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7. Abstract

This report summarizes the results of the testing program conducted by WHC to confirm the baseline waste form selection for use in WRAP (Waste Receiving and Processing) Module 2A. WRAP 2A will provide treatment required to properly dispose of Contact Handled (CH) Mixed Low Level Waste (MLLW) accumulating at the DOE Hanford Site in Richland, WA. Screening tests were performed using the major chemical constituent of each waste type to measure the gross compatibility with the immobilization media. Positive results were obtained resulting in the production of a solid monolith from each major chemical constituent with the selected immobilization medium. This indicated that more advanced testing should be performed to confirm that a detailed surrogate waste in the immobilization matrix could pass all applicable test criteria imposed on the final waste form.

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EXECUTIVE SUMMARY

A testing program has been conducted by the Westinghouse Hanford Company (WHC) to confirm the baseline waste form selection for use in WRAP (Waste Receiving and Processing) Module 2A. The WRAP Module 2A will provide treatment required to properly dispose of contact handled mixed low-level waste accumulating at the U.S. Department of Energy (DOE) Hanford Site in Richland, Washington. Solidification/stabilization has been selected as the appropriate treatment for this waste to reduce its toxicity and mobility in the disposal site. This work is intended to test various solidification media and confirm the baseline technologies selected for WRAP 2A.

The testing used a phased approach, consisting of first screening the compatibility of surrogate wastes with the immobilization media, then performing detailed physical and chemical tests on laboratory-prepared surrogate waste forms. This will be followed by performance testing of surrogate waste form specimens prepared by full-scale mixing equipment. Further testing will be performed during startup of the plant and introduction of new waste streams. It is conceived that similar testing as described above will be required throughout the life of the plant as new wastes and variations to the process are encountered. This report details the efforts and results obtained from the initial phase of testing (waste form compatibility screening and surrogate performance testing).

The current focus of this test work is to verify the ability of the immobilization media identified in the conceptual design report to adequately solidify certain waste types (UE&C 1992). As such, the first efforts of this testing focus on using two matrices for waste solidification; cement-based materials and thermosetting polymer resins. Project background, feedstream overview, and the conceptual design baseline approach are discussed in this report to further clarify the focus of the test work.

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Eight different waste types, representing about 80% of the projected feed to WRAP 2A were used for these initial phases of testing. The remaining 20% consists of small quantities of various waste types that require better characterization data before testing. This 20% will be tested as better information becomes available. Four of the waste types were tested with cementitious waste forms, and four different waste types were tested with the thermosetting polymer. The split as to which waste was to be treated with which immobilization medium was based on the conceptual design baseline.

Screening tests were performed using the major chemical constituent of each waste type to measure the gross compatibility with the immobilization media. Positive results were obtained here in that a solid monolith was successfully prepared from each major chemical constituent with the selected immobilization medium. This indicated that more advanced testing should be performed to confirm that a detailed surrogate waste in the immobilization matrix could pass all applicable test criteria imposed on the final waste form.

Test criteria for solidified mixed waste were assembled from applicable regulatory documentation (DOE Order 5820.2A [DOE 1988], Washington Administrative Code 173-303 [WAC 1990], and 10 CFR 261 [NRC 1992]), including guidance documents from the U.S. Nuclear Regulatory Commission (*NRC Technical Position on Waste Form* [NRC 1991]) and the U.S. Environmental Protection Agency *Handbook for Stabilization and Solidification of Hazardous Wastes* (EPA 1984).

Waste surrogates were then prepared by WHC to represent each of the eight waste types for testing. Surrogates for polymer testing were sent to the vendor commissioned for that portion of the test work. Surrogates for the cementitious testing were used in the WHC laboratory responsible for the grout performance testing.

Test specimens were prepared with the surrogate wastes, and tests were performed. Detailed discussion of the laboratory work and results are contained in this report. All cementitious specimens performed as expected and confirmed baseline process selection. Successful test results have also

been achieved with some of the polymer specimens. All surrogates have been successfully solidified and have formed free-standing monoliths that exceed strength criteria. Some additional formulation work is necessary with the polymer waste types to ensure adequate encapsulation of some key constituents.

If the remaining tests show positive results, then the baseline process selection will be confirmed and the next stage of testing will proceed. The follow-on tests will consist of laboratory parametric studies, mixing equipment tests, and confirmatory testing using actual waste. These tests will generate process control data, detailed design data, and data required for permit approval.

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DESCRIPTION OF APPENDICES

A. Statement of Work — Thermosetting Polymer

Statement of Work prepared by Westinghouse Hanford Company (WHC) as part of the bid package soliciting qualified vendors to perform waste form performance testing using a thermosetting polymer with WHC-prepared surrogate waste.

B. Technical Task Plan — Grout

Technical Task Plan prepared by WHC for an "in-house" (WHC) testing program for waste form performance testing using cement-based waste forms and surrogate waste. Similar to the statement of work for thermosetting polymer.

C. Thermosetting Polymer Test Plan

Detailed Test Plan prepared by the vendor awarded the contract for thermosetting polymer testing described in Appendix A. Outlines test procedures, quality control, and testing deliverables.

D. Characterization Data

1. Two memos prepared by WHC Chemical Process Engineering Group. The first summarizes the "to date" characterization data on the 183H basin wastes (the largest volume of the currently stored low-level mixed waste types. The second memo describes the recommended waste forms for the various basin wastes and some to the future generated waste streams (Liquid Effluent Treatment Facility [LETF] and Incinerator Ash).

   Memo 1: JBW-183-001
   Memo 2: CPE-WOG-002

2. Four WHC-generated Internal Letter Reports reviewing the records of the contents of all currently stored low-level mixed waste at the Hanford Site. The characterization data and the U.S. Environmental Protection Agency waste codes were used to group the containers into lots of similar waste types for processing. A technical evaluation was then performed (by a solidification technology expert) as to the best treatment approach for each lot. The rationale for the treatment selection is included.

   Memo No.s: 87330-92-MLS-023, -025, -026 -028.

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DESCRIPTION OF APPENDICES (cont.)

E. Literature Search Results

1. This WHC Letter Report (CEP-WOG-001) contains a thorough literature search and review of solidification technologies. This review was done in support of the Waste Receiving and Processing (WRAP) Facility, Module 2A, Waste Form Qualification efforts. It included a review of all known solidification technologies.

2. This report (generated by solidification expert Earl McDanial, Oak Ridge National Laboratory) is a review specifically of grouting technology (cement-based solidification) used throughout the world. This report was done to support the selection of a grout technology in WRAP 2A.

F. Thermosetting Polymer Test Results

Contained under four reports:

Test Status Report (1) — WHC Trip Report to Stock Equipment Company
Thermosetting Polymer Test Report (2) — Stock Equipment Company
Thermosetting Polymer Test Report (3) — Stock Equipment Company
Thermosetting Polymer Test Report (4) — Stock Equipment Company

G. Overview of Solidification Technologies

This is an internal WHC memo report that was prepared as a review of all available solidification technologies, important processing considerations, and general advantages and disadvantages of various technologies. The report is not specific to WRAP 2A and is intended to provide general background needed to begin evaluating the various waste forms.

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LIST OF TERMS

ANS	American Nuclear Society
ASTM	American Society for Testing and Materials
BDAT	Best Demonstrated Achievable Technology
CDR	Conceptual Design Report
CH	contact handled
CH-MLLW	contact handled mixed low-level waste
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
LETF	Liquid Effluent Treatment Facilities
LLW	low-level waste
MLLW	mixed low-level waste
NRC	U.S. Nuclear Regulatory Commission
RCRA	Resource Conservation and Recovery Act
RH	remote handled
RMW	radioactive mixed waste
TCLP	Toxicity Characteristic Leaching Procedure
UE&C	United Engineers and Constructors, Inc.
WFQ	Waste Form Qualification
WHC	Westinghouse Hanford Company
WRAP	Waste Receiving and Processing

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WASTE RECEIVING AND PROCESSING MODULE 2A WASTE FORM QUALIFICATION STATUS REPORT

1.0 INTRODUCTION

This report provides a status of the waste form testing work being performed in support of Waste Receiving and Processing (WRAP) Facility, Module 2A. The WRAP 2A will provide treatment required to properly dispose of inorganic contact-handled (CH) mixed low-level waste (MLLW) (CH-MLLW). It has been determined that solidification/stabilization is the appropriate treatment for this waste to reduce its toxicity and mobility in the disposal site. This work is intended to test various solidification media to confirm the baseline technologies selected for the WRAP 2A.

The testing used a phased approach, consisting of first screening the compatibility of surrogate wastes with the immobilization media, then performing detailed physical and chemical tests on laboratory-prepared surrogate waste forms. This will be followed by testing of surrogate waste form specimens prepared by full-scale mixing equipment. Details of the test program can be found in the *WRAP Module 2A Waste Form Qualification Plan* (WHC 1993). This report details the testing efforts performed during calendar year 1992.

The current focus of this test work is to verify the ability of the immobilization media identified in the *WRAP Module 2A Conceptual Design Report* (UE&C 1992) to adequately treat certain waste types. As such, the first efforts of this testing focus on using two matrices for waste solidification: cement-based materials and thermosetting polymer resins. Project background, feedstream overview, and the conceptual design baseline approach are discussed in the following sections to further clarify the focus of the test work.

1.1 WRAP 2A BACKGROUND

The WRAP Module 2A, provided by Project W-100, is the proposed second module of the WRAP Facility. This facility will provide treatment for CH-MLLW to allow its permanent disposal. The treatment process will reduce the toxicity and mobility of the waste by using nonthermal solidification and stabilization technologies. The facility will only treat those wastes that are amenable to this approach. Wastes with regulated levels of organic contamination that require thermal treatment will be treated at another facility. The WRAP 2A will be designed to provide the capacity to treat both the stored waste and the future generated Hanford Site MLLW. The WRAP 2A is part of Milestone M-19-00 in the Tri-Party Agreement (Ecology, EPA, and DOE 1992) to begin operation of the second module of WRAP in 1999.

Several different facilities will be needed to provide all of the capabilities required to handle the different solid wastes at the Hanford Site. Table 1-1 lists the facilities. The WRAP 1 is a facility that will handle transuranic waste. The waste with the least amount of uncertainties,

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best characterization data, and most immediate need was determined to be CH-MLLW. The hazards and technical uncertainties associated with performing the required thermal treatment for organic wastes would impede the progress of dealing with inorganic wastes. Hence, organic wastes were deferred to a thermal facility project scope, and WRAP 2A was initiated as a treatment facility for inorganic CH-MLLW contained in drums or waste boxes.

