)	153 (solid)	157a (liquid)	157a (solid)	186 (solid)	B&W (sludge)
Mercury	Before	1,900[a]	0.15	0.1[b]	0.1[b]	95	920[a]	0.93	0.11	27.8
	After	0.1[b]	0.1[b]	0.1[b]	0.1[b]	85	0.1[b]	0.1[b]	0.1[b]	0.1[b]
	Recipe code	a	m	k	q	r	m	j	d	o
Lead	Before	7,080[a]	425	100[b]	100[b]	100[b]	1,430	100[b]	2,930	246
	After	22[b]	23	22[b]	22[b]	107	22[b]	78[b]	34	22[b]
	Recipe code	a	m	k	q	r	m	j	d	o

a. Indicates a value that exceeds the EPA/RCRA limit for that metal.

b. Indicates a value at or below the shown detection limit for that metal. Detection limits for a given metal may vary according to the instrument detection limit (IDL) of analytical instruments used on a given set of samples.

NOTE: "Before" and "After" are with respect to solidification treatment.

B&W results for Cr: Before = 105,000 μg/L; After = 19.0 μg/L. The RCRA limit for Cr is 5,000 μg/L.

Waste codes 142 and 153 were solidified with SPC.

Untreated samples of INEL waste codes 153 and 186 should be resubmitted for TCLP analysis.

Key of recipe codes (percentages shown are percent weight in concrete):

a = waste/Portland cement = 0.6; water = 36%; no added sodium silicate
b = waste/Portland cement = 0.4; water = 36%; no added sodium silicate
c = waste/Portland cement = 0.2; water = 36%; no added sodium silicate
d = waste/Portland cement = 0.6; water = 30%; no added sodium silicate
e = waste/Portland cement = 0.4; water = 30%; no added sodium silicate
f = waste/Portland cement = 0.2; water = 30%; no added sodium silicate
g = waste/Portland cement = 0.6; water = 36%; sodium silicate = 8%
h = waste/Portland cement = 0.4; water = 36%; sodium silicate = 8%
i = waste/Portland cement = 0.2; water = 36%; sodium silicate = 8%
j = waste/Portland cement = 0.6; water = 30%; sodium silicate = 8%
k = waste/Portland cement = 0.4; water = 30%; sodium silicate = 8%
l = waste/Portland cement = 0.2; water = 30%; sodium silicate = 8%
m = waste/Portland cement = 0.5; water = 36%; no added sodium silicate
n = waste/Portland cement = 0.5; water = 36%; sodium silicate = 8%
o = waste/Portland cement = 0.5; water = 30%; no added sodium silicate
p = waste/SPC = 0.75
q = waste/SPC = 0.50
r = waste/SPC = 0.25.

Table 6-3. Failed TCLP results (μg/L) for solidified mixed waste samples.

INEL waste code	Recipe code	Heavy metal concentration, μg/L			
		Mercury		Cadmium	
		Before	After	Before	After
153	p	95.0	737[a]	NA	NA
153	p	95.0	203	NA	NA
153	q	95.0	299	NA	NA
186	g	NA	NA	5.0[b]	5,895[a]
186	i	NA	NA	5.0[b]	1,200
186	j	NA	NA	5.0[b]	3,030

a. Indicates an average value derived from duplicate TCLP analyses.

b. Indicates a value at or below the shown detection limit for that metal. Detection limits for a given metal may vary according to the instrument detection limit (IDL) of analytical instruments used on a given set of samples.

NA — not applicable

NOTE: "Before" and "After" are with respect to solidification treatment.

Key of recipe codes (percentages shown are percent weight in concrete):

a = waste/Portland cement = 0.6; water = 36%; no added sodium silicate
b = waste/Portland cement = 0.4; water = 36%; no added sodium silicate
c = waste/Portland cement = 0.2; water = 36%; no added sodium silicate
d = waste/Portland cement = 0.6; water = 30%; no added sodium silicate
e = waste/Portland cement = 0.4; water = 30%; no added sodium silicate
f = waste/Portland cement = 0.2; water = 30%; no added sodium silicate
g = waste/Portland cement = 0.6; water = 36%; sodium silicate = 8%
h = waste/Portland cement = 0.4; water = 36%; sodium silicate = 8%
i = waste/Portland cement = 0.2; water = 36%; sodium silicate = 8%
j = waste/Portland cement = 0.6; water = 30%; sodium silicate = 8%
k = waste/Portland cement = 0.4; water = 30%; sodium silicate = 8%
l = waste/Portland cement = 0.2; water = 30%; sodium silicate = 8%
m = waste/Portland cement = 0.5; water = 36%; no added sodium silicate
n = waste/Portland cement = 0.5; water = 36%; sodium silicate = 8%
o = waste/Portland cement = 0.5; water = 30%; no added sodium silicate
p = waste/SPC = 0.75
q = waste/SPC = 0.50
r = waste/SPC = 0.25.

and pestle. INEL waste code 186 was pretreated by size reduction only. It is useful to note that all of the monolith recipes that failed TCLP for INEL waste code 186 contained added sodium silicate. The cause for the anomalous results in Table 6-3 should be found before full-scale solidification of these wastes is attempted.

The results in Tables 6-2 and 6-3 were used to derive the suggested concrete recipes for each mixed waste under this study, which are summarized in Table 6-4. The basis for each of the recipes in Table 6-4 is 100 lb of mixed waste. It should be noted that each recipe took into consideration the amount of moisture contained in each untreated waste, as well as the waters of hydration that are present in the additive $Na_2SiO_3 \cdot 5H_2O$ (if used). In so doing, the amount of total water in a concrete mixture can be known with good accuracy, or a desired percentage of water can be achieved with excellent precision. The recipes in Table 6-4 should perform very well for the full-scale solidification of the indicated waste codes if the mixed waste sample material used in this study is representative of the remaining bulk of these mixed wastes, currently stored at the INEL.

Table 6-4. Suggested concrete recipes for LDR nonincinerable mixed waste (basis: 100 lb mixed waste).

INEL waste identification number	Dry Portland cement (lb)	Water[a] to add lb (wt% to water)	$Na_2Si0_3 \cdot 5H_20$ to add, lb (wt% Na_2Si0_3)	Water in raw waste, as used to derive recipe (wt%)
124 (solid)	167	73.0 (36)	0	49.4
128 (sludge)	200	31.6 (36)	0	87.8
128 (solid)	250	133.8 (30)	78.1 (8)	1.6
142 (solid)	200 lb SPC	NA	NA	NA (49.0)
153 (solid)	400 lb SPC	NA	NA	NA (10.5)
157(a) (liquid)	200	15.6 (36)	0	98.0
157(a) (solid)	167	100.8 (30)	59.4 (8)	2.2
186 (solid)	167	85.6 (30)	0	20.2
B&W (sludge)	200	7.1 (30)	0	85.0

a. The amount of water that is added depends on the desired percentage of water in the concrete recipe, the wt% water (moisture) in the raw waste, and the waters of hydration present in the added $Na_2Si0_3 \cdot 5H_20$.

