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Test Plan for Immobilization of Salt-containing Surrogate Mixed Wastes Using Polyester Resins

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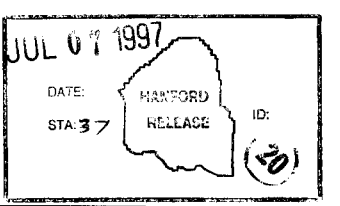
Abstract: This document provides the test plan for the preparation of surrogate mixed wastes and their immobilization using polyester resins. The solidified waste forms will be subjected to physical property tests, including a modified ANSI 16.1 leach test, TCLP (Toxicity Characteristic Leaching Procedure) and compressive strength. Waste loadings and waste volume increases will be documented.



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1.0 INTRODUCTION

Past operations at many Department of Energy (DOE) sites have resulted in the generation of several waste streams with high salt content. These wastes contain listed and characteristic hazardous constituents and are radioactive. The salts contained in the wastes are primarily chloride, sulfate, nitrate, metal oxides, and hydroxides. DOE has placed these types of wastes under the purview of the Mixed Waste Focus Area (MWFA). The MWFA has been tasked with developing and facilitating the implementation of technologies to treat these wastes in support of customer needs an drequirements. The MWFA has developed a Technology Development Requirements Document (TDRD), which specifies performance requirements for technology owners and developers to use as a framework in developing effective waste treatment solutions.

Current techniques for stabilization and safe disposal of these waste types, e.g. mixing with cement and additives, result in considerable volume increases. Salt-loading in these methods is limited because the final waste form criteria include no free liquids, adequate compression strength, and leach resistance. Pollution prevention principles dictate minimization of waste volume to an extent that is economically feasible.

Improved methods for such waste treatment are sought to reduce disposal costs and ease the burden on burial sites. A process that is not sensitive and easily adaptable to variations in waste chemistry may provide the sought improvements. However, current stabilization methods are often deficient on this account. This project will demonstrate the use of polyester resins in encapsulating and solidifying DOE's mixed wastes (MW) containing salts, as an alternative to conventional and other emerging immobilization technologies..

Surrogate salt-containing waste streams will be prepared in the laboratory and Aropol™ polyester, and Hetron® vinyl ester resins[1] will be used as binding agents for immobilizing these wastes. Physical property tests will be performed on solidified specimens. These tests will include compressive strength measurement and leachability. Waste loadings and associated waste volume increases will be documented. This data will support subsequent testing with actual mixed wastes, for which a separate test plan will be prepared.

This work is funded by the U.S. Department of Energy Office of Science and Technology Mixed Waste Focus Area under Technical Task Plan (TTP) RL47MW42 *Microencapsulation of Salt Waste Using Polyester Resin* through Fluor Daniel Hanford, Inc.

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[1]Aropol™ is a trademark and Hetron® is a registered trademark of the Ashland Chemical Co., Columbus, OH.

1.1 BACKGROUND

This polyester waste treatment process was conceived and developed in the mid to late 70s at Washington State University (WSU) in Pullman, Washington. There are two basic microencapsulation techniques with polyester resins — one for dry or damp particulate waste with no free liquids, and the other for aqueous slurry/sludge wastes.

For dry waste, the waste and polyester resin are intimately mixed in a batch. The thermosetting resin thereby uniformly coats each particle. This resin coating is solidified by the addition of an intiator, methyl ethyl ketone peroxide, which starts the curing. Setup time for the resin varies from a several minutes to a several hours, depending upon the amount of initiator added, the type of waste, and the temperature. Although certain metal ions and the pH of the waste could affect curing profiles, adjusting the amount of initiator added and/or use of inhibitors would yield consistent solidification profiles.

For water-containing wastes, a specially formulated water-extendible resin is used to form an emulsion with the waste droplets finely dispersed in the resin. The continuous resin phase is cured and solidified by the addition of an inititator. In both the emulsion and the direct resin methods, the waste component is immobilized. This is the key benefit of this process. Over time, the radioactivity in the waste continues to enhance polymer crosslinking, resulting in improved leach resistance. Polyester samples irradiated by ^{60}Co sources with a total dose of 10^9 rad showed an increase in their compressive strength [IAEA 1988]. The dose expected by the encapsulated radionuclides in DOE's high-salt mixed wastes is estimated to be lower.