The WRAP 2B is proposed as a follow-on project to WRAP 2A, which will provide treatment for remote handled (RH), large, or otherwise noncompliant waste. The need for WRAP 2B as a separate project is based on the uncertainty in the characteristics of these waste types, the uncertainty in dispositioning these waste types, and the inherent design differences between a facility that handles CH waste and one that handles RH waste.

Table 1-1. Hanford Site Solid Waste Treatment Facilities.

Project	Facility	Waste type	Line item
W-026	WRAP Module 1	CH-TRU and CH-LLW	FY 1991
W-100	WRAP Module 2A	Inorganic CH-MLLW	FY 1994
W-255	WRAP Module 2B	RH and irregular	FY 1995
W-242	Thermal treatment	Organic LL-MW	FY 1996

NOTE: WRAP 2A is scheduled to be operational by 1999.

CH = contact handled.
FY = fiscal year.
LL = low level.
MLLW = mixed low-level waste.
MW = mixed waste.
RH = remote handled.
TRU = transuranic.
WRAP = Waste Receiving and Processing.

1.2 WRAP 2A FEEDSTREAM OVERVIEW

The feedstreams for WRAP 2A have been identified by a review of the records of the waste that is currently in storage and a survey of the generators of future waste at the Hanford Site. The wastes have been broken into several feedstream categories based on similarity in waste type and source and the perceived treatability of the wastes by various technologies. For the purposes of conceptual design for the facility, the wastes have been grouped into eight major categories and several subcategories. The total throughput to WRAP 2A is estimated to be on the order of 850 m^3 (30,000 ft^3) each year. The feedstreams are described in the following sections.

1.2.1 Feedstream 1: 183H Solar Basin Waste

The 183H Solar Evaporation Basins were used to reduce waste by means of natural evaporation of liquid chemical wastes generated as part of N Reactor fuel fabrication activities. The liquid waste discharged to the four concrete basins consisted primarily of spent acid etch solutions (sulfuric, nitric, and hydrofluoric acids). This waste was neutralized with sodium hydroxide before discharge to the basins. The wastes contained various metallic contaminants. Several types of nonroutine wastes were also discharged to the basins. The basins eventually ceased accepting waste and subsequently were found to be leaking. A timely cleanup and closure of the basins was then pursued. This cleanup activity resulted in roughly 2,605 m^3 (92,000 ft^3) of waste divided into the four types discussed in the following sections.

1.2.1.1 183H Solidified Liquid. The liquid portion of the waste remaining in the basins consisted of slightly radioactively contaminated (uranium and technetium) saturated sodium nitrate solution. The liquid was removed from the basins in drums and solidified (in the drums) with a product called Sorbond[1] LPC-II. An absorbant was added on top of the solidified waste. Several problems with the solidification, including swelling and cracking of the waste form and incomplete solidification, has lead to the decision that the waste must be retreated in WRAP 2A. The throughput of this waste to WRAP 2A is estimated to be around 23 m^3 (800 ft^3) each year.

1.2.1.2 183H Crystalline Solid. The evaporation of the liquid waste also produced a crystalline solid consisting mostly of salts of nitrate, sulfate, fluoride, and sodium. These wastes were removed from the basins and packaged in 208-L (55-gal) drums without further treatment. They account for about 37 m^3 (1,300 ft^3) each year throughput to WRAP 2A.

1.2.1.3 183H Sludge. The remaining fraction of waste in the 183H basins was a sludge like material consisting of a mixture of mostly sodium sulfate and sodium nitrate. This fraction was also relatively high in copper content and had more apparent water content than the other wastes (thus its sludge-like consistency). The sludge was packaged in drums with an absorbent material but had no further treatment. About 40 m^3 (1,400 ft^3) each year of this waste is planned to be treated at WRAP 2A.

1.2.1.4 183H Miscellaneous Cleanup. After removal of the waste from the basins, contamination remained on the concrete floors and walls. These areas were sandblasted to remove this contamination, resulting in another waste form. Also, tumbleweeds and various tools and structures used in the cleanup operation were packaged as additional waste. The sandblast grit and other cleanup debris account for an additional 11 m^3 (400 ft^3) each year throughput to WRAP 2A.

---

[1]Sorbond is a trademark of the American Colloid Company.

1.2.2 Feedstream 2: Liquid Effluent Treatment Facilities Secondary Solids

Two Liquid Effluent Treatment Facilities (LETF) are planned for construction at the Hanford Site in the near future. The C-018 Facility in the 200 East Area will treat evaporator condensate from selected double-shell tanks and will begin operation in 1995. The L-045 Facility will be constructed at the Hanford Site's 300 Area and will treat the combined sewer effluents from various laboratory buildings. It will also begin operation in 1995. Both facilities will produce several secondary waste streams that may be both radiologically and chemically hazardous. It is assumed that these streams will require treatment to meet federal and state land disposal regulations.

1.2.2.1 Ammonium Sulfate. The major secondary waste from the C-018 process will be an ammonium sulfate salt produced in an evaporative crystallization process. The high ammonia content of many of the double-shell tanks and the addition of sulfuric acid in the C-018 process leads to the formation of ammonium sulfate. This waste stream will be generally <90 wt% ammonium sulfate with trace regulated contaminants, such as chromium and mercury. The waste will be dried before shipment out of the C-018 Facility. The throughput of this waste to the WRAP 2A Facility is estimated to be around 283 m^3 (10,000 ft^3) each year.

1.2.2.2 Treatment Media/Ion Exchange Resins. Both the C-018 and the L-045 facilities will use ion exchange systems as part of the treatment chain. It is assumed that these spent resins will be contaminated with the substances in the liquid that are regulated and will, therefore, require treatment in WRAP 2A. This combined feedstream is assumed to be around 57 m^3 (2,000 ft^3) each year to WRAP 2A.

1.2.2.3 Metal Sludge. The L-045 Facility will use a coprecipitation process to remove dissolved contaminants. An iron hydroxide is the baseline precipitation agent in the process. The precipitates are assumed to include various soluble metal contaminants that will be regulated. The sludge will be filtered and possibly dried before shipment from the L-045 Facility. The throughput of this waste to WRAP 2A is estimated to be around 85 m^3 (3,000 ft^3) each year.

1.2.2.4 Treatment Media/Filter Elements. The C-018 Facility will use reverse osmosis in its treatment chain and the L-045 Facility will use some sort of multimedia filtration system. It is assumed that these spent filter media will require treatment in WRAP 2A as they will be contaminated with the regulated components that they are removing from the liquid waste. This combined throughput is assumed to be less than 14 m^3 (500 ft^3) each year to WRAP 2A.

1.2.3 Feedstream 3: Compactible Solids

The compactible solids consist of waste currently in storage and waste that will be generated from future operations at the Hanford Site. Wastes of this category could consist of items, such as contaminated clothing, plastic bags, filters, wood (planking), or other soft debris, that have been

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contaminated with hazardous chemicals and are radioactive. Such debris could result from cleanup or construction work performed in contaminated areas. It is assumed that these wastes will have low levels of contamination and would be easily size reduced for compatibility with immobilization. Much of this waste will need to be dealt with on a case-by-case basis as it is generated in relatively small quantities from various sources. This waste will add about 59 m^3 (2,100 ft^3) each year of throughput to the WRAP 2A Facility.

1.2.4 Feedstream 4: Noncompactible Solids

Noncompactible solids will come from similar sources as compactible solids but will consist of hard debris, such as metal piping, brick, concrete or glass. It will account for as much as 34 m^3 (1,200 ft^3) each year of throughput to WRAP 2A.

1.2.5 Feedstream 5: Metals

This feedstream has been subgrouped into three categories. It consists of both currently stored and future generated wastes that contain metals that are known to require special handling or treatment before or as part of the immobilization process. These are generally small volume waste streams that will not be treated in the main process line at WRAP 2A. The subcategories are discussed in the following sections.

1.2.5.1 Mercury/Mercury Contaminated Solids. This waste consists of elemental mercury and bulk contaminated solid wastes, such as fluorescent light bulbs, laboratory thermometers, manometers, and mercury absorbents. Elemental mercury will be treated in accordance with Best Demonstrated Achievable Technology (BDAT), which requires amalgamation. Bulk contaminated solids will be shredded and residual mercury metal removed as required by BDAT.

1.2.5.2 Reactive Metals. This stream contains zirconium and beryllium, which are easily ignited or oxidized in air if the particle size is fine enough and an ignition source is available. It is assumed that 50 wt% of the total incoming feedstream must be deactivated by pretreatment before encapsulation; the rest will require no pretreatment before encapsulation. No distinction is made between zirconium or beryllium metals for treatment requirements. It is assumed that no other reactive metals, such as sodium, potassium, or calcium, are present in this feedstream. These reactive metals would require entirely different treatment techniques because of their reactive properties.

1.2.5.3 Lead/Lead Contaminated Solids. This feedstream consists of lead and lead contaminated bulk solids. Elemental lead will be treated in accordance with BDAT, which requires macroencapsulation. Bulk contaminated solids will be shredded before encapsulation.

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1.2.6 Feedstream 6: Absorbed Chemicals/ Solidified Liquids

This waste consists of both currently stored and future generated waste. It includes things, such as regulated chemicals absorbed on rags or liquid waste absorbed on other absorbents, such as vermiculite. This waste stream will consist of very small lots of similar wastes. This is due to the fact that this stream will be generated, as with the compactible and noncompactible solids, as part of isolated operations at various generating sites. The throughput of this waste to WRAP 2A is estimated to be about 48 m^3 (1,700 ft^3) each year.

1.2.7 Feedstream 7: Ash From Thermal Treatment

This waste will be produced by the proposed thermal treatment facility for organic mixed waste. The ash residue from this process may need to be treated to account for residual contamination in the waste or to meet BDAT treatment standards for mixtures of waste types (i.e., a waste may contain a mixture of waste types in which one type requires thermal treatment and the other requires immobilization). The generation of this waste is estimated to add about 65 m^3 (2,300 ft^3) each year to the throughput of WRAP 2A.

1.2.8 Feedstream 8: Contaminated Soils

This waste consists of both currently stored and future generated contaminated soils. Similar to some of the other wastes, it will mostly be generated from isolated operations, such as the excavation of soils in contaminated zones for construction or remediation. As such, most of this waste will be in small lots and handled on a case-by-case basis. The throughput of this waste to WRAP 2A is estimated to be about 20 m^3 (700 ft^3) each year.