NA — not applicable.

NOTE: Waste codes 142 and 153 were solidified with SPC.

One final comment should be made concerning the TCLP results presented herein. As Table 2-2 indicates, only a small fraction of the untreated mixed waste samples tested via TCLP actually contain hazardous amounts of toxic metals, as defined by RCRA. This result implies that many of the drums that currently reside at the Mixed Waste Storage Facility actually contain nonhazardous low-level waste instead of low-level mixed waste. In order to confirm which drums truly contain low-level mixed waste, drum-wise sampling should be performed, and those drums containing nonhazardous low-level waste should be slated for disposal at the RWMC. In so doing, it may be possible to significantly decrease the number of drums in storage that are presumed to contain mixed waste.

6.4 Free Liquids Test Results

A free liquids test was performed on samples of the cured monoliths in accordance with EPA Method 9095, Paint Filter Liquids Test,[20] and the results indicate that none of the concrete formulations described above produced monoliths that had free liquids. However, there were a small number of monoliths that had a thin layer of liquid on the top surface, which is common for hydraulic-type systems. These monoliths are included in the following list of codes:

157A.S.HC1
157A.S.HC2
157A.S.HC3
157A.S.HC4
157A.S.HC1D
186.S.HC1
186.S.HC2
186.S.HC3
HC2B (blank).

Realistically, this liquid layer could be decanted and set aside for further treatment if it contains toxic amounts of heavy metals, then used as process or makeup water for other solidification work. It is worth noting that none of the formulations containing added sodium silicate contained such a liquid layer, as the sodium silicate appears to have effectively bound the excess water within the concrete matrices.

6.5 Radiological Screening of Monoliths

The monoliths that pass TCLP and free liquids tests are also required to satisfy radiation-related waste acceptance criteria (WAC) before they are disposed of into the RWMC at the INEL. Generally, treated waste forms must undergo a gamma ray screening (at container surface and 3 ft from surface), and must not contain transuranic components or fissionable materials that are in quantities that exceed the limits imposed by the WAC. Since the WAC radiation limits are sensitive to the prevailing political climate (and hence may change from time to time), the specific numbers will not be given here. However, the reader is encouraged to consult the INEL manual that addresses WAC at the RWMC.[22] Finally, the waste material investigated herein was determined to be low-level waste prior to solidification, thus the gamma and alpha activities of the

treated mixed waste monoliths can be postulated from the radiological testing done to the untreated mixed waste samples (see Sections 2.4, 2.5, and 2.6).

7. CONCLUSIONS AND RECOMMENDATIONS

This report has provided a summary description and evaluation of Portland cement-based and SPC-based solidification of mixed wastes generated at the INEL, as performed under a bench-scale RCRA treatability study. The basis of this evaluation is the ability of a given monolith recipe to satisfy pertinent disposal criteria, namely, TCLP and free liquids tests.

The results indicate that Portland cement systems can be used to successfully immobilize toxic metals in solid, liquid, and sludge mixed waste material. Of the 92 hydraulic monoliths produced under the experimental design matrix, only 3 failed TCLP criteria for the toxic metals of concern. Only 3 SPC-based monoliths failed TCLP. Concerning free liquids tests, no monoliths possessed free liquids as defined by EPA Method 9095 (Paint Filter Liquids Test).

The data presented herein indicate that the most favorable concrete formulations are waste-specific, but overall have the following general composition: the ratio of waste to dry Portland cement is 0.5 to 0.6, with 30–36 wt% water. This composition range takes into consideration the need to incorporate as much waste as possible into the monolithic form, thereby minimizing the solidified volume produced per unit of treated waste, while satisfying the waste disposal criteria for TCLP (RCRA metals) and free liquids. Such results infer that it may be possible to load the concrete with even greater amounts of waste while satisfying disposal criteria.

The addition of Na_2SiO_3 appears to be optional for most of the concrete formulations, considering the disposal criteria of passing TCLP and free liquids tests. This additive should be used only with good cause, as its use will result in greater treatment costs and greater disposal costs due to the small increase of the monolithic mass and volume that it causes. Finally, sodium silicate should not be added to concrete mixtures that contain INEL waste code 186, as it appears to promote the leaching of cadmium from this treated waste.

INEL waste code 142 appears to be better suited for Portland cement systems than SPC. This is largely due to the moisture content of this waste (roughly 50% water), which makes it more compatible with hydraulic-based systems. If solidified with Portland cement, this mixed waste would require no pretreatment aside from mixing and blending. Also, when INEL waste code 142 is dried, it has a relatively low density (about 0.4 g/cc), which tends to make it float to the top of molten SPC. This floating problem could be eliminated by using a Portland cement system with a higher viscosity than molten SPC.

INEL waste code 153, as sampled, contained a small amount of elemental mercury that apparently caused the solidified monoliths for this waste to exceed the RCRA limit for mercury. Regardless of the full-scale solidification technique that will be used on this mixed waste, a pretreatment step should be used wherein the elemental mercury is effectively removed from the waste matrix. A gravity-based separation technique would be a good candidate for such a pretreatment step.

Finally, this study is valuable in that it demonstrates which concrete recipes succeed in passing disposal criteria, and which ones fail. The recipes that fail serve to define a set of limiting conditions (here, the concrete formulation) that can be used as a baseline for future solidification of a particular waste. Monoliths can fail TCLP or free liquids tests because of one or more

reasons: (a) the untreated waste form could be unprepared for solidification (e.g., a soil that has elemental mercury), (b) the untreated waste form could be incompatible with the solidification technique, or (c) improper mixing or an errant recipe could produce a monolith that is chemically or mechanically unstable. A monolith recipe that fails one or more disposal criteria should be investigated further. For this study, treated samples of INEL waste codes 153 and 186 failed TCLP tests, along with the HGSOIL waste (see Appendix D). These wastes should undergo further bench-scale studies until optimal recipes are derived. Even though there are suggested recipes given in Table 6-4 for these two waste codes, these recipes may not be optimal, as they were the recipes determined by the particular experimental design matrix used for this treatability study. A different design matrix could produce optimal recipes that differ slightly from what are given herein.