Low contaminant leach rates and versatility of treating both dry and wet wastes are the main drivers for pursuing development of this technology. Pilot plant demonstration of this process has been done at WSU for low-level waste (LLW) from power plants, namely sodium sulfate and boric acid solutions and slurries. Several manufacturers of polyester resin have been mentioned in the WSU reports. A water-extendible polyester resin made by Ashland Chemical Co. was used for pilot plant tests at WSU.

Concurrent with the WSU work, The Dow Chemical Company developed a similar method of waste disposal targeted towards nuclear power plant LLW. Instead of the polyester resin, the Dow process used its proprietary vinyl ester resin with similar performance. This polymer solidification process has been applied in nuclear utilities by Diversified Technologies Services, Inc., Knoxville, TN. Worldwide, there have been many full-scale waste solidification applications [IAEA, 1988] using polyester resins.

2.0 TEST OBJECTIVE

The overall objective of these tests is to demonstrate, via factorial bench-scale tests, the use of four polyester resins for solidifying three surrogate wastes representative of DOE's salt-

containing mixed wastes in inventory and those being generated. The waste stream specifications to be used in these tests have been developed on the basis of the MWFA's TDRD, and typical effluent treatment plant residues at DOE's sites. The objective of these tests is to demonstrate the high waste loading of these generalized wastes, not optimization, which should be conducted with stream-specific compositions.

The solidified specimens prepared will be subjected to qualification tests per EPA and NRC approved methods indicated in the TDRD. The performance of the polyester process will be evaluated primarily by waste loading (wt.%), compressive strength measurement, and leach testing of immobilized waste specimens.

2.1 TEST ACTIVITIES

The specific activities to meet the objective are:

- Investigation of compositions of DOE's salt streams in inventory and as projected, and preparation of surrogate waste mixtures for stabilization tests.
- Assembly of processing and test equipment and materials, and procurement of polyester resins, initiator, and promoter.
- Preparation of stabilized waste specimens as outlined in Section 5.0 procedures and to be described in a separate test procedures document.
- Monitoring of the polymerization exotherm for comparison by variable, e.g. waste type and loading, resin type, and initiator to resin ratio used.
- Testing of specimens from all batches for compressive strength, and leach testing of selected samples per the 90-day modified ANSI 16.1 method [ANS 1986] and TCLP [EPA 1990].
- Reporting on waste loading (wt.%) and percent volume increase, and comparison of the performance of vinyl ester resins vis-a-vis the isophthalic, and ortho-phthalic polyesters, considering that vinyl esters are roughly twice the cost of polyesters.
- Appropriate and safe disposition of test debris and material.

3.0 DESCRIPTION OF THE TESTS

This section describes the test materials, including the surrogate wastes and microencapsulation resins, and provides the basis for the experimental approach to the testing and analyses to be performed.

3.1 SURROGATE WASTE COMPOSITIONS

Three mixed waste simulants have been selected for microencapsulation testing. Table 3.1 lists the composition of each simulant.

Table 3.1 Composition of Mixed Waste Test Simulants

Fe_2O_3	0.0	12.8	6.0
$Al(OH)_3$	0.0	8.5	4.0
Na_3PO_4	0.0	4.3	2.0
$Mg(OH)_2$	1.2	8.5	4.0
MicroCel E	0.0	17.0	8.0
Portland cement (Type 2)	0.0	4.3	2.0
H_2O	75.0	28.8	13.0
SiO_2	0.7	0.0	0.0
Na_2SO_4	12.7	0.0	0.0
$NaNO_3$	5.9	0.0	60.0
$CaSO_4$	3.8	5.0	0.0
NaCl	0.7	10.0	0.0
PbO	0.0	1,000	1,000
CrO_3	0.0	1,000	1,000
HgO	0.0	1,000	1,000
CdO	0.0	1,000	1,000
NiO	0.0	1,000	1,000
Trichloroethylene	0.0	1,000	1,000
$Sr(NO_3)_2$	0.0	1,000	1,000
$CsNO_3$	0.0	1,000	1,000
$Co(NO_3)_2$	0.0	1,000	1,000
	100.0	100.0	100.0