1.3 WRAP 2A CONCEPTUAL DESIGN BASELINE APPROACH

The aforementioned feedstreams represent a broad variety of wastes both in physical form and chemical makeup. All of the wastes, however, require some form of immobilization treatment before disposal. The selection of a dual technology process approach is documented in the *WRAP 2 Preconceptual Design Additional Follow-On Activities Report* (UE&C 1992b). In this approach a standard cement based solidification system would be employed to process the bulk of the waste, and a more sophisticated system would be employed to handle those wastes that were not amenable to cementation. This approach is expected to eliminate the various pretreatment operations that would be required to make all wastes amenable to a single technology approach.

The cement-based system uses relatively inexpensive materials and simple processing systems. This would be the method of choice for the bulk of the waste. The secondary system was chosen to use a thermosetting polymer system. This technology was chosen because of the high degree of confidence in this waste form to immobilize wastes that were identified to cause problems with cement. This technology also represents a conservative approach for conceptual design cost estimation in that it represents a level of equipment complexity that is unlikely to be surpassed by alternative technologies.

Both process lines will use "in-drum" mixing techniques consisting of both agitated drum and vibrating drum systems. Agitated mixing will be used for sludges, powders, and particulate wastes. These wastes will be processed through a pug mill and measured into 208-L (55-gal) drums with installed agitators before movement to the solidification systems. The drums will then be coupled to an agitator drive and fill station. The stabilization agents are then added and mixing begins. When mixing is complete the drum is removed from the fill station with the agitator remaining in the drum. The drum is then inspected and capped for movement to the curing storage area. The vibrating drum system will be used for debris wastes that have been size reduced by shredders. The operation is similar to the agitated system except the drum is vibrated to achieve the required mixing, and no agitator is involved.

The baseline approach for the cement-based system offers the capability to blend portland cements with various pozzolonic additives, including blast furnace slag, pulverized fly ash, and other dry mixtures, as well as small quantities of specialized additives. The system will allow tailoring the formula on a lot-by-lot or a drum-by-drum basis. The agitated grout line will add the necessary water to the drum, followed by preblended dry materials. The initial addition of water is to ensure that the waste is easily before the powders are added. The vibrated grout line will preblend the water and dry materials before charging the drum.

The thermosetting polymer system uses several components to achieve solidification: a vinyl ester-based liquid resin, a promoter, a catalyst, and an extender. The resin, promoter, and extender are premixed in a day storage tank. In the agitated polymer system, this mix is charged to the waste loaded drum and mixing begins. The catalyst is then added to the mix and the polymerization reaction begins. Mixing is then stopped and the drum allowed to cure. As with the cement side, the mixer is left in the drum and the drum is capped and removed from the station. On the vibrated polymer system, the promoter, catalyst, and extender are premixed, as on the agitated side. The catalyst is then mixed in line with this mixture as it is charged to the drum. The drum is then agitated to achieve proper distribution of the polymer into the void spaces.

Drum curing storage, inspection, and monitoring, are also required as part of these systems; however, the details are still under development.

The overall process philosophy for WRAP 2A is that drums of waste will be characterized and grouped into lots of similar waste before receipt at the facility. The WRAP 2A will perform verification testing to confirm the identity of the incoming waste lots. The waste will then be size reduced in a shredder or homogenized in a pug mill to make the waste suitable for solidification. The waste will then be premeasured into drums for solidification. After the drums have cured and been inspected they will be transferred out of the WRAP 2A Facility for final disposal.

Table 1-2 illustrates the proposed conceptual design split as to which technology will be used for the various feedstreams. This split is reflected in the approach used in the test work described in this report.

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Table 1-2. WRAP 2A Design Basis Summary.

Waste source	Waste type	Major chemical species of concern	Projected total inventory (ft^3)	Annual feed throughput (ft^3)	Treatment process	Annual production output (drums)
183-H Solar Evaporation Basins (in storage)	Sorbond[1] liquids Crystalline solids Sludge	Sodium nitrate Sodium sulfate Copper sulfate	87,912	3,525	Polymer	999
	Miscellaneous cleanup	Contaminated debris	9,471	385	Grout	53
Liquid Effluent Treatment Facilities (forecast)	C-018 evaporator salt cake Ion exchange resins	Ammonium sulfate Nitrates and radionuclides	277,000	12,600	Polymer	3,288
	L-045 metal sludge RO filter elements	Heavy metal hydroxides Contaminated debris	75,000	3,400	Grout	873
Operations (in storage and forecast)	Dry active waste Construction debris	Contaminated debris	65,100	3,255	Grout	443
	Metal wastes	Lead, mercury, reactives	21,500	Varies[2]	Polymer	Varies[2]
	Absorbed chemicals	Inorganics and heavy metals	34,000	1,700	Polymer	495
Thermal Treatment Facility (forecast)	Incinerator ash	Heavy metals	59,600	2,980	Grout	809
Retrieval (forecast)	Contaminated soils					

[1]Sorbond is a trademark of American Colloid Company.
[2]Metal waste is campaigned. Throughput varies with campaign length and waste volume.

2.0 WASTE FORM PERFORMANCE SPECIFICATIONS

2.1 REGULATORY FRAMEWORK

The purpose of WRAP 2A is to manage CH-MLLW by treating it in such a way as to produce a final waste form that meets all applicable, relevant, and appropriate regulations and ensures its suitability for land disposal in the mixed waste disposal trench at the Hanford Site. The regulations that apply to radioactive mixed waste (RMW) come from three main sources.

2.1.1 Federal Regulations

The federal regulations regarding disposal of RMW can be divided into two categories. The first set of regulations is concerned with the radioactive portion of the waste and is embodied in 10 CFR 61 (NRC 1992). These regulations establish technical requirements for the land disposal of commercial low-level waste, including site selection, site design, facility operation, and closure. Although not legally required, these regulations have been used for guidance. The second set of regulations was promulgated after passage of the *Resource Conservation and Recovery Act of 1976* (RCRA) and is concerned with the chemical hazards of the waste, embodied in 40 CFR 261-268 (EPA 1992). These regulations establish minimum standards for packaging, labeling, record keeping, and reporting for all generators, transporters, owners, and operators of hazardous waste treatment, storage, and disposal facilities. They also impose restrictions on land disposal of hazardous waste and identify acceptable treatment technologies that can be used to meet the land disposal restrictions.

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2.2.2 State of Washington

The State of Washington has established regulations that are applicable to RMW through the Washington Administrative Code, WAC-173-303. These regulations overlap the federal RCRA regulations but include some additional requirements for management of dangerous and hazardous wastes.

2.2.3 Hanford Site Solid Waste Acceptance Criteria

The *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-3 (WHC 1991), includes additional reporting requirements and limitations on radionuclide content of low-level waste (LLW) and RMW to be disposed of at the Hanford Site. These requirements are based on U.S. Department of Energy (DOE) Orders 5820.2A (DOE 1988) and 5400.3 (DOE 1989) and will include requirements imposed by performance assessments of the disposal grounds.

2.2 PROGRAMMATIC AND FUNCTIONAL REQUIREMENTS

The WRAP 2A Facility will serve to treat all inorganic CH-MLLW received by the Hanford Central Waste Complex. Major waste streams that have been identified for treatment in WRAP 2A contain oxidizers, corrosives, toxic heavy

metals, soluble salts, and reactive metals. The physical characteristics range from semiliquid sludges and salt cake to dry powders, ash, soils, and contaminated debris.

The wide variety of chemical and physical characteristics expected in WRAP 2A feedstreams precludes the use of a single immobilization technology for all waste types. The desire to minimize operating costs suggests the use of cement-based binders whenever possible. However, several feedstreams are known to be incompatible with cement-based materials, so a second technology is required. The objective of this approach is to provide two immobilization technologies that together can successfully treat all known and anticipated WRAP 2A feedstreams.

The conceptual design of WRAP Module 2A thus includes two immobilization process trains: a cement-based grouting train and a vinyl ester styrene polymer train. Both systems provide the capability to mix binder and waste either in the waste drum or use a vibratory mixing technique. Additionally, the design of the grout system includes the flexibility to allow use of multiple formulations of inorganic binders, (i.e., portland cement, slag cement, or gypsum cement). The available combination of technologies is expected to be able to successfully treat all WRAP 2A feeds.

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2.3 TEST SELECTION AND ACCEPTANCE CRITERIA

The WRAP 2A waste forms are subject to rules and regulations promulgated by several entities. Primary performance requirements are described in U.S. Environmental Protection Agency (EPA) regulations, Washington Administrative Code, and DOE orders. Other applicable guidance comes from the *Hanford Site Solid Waste Acceptance Criteria* (WHC 1991) and U.S. Nuclear Regulatory Commission (NRC) regulations. Since there is no single regulation or guidance document that contains all applicable performance requirements and some discrepancies exist between similar requirements in different regulations, the WRAP 2A WFQ program has developed project-specific waste form performance specifications that ensure that waste forms that meet the specifications will also be compliant with all applicable regulatory requirements and guidance documents. The WRAP 2A waste form performance specifications are summarized in Table 2-1. The following sections describe the performance specifications for WRAP 2A waste forms in detail.

2.3.1 Compressive Strength

The measurement of the compressive strength is the key method of determining the stability and structural integrity of the waste form. The need for adequate compressive strength is a result of the desire to control subsidence in the disposal grounds, thus requiring the waste form to be able to withstand the full pressure of the overburden after it is buried.

The most stringent compressive strength requirements are based on NRC requirements in 10 CFR 61 (NRC 1992) for shallow land disposal of Class B and Class C LLW. There are presently two NRC standards, depending on the nature of the matrix. For cementitious matrices, the minimum acceptable compressive

Table 2-1. WRAP 2A Waste Form Performance Specifications.