8. REFERENCES

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Appendix A

SPC Handling Procedures

Appendix A

SPC Handling Procedures

Process Steps (as done for bench-scale solidification):

1. Gently heat moist waste to complete dryness, preferably overnight in an oven or on a hot plate.

2. Place the SPC into the melting pot; adjust the thermostat to achieve approximately 280–290°F, which should be monitored via a thermometer positioned in the molten SPC.

3. Into each monolith cast, weigh in a predetermined amount of dry waste.

4. Preheat monolith cast and contents to 280–290°F.

5. Once the SPC has melted and the temperature has become steady, transfer/weigh a given amount of SPC into a pre-heated monolith cast, which should be on a heat-resistant pad on the balance. It may be advantageous for mixing if only a portion of the prescribed waste is present in the monolith cast when the SPC is poured in.

6. Stir contents by hand for two to four minutes, stirring in any remaining pre-heated mixed waste material.

7. Pour in a thin SPC "cap" as a final seal if needed.

8. Set monoliths aside for hardening and cooling; label as needed.

Health and Safety Concerns:

1. All work should be done inside a negative pressure ventilation hood.

2. A H_2S and/or SO_2 monitor should be placed near the person doing the handling of the molten SPC.

3. Heat-resistant clothing should be used where needed. Heat-resistant gloves are recommended.

4. Avoid direct handling of heated surfaces. Use tools (e.g., tongs) to minimize the risk of burns.

5. Molten SPC should not be poured over "wet" waste, as the steam generated may initiate chemical reactions or cause spattering of the waste. Also, avoid mixing SPC with strong oxidizers, such as nitrate salts.

Appendix B

TCLP Results for Semivolatile Organics

1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

24MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002396

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7984

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #124, Solid

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 24MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002396

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7984

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{ INEL #124, Solid }

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	3	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

FORM I SV-2 1/87 Rev

SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

24MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002396

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7984

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{ INEL #124, Soil

Number TICs found: 16 CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	109604	PROPYL ESTER ACETIC ACID	3.22	50	J
2.		UNKNOWN	3.41	18	J
3.		UNKNOWN	3.60	470	J
4.	105544	ETHYL ESTER BUTANOIC ACID	4.31	120	J
5.		UNKNOWN	4.45	54	J
6.	638119	1-METHYLETHYL ESTER-BUTANOIC ACID	5.09	560	J
7.		UNKNOWN	7.90	190	J
8.		UNKNOWN	8.31	110	J
9.		UNKNOWN	8.75	130	J
10.		UNKNOWN	9.60	110	J
11.		ISOMER OF C5H4N4O	11.30	38	J
12.		ISOMER OF C12H9F	14.16	17	J
13.	118796	2,4,6,-TRIBROMO-PHENOL	17.82	49	J
14.		UNKNOWN	19.52	61	J
15.		UNKNOWN	23.77	38	J
16.		UNKNOWN	26.34	20	J
17.					
18.					
19.					
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1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 28MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002380

Sample wt/vol: 500 (g/ml) ML Lab File ID: >07956

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #128, Solid

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

28MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002380

Sample wt/vol: 500 (g/ml) ML Lab File ID: >07956

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#128, Solid}

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	11	BJ
117-84-0	Di-n-octylphthalate	11	BJ
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

28MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002380

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7956

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#128, Solid}

Number TICs found: 12

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.		ISOMER OF C7H13NO	8.33	18	J
2.		ISOMER OF C12H9F	10.77	31	J
3.		ISOMER OF C8H9C10	11.32	18	J
4.		UNKNOWN	12.20	27	J
5.		UNKNOWN	12.56	30	J
6.		ISOMER OF C15H240	12.86	21	J
7.		UNKNOWN	13.06	20	J
8.		UNKNOWN	14.20	30	J
9.		UNKNOWN	15.73	31	J
10.		UNKNOWN HYDROCARBON	19.70	28	J
11.		UNKNOWN	19.90	21	J
12.		ISOMER OF 1,2 BENZENEDICAR-BOXYLIC ACID	26.10	19	B J
13.					
14.					
15.					
16.					
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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

28MR2

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002382

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7959

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #128, Sludge

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	100	
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	46	
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	57	
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

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1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

28MR2

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002382

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7959

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#128, Sludge}

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	7	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

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SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

28MR2

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002382

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7959

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

Number TICs found: 9 CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L {#128, sludge}

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.		UNKNOWN HYDROCARBONE	3.53	35	J
2.		UNKNOWN	5.80	80	J
3.		UNKNOWN	6.13	20	J
4.	2613890	PHENYL-PROPANEDIOIC ACID	9.74	70	J
5.	291214	1,3,5,-TRITHIANE	9.87	31	J
6.		ISOMER OF C12H100	11.25	27	J
7.		ISOMER OF C12H100	11.35	360	J
8.		UNKNOWN	13.44	23	J
9.		UNKNOWN HYDROCARBON	19.69	17	J
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

42MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002393

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7983

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #142, Solid Q

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	100	
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	4	J
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	55	J
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

42MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002393

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7983

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#142, Solid}

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	7	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

42MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002393

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7983

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

Number TICs found: 20 CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L {#142, Solid}

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	109604	PROPYL ESTER ACETIC ACID	2.83	21	J
2.		ISOMER OF C7H1402	3.34	140	J
3.		UNKNOWN	3.82	30	J
4.		UNKNOWN	3.89	18	J
5.	105544	ETHYL ESTER BUTANOIC ACID	4.13	18	J
6.		ISOMER OF C7H1402	4.96	160	J
7.		UNKNOWN	5.88	37	J
8.		UNKMNOW	6.13	75	J
9.		UNKNOWN	6.30	17	J
10.	646071	4-METHYL PENTANOIC ACID	7.55	22	J
11.		UNKNOWN	8.43	34	J
12.		UNKNOWN	10.78	2400	J
13.	149575	2-ETHYL-HEXANOIC ACID	10.86	21	J
14.		UNKNOWN	12.61	100	J
15.		UNKNOWN	12.74	86	J
16.	501520	BENZENEPROPANOIC ACID	13.96	130	J
17.		UNKNOWN	14.74	100	J
18.	120321	4-CHLORO-2-(PHENYLMETHYL) PHENOL	21.02	180	J
19.		UNKNOWN	25.31	20	J
20.	78513	2-BUTOXY-,PHOSPHATE_ETHANOL	25.90	150	J
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					

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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

53MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002385

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7962

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #153, Solid

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

53MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002385

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7962

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#153, Solid}

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	6	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Diberzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

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SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

53MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002385

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7962

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

Number TICs found: 2

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L {#153, Solid}

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.		ISOMER OF C15H240	12.84	21	BJ
2.	123795	DIOCTYL ESTER HEXANEDIOIC ACID	21.97	18	J
3.					
4.					
5.					
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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

532MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002387

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7963

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

(#153, Duplicate

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

532MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002387

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7963

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1 (#153, Duplicate)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	11	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

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SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

532MR

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002387

Sample wt/vol: 500 (g/ml) ML Lab File ID: >07963

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/24/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L (#153, Duplicate)

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.					
2.					
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SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 57AMR1

Lab Name: TCT-ST.LOUIS Contract: ERFSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002391

Sample wt/vol: 500 (g/ml) ML Lab File ID: >07982

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

INEL #157(a), Solid

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NO.	COMPOUND		Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

57AMR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002391

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7982

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

{#157(a), Solid}

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	5	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

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SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

57AMR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002391

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7982

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 5 Dilution Factor: 1

Number TICs found: 7

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

{#157(a), Solid}

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	109604	PROPYL_ESTER_ACETIC_ACID	2.83	45	J
2.		UNKNOWN	3.10	32	J
3.		UNKNOWN	3.33	250	J
4.		UNKNOWN	4.04	22	J
5.	105544	ETHYL ESTER BUTANOIC ACID	4.11	40	J
6.		UNKNOWN	4.28	27	J
7.	638119	1-METHYLETHYL ESTER BUATNOIC ACID	4.95	370	J
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1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 86MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7973

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/29/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1

INEL #186, Solid

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 86MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7973

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/29/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1 {#186, Soil}

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	8	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyre e	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

86MR1

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: >07973

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 04/29/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1

Number TICs found: 3 CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L { #(86, Solid }

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.		UNKNOWN	9.33	31	J
2.	149575	2-ETHYL-HEXANOIC ACID	11.20	160	J
3.		ISOMER OF C15H240	17.02	17	J
4.					
5.					
6.					
7.					
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10.					
11.					
12.					
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1B

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.: 86MR1 RE

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: D7985

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1

(#186, Duplicate)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
108-95-2	Phenol	20	U
111-44-4	bis(2-Chloroethyl)Ether	20	U
95-57-8	2-Chlorophenol	20	U
541-73-1	1,3-Dichlorobenzene	20	U
106-46-7	1,4-Dichlorobenzene	20	U
100-51-6	Benzyl alcohol	20	U
95-50-1	1,2-Dichlorobenzene	20	U
95-48-7	2-Methylphenol	20	U
108-60-1	bis(2-Chloroisopropyl)ether	20	U
106-44-5	4-Methylphenol	20	U
621-64-7	N-Nitroso-di-n-propylamine	20	U
67-72-1	Hexachloroethane	20	U
98-95-3	Nitrobenzene	20	U
78-59-1	Isophorone	20	U
88-75-5	2-Nitrophenol	20	U
105-67-9	2,4-Dimethylphenol	20	U
65-85-0	Benzoic acid	100	U
111-91-1	bis(2-Chloroethoxy)methane	20	U
120-83-2	2,4-Dichlorophenol	20	U
120-82-1	1,2,4-Trichlorobenzene	20	U
91-20-3	Naphthalene	20	U
106-47-8	4-Chloroaniline	20	U
87-68-3	Hexachlorobutadiene	20	U
59-50-7	4-Chloro-3-methylphenol	20	U
91-57-6	2-Methylnaphthalene	20	U
77-47-4	Hexachlorocyclopentadiene	20	U
88-06-2	2,4,6-Trichlorophenol	20	U
95-95-4	2,4,5-Trichlorophenol	100	U
91-58-7	2-Chloronaphthalene	20	U
88-74-4	2-Nitroaniline	100	U
131-11-3	Dimethylphthalate	20	U
208-96-8	Acenaphthylene	20	U
606-20-2	2,6-Dinitrotoluene	20	U

1C

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EG&G SAMPLE NO.

86MR1 RE

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7985

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1

(#186, Duplicate)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
99-09-2	3-Nitroaniline	100	U
83-32-9	Acenaphthene	20	U
51-28-5	2,4-Dinitrophenol	100	U
100-02-7	4-Nitrophenol	100	U
132-64-9	Dibenzofuran	20	U
121-14-2	2,4-Dinitrotoluene	20	U
84-66-2	Diethylphthalate	20	U
7005-72-3	4-Chlorophenyl-phenyl ether	20	U
86-73-7	Fluorene	20	U
100-01-6	4-Nitroaniline	100	U
534-52-1	4,6-Dinitro-2-methylphenol	100	U
86-30-6	N-Nitrosodiphenylamine	20	U
101-55-3	4-Bromophenyl-phenylether	20	U
118-74-1	Hexachlorobenzene	20	U
87-86-5	Pentachlorophenol	100	U
85-01-8	Phenanthrene	20	U
120-12-7	Anthracene	20	U
84-74-2	Di-n-butylphthalate	20	U
206-44-0	Fluoranthene	20	U
129-00-0	Pyrene	20	U
85-68-7	Butylbenzylphthalate	20	U
91-94-1	3,3'-Dichlorobenzidine	40	U
56-55-3	Benzo(a)anthracene	20	U
218-01-9	Chrysene	20	U
117-81-7	bis(2-Ethylhexyl)phthalate	11	BJ
117-84-0	Di-n-octylphthalate	20	U
205-99-2	Benzo(b)fluoranthene	20	U
207-08-9	Benzo(k)fluoranthene	20	U
50-32-8	Benzo(a)pyrene	20	U
193-39-5	Indeno(1,2,3-cd)pyrene	20	U
53-70-3	Dibenzo(a,h)anthracene	20	U
191-24-2	Benzo(g,h,i)perylene	20	U

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EPA SAMPLE NO.

86MR1 RE

SEMI-VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

Lab Name: TCT-ST.LOUIS Contract: ERPSOW90

Lab Code: TCT Case No.: SOW90 SAS No.: SDG No.: 24MR1

Matrix: (soil/water) WATER Lab Sample ID: 92002398

Sample wt/vol: 500 (g/ml) ML Lab File ID: >D7985

Level: (low/med) LOW Date Received: 04/10/92

% Moisture: not dec. dec. Date Extracted: 04/16/92

Extraction: (Sepf/Cont/Sonc) SEPF Date Analyzed: 05/01/92

GPC Cleanup: (Y/N) N pH: 12 Dilution Factor: 1

Number TICs found: 3

CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

(#186, Duplicate)

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.		UNKNOWN	3.11	41	J
2.		UNKNOWN	4.23	23	J
3.	149575	2-ETHYL-HEXANOIC ACID	10.67	160	J
4.					
5.					
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Appendix C

Summary of Monolith Recipes

MW Treated to Date 8/25/92:
21,396 g → (21.6 kg)