Notes: MicroCel E is a registered trademark of the Celite Corporation, Lompoc, CA

The Hanford Site 200 Area Effluent Treatment Facility (ETF) has been experiencing continual operational problems in the thin-film drier, which is the final step in the Secondary Treatment

Train (STT). It was suggested [Lindsey 1997] that the drying step be eliminated and the evaporator bottoms be treated using the polyester process for liquid wastes. The ETF liquid waste simulant in Table 3.1, an aqueous solution containing primarily sulfate salts, represents the evaporator bottoms stream from contaminated groundwater being treated at ETF [Scully 1997].

The high-chloride and high-nitrate simulant compositions are derived from a table obtained from the Mixed Waste Focus Area (Beitel 1997). These streams are representative of the salt-containing wastes in DOE's complex-wide inventory, and are required to be tested. The only deviation made to the recommended compositions is the addition of trace quantities of radionuclide surrogates that have been added for measuring the Leachability Index of these elements. The water to be added had to be decreased by one percent to accommodate the hazardous contaminants and the radionuclide surrogates.

3.2 RESIN AND INITIATOR/PROMOTER SELECTION

For the purpose of understanding the basis for the design of the experiments, a brief description is provided herein of the resin types and their curing mechanisms. Used widely in the manufacture of fiberglass-reinforced plastic products, polyester resins are cured by free-radical polymerization [Ashland 1995 and Biyani 1980]. An initiator, e.g. methyl ethyl ketone peroxide, used with a promoter, such as cobalt napthenate, facilitates room-temperature resin curing. Quantities of the initiator and promoter added, and the curing temperature are the main variables in determining gel time of the resins.

The resin may be purchased prepromoted, or, for formulation flexibility, the user may add the promoter separately to the resin. All the resins to be used in these tests will be obtained prepromoted. Gel times will be adjusted by varying initiator ratios. Polyester resins contain 40 percent to 60 percent styrene monomer, which provides crosslinking and forms a rigid three-dimensional polyester matrix.

Vinyl ester resins, though broadly classified as polyesters, are typically diesters that contain repeating ester linkages [Lubin 1982]. Both vinyl esters and polyesters have been used commercially for the solidification of radioactive and hazardous wastes [IAEA, 1988]. Vinyl ester resins, with a lower ester content, may apparently be more resistant to hydrolysis by water than polyester resins [Miles and Briston 1979]. However, with greater unsaturation in the polyester backbone, the polystyrene linkages in cured polyester resins hold together the wire-mesh-like grid structure. Excellent retention of contaminants in cured polyester resin has been proven by leaching tests [IAEA 1988 and Wu 1978].

A comparative evaluation of three types of unsaturated polyester resins is proposed to be done in this study — ortho-phthalic, isophthalic, and vinyl ester resins. Corrosion and heat resistance improve in the following order — ortho-phthalic, and isothalic polyester resins, followed by vinyl ester resins. These three types of resins will be evaluated in the solid-phase waste

immobilization demonstration. A fourth type, Ashland's unsaturated water-extendible polyester resin [Mark 1985, Ashland 1980] WEP® 662P, has been chosen for stabilizing ETF's aqueous salt solution.

There are many reputable polyester resin manufacturers who make a variety of resins to suit specific applications. Following curing, it is expected that waste encapsulation performance will be closely comparable among the resins. Resin cost is to be balanced against ease of use and acceptable product performance. The Hetron® vinyl ester specialty resins are approximately twice the cost of the ortho-phthalic polyester resins.

With three waste types and four resins to be evaluated, varying resin to waste, and initiator ratios, the design of experiments can quickly become complex. To remain focused on the test objective and to reduce testing costs, resins from only one manufacturer will be evaluated in this study. Ashland's polyester resins have been extensively studied at WSU [Wu 1978 and Pojasek 1980]; result from this project will complement those studies.