Waste form characteristic	Test method	Acceptance criteria
Compressive strength	ASTM D695 or ASTM C39	Strength >500 lbf/in^2
Leachability index	ANS 16.1	Leach Index >6
Biodegradation	ASTM G21 and G22, ASTM D695 or ASTM C39	No growth, Strength >500 lbf/in^2
Thermal cycling	ASTM B553, ASTM D695 or ASTM C39	Strength >500 lbf/in^2 after 30 thermal cycles
Radiation stability	ASTM D695 or ASTM C39	Strength >500 lbf/in^2 after irradiation to 10^8 rad
Immersion	ASTM D695 or ASTM C39	Strength >500 lbf/in^2 after 90-day water immersion
Free liquids	ANS 55.1	Free liquid <0.5%
Hazardous characteristics	40 CFR 261	Not ignitible, not corrosive, not reactive
Toxicity characteristics	EPA 1311 (TCLP), EPA 6010	TCLP leachable constituents below EPA limits*

*EPA limits as described in 40 CFR 268.41, Table CCWE.
ANS = American Nuclear Society.
ASTM = American Society for Testing and Materials.
EPA = U.S. Environmental Protection Agency.
TCLP = Toxicity Characteristic Leaching Procedure.

strength is 500 lbf/in^2. For all other matrices, 60 lbf/in^2 is sufficient. The EPA guidance for immobilization and stabilization of hazardous wastes recommends a minimum compressive strength of 150 lbf/in^2. The WRAP 2A compressive strength performance specification is a minimum of 500 lbf/in^2 for all waste forms. The methods used for compressive strength testing are American Society for Testing and Materials (ASTM) C39 for cementitious specimens, and ASTM D695 for rigid plastics.

2.3.2 Leachability Index

The leachability index is a measure of the ability of the waste form to immobilize leachable waste constituents. It is calculated from measurements of the fraction of the component of interest that is leached out of the waste form over a given time period and is related to the effective diffusivity of the matrix. A higher leach index indicates better immobilization of the waste constituents. The American Nuclear Society (ANS) 16.1 Standard was developed specifically for measurement of this parameter and has been adopted by the NRC

to support 10 CFR 61 (NRC 1992) radioactive waste disposal regulations. The WRAP 2A performance specification of a minimum leach index of 6.0 for all waste forms is the same as the NRC requirements.

Leachate characteristics will also be analyzed and compared with the design basis for performance modeling of the mixed waste disposal facility to ensure that the performance of the liner leachate collection system will not be compromised. Leachate aggressiveness shall be less than that used for EPA 9090 performance testing of the W-025 disposal trench liner system.

2.3.3 Biodegradation

The long-term durability of waste forms can be adversely affected if they are susceptible to microbial degradation. Therefore, the waste form specimens are tested for resistance to fungal growth (ASTM G21) and bacterial growth (ASTM G22). The tests provide ideal conditions for microbial growth, such as proper moisture, temperature, and nutrients. After 21 days of incubation, the specimen is inspected for growth and tested for compressive strength. The WRAP 2A performance specification is for no observable microbial growth and a minimum compressive strength of 500 lbf/in^2 following the test.

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2.3.4 Thermal Cycling

Thermal cycle testing is used to determine the durability of the waste form when exposed to extremes of temperature that may be experienced during storage, transportation, or disposal. The standard method for thermal cycling is ASTM B-553, which involves exposing the test specimen to temperature extremes of -40 °C to +60 °C (-40 °F to 140 °F) for a total of 30 five-hour periods. After cycling, the compressive strength must continue to meet the minimum 500 lbf/in^2 performance specification requirement.

2.3.5 Radiation Stability

Exposure of waste matrices to radiation can cause chemical changes in the molecular structure, such as radiolysis or crosslinking, which can in turn affect the physical properties of the material. Therefore, 10 CFR 61 (NRC 1992) regulations require that the waste form be tested to determine the effects that long-term exposure to radiation may have on the waste form. The WRAP 2A performance specification is for a minimum 500 lbf/in^2 compressive strength after exposure to a total gamma dose of 10^8 radiation, as required by NRC regulations.

2.3.6 Water Immersion

Waste forms in the shallow land disposal environment will inevitably be exposed to moisture. Depending on the type of waste and the immobilization matrix, exposure to moisture can cause swelling, cracking, and other adverse changes in the waste form. To ensure adequate performance under these conditions, the waste form specimens are immersed in water for 90 days, after

which the compressive strength is measured to determine the effects of the exposure. The WRAP 2A performance specification is for a minimum compressive strength of 500 lbf/in^2 following the 90-day immersion period.

2.3.7 Free Liquids

The regulations in 10 CFR 61 (NRC 1992) and DOE Order 5820.2A (DOE 1988) prohibit the disposal of liquid low-level waste and require that all solidified liquids contain no more than 0.5% by volume of free liquids. The ANS 55.1 Standard is the accepted method for determination of the amount of free liquids in a waste form. The WRAP 2A waste form performance specifications also require that the waste form have no more than 0.5% free liquids.

2.3.8 Hazardous Characteristics

The RCRA land disposal restriction regulations (40 CFR 268 [EPA 1992]) prohibit land disposal of any waste that exhibits a hazardous characteristic. The four hazardous waste characteristics are ignitibility, corrosivity, reactivity, and toxicity. The tests used for determination of these characteristics depend on the physical properties of the waste but generally involve measurement of the flash point or autoignition point, the pH of the waste or waste extract, and comparisons against reference oxidizing materials.

The toxicity characteristic is determined by using EPA Method 1311, Toxicity Characteristic Leaching Procedure (TCLP), to obtain an extract from the waste form and by analyzing the extract for toxic constituents. The WRAP 2A performance specification requires that the maximum allowable concentrations for waste form TCLP extracts be below the limits stated in 40 CFR 268.41, Table CCWE.

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3.0 TESTING SCOPE AND DESCRIPTION

The current focus of this test work is to verify the ability of various immobilization media to adequately solidify the waste feedstreams identified for WRAP 2A. The baseline design as provided in the conceptual design for this facility was used as guidance in selecting which technologies should be applied for testing (i.e., thermosetting polymer and cement based immobilization matrices). The following sections describe the logic in selecting the waste types and waste forms for testing, as well as a description of the testing approach. Detailed test plans are provided in the Appendixes A, B, and C.

3.1 SELECTION OF WASTE TYPES FOR TESTING

Because of the lack of definition for some of the feedstreams identified for WRAP 2A, not all streams have been addressed in this initial testing phase. Instead, the approach taken was to address the large volume feedstreams that would have the greatest impact on facility design. These include 183H Basin Waste, LETF Secondary Solids (C-018 and L-045), and ash from thermal treatment. Together these represent the majority of the total feed to WRAP 2A. Certain other feedstreams, such as ion exchange resins and elemental lead, were not chosen for this testing phase because successful treatment of these streams has been sufficiently demonstrated commercially.

The other smaller feedstreams for WRAP 2A will be tested at a later date.

The specific waste types selected for this phase of testing are shown in Table 3-1.

Table 3-1. Initial Testing Phase of Large Volume Feedstreams.

Feedstream number (test ID)	Feedstream title
2A (Type 1)	C-018 Ammonium sulfate
1C (Type 2)	183H Sludge (Basins 1 and 2)
1C (Type 3)	183H Sludge (Basins 3 and 4)
1A (Type 4)	183H Crystalline solid
1D (Type 5)	183H Miscellaneous cleanup (contaminated sandblast grit [high copper])
1D (Type 6)	183H Miscellaneous cleanup (sandblast grit [high nitrate])
2C (Type 7)	L-045 Metal sludge
7 (Type 8)	Ash from thermal treatment

Surrogates were based on anticipated waste feedstreams. Characterization data for these wastes have been compiled (Appendix E). Based on this data, surrogate recipes were prepared and are documented in Appendix F.

3.2 SELECTION OF WASTE FORMS FOR TESTING

Vendor contacts, literature reviews (Appendix G), and discussions with specialists in the field of nuclear waste solidification have led to the selection of the various waste forms chosen for testing in this phase of the WFQ Program. An overall discussion of the various waste forms, their advantages and disadvantages, a description of the equipment needed for the various processes, and other pertinent terminology are provided in Appendix J. The waste forms chosen, as mentioned earlier, consist of cement-based waste forms and a thermosetting polymer waste form. The overall analysis of the information gathered has led to the selection of which waste types should be tested in which of the above two waste forms. This selection is similar to the selection provided in the CDR for the project and is provided in Table 3-2.

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Table 3-2. Solidification Technologies.

Feedstream number (test ID)	Title	Cement-based testing	Thermosetting polymer testing
2A (Type 1)	C-018 Ammonium sulfate	Yes*	Yes
1C (Type 2)	183H Sludge (Basins 1 and 2)	--	Yes
1C (Type 3)	183H Sludge (Basins 3 and 4)	--	Yes
1A (Type 4)	183H Crystalline solid	--	Yes
1D (Type 5)	183H Miscellaneous cleanup (high copper)	Yes	--
1D (Type 6)	183H Miscellaneous cleanup (high nitrate)	Yes	--
2C (Type 7)	L-045 Metal sludge	Yes	--
7 (Type 8)	Ash from thermal treatment	Yes	--

*Envirostone is a trademark of the United States Gypsum Company.

The first four waste types were chosen for testing with the thermosetting polymer because of their high soluble salt content (including high nitrate content), which are known to cause problems with cement solidification. The last four waste types (5-8) were chosen for testing with cement waste forms because they did not contain high concentrations of any constituents that interfere with cement solidification.

Type 1 waste demonstrates a special problem with cement in that the acidic nature of the ammonium sulfate would react with the pH solutions in ordinary portland cement, thus evolving ammonia gas. Envirostone[2] was selected as an alternative to ordinary portland cement for this waste stream. This is a gypsum-based cement, which exhibits a neutral pH. Using Envirostone would be similar to using an ordinary cement and would not require additional equipment (i.e., this process could use the same equipment as the cement solidification system). Also, if successful, its use may provide a substantial cost savings over polymer for this large volume waste stream.

The actual formulations, chemicals, and waste loadings to be used in the thermosetting polymer test work were developed by the vendor (Stock Equipment Company of Chagrin Falls, Ohio) and are included in the test reports on this phase of work contained in the Appendix F and Section 4.22.

The formulations for the cement solidification testing have been developed by Westinghouse Hanford Company (WHC) personnel and the test work was performed onsite at the Hanford Site by WHC. The selection of cement type, the general composition used, and the target waste loadings for the five wastes are given in Table 3-3.

Portland cement type III was selected for Grit 1 because the grit contained copper, which retards the setting of ordinary portland cement. The type III sets fast and achieves a high strength comparatively early. Thus, it was selected in lieu of the type I or II cement. Also, a quick screening experiment using slag and type III cement indicated type III cement was achieving the better set.

The blast furnace slag cement was selected for Grit 2 because the grit contained a large quantity of nitrate. Based on a literature review, the slag cement contains the nitrate better than the portland cements. The slag cement produced a good product in a laboratory screening experiment and, thus, was selected for testing.

Portland cement type III was selected for the ferric oxide mix because the iron acts similar to copper and interferes with the cement set. The fast set of the type III minimizes the set-retarding effects.