Summary of Monolith Recipes: Hydraulic and Non-hydraulic Cements

I. Hydraulic Cements: Portland Cement (PC)-Based

INEL Waste ID 157(a) (Liquid - 98% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
157A.L.HC1 6/1/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [35.4] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 300 [304] Added Water = 38 [34] Na-Silicate* = 0
157A.L.HC2 6/1/92	Waste/Dry PC = 0.4 Water (wt%) = 36 [35.5] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 240 [241] Added Water = 98 [97] Na-Silicate* = 0
157A.L.HC3 6/1/92	Waste/Dry PC = 0.2 Water (wt%) = 36 [35.8] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 120 Added Water = 218 Na-Silicate* = 0
157A.L.HC4 6/2/92	Waste/Dry PC = 0.4 Water (wt%) = 30 [29.5] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 240 Added Water = 18 Na-Silicate* = 0
157A.L.HC5 6/2/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.8] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 120 Added Water = 138 Na-Silicate* = 0
157A.L.HC1D 6/2/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [35.4] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 300 [301] Added Water = 38 [37] Na-Silicate* = 0
157A.L.HC4D 6/2/92	Waste/Dry PC = 0.4 Water (wt%) = 30 [29.4] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 240 [239] Added Water = 18 Na-Silicate* = 0
157A.L.HCA1 6/4/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [35.5] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 300 [301] Added Water = 22 Na-Silicate* = 149

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 157(a) (Liquid) 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
157A.L.HCA2 6/4/92	Waste/Dry PC = 0.4 Water (wt%) = 36 [35.6] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 240 Added Water = 83 Na-Silicate* = 149
157A.L.HCA3 6/4/92	Waste/Dry PC = 0.2 Water (wt%) = 36 [35.7] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 120 Added Water = 202 Na-Silicate* = 149
157A.L.HCA4 6/4/92	Waste/Dry PC = 0.4 Water (wt%) = 30.5 [30.0] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 240 Added Water = 0 Na-Silicate* = 136
157A.L.HCA5 6/4/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.7] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 120 Added Water = 113 Na-Silicate* = 135
157A.L.HCA5D 6/4/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.7] Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 120 Added Water = 113 Na-Silicate* = 135
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 2706 g treated

INEL Waste ID 128 (Sludge, 88% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
128.SL.HC1 6/10/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [34.1] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 150 Added Water = 37 Na-Silicate* = 0
128.SL.HC2 6/10/92	Waste/Dry PC = 0.4 Water (wt%) = 36 [34.9] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 120 Added Water = 63 Na-Silicate* = 0
128.SL.HC3 6/10/92	Waste/Dry PC = 0.2 Water (wt%) = 36 [35.5] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 60 Added Water = 116 Na-Silicate* = 0
128.SL.HC4 6/10/92	Waste/Dry PC = 0.4 Water (wt%) = 30 [29.4] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 120 [119] Added Water = 23 [26] Na-Silicate* = 0
128.SL.HC5 6/10/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.5] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 60 Added Water = 76 Na-Silicate* = 0
128.SL.HC1D 6/10/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [34.7] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 150 Added Water = 37 Na-Silicate* = 0
128.SL.HC4D 6/10/92	Waste/Dry PC = 0.4 Water (wt%) = 30 [29.0] Na-Silicate (wt%) = 0	Dry PC = 300 Waste = 120 Added Water = 23 Na-Silicate* = 0
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 128 (sludge) 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
128.SL.HCA1 6/11/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [34.8] Na-Silicate (wt%) = 8 [7.7]	Dry PC = 300 Waste = 150 Added Water = 29 Na-Silicate* = 74
128.SL.HCA2 6/11/92	Waste/Dry PC = 0.4 Water (wt%) = 36 [35.1] Na-Silicate (wt%) = 8 [7.7]	Dry PC = 300 Waste = 120 Added Water = 56 Na-Silicate* = 74
128.SL.HCA3 6/11/92	Waste/Dry PC = 0.2 Water (wt%) = 36 [35.5] Na-Silicate (wt%) = 8 [7.9]	Dry PC = 300 Waste = 60 Added Water = 108 Na-Silicate* = 74
128.SL.HCA4 6/11/92	Waste/Dry PC = 0.4 Water (wt%) = 30 [29.1] Na-Silicate (wt%) = 8 [7.7]	Dry PC = 300 Waste = 120 Added Water = 11 Na-Silicate* = 67
128.SL.HCA5 6/11/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.6] Na-Silicate (wt%) = 8 [7.9]	Dry PC = 300 Waste = 60 Added Water = 64 Na-Silicate* = 67
128.SL.HCA5D 6/11/92	Waste/Dry PC = 0.2 Water (wt%) = 30 [29.6] Na-Silicate (wt%) = 8 [7.9]	Dry PC = 300 Waste = 60 Added Water = 64 Na-Silicate* = 67
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 1349g + residual H2O

INEL Waste ID ___ B&W Cr-Sludge (85% H_2O) 1/1

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
BW.SL.HC1 6/15/92	Waste/Dry PC = 0.25 Water (wt%) = 30 [29.3] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 150 Added Water = 130 Na-Silicate* = 0
BW.SL.HC1D 6/15/92	Waste/Dry PC = 0.25 Water (wt%) = 30 [29.3] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 150 Added Water = 130 Na-Silicate* = 0
BW.SL.HC2 6/16/92	Waste/Dry PC = 0.5 Water (wt%) = 30 [28.5] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 300 Added Water = 2 Na-Silicate* = 0
BW.SL.HC3 6/16/92	Waste/Dry PC = 0.25 Water (wt%) = 36 [35.2] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 150 Added Water = 210 Na-Silicate* = 0
BW.SL.HC4 6/16/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [34.4] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 300 Added Water = 83 Na-Silicate* = 0
BW.SL.HC4D 6/16/92	Waste/Dry PC = 0.5 Water (wt%) = 36 [34.4] Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 300 Added Water = 83 Na-Silicate* = 0
BW.SL.BLANK1 6/16/92	Waste/Dry PC = 0 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 0 Added Water = 257 Na-Silicate* = 0
BW.SL.BLANK2 6/16/92	Waste/Dry PC = 0 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 0 Added Water = 338 Na-Silicate* = 0

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 1350 g

INEL Waste ID 124 (Solids, 48% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
124.S.HC1 6/25/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 420 Added Water = 315 Na-Silicate* = 0
124.S.HC2 6/25/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 341 Na-Silicate* = 0
124.S.HC3 6/25/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 140 Added Water = 368 Na-Silicate* = 0
124.S.HC4 6/24/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 420 Added Water = 192 Na-Silicate* = 0
124.S.HC5 7/7/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 228 Na-Silicate* = 0
124.S.HC6 7/7/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 140 Added Water = 264 Na-Silicate* = 0
124.S.HC1D 7/7/92	Waste/Dry PC = 0.6 Water (wt%) = 36 [36.8] Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 420 [421] Added Water = 315 [334] Na-Silicate* = 0
124.S.HC5D 7/7/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 228 Na-Silicate* = 0