3.3 EXPERIMENTAL DESIGN

There are three primary factors to be explored in these tests: (1) resin type, (2) waste type, and (3) waste loading. Table 3.2 summarizes the factors and their respective levels. The tests with the 25-weight-percent-solids ETF waste is a test separate from the solid-phase mixed waste simulants. The primary purpose for testing the aqueous-phase simulant is to demonstrate the feasibility of using a water-extendible polyester resin to successfully encapsulate an aqueous-

Table 3.2 Waste Microencapsulation Testing Matrix.

Resin type	1	Aropol WEP 662P		
Waste simulant	1	ETF Liquid		
Waste loadings (wt%)	2	60	70	
Initiator concentration	1	1.25 wt%		
Reaction temperature	1	ambient		
Resin type	3	S2293	Aropol 7334	Hetron 922-L25
Waste simulant	2	High-Chloride	High-Nitrate	
Waste loadings (wt%)	3	50	60	70
Initiator concentration	1	1.25 wt%		
Reaction temperature	1	ambient		

phase mixed waste.

ETF's evaporator bottoms stream has a pH≈10 and cools down to ambient temperatures in holding tanks before being fed to the drier. Funds permitting, further polyester microencapsulation testing with ETF wastes at lower pH, higher temperature, and in-line emulsification using a static mixer [Powell 1992] may be conducted. This will provide useful data for process simplification and flexibility for ETF's application.

Testing with the *solid-phase simulants* spans a 2 x 3 x 3 factorial experiment design. This experiment design will allow the three primary factors to be explored over a range potentially useful for actual waste processing.

Initial experiments with the two solid-phase mixed-waste simulants will be aimed at determining the optimal values for the initiator in order to obtain curing at 50 weight-percent simulant loading. Initial levels of promoter and initiator to be used will be those recommended by the resin manufacturer. Initiator (and possibly promoter) levels will then be adjusted as necessary to obtain curing of the resins at simulant loadings of 50 weight-percent for solids wastes and 60 weight-percent for the liquid waste. After this initial exploratory study, the promoter and initiator levels will likely remain fixed for the remainder of the testing.

Table 3.3 is an overview of the test studies to be performed under this test plan, and Table 3.4 lists the projected quantities of materials required to complete the testing. The quantities of materials required are based on a 200 mL cured sample size and a 20 percent allowance for material left behind in the mixing bowl and on the mixer.

Samples for the TCLP test will be obtained from the sample fragments left over from the compressive strength test. The TCLP leachate will be tested for the toxic metals and trichloroethylene.

Samples listed in the column marked "Other" in Table 3.3 will be used either for the ANSI 16.1 static leach test, or as a duplicate sample for compressive strength measurement. As a minimum, this leach test will be performed on those samples with loadings of 50 percent for solids and 60 percent for liquid waste surrogates. The leachates from the test will be analyzed for the nitrate, sulfate, and chloride anions by ion-chromotography, and cesium, strontium, and cobalt metals by ICP-MS (Inductively Coupled Plasma - Mass Spectroscopy). The charges for analyses of the leachates are being finalized; if funds permit, more samples will be static-leach tested.

Table 3.3 Test Run Conditions.