Slag cement was selected for incinerator ash because of its good retention properties. It is expected to retain the chemical and radionuclide contaminants better than portland cement.

As mentioned earlier, Envirostone is a gypsum cement, which was selected for solidifying the stabilized evaporator residues because of the large quantity of ammonium sulfate. Portland cement slurry matrices are strongly basic exhibiting pHs characteristically around 12 and 13.

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[2]Envirostone is a trademark of the United States Gypsum Company.

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Table 3-3. Formulations for Cement Solidification Testing.

Type	General composition
Portland Cement Type III Solidifier	
5	4.2% Basin 1 sludge powder 37.5% Grit (garnet) 41.6% Portland cement type III 16.7% Water
Blast Furnace Slag Cement Solidifier	
6	4.2% Basin 4 crystal powder 37.5% Grit (garnet) 37.5% Slag cement 4.2% Portland cement type III 16.7% Water
Portland Cement Type III Solidifier	
7	15.4% Ferric oxide mix 46.2% Portland cement type III 38.5% Water
Blast Furnace Slag Cement Solidifier	
8	30.0% Ash mix 40.5% Slag cement 4.5% Portland cement type III 25.0% Water
Envirostone* Solidifier	
1	11.5% Ammonium sulfate mix 1.1% Citric acid 1.1% Sodium bicarbonate 28.7% Water 57.5% Envirostone

NOTE: The ammonium sulfate mix that was used in the experiment was dry. The C-018 ammonium sulfate feedstream would normally be an aqueous liquid, and the waste loading of 60% to 70% would be expected.

*Envirostone is a trademark of the United States Gypsum Company.

This strongly basic liquid will cause the ammonium sulfate salt to hydrolyze to ammonium hydroxide leading to the generation of ammonia gas. The gypsum (plaster of paris) slurry matrix is neutral, exhibiting a pH of 6 to 7. The ammonium sulfate is stable in the neutral matrix, no appreciable ammonium hydroxide is generated and, therefore, no ammonia gas is released.

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3.3 TESTING APPROACH

The WFQ test work is directed toward three goals. First, suitable formulations that can produce waste forms meeting all performance specifications and regulatory requirements must be developed. Second, the in-drum mixing process must be developed to determine the effect the mixing process has on waste form performance and to evaluate the ability of the mixing process to achieve the required process objectives. Third, hot testing will demonstrate the immobilization processes on actual WRAP 2A feedstreams for verification of results obtained with waste surrogates. Figure 3-1 depicts the strategy for the WFQ program.

The objectives of the WFQ program are to confirm the technical basis for the process design by demonstrating successful MLLW immobilization formulations and mixing processes. A further objective is to gather the data needed for support of detailed facility design and regulatory permitting efforts and to develop baseline process control parameters for use in preparing operating procedures for the WRAP 2A immobilization systems.

The test results reported in this status report have been focused on formulation development efforts. Screening tests and performance testing have been performed on surrogate waste forms representing 80% of the design basis feed volume. Future testing, described in detail in Section 5.3 of this report, will be directed toward mixing process demonstration and optimization of the formulations and immobilization processes.

A brief description of the major objectives of the WFQ program and the interfaces between WFQ and other key project activities is presented in the following text. Figure 3-2 presents a logic diagram outlining the test program and the flow of information between the various project activities relating to the WFQ program.

3.3.1 Confirm Process Design

Confirmation of the immobilization systems process design is the primary objective of the WFQ program. The process design basis will be confirmed when a successful immobilization formulation has been developed for each feedstream and when the in-drum mixing process has been demonstrated.

Development of a successful formulation is achieved when a surrogate that is chemically similar to the waste stream in question is successfully immobilized. Successful immobilization is defined as production of final waste form specimens that meet or exceed the WRAP 2A waste form performance specifications, as measured through laboratory tests of waste form performance.

The in-drum mixing process will be demonstrated when surrogates that are physically similar to the WRAP feedstreams have been successfully mixed with immobilization matrices using the in-drum mixing equipment. Successful mixing is defined as production of a mixture that meets or exceeds the mixing process objectives, as measured through tests on full size pilot plant mixing equipment.

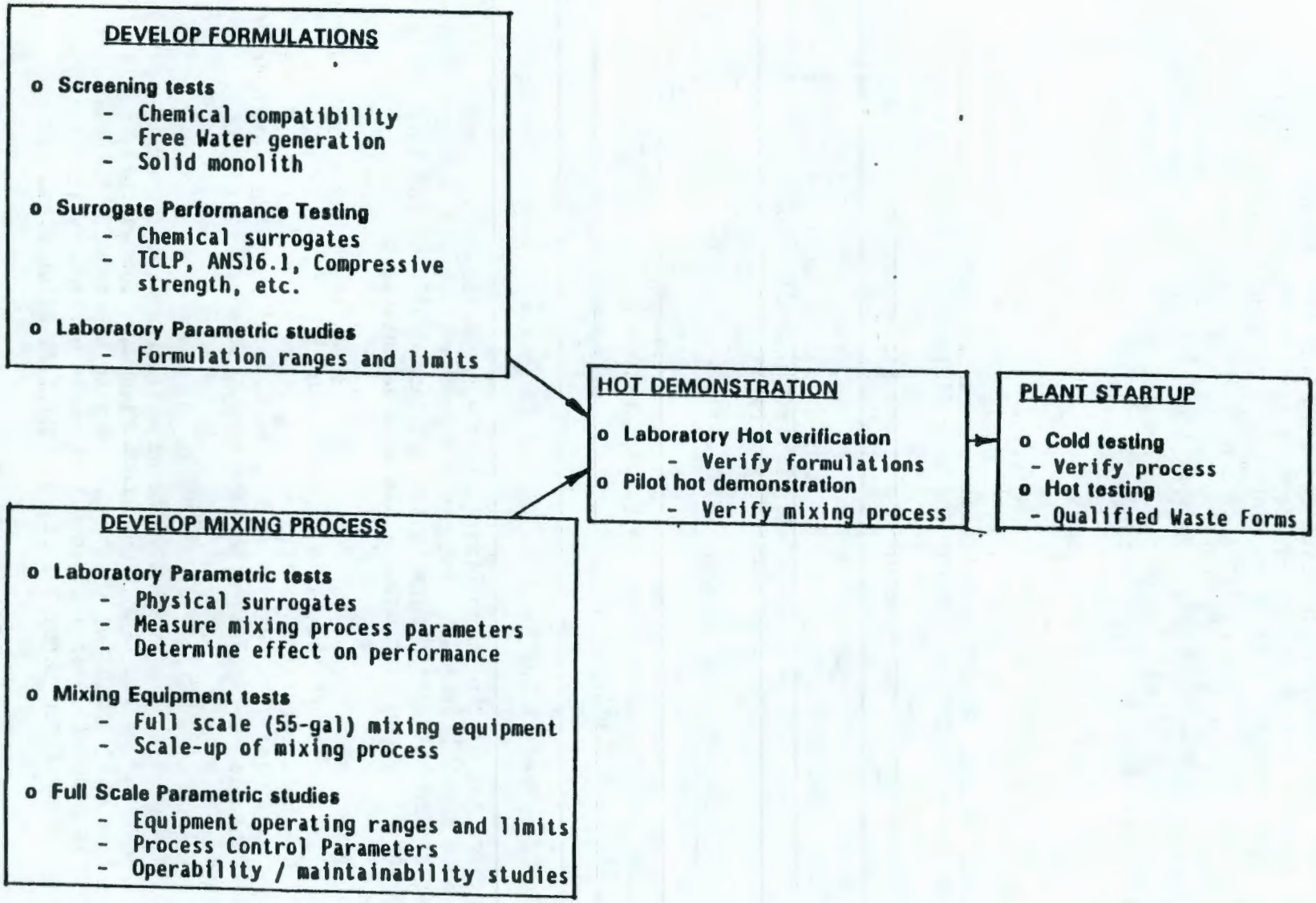

Figure 3-1. Waste Form Qualification Strategy.

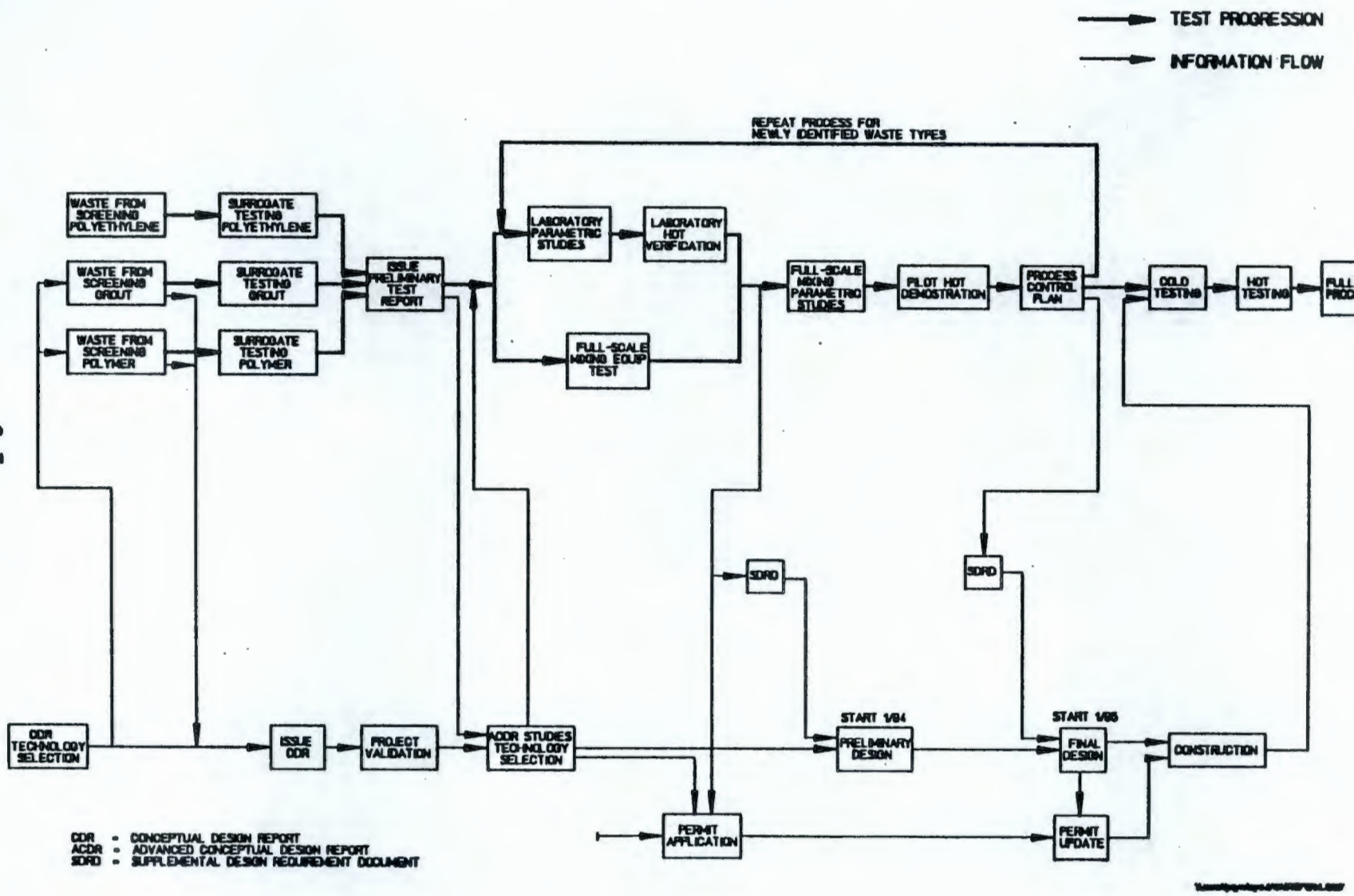

Figure 3-2. WRAP 2A Process Development Waste Form Qualification Project Logic.