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 124 (Solids) 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
124.S.HCA1 7/8/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 360 Added Water = 250 Na-Silicate* = 195
124.S.HCA2 7/8/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 240 Added Water = 274 Na-Silicate* = 180
124.S.HCA3 7/9/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 120 Added Water = 298 Na-Silicate* = 164
124.S.HCA4 7/9/92	Waste/Dry PC = 0.6 [0] Water (wt%) = 30 [23.2] Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 0 Added Water = 133 [137] Na-Silicate* = 177
124.S.HCA5 7/9/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 240 Added Water = 166 Na-Silicate* = 163
124.S.HCA6 7/9/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 120 Added Water = 200 Na-Silicate* = 149
124.S.HCA6D 7/9/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 600 Waste = 120 Added Water = 200 Na-Silicate* = 149
	Waste/Dry PC = Water (wt%) = Na-Silicate = (wt%)	Dry PC = Waste = Added Water = Na-Silicate* =

Unworkable Recipe; Too dry

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 355 g Hexalum Mix

INEL Waste ID 128 (Solids, ~2% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
128.S.HC1 7/15/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 441 Na-Silicate* = 0
128.S.HC2 7/15/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 388 Na-Silicate* = 0
128.S.HC3 7/15/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 100 Added Water = 334 Na-Silicate* = 0
128.S.HC4 7/15/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 334 Na-Silicate* = 0
128.S.HC5 7/15/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 244 Na-Silicate* = 0
128.S.HC6 7/15/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 100 Added Water = 254 Na-Silicate* = 0
128.S.HC1D 7/15/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 441 Na-Silicate* = 0
128.S.HC5D 7/15/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 294 Na-Silicate* = 0

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 128 (Solids) 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
128.S.HCA1 7/16/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 300 Added Water = 421 Na-Silicate* = 197
128.S.HCA2 7/16/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 200 Added Water = 370 Na-Silicate* = 173
128.S.HCA3 7/16/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 319 Na-Silicate* = 148
128.S.HCA4 7/16/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 300 Added Water = 303 Na-Silicate* = 178
128.S.HCA5 7/16/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 200 Added Water = 266 Na-Silicate* = 156
128.S.HCA6 7/16/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 230 Na-Silicate* = 134
128.S.HCA6D 7/16/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 230 Na-Silicate* = 134
	Waste/Dry PC = Water (wt%) = Na-Silicate = (wt%)	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 3000 g total

INEL Waste ID 186 (Solids, ~20% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
186.S.HC1 7/23/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 356 Na-Silicate* = 0
186.S.HC2 7/23/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 331 Na-Silicate* = 0
186.S.HC3 7/23/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 100 Added Water = 306 Na-Silicate* = 0
186.S.HC4 7/23/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 257 Na-Silicate* = 0
186.S.HC5 7/23/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 243 Na-Silicate* = 0
186.S.HC6 7/23/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 100 Added Water = 229 Na-Silicate* = 0
186.S.HC1D 7/23/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 300 Added Water = 356 Na-Silicate* = 0
186.S.HC5D 7/23/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 500 Waste = 200 Added Water = 243 Na-Silicate* = 0

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 186 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
186.S.HCA1 8/3/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 8	Dry PC = 500 Waste = 300 Added Water = 338 Na-Silicate* = 184
186.S.HCA2 8/3/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate (wt%) = 8	Dry PC = 500 Waste = 200 Added Water = 315 Na-Silicate* = 164
186.S.HCA3 8/3/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate (wt%) = 8	Dry PC = 500 Waste = 100 Added Water = 292 Na-Silicate* = 144
186.S.HCA4 8/4/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate (wt%) = 8	Dry PC = ~~500~~ 300 Waste = ~~300~~ 180 Added Water = ~~228~~ 137 Na-Silicate* = ~~166~~ 100
186.S.HCA5 8/4/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 8	Dry PC = 500 300 Waste = 200 120 Added Water = 217 130 Na-Silicate* = 148 89
186.S.HCA6 8/4/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 8	Dry PC = ~~500~~ 300 Waste = ~~100~~ 60 Added Water = ~~205~~ 123 Na-Silicate* = ~~130~~ 78
186.S.HCA6D 8/4/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 8	Dry PC = ~~500~~ 300 Waste = ~~100~~ 60 Added Water = ~~205~~ 123 Na-Silicate* = ~~130~~ 78
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

Σ = 2720 g

INEL Waste ID 157(a) (Solids : ~2% H_2O) 1/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
157A.S.HC1 8/10/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 420 Added Water = 617 Na-Silicate* = 0
157A.S.HC2 8/10/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 543 Na-Silicate* = 0
157A.S.HC3 8/10/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 140 Added Water = 468 Na-Silicate* = 0
157A.S.HC4 8/10/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 420 Added Water = 468 Na-Silicate* = 0
157A.S.HC5 8/10/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 412 Na-Silicate* = 0
157A.S.HC6 8/11/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 140 Added Water = 356 Na-Silicate* = 0
157A.S.HC1D 8/11/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 360 Added Water = 529 Na-Silicate* = 0
157A.S.HC5D 8/11/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 412 Na-Silicate* = 0

* as $Na_2SiO_3 \cdot 5H_2O$

INEL Waste ID 157(a) (Solids) 2/2

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
157A.S.HCA1 8/12/92	Waste/Dry PC = 0.6 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 300 Added Water = 421 Na-Silicate* = 197
157A.S.HCA2 8/12/92	Waste/Dry PC = 0.4 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 200 Added Water = 370 Na-Silicate* = 173
157A.S.HCA3 8/12/92	Waste/Dry PC = 0.2 Water (wt%) = 36 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 319 Na-Silicate* = 148
157A.S.HCA4 8/12/92	Waste/Dry PC = 0.6 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 300 Added Water = 303 Na-Silicate* = 178
157A.S.HCA5 8/12/92	Waste/Dry PC = 0.4 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 200 Added Water = 266 Na-Silicate* = 156
157A.S.HCA6 8/12/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 230 Na-Silicate* = 134
157A.S.HCA6D 8/12/92	Waste/Dry PC = 0.2 Water (wt%) = 30 Na-Silicate = 8 (wt%)	Dry PC = 500 Waste = 100 Added Water = 230 Na-Silicate* = 134
	Waste/Dry PC = Water (wt%) = Na-Silicate = (wt%)	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