	Aropol WEP 662P	40	317	ETF Liquid	60	475	1.25	3.96	3.52	1	1	1		
2	Aropol WEP 662P	30	238	ETF Liquid	70	554	1.25	2.97	2.64	1	1	1		
	S2293	50	410	High Chloride	50	410	1.25	5.13	4.57	1	1	1		
2	Aropol 7334	50	389	High Chloride	50	389	1.25	4.86	4.33	1	1	1		
3	Hetron 922-L25	50	410	High Chloride	50	410	1.25	5.13	4.57	1	1	1		
4	S2293	50	410	High Nitrate	50	410	1.25	5.13	4.57	1	1	1		
5	Aropol 7334	50	389	High Nitrate	50	389	1.25	4.86	4.33	1	1	1		
6	Hetron 922-L25	50	410	High Nitrate	50	410	1.25	5.13	4.57	1	1	1		
7	S2293	40	328	High Chloride	60	492	1.25	4.10	3.65	1	1	1		
8	Aropol 7334	40	311	High Chloride	60	467	1.25	3.89	3.46	1	1	1		
9	Hetron 922-L25	40	328	High Chloride	60	492	1.25	4.10	3.65	1	1	1		
10	S2293	40	328	High Nitrate	60	492	1.25	4.10	3.65	1	1	1		
11	Aropol 7334	40	311	High Nitrate	60	467	1.25	3.89	3.46	1	1	1		
12	Hetron 922-L25	40	328	High Nitrate	60	492	1.25	4.10	3.65	1	1	1		
13	S2293	30	246	High Chloride	70	575	1.25	3.08	2.74	1	1	1		
14	Aropol 7334	30	233	High Chloride	70	544	1.25	2.92	2.60	1	1	1		
15	Hetron 922-L25	30	246	High Chloride	70	575	1.25	3.08	2.74	1	1	1		
16	S2293	30	246	High Nitrate	70	575	1.25	3.08	2.74	1	1	1		
17	Aropol 7334	30	233	High Nitrate	70	544	1.25	2.92	2.60	1	1	1		
18	Hetron 922-L25	30	246	High Nitrate	70	575	1.25	3.08	2.74	1	1	1		

Table 3.4 Quantities of Materials Required for Testing

Resins			
Aropol WEP 662P	1.10	554	504
S2293	1.09	1,970	1,728
Aropol 7334	1.08	1,866	1,728
Hetron 922-L25	1.14	1,970	1,728
Initiator			
MEKP	1.12	80	71
Waste Surrogates			
ETF Liquid	1.21	1,030	851
High-Chloride	n/a	4,355	n/a
High-Nitrate	n/a	4,355	n/a

Notes: n/a means not available

3.4 TEST LOCATION

The test location for the surrogate wastes and final waste form preparation is Hanford's 306E laboratory (300 Area). Compression testing and the leach tests, including the TCLP, will be done there as well. Analyses of leachate samples will be performed either at the Special Analytical Support Laboratory or the Waste Sampling and Characterization Facility in Hanford's 200 Area.

4.0 EXPECTED RESULTS

The tests will demonstrate the efficacy of polyester resins in stabilizing salt-containing surrogate mixed wastes. It is expected that there will be no free liquids after resin curing and the specimens with 50 percent waste loading should pass the TCLP and the ANSI 16.1 leach tests. As the waste loading is increased beyond 60 percent, the compresive strength is expected to decrease and the leachability may be compromised to the point of failure to achieve a minimum required Leachability Index of 6. There should be a satisfactory degree of immobilization of the liquid-containing ETF surrogate waste at least to 60 percent loading.

5.0 TEST PROCEDURES

The content of the test procedure document being developed is summarized here.

5.1 SURROGATE WASTES PREPARATION

A batch of 5.0 kg each of high-chloride and high-nitrate surrogate waste, and 1.5 kg of the ETF liquid waste will be prepared by mixing the ingredients listed in Table 3.1. The dry salts will be uniformly blended first followed by the liquids, water, and trichloroethylene.

5.2 WASTE FORM SPECIMEN PREPARATION

As described in Section 3.3, several batches of resin-waste mixtures will be prepared. The quantities of surrogate waste, resin, and initiator required for each batch are specified in Table 3.3. Data sheets will be prepared and used for recording essential batch information. A laboratory flow diagram for the sample preparation process is given in Figure 1.

5.2.1 Dry Waste Immobilization

The steps to be followed for preparing immobilized dry/damp particulate waste specimens are:

1. Weigh the specified amount of the prepromoted resin type into the mixing bowl.
2. Weigh the corresponding quantity of waste surrogate into a tared beaker.
3. Spray the inside surface of all the molds with a mold release spray.
4. Start the mixer and adjust speed to approximately 40 rpm.
5. Slowly, over a period of five to seven minutes, add the dry waste to the vortex region of the resin in the bowl.
6. When the resin-waste mixture appears to be homogeneous, add the specified amount of initiator to the bowl and continue to mix for an additional three to five minutes. Transfer the contents of the bowl to the cylindrical polyethylene molds.
7. Place a sheathed thermocouple at the center of the one mold and set aside to cure.
8. Clean the mixing blade and inner surface of the mixing bowl with a paper towel and dibasic ether (DBE) .