Confirmation of the baseline process design basis will be subject to independent review by an outside panel of experts. A report summarizing the findings of the review panel will provide the basis for approval of commencement of Title I preliminary design activities.

3.3.2 Process Optimization

The second major objective of the WFQ program is to optimize the immobilization formulations and mixing processes. These studies will serve to expand and define the limits of the "windows" of formulations and mixing process operating conditions within which waste forms exhibiting acceptable performance can be produced. Process optimization will consist of methodical variation of formulations and mixing parameters in factorial experiments covering the full range of achievable conditions.

Results from process optimization studies will provide the majority of data required to prepare the Process Control Plan for the immobilization systems. The Process Control Plan will provide the interface with the RCRA facility permit, describing the formulation and mixing parameters that must be maintained to ensure production of fully compliant waste forms. It also will provide the foundation for development of operating procedures to be used with the immobilization systems equipment.

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3.3.3 Hot Verification

The third major objective is verification testing of the formulations and mixing process performance on actual WRAP 2A feedstreams. Hot verification tests will be performed on the feedstreams as they become available. Formulation testing will be performed in the laboratory, and, if any discrepancies in waste form performance are encountered, drum-scale hot testing will also be performed. Hot testing results that create modifications or additional requirements in the formulation or mixing conditions will be documented in the Process Control Plan.

3.3.4 Additional Objectives

Additional WFQ activities will include participation in the Polymer Solidification National Program at Brookhaven National Laboratory for development of a thermoplastic polymer encapsulation process using a heated extruder. Demonstration of BDAT technologies for special processes, such as mercury amalgamation or reactive metals treatment,, will also be included in the WFQ testing program. The scope of these additional activities has not yet been fully defined.

4.0 TEST RESULTS

4.1 SCREENING TEST RESULTS

4.1.1 Cement-Based Waste Form Screening Test Results

Waste surrogates for each waste type were immobilized with various cementitious binders to determine which would be selected for the grout formulations. Three things were considered when selecting the cementitious binders: (1) a hard set must be achieved within 48 hours, (2) a hard set must not occur within 6 hours, and (3) a reasonable waste loading must be achieved.

4.1.1.1 Type 5 — 183H Sandblast Grit 1 (High Copper Content). The binders that were evaluated were portland cement type III, a combination of portland cement types I and II, and slag cement. Portland cement type III is a rapid setting cement and was selected to balance the effect of the copper in the waste, which is known as a set retarder. A hard set was achieved in 48 hours. The combination of portland cement types I and II gave a set time of 72 hours. The slag cement required more time to achieve a hard set and was not considered for further evaluation. Portland cement type III was selected as the cementitious binder.

Mix formulation for sand grit/sludge ratio of 90:10:

- Waste loading = 41.7 wt%
- Water/cement ratio = 0.4
- Binder = 100 % portland cement type III.

4.1.1.2 Type 6 — 183H Sandblast Grit 2 (High Nitrate). The same cementitious binders as above were evaluated for this waste type. Because the nitrate content apparently did not interfere with the set time, a mixture of slag cement and portland cement type III was selected as the binder. A hard set was achieved in 24 to 48 hours using slag cement with portland cement type III as the initiator.

Mix formulation for sand grit/sludge ratio of 90:10:

- Waste loading = 41.7 wt%
- Water/cement ratio = 0.4
- Binder = 0.11 ratio of portland type III/slag cement.

4.1.1.3 Type 7 — L-045 Metal Sludge (Iron). The transition metal ions, including iron, tend to interfere with the setting properties of the cement matrix. Several cementitious binders were considered to immobilize the iron sludge surrogate, including portland cement type III, lime or a lime-portland cement mixture, a combination of portland cement types I and II, and slag cement. The lime (natural cement) produced a soft set and the lime/portland cement mixtures had to be added in excess to achieve a reasonable set. The

combination of portland cement types I and II and the slag cement performed adequately but not as well as the type III. The cementitious binder that produced the best results was the portland cement type III.

Mix formulation:

- Waste loading = 15.4 wt%
- Water/cement ratio = 0.83
- Binder = 100% portland cement type III.

4.1.1.4 Type 8 — ASH from Thermal Treatment. Slag cement was chosen for testing because of the similarity of the ash to slag cement. Slag cement was also selected based on its high chemical retention capability. A hard set was achieved within 24 hours.

Mix formulation:

- Waste loading = 30 wt%
- Water/cement ratio = 0.55
- Binder = 0.11 ratio of portland cement type III to slag cement.

4.1.1.5 Type 1 (Alternate Waste Form) — C-018 Ammonium Sulfate. Envirostone (gypsum cement) was selected to immobilized this waste stream because of its ability to solidify acidic waste. Envirostone remains neutral when mixed with water as opposed to most cementitious binders, which are strongly basic when mixed with water. A strongly basic media would readily react with ammonium sulfate or other ammonium salts to form ammonium hydroxide, which decomposes to ammonia gas. The one problem with Envirostone is that when it mixes with ammonium sulfate, the set occurs too rapidly to be of use in a typical mechanical mixer. Additional testing was performed and results indicated that the addition of citric acid or sodium citrate would retard the set time.

Mix formulation:

- Waste loading = 20 wt%
- Water/cement ratio = 0.5
- Binder = 0.02 ratio of retardant to Envirostone.

4.1.2 Thermosetting Polymer Screening Test Results

Screening tests for the thermosetting polymer immobilization process were performed at a private vendor's (Diversified Technologies) rented laboratory space at Saginaw Valley State University. Fifteen screening tests were performed using the Diversified Technologies vinyl ester polymer immobilization process. The technique was observed by the attenders and videotaped by WHC. The materials that were solidified were meant to represent the major chemical characteristics of the wastes selected for thermosetting polymer testing (see Section 3.2) as well as some waste samples that the vendor had prepared for demonstration purposes. The materials that were solidified and the test results are described in this section.

The process used in all cases involved adding a measured amount of binder, either 100 g (3.5 oz) or 50 g (1.8 oz), depending on the amount of final product desired, to a paper cup. Extender was added to the binder for the first 11 samples, then the process was tried without extender for the remaining samples. Surrogate waste was then added, at waste:binder ratios of either 1.5:1 or 1:1 (weight basis). Following mixing of the waste and binder, a catalyst was added and allowed to mix for 1 minute. The promoter was then added, mixed for 1 minute, and the agitator withdrawn. The gel time was measured and the samples allowed to cure.

Sample 1: Wet ammoniated powdex resin. The material was supplied by Diversified and consisted of a thick sludge of resin that had been drained of free water. 150 g (5.3 oz) of resin was added to 100 g (3.5 oz) of binder, for a waste loading of 60 wt%. The formulation was successful.

Sample 2: Ammoniated powdex resin, 30 wt% slurry in water. Processed as described for Sample 1. The formulation was successful.

Sample 3: Ammonium sulfate crystals (Type 1 Waste). 75 g (2.6 oz) of crystals were added to 50 g (1.8 oz) of binder. Processing was as described for Sample 1. The formulation was successful.

Sample 4A/4B: Ammonium sulfate crystals (Type 1 Waste). Processed as for Sample 3 but double the quantities. This material was transferred to specimen vials before curing. The vials were retained by WHC.

Sample 5: Surrogate basin sludge (Type 2 or 3 Waste). The sludge was formulated to represent the average composition of the basin 183-H sludge. This material was prepared to the UE&C recipe, where 100 g (3.5 oz) of sodium nitrate, 42 g (1.5 oz) of sodium sulfate decahydrate, and 79 g (2.8 oz) of water were mixed well. The water was not sufficient to fully dissolve the crystals. The crystal slurry was added to 79 g (2.8 oz) of Celite[3] 545 diatomaceous earth filter aid. This resulted in a moist cakey powder consistency. 75 g (2.6 oz) of this material was added to 50 g (1.8 oz) of binder and processed. The mixture formed a stable emulsion, but free water was exuded as the polymerization exotherm progressed. Following solidification, the free water was apparently reabsorbed into the matrix.

Sample 6: Wet basin sludge slurry (Type 2, 3 or 4 Waste). The WHC and UE&C observers agreed that the original recipe appeared to contain less moisture than the actual basin sludge, so this material was prepared by adding water to the above recipe until the desired consistency was obtained. This resulted in a recipe that contained 35% water. 85 g (3.0 oz) of the slurry was added to 50 g (1.8 oz) of binder and processed as above. The matrix exuded water during the exothermal reaction, and the water was not reabsorbed. Approximately 2 wt% free liquid was produced.

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[3]Celite is a trademark of Celite Corporation.

Sample 7: Sodium nitrate crystals (Type 4 Waste). 75 g (2.6 oz) was added to 50 g (1.8 oz) binder and processed. The material was successfully solidified.

Sample 8A/8B: Wet basin sludge slurry (Type 2, 3, or 4 Waste). 150 g (5.3 oz) of Sample 6 material was added to 100 g (3.5 oz) of binder and processed. The material was transferred into specimen vials and allowed to cure. Free water was exuded during the exothermal reaction. The vials were retained by WHC.