$\Sigma = 3620$ g

INEL Waste ID "BLANKS" (No Waste)**

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
HC3-B 5/22/92	Waste/Dry PC = 0 Water (wt%) = 30 Na-Silicate (wt%) = 0	Dry PC = Waste = 0 Added Water = Na-Silicate* = 0
HC4-B 5/26/92	Waste/Dry PC = 0 Water (wt%) = 36 Na-Silicate (wt%) = 0	Dry PC = Waste = 0 Added Water = Na-Silicate* = 0
HCA2-B 5/27/92	Waste/Dry PC = 0 Water (wt%) = 30 Na-Silicate (wt%) = 8	Dry PC = Waste = 0 Added Water = Na-Silicate* =
HCA3-B 5/28/92	Waste/Dry PC = 0 Water (wt%) = 36 Na-Silicate (wt%) = 8	Dry PC = Waste = 0 Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

** There were other BLANKS made, but these are the ones of concern -

II. Non-hydraulic Cement (Sulfur Polymer Cement)

INEL Waste ID 142 1/1

Monolith ID, date formed	Intended Composition* [actual]	Ingredients, grams [actual]
"TRIAL" 8/19/92	Waste/SPC = 0.145	SPC = 620 Waste = 90
142.S.SPC1 8/20/92	Waste/SPC = 0,5 [0.47]	SPC = 600 [638] Waste = 300
142.S.SPC2 8/20/92	Waste/SPC = 0.25 [0.245]	SPC = 600 [612] Waste = 150
142.S.SPC3 8/20/92	Waste/SPC = 0.15 [0.145]	SPC = 600 [619] Waste = 90
142.S.SPC1D 8/20/92	Waste/SPC = 0.5 [0.473]	SPC = 600 [634] Waste = 300
142.S.SPC2D 8/20/92	Waste/SPC = 0,25 [0.24]	SPC = 600 [625] Waste = 150
142.S.SPC3D 8/20/92	Waste/SPC = 0.15 [0.145]	SPC = 600 [619] Waste = 90
"BLANK" 8/18/92	Waste/SPC = 0	SPC = 1000 Waste = 0
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =

* ratio considers dry waste only.

Σ = 1170 g ~~treated~~ MW

INEL Waste ID 153 1/1

Monolith ID, date formed	Intended Composition* [actual]	Ingredients, grams [actual]
153.S.SPC1 8/25/92	Waste/SPC = 0.75	SPC = 700 Waste = 525
153.S.SPC2 8/25/92	Waste/SPC = 0.5	SPC = 700 Waste = 350
153.S.SPC3 8/25/92	Waste/SPC = 0.25	SPC = 700 Waste = 175
153.S.SpC1D 8/25/92	Waste/SPC = 0.75	SPC = 700 Waste = 525
153.S.SPC2D 8/25/92	Waste/SPC = 0.5	SPC = 700 Waste = 350
153.S.SPC3D 8/25/92	Waste/SPC = 0.25	SPC = 700 Waste = 175
"BLANK 2" 8/25/92	Waste/SPC = 0	SPC = ? - Not Waste = 0 Important
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =

* ratio considers dry waste only.

Σ = 2100 g

Treatment of Secondary Wastes

(Assumed waste composite was 67% H_2O) p 1/2

INEL Waste ID ___ Rinsing Waste & Sludges from Solidification & IX studies

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]
RINSE.SL.HCAL 9/2/92	Waste/Dry PC = 0.6 Water (wt%) = 33 [33.7] Na-Silicate (wt%) = 8 [7.44]	Dry PC = 4880g Waste = 2928 Added Water = 723 [823] Na-Silicate* = 1378 [1381]
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =

* as $Na_2SiO_3 \cdot 5H_2O$

Treatment of Secondary Wastes

p 2/2

INEL Waste ID ____ Paper Rags & Scrap SPC contaminated w/MW.

Monolith ID, date formed	Intended Composition* [actual]	Ingredients, grams [actual]
RAGS.SPC1 9/3/92	Waste/SPC = 0.123	SPC = 1220 Waste = 150**
RAGS.SPC2 9/3/92	Waste/SPC = 0.123	SPC = 1220 Waste = 150**
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =
	Waste/SPC =	SPC = Waste =

* ratio considers dry waste only.

** The 150g was composed of : 81g rags + 69g SPC waste -

Additional Monoliths : Those not covered by the bench-scale design matrix for Solidification.

INEL Waste ID ____ 1/1

Monolith ID, date formed	Intended Composition [actual]	Ingredients, grams [actual]	
For D. Haefner: IETVP.L. HCA1 9/9/92	Waste/Dry PC = 0.4 Water (wt%) = 33 Na-Silicate (wt%) = 8	Dry PC = 828 Waste = 331 Added Water = 73 Na-Silicate* = 199	Assumes Waste is 95% H_2O
For D. Haefner: FILE8.SL. HCA1 9/9/92	Waste/Dry PC = 0.4 Water (wt%) = 33 Na-Silicate (wt%) = 8	Dry PC = 650 Waste = 260 Added Water = 76 Na-Silicate* = 159	Assumes Waste is 90% H_2O
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =	
For D. Tyson: HGSOIL.SL. HC1 9/30/92	Waste/Dry PC = 0.4 Water (wt%) = 33 Na-Silicate (wt%) = 0	Dry PC = 700 Waste = 280 Added Water = 240 Na-Silicate* = 0	Determine Waste to be 58% H_2O
For D. Tyson: HGSOIL.SL. HC2 9/30/92	Waste/Dry PC = 0.6 Water (wt%) = 33 Na-Silicate (wt%) = 0	Dry PC = 600 Waste = 360 Added Water = 161 Na-Silicate* = 0	
For D. Tyson: HGSOIL.SL. HCA1 9/30/92	Waste/Dry PC = 0.4 Water (wt%) = 33 Na-Silicate (wt%) = 8	Dry PC = 700 Waste = 280 Added Water = 213 Na-Silicate* = 193	
For D. Tyson: HGSOIL.SL. HCA2 9/30/92	Waste/Dry PC = 0.6 Water (wt%) = 33 Na-Silicate (wt%) = 8	Dry PC = 600 Waste = 360 Added Water = 136 Na-Silicate* = 177	
	Waste/Dry PC = Water (wt%) = Na-Silicate (wt%) =	Dry PC = Waste = Added Water = Na-Silicate* =	

* as $Na_2SiO_3 \cdot 5H_2O$

Appendix D

Additional Solidification Not Included in Experimental Design Matrix

Appendix D

Additional Solidification Not Included in Experimental Design Matrix

In addition to the mixed wastes investigated through the experimental design matrix of this bench scale study, there are other mixed or hazardous wastes that could be treated by solidification with Portland cement.[27] These include EDTA-laden liquid wastes, IET valve pit waste, File 8 sludges, plating solution wastes, many wastes currently residing at the Mixed Waste Storage Facility (MWSF), and any other waste that would exhibit favorable compatibility with Portland cement.