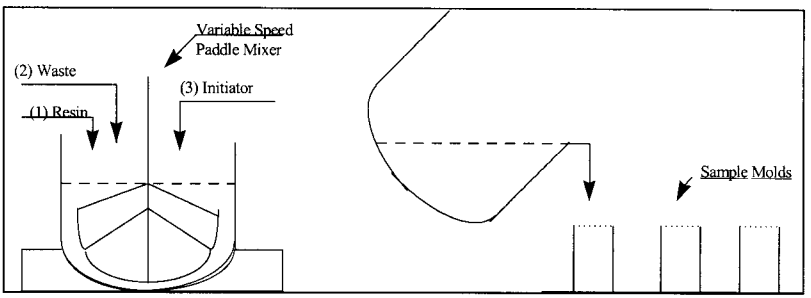

Figure 1: Laboratory Polyester Microencapsulation Flow Diagram

5.2.2 Liquid Waste Immobilization

The steps to be followed for waste immobilization by emulsification are:

1. Weigh a predetermined amount of resin into the jar of a blender.
2. Weigh the corresponding amount of liquid/slurry waste into a beaker.
3. Turn on the blender at its lowest speed setting and slowly start adding the waste in a steady stream into the vortex of the mixing resin. Adjust the rate of pouring such that there is minimal free liquid on the resin surface to ensure formation of a stable waste-in-polyester emulsion. If necessary, decrease the rate of waste addition, or increase the mixer speed.
4. After formation of a stable emulsion, add the predetermined amount of initiator to the emulsion in the blender and mix for two minutes to evenly disperse the initiator.
5. Pour the emulsion into three empty molds and insert a sheathed thermocouple into one mold to record the exotherm.
6. Clean the mixing blade and inner surface of the blending jar with a paper towel and DBE.

5.3 TESTING OF SPECIMENS

Specimens will be examined for the presence of free surface liquids and surface fissures created during curing. Final waste form density, and percent increase in waste volume will be measured and reported. Only compressive strength measurements [ASTM 1993], will be made on the initial samples prepared for establishing the initiator ratio required. Samples from subsequent batches will be subjected to compressive strength measurements and leach tests.

One indicator of satisfactory specimen curing is the rise in temperature during cure. One sample from each batch made will be measured for the peak exotherm reached. After filling, the sample molds will be capped and placed in an insulated ice chest to simulate adiabatic conditions necessary for the measurement of the true exotherm. This information is important, especially

for full-scale application of the polyester process.

The TCLP test will also be performed for measuring the loss of hazardous metals [EPA 1990]. The 90-day modified ANSI 16.1 method [ANS 1986] will be done to evaluate the retention/loss of radionuclide simulants, and anions. An accelerated leach test [ASTM 1995], proposed in the Technical Task Plan for comparison with the modified ANSI 16.1 method, will not be done because it is not being widely used.

6.0 SAFETY

All personnel involved in these tests will be trained in the proper procedure for handling the various chemicals, which includes familiarity with all pertinent Material Safety Data Sheets. A review of the reports of full-scale applications of the polyester process, and Diversified's experience base [Jensen 1997], establishes that there are no extraordinary safety requirements in running this process. Notwithstanding, noteworthy hazards in performing the tasks outlined in Sections 3.0 and 5.0 are listed below:

- Handling RCRA toxic metal compounds, e.g lead and mercury, in the preparation of surrogate wastes and in the preparation of the final waste forms.
- Potential release of styrene vapors during handling and processing of the polyester and vinyl ester resins and trichloroethylene vapors in the preparation of waste surrogates. Both of these volatile compounds can also be released during waste form preparation.
- Uncontrolled and violent exothermic reaction between the initiator and promoter if inadvertently mixed together. For this reason, only prepromoted resins are being procured, but additional promoters may need to be used if formulation flexibility mandates it.