Sample 9A/9B: Sodium nitrate crystals (Type 2, 3, or 4 Waste). 150 g (5.3 oz) of crystals was added to 100 g (3.5 oz) of binder and processed. The material was transferred into two specimen vials and allowed to cure. The cured vials were retained by WHC.

Sample 10: Sodium sulfate decahydrate (Type 4 Waste). 50 g (1.8 oz) of crystals were added to 50 g of binder and processed. Water was exuded during the exotherm. The water evaporated, leaving behind salt crystals.

Sample 11: Wet basin sludge slurry (Type 2, 3, or 4 Waste). This sample was processed at 50:50 waste:binder ratio in an attempt to prevent formation of free water. During the exothermal reaction, about 2.3 wt% free water was produced.

Sample 12: Sodium sulfate decahydrate (Type 4 Waste). 75 g (2.6 oz) of crystals were added to 50 g (1.8 oz) of binder. For this test, the polymer extender was not added to the binder. This caused less heat to be produced during the exothermal reaction and a significant reduction in the amount of free water produced. The free liquid evaporated, leaving dry crystalline powder on the surface of the sample. The observers estimated that less than 0.5 wt% free liquid had been produced.

Sample 13: Wet basin sludge slurry (Type 2, 3, or 4 Waste). This sample was processed at 75 g (2.6 oz) waste to 50 g (1.8 oz) binder. No extender was added to the binder. The material produced 2.1 wt% free liquid.

Sample 14: Wet ammonium sulfate (Type 1 Waste). Water was added to the ammonium sulfate crystals to produce 10 wt% moisture to simulate LETF filter cake. The material was successfully solidified at 60 wt% loading (75 g [2.6 oz] wet salt:50 g [1.8 oz] binder) with no extender added to the binder.

Sample 15A/15B: Sodium sulfate decahydrate (Type 4 Waste). 150 g (5.3 oz) of the crystals was added to 100 g (3.5 oz) of binder without extender. The material was transferred into two specimen vials retained by WHC. Traces of water were exuded, leaving small spots of dry crystals on the surface of the specimens.

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4.1.3 Thermosetting Polymer Results Summary

The technology shows promise as an alternative to conventional cement-based grout for immobilization of the materials tested. Further development of the formulation will be required to eliminate the free liquids that were formed when processing the materials, which contained hydrated sodium sulfate crystals. The process was able to successfully immobilize sodium nitrate and ammonium sulfate, at 60 wt% loading, with no apparent side reactions. The immobilized material appears to be homogeneous and possesses considerable structural strength and durability.

Based on the results of these initial screening tests, it was recommended that the technology be considered for further WFQ testing to support possible use in WRAP 2A for the immobilization of mixed wastes containing nitrates and ammonium salts. Additional development will be required to determine if the polymer formulation can be adjusted to prevent the formation of free liquids when processing material containing hydrated sodium sulfate salts.

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4.2 SURROGATE PERFORMANCE TESTS

4.2.1 Cement-Based Waste Form Results

Sample Preparation

The cementitious waste forms were prepared by combining the waste surrogates and the cementitious binders according to the formulations developed during the screening tests, as shown in Section 4.1.1. The surrogate material and the cementitious binder were measured into a 19-L-(5-gal-) capacity, heavy duty Hobart[4] variable mixer, where they were mixed until a homogeneous mixture was obtained. A minimum of 9.5 L (2.5 gal) of cement-waste slurry was required for each set of experiments. For each waste type tested, a cement-waste slurry was prepared in three batches and poured out separately into the appropriate sized molds. Sample molds included 5 cm by 5 cm by 5 cm (2 in. by 2 in. by 2 in.) cubes, small cylinders 7.6 cm in diameter by 15 cm high (3 in. in diameter by 6 in. high), and large cylinders 15 cm in diameter by 30.5 cm high (6 in. in diameter by 12 in. high). The wet specimens were covered with plastic or placed in plastic bags to simulate placement in a 208-L (55-gal) drum or another sealed container. The cube samples were removed from their metal molds after about 3 days. The samples were labeled and placed in plastic bags at room temperature until the appropriate cure time was achieved. After curing, the samples were weighed and then tested. The cylinders were kept in their molds and covered until tested. Cement controls (no waste) were made for compression strength reference.

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[4]Hobart is a trademark of Hobart Corporation.

RESULTS

Compressive Strengths

The first set of waste forms tested were 5 cm by 5 cm by 5 cm (2 in. by 2 in. by 2 in.) cubes. The compressive strength tests were performed on two cube samples for each waste type. The first cube for each waste type was tested after 14 days of curing, the second cube for each waste type was tested after 28 days of curing. The results are shown on Table 4-1.

The second set of waste forms were small cylinders, 15 cm (6 in.) high with a 7.6-cm (3-in.) diameter. The cylinders were allowed to cure for 28 days before the compressive strength tests were performed. The small cylinder results are shown in Table 4-2.

Table 4-1. WRAP 2A Waste Form Characteristics.

Sample	Solidifier	Density (g/cc)	Free liquid (vol.%)	Compressive strength	
				14 day (lbf/in^2)	28 day (lbf/in^2)
Type 5	Portland Type III	2.5	0	6,800	5,000
Type 5	Portland Type I and II	2.5	0	4,600 (28d)	5,600 (42d)
Type 6	Slag Cement/portland Type III	2.4	0	3,800	3,000
Type 7	Portland Type III	1.7	0	1,000	1,300
Type 8	Slag Cement/portland Type III	1.7	0	3,100	1,800
Type 1	Environstone*	1.5	2.6 at 1 day 1.6 at 2 day 0.0 at 3 day (Liquid pH is 6)	70	60

*Envirostone is a trademark of the United States Gypsum Company.

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Table 4-2. WRAP 2A Cement Waste Form Tests Results.

Sample	Compressive strength		Radiation stability	Biodegradation	Leachability Index	Waste immersion			Thermal cycling
						Compressive strength (lbf/in^2)			Compressive strength (lbf/in^2)
	Small cylinder (lbf/in^2)	Large cylinder (lbf/in^2)	Compressive strength (lbf/in^2)	Compressive strength (sample/control) (lbf/in^2)		14d	42d	90d	
Control	7,400	4,500	--	--	--	--	--	--	--
Type 5	7,100	5,400	8,500/9,100	No growth 10,300/10,800	12.2 (Ru) 13.3 (Mo)	8900	3900	8400	5500/8000
Type 6	3,500	4,200	3,800/4,800	No growth 6,100/6,000	12.7 (Co) 11.2 (Sr) 12.8 (Mo)	5300	2600	5500	4000/4400
Type 7	2,800	2,100	2,500/2,000	No growth 3,100/2,600	9.7 (Na) 7.1 (Cs)	2400	1100	3000	2200/2400
Type 8	3,400	2,400	4,100/3,900	No growth 4,600/4,500	12.8 (Ru) 12.2 (Ce)	3900	2500	4380	2900/3100
Type 1	<50	70	35/<50	No growth >50 >50	9.9 (Ce) No data (Sr)	Failed			<50/50

The third set of waste forms were the large cylinders, 30.5 cm (12 in.) high with a 15-cm (6-in.) diameter. The large cylinder waste forms were allowed to cure for 28 days before they were compressive strength tested. The large cylinder test results are shown in Table 4-2.

Radiation Stability

Two identical waste form cubes for each waste type were irradiated to a total dose of 10^8 radiation in a gamma irradiation facility. Each cube was then compressive strength tested. Weights for each of the ten samples were recorded before and after irradiation. No weight change was observed and no visual change in color or appearance was observed. The compressive strength test results are shown in Table 4-2.

Biodegradation

Ten waste form cubes, two duplicate cubes for each waste type, were subject to ideal growth conditions for bacteria, for a period of 21 days. After this incubation period, the waste forms were tested for compressive strength. The results are shown in Table 4-2.

Leachability Index

Cube samples for each waste type were subject to the leachability index test. The test results are shown in Table 4-2.

Water Immersion

Three cube samples for each waste type were stored in moist conditions over a period of time. After 14 days, one of the cubes for each of the waste types was compressive strength tested. After 42 days, the second cube sample was compressive-strength tested. After 90 days, the third sample was tested. The results are shown in Table 4-2.

Thermal Cycling

Two cube samples for each waste stream were heated to +60 °C (140 °F), cooled, frozen to -40 °C (-40 °F), and then thawed. The cycle was repeated 30 times and then a compressive strength test was performed on each cube sample. Results are shown in Table 4-2.

Free Liquid

The samples were prepared by pouring the slurry mix into 13 cm^2 (2-in^2) plastic bottles to a 5-cm (2-in.) height, for each of the waste types. Duplicate samples for each waste type were prepared. At the end of a 24-hour period each sample was visually inspected for the presence of liquid. The amount of liquid, if any, was measured. The results are shown in Table 4-1.

EPA (TCLP) Tests

The test involves obtaining an extract from the waste form and analyzing the extract for toxic constituents. The test results for the TCLP tests are summarized in Table 4-3.

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Table 4-3. TCLP Results for WRAP 2A Cement Waste Forms.

Sample	Specie	Original Cont.	TCLP Cont.	Limit	Pass/fail
Type 5	Chromium	50 ppm	0.07 ppm	5 ppm	Pass
	Copper	1.7%	0.09 ppm	No limit	N/A
Type 6	Chromium	50 ppm	<0.02 ppm	5 ppm	Pass
Type 7	Barium	100 ppm	0.05 ppm	100 ppm	Pass
	Cadmium	100 ppm	<0.01 ppm	1.0 ppm	Pass
	Chromium	500 ppm	0.3 ppm	5.0 ppm	Pass
	Lead	100 ppm	<0.12 ppm	5.0 ppm	Pass
	Mercury	100 ppm	0.5 ppb	0.2 ppm	Pass
	Selenium	100 ppm	<0.12 ppm	1.0 ppm	Pass
	Silver	100 ppm	<0.02 ppm	5.0 ppm	Pass
Type 8	Chromium	100 ppm	<0.03 ppm	5.0 ppm	Pass
	Mercury	100 ppm	<0.1 ppb	0.2 ppm	Pass
Type 1	Chromium	700 ppm	4.0 ppm	5.0 ppm	Pass
	Mercury	10 ppm	0.3 ppb	0.2 ppm	Pass
	Nickel	50 ppm	0.25 ppm	No limit	Pass

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CONCLUSIONS

The results indicate that the formulations developed in phase I were successful at immobilizing each of the waste types, with the exception of the ammonium sulfate waste. The waste forms produced from waste Types 5, 6, 7, and 8 contained no free water, exhibited compressive strengths well above what is required, and passed the TCLP tests. These waste types will be further evaluated for grout processing in WRAP 2A.