Some of these one-of-a-kind wastes were investigated by this study, where Portland cement and SPC were used to solidify small samples of this low-level MW material, which included rinsing and paper towel wastes from the bench-scale solidification experiments, IET Valve Pit waste liquid, File 8 waste sludge, and mercury-contaminated sludge leftover from an amalgamation study.[29] The same solidification methodology was used on these MW samples as was used on the waste samples discussed in the main body of this report. The solidification results for these additional mixed wastes are discussed and summarized below. The recipes for the monoliths mentioned below are given in Appendix C.

Monolith ID: RINSE.SL.HCA1
Waste Source: Rinsing waste accumulated during bench-scale solidification study.
Solidification Method: Portland cement with added sodium silicate.
TCLP Before Solidification: Not Done.
TCLP After Solidification: 190 µg/l Hg (average from duplicate analyses: 282 and 98 µg/l).

Monolith ID: RAGS.SPC1, RAGS.SPC2
Waste Source: Paper towel and SPC waste accumulated during bench-scale solidification study.
Solidification Method: SPC.
TCLP Before Solidification: Not Done.
TCLP After Solidification: RAGS.SPC1: 78 µg/l Pb (DL), 0.1 µg/l Hg (DL)*
RAGS.SPC2: 78 µg/l Pb (DL), 0.4 µg/l Hg.

Monolith ID: IETVP.L.HCA1
Waste Source: IET Valve Pit liquid waste.
Solidification Method: pH adjustment; Portland cement with added sodium silicate.
ICP* Before Solidification: 16,000 to 18,000 µg/l Pb, 800 to 1,500 µg/l Hg.
TCLP After Solidification: 78 µg/l Pb (DL), 0.1 µg/l Hg (DL).

* ICP = Induced Coupled Plasma analysis; performed at the INEL.
DL = Detection Limit.

Monolith ID: FILE8.SL.HCA1
Waste Source: File 8 sludge waste.
Solidification Method: Portland cement with added sodium silicate.
TCLP Before Solidification: 910,000 µg/l Pb, 128 µg/l Hg.
TCLP After Solidification: 146 µg/l Pb, 0.31 µg/l Hg.

Monolith ID: HGSOIL.SL.HC1, HGSOIL.SL.HC2, HGSOIL.SL.HCA1, HGSOIL.SL.HCA2
Waste Source: mercury-contaminated soil/sludge leftover from an amalgamation study.[29]
Solidification Method: Precipitation, then Portland cement with and without added sodium silicate.
TCLP Before Solidification: Not Done.
TCLP After Solidification: HGSOIL.SL.HC1: 29,300 µg/l Hg
HGSOIL.SL.HC2: 11,200 µg/l Hg
HGSOIL.SL.HCA1: 17,100 µg/l Hg
HGSOIL.SL.HCA2: 18,100 µg/l Hg

It is seen that all of the above monoliths passed TCLP for the toxic metals of concern, except the monoliths that are part of the "HGSOIL" group. The untreated waste used for the HGSOIL monoliths was a diverse, sludge-like mixture of soil, organic matter (twigs, leaves, etc.), water, and elemental mercury. An initial attempt had been made to acidify the elemental mercury in this material to transform the mercury into the ionic form which could then be chemically precipitated. However, a small amount of elemental mercury still remained in the acidified mixture, which is suspected to have caused the HGSOIL monoliths to exceed RCRA limits for mercury. If similar waste forms are encountered in the future, a pretreatment scheme should be developed that would remove most of the elemental mercury. Perhaps a gravity-based separation would be ideally suited for such a scenario.

Appendix E

Results of Hydrogen Sulfide Monitoring

EG&G Idaho

"Providing research and development services to the government"

INTEROFFICE CORRESPONDENCE

Date: October 8, 1992

To: K. L. Martin, MS 7113
J. J. McCarthy, MS 3505

From: J. M. Erickson, MS 2113 JME

Subject: MONITORING RESULTS AT TRA - JME-23-92
(During use of Sulfur Polymer Cement)

Activity

Monitoring was conducted on August 20 and September 3, 1992, during the Solidification of Non-Incinerable LDR Mixed Wastes Experiment conducted at TRA 661 in lab 129. The monitoring was to verify the class A hood's adequacy in protecting the worker conducting the experiment and to assess his exposure to Hydrogen Sulfide. This experiment was reviewed by the ISRG, but no JHA was written. A description of the experiment can be found in the ISRG document. A concern was indicated in the document for the potential liberation of Hydrogen Sulfide gas at elevated temperatures in the experiment.

Long duration colormetric Drager tubes specific for Hydrogen Sulfide were used in line with a low flow pump and placed on the outside of the sash of the hood near the employee's breathing zone to assess a worst case exposure (Employee with face directly at sashes opening for entire sample period). The employee wore a lab coat, safety glasses, and gloves during the experiment. The employee normally wore surgical gloves, but when potential for skin exposure was increased by the activity, Anti-C gloves were also used in conjunction with the surgical gloves.

Monitoring Results and Conclusions

The employee involved in the experiment and the monitoring results are indicated in the attached table. As can be seen in the results table, no hydrogen sulfide was detected outside of the class A hood. It is recommended that the sampling results be communicated to the employee who was involved in the activity and other employees within your organization who may perform the same or similar operations.

If you have any questions on the sampling results or need more details on the sampling performed, please contact me at 6-9185.

Attachment:
As Stated

JME:emc

cc: (with Attach)
S&T Industrial Hygiene File
Central Files, MS 1651

(w/o Attach)
D. E. Ardary, MS 2113 DEA
D. R. Quigley, MS 2215
Letter File (2)

Limited Access

MONITORING RESULTS TABLE 1

The employee represented by the monitoring is K. L. Gering, [redacted].

Sample Date Sample Number	Monitored Agent	Results - PPM*	Limit in PPM TLV/PEL**
8-20-92 0198701	Hydrogen Sulfide	None Detected	10 (PEL)
9-03-92 0198901	Hydrogen Sulfide	None Detected	10 (PEL)
9-03-92 0198902	Hydrogen Sulfide	None Detected	10 (PEL)

* Parts Per Million in air.

**Limit listed is the lower of the O.S.H.A. Permissible Exposure Limit (PEL) or the ACGIH Threshold Limit Value (TLV).

END

DATE
FILMED
7/19/93