Laboratory personnel will wear PPE (Personal Protective Equipment) as specified in the Job Hazards Analysis, which will be completed prior to commencing the tests. Personnel directly involved in conducting the tests will be monitored for exposure to styrene until it is determined, by an industrial hygiene specialist, that such monitoring is not necessary.

In the procedures being developed for the tasks, every step will be reviewed for conformance with safety and ALARA (As Low as Reasonably Achievable) principles. For example, resin in any open containers will be handled only inside a laboratory hood. Batch size for specimen preparation will be adjusted to ensure minimum leftover waste-resin mixes. Any residuals may be retained as waste form examples. Use of a non-hazardous resin cleaning solvent, DBE, allows a dramatic reduction of the volatile organic compound emissions compared to acetone. Such practices uphold P2 (pollution prevention) guidelines.

7.0 WASTE MANAGEMENT

Wastes, including used paper towels and gloves, and spent samples generated during the high-chloride and high-nitrate wastes testing may be characteristic wastes [WDOE 1994] because they contain hazardous metals and organics. These wastes will be segregated from the wastes generated during testing of the ETF surrogate waste. Leachates will be collected in a separate container, characterized, and disposed appropriately. All potentially hazardous wastes will be segregated and accumulated in Satellite Accumulation Areas until they are determined to be non-hazardous. Lab personnel will be instructed in the proper use of the satellite accumulation containers. Hazardous wastes will be disposed in accordance with WAC-173-303 [WDOE 1994].

8.0 QUALITY ASSURANCE

The Hanford Site *Quality Assurance Manual* (WHC-CM-4-2 *Quality Assurance Manual*) will govern performance of the work described in this test plan. The quality assurance manual provides the Hanford Site implementation of 10 CFR 830.120 and DOE order 5700.6C.

The quality assurance plan for the chemical analysis of sample leachates is the *Special Analytical Support Quality Assurance Plan* [NHC 1997]. This plan implements the *Hanford Analytical Services Quality Assurance Requirements Document* (DOE 1996), which in turn is the implementation of DOE order 5700.6C [DOE 1991]for laboratory analytical work.

The test procedures will contain any additional implementation of the *Quality Assurance Manual* as required.

9.0 FUNCTIONAL RESPONSIBILITIES AND SCHEDULE

Lead staff on this task are from SESC's Process Engineering (PE) organization managed by James A. Hunter. PE staff anticipated to be involved with this task include the Principal Investigator, Rabindra K. Biyani, P.E., James G. Douglas, and Douglas W. Hendrickson, P.E.

Rabindra K. Biyani, a Senior Engineer, has an M.S. in Chemical Engineering. He has done pilot plant development work for the polyester waste encapsulation process at Washington State University. He was the cognizant engineer in the treatability study of Hanford's 183-H Basin sludge waste, and in the evaluation of the effect of organics in the performance of Hanford grout. Mr. Biyani provided support for the conduct of the EM-50 funded Hanford tank waste cesium removal test and its report writing.

James G. Douglas, a Senior Scientist, has an M.S. in Chemistry. Mr. Douglas has worked professionally in the field of analytical chemistry for 15 years. Most recently he has supported Hanford Site characterization efforts of radioactive waste stored in underground storage tanks. His support has included production and review of Hanford tank characterization reports, and the

creation of the tank vapor sampling and analysis data package format used by the Tank Vapor Program.

Douglas W. Hendrickson, a Senior Engineer, has an M.S. in Chemical Engineering. He has been active in the sampling, characterization, and pretreatment and treatment of Hanford tank wastes. Recent duties have included those of Principal Investigator for Hanford Tank Waste Cesium Removal Test (EM-50 funded), Plasma Calcination of Hanford Waste (EM-30 and EM-50 funded), Principal Investigator for Supercritical Carbon Dioxide Extraction of Solid Mixed Wastes (EM-50 funded), pretreatment application reviews, and Project Engineer for Plasma Arc Vitrification of Hanford Low Level Waste.

SESC's laboratory technicians at Hanford's Building 306 will be involved in establishing test procedures, preparing the surrogate wastes, and the waste form specimens. They will also conduct the leach tests and compressive strength measurements. These technicians have extensive experience in making simulants and performing waste form evaluations.

Leachate samples from the TCLP, accelerated leach, and modified 90-day leach testing will be analyzed either at Hanford's WSCF laboratory or SAS Laboratory in the 200 Area.

A detailed schedule of activities is depicted in Figure 2.

ID	Task Name	Start	Finish
10	**Surrogates Testing**	**Tue 6/10/97**	**Thu 12/4/97**
11	**Surrogates Test Plan**	**Tue 6/10/97**	**Mon 7/7/97**
12	**Preparation**	**Tue 6/10/97**	**Mon 6/23/97**
13	Waste Stream Specification	Tue 6/10/9	Mon 6/16/9
14	Equipment Specification	Tue 6/17/9	Wed 6/18/9
15	Procedures	Tue 6/17/9	Mon 6/23/9
16	Review and Approval	Tue 6/24/9	Mon 7/7/9
17	Issue Surrogates Test Plan	Mon 7/7/9	Mon 7/7/9
18	**Surrogates Test Conduct**	**Thu 6/19/97**	**Fri 10/31/9**
19	**Equipment Procurement**	**Thu 6/19/97**	**Thu 7/10/97**
20	Procurement	Thu 6/19/9	Thu 6/26/9
21	Delivery	Fri 6/27/9	Mon 7/7/9
22	Setup	Tue 7/8/9	Thu 7/10/9
23	Prepare Aqueous Waste Specimens	Fri 7/11/9	Wed 7/23/9
24	Prepare Dry Waste Specimens	Fri 7/11/9	Wed 7/23/9
25	**Conduct Property Tests**	**Thu 7/24/97**	**Fri 10/31/9**
26	**Conduct Leach Test**	**Thu 7/24/97**	**Tue 10/28/97**
27	Modified ANSI 16.1 leach	Thu 7/24/9	Tue 10/28/9
28	Accelerated Leach	Thu 7/24/9	Tue 8/12/9
29	**Conduct Comp. Strength Test**	**Thu 7/24/97**	**Fri 10/31/9**
30	Unleached Samples	Thu 7/24/9	Mon 7/28/9
31	Accelerated Leached Samples	Wed 8/13/9	Fri 8/15/9
32	Modified ANSI Leached Sampl	Wed 10/29/9	Fri 10/31/9
33	**Surrogates Test Report**	**Wed 8/13/97**	**Thu 12/4/97**
34	**Analyze Leachate Samples**	**Wed 8/13/97**	**Thu 12/4/97**
35	Accelerated Leaches	Wed 8/13/9	Wed 9/24/9
36	Modified ANSI 16.1 Leaches	Wed 10/29/9	Thu 11/13/9
37	Write Report	Wed 10/22/9	Thu 12/4/9
38	Issue Surrogates Report	Thu 12/4/9	Thu 12/4/9

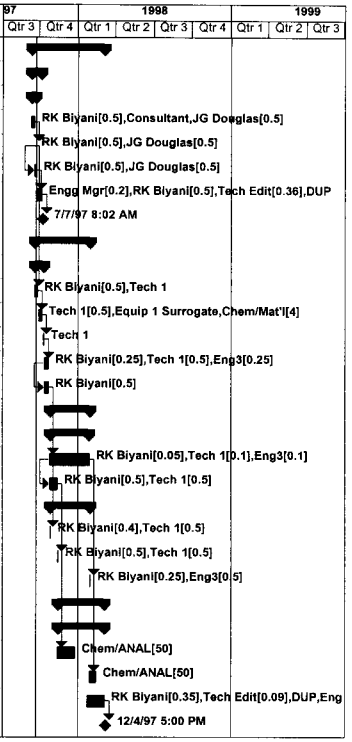

Figure 2: Surrogates Testing Schedule

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