4.2.2 Thermosetting Polymer Waste Form Test Results

Testing of polymer waste forms was performed at vendor facilities. Screening tests were performed to obtain a qualitative measure of waste loading capacity, chemical compatibility, and free water generation. The screening tests were followed by waste form performance tests to quantitatively determine the waste form stability, durability, and leach characteristics.

FORMULATION DEVELOPMENT

Formulation development activities were performed at Stock Equipment Company laboratories. The initial trials were successful for Type 1 and Type 3 surrogates. Additional investigation of Type 2 waste revealed that the pH of the surrogate did not resemble the actual waste. The pH of Type 2 surrogate was adjusted to 10.5 to more closely resemble the actual waste, and a suitable formulation was developed for Type 2 and 4 wastes using a different binder

material. Table 4-4 summarizes the formulations that were used to prepare the waste form specimens.

Table 4-4. Formulation Parameters.

Formulation parameter	Type 1	Type 2	Type 3	Type 4
Waste/binder ratio, (kg/kg)	4/2	3/3	4/2	3/2
Binder type	411-45	470-45	411-45	470-45
Catalyst dose (wt% of binder)	2.5	7.5	2.5	5.0
Promoter dose (wt% of binder)	0.1	2.0	0.1	1.0
Total mixing time (minutes)	25	8.5	8.5	10.5
Peak mixing power (W)	45	12.3	9.9	13.9
Peak exotherm (°C)	38.2	70	57.5	63
Peak exotherm time (minutes)	75	30	120	25

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SPECIMEN PREPARATION

Test specimens were prepared from waste surrogates at the Stock Equipment Company laboratories. Batch size was approximately 4.7 L (1.25 gal). A variable speed laboratory mixer with propeller blade operating at 1,800 rpm was used. Each set of specimens was made from a single batch and poured into cylindrical molds. The tests described in Section 2.0 were performed on the specimens. Replicate tests were performed as described in Table 4-5.

Table 4-5. Replicate Specimens Tested.

Performance test	Number of replicates tested
Compressive strength	10 @ 5-day cure, 10 @ 90-day cure
Biodegradation	3
Radiation stability	3
Leachability/immersion	6 spiked, 6 unspiked
Thermal cycling	3
Toxicity characteristic	2 + 1 @ independent lab

TESTING RESULTS

Results of the testing are summarized in Table 4-6. All specimens were successfully immobilized and exhibited strength and durability characteristics meeting or exceeding the waste form performance specifications. Type 3 surrogate met all of the performance specifications. Leaching characteristics for all surrogates met the requirements for LLW, but some TCLP constituents of Types 1, 2, and 4 surrogates exceeded the allowable limits. Additional formulation development will be required for these waste types.

CONCLUSIONS

Surrogate waste form specimens were successfully immobilized at waste loadings ranging from 50 wt% to 67 wt%. Type 1 surrogate met all performance specifications with the exception of TCLP mercury. Type 2 surrogate met all performance specifications with the exception of TCLP mercury and chromium. Type 3 surrogate met all performance specifications. Type 4 surrogate met all performance specifications with the exception of TCLP chromium.

The results show that the technology is capable of producing a waste form that meets or exceeds all applicable performance requirements. Additional formulation development will be required to optimize the waste loading for waste Types 1, 2, and 4 to enable the waste form to meet the TCLP limits for mercury and chromium.

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4.3 FOLLOW-ON TESTING

The TCLP results prompted additional work to develop formulations that could meet the regulatory limits for chromium and mercury. Additional testing was performed using waste loading of 25 wt%. Three methods for preparing the TCLP extraction specimens were investigated. One method involved casting pellets from the mixture so no size reduction was required. The other two methods used larger specimens that were crushed to meet the size requirements for TCLP; all material was used in the extraction for one method and the other method discarded fines less than 1 mm screen size before extraction.

The results of the follow-on TCLP testing are summarized in Table 4-7. The samples prepared as pellets passed for all TCLP constituents present. Neither of the crushing methods were able to meet TCLP limits for mercury. The results show that reduced waste loading is effective for controlling the chromium concentrations. The use of reduced waste loadings was successful in decreasing the concentrations of all TCLP metals observed in the waste extracts, but the sample preparation method apparently has a larger influence on the final results than waste loading. Further investigation is planned to address these concerns.

Table 4-6. Summary of Polymer Waste Form Testing Results.

Waste form characteristic	Acceptance criteria		Test results			
			Type 1	Type 2	Type 3	Type 4
Compressive strength	Strength >500 psi		2,472 psi	1,085 psi	1,411 psi	942 psi
Leachability index	Leach index >6 Demin/sea water	Cs	7.7/7.4	7.0/7.0	7.3/7.2	7.1/7.1
		Co	8.2/7.9	9.2/9.3	10.1/10.3	7.5/7.7
		Sr	8.9/8.7	9.3/9.1	10.2/9.4	9.1/9.0
Biodegradation	No growth, strength >500 psi		No growth	No growth	No growth	No growth
			2,247 psi	3,710 psi	994 psi	1,114 psi
Thermal cycling	Strength >500 psi after 30 thermal cycles		5,111 psi	640 psi	990 psi	850 psi
Radiation stability	Strength >500 psi after irradiation to 10^8 rad		5,127 psi	6,028 psi	964 psi	2,575 psi
Immersion	Strength >500 psi after 90-day immersion		1,114 psi/ 1,151 psi	1,034 psi/ 842 psi	1,048 psi/ 952 psi	981 psi/ 1,028 psi
Free liquids	Free liquid <0.5%		Pass	Pass	Pass	Pass
Hazardous characteristics	Not ignitible Not corrosive Not reactive		Pass Pass Pass	Pass Pass Pass	Pass Pass Pass	Pass Pass Pass
Toxicity characteristics	TCLP leachable metals below EPA limits (parts per million)	Ba 100	N/A	N/A	0.511 pass	0.183 pass
		Cd 1.0	N/A	N/A	0.270 pass	N/A
		Cr 5.0	2.43 pass	9.61 fail	4.65 pass	8.88 fail
		Hg 0.2	1.65 fail	1.54 fail	N/A	N/A
		Ag 5.0	N/A	0.355 pass	0.397 pass	N/A

EPA = U.S. Environmental Protection Agency.
N/A = not applicable.
psi = pounds-force per square inch.
TCLP = Toxicity Characteristic Leaching Procedure.

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Table 4-7. Follow-On Testing Results.

Waste form characteristic	Acceptance criteria		Test results								
			Waste type 1			Waste type 2			Waste type 4		
	Sample preparation method*		A	B	C	A	B	C	A	B	C
Toxicity characteristics	TCLP leachable metals below EPA limits (parts per million)	Ba 100	N/A	N/A	N/A	N/A	N/A	N/A	0.022 pass	0.320 pass	0.268 pass
		Cd 1.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Cr 5.0	0.275 pass	0.844 pass	1.056 pass	1.76 pass	4.37 pass	4.82 pass	2.03 pass	2.19 pass	2.46 pass
		Hg 0.2	0.182 pass	0.385 fail	0.350 fail	0.194 pass	0.270 fail	0.245 fail	N/A	N/A	N/A
		Ag 5.0	N/A	N/A	N/A	0.045 pass	0.040 pass	0.066 pass	N/A	N/A	N/A

*Method A = Pellets; Method B = Crushing; Method C = Crush, discard fines.
N/A = not applicable.
TCLP = Toxicity Characteristic Leaching Procedure.

CONCLUSIONS

The immobilization/stabilization technologies selected for use in WRAP 2A have been tested on waste surrogates approximately reflecting the chemical characteristics of 80% of the baseline feed volume. The baseline process selection has been confirmed for the feed streams studied. Suitable formulations have been developed and waste form performance testing has shown that the technologies are capable of meeting all applicable regulatory acceptance criteria.

Thermosetting polymer formulations have been developed for four baseline WRAP 2A waste streams. Waste surrogates were successfully immobilized at waste loadings from 50 wt% to 66 wt%. Performance test results at these waste loadings met all specifications except TCLP for chromium and mercury. Specimens prepared as pellets with a 25 wt% waste loading met TCLP limits for all constituents. TCLP results for polymer waste forms were shown to be highly dependent on the method used for TCLP sample preparation and somewhat less strongly influenced by waste loading.

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APPENDIX A

STATEMENT OF WORK — THERMOSETTING POLYMER

Statement of Work (SOW) prepared by Westinghouse Hanford Company (WHC) as part of the bid package soliciting qualified vendors to perform waste form performance testing using a thermosetting polymer with WHC prepared surrogate waste.

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STATEMENT OF WORK — THERMOSETTING POLYMER

Waste Form Qualification Testing
Statement of Work W-277587
May 14, 1992

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1.0 INTRODUCTION

The Westinghouse Hanford Company (WHC), under contract to the United States Department of Energy (DOE), is currently responsible for the design, construction, startup, and operation of the Waste Receiving and Processing Facility (WRAP) at the DOE's Hanford site. The second module of the facility (WRAP 2A) will handle and process contact-handled low level mixed (hazardous and radioactive) wastes (CH-LLMW). The WRAP 2A project is currently in the conceptual design stage, with architect/engineer services being provided by United Engineers and Constructors (UE&C).

As part of the conceptual design effort for this project, WHC is seeking contractors to provide services in support of the polymer immobilization technology waste form qualification program. The required services will involve the formulation, preparation and testing of vinyl ester styrene waste forms, and documentation of the waste form content, formulation, process parameters, and analytical results.

This document describes the work to be done by the contractor in support of the WRAP 2A waste form qualification program. The contractor shall comply with all provisions of this statement of work during the performance of the work.

2.0 PURPOSE

The first purpose of this phase of the WRAP 2A waste form qualification program is to develop polymer immobilization formulations for the four CH-LLMW waste types of concern, and to demonstrate the ability of the immobilization process to create a final waste form which is chemically and physically stable, and which meets all applicable regulatory requirements with respect to low-level radioactive and hazardous waste disposal.

The second purpose of the program is to provide full and complete documentation of the qualification testing procedures, practices, and results. The documentation must be of sufficient quality to support ongoing efforts for regulatory compliance and detailed facility design. The test program will be performed in laboratories which are qualified to perform the work described.

The results of this test program will be used to evaluate the suitability of the immobilization process for use in WRAP 2A. Successful demonstration of

suitable immobilization technologies is a critical element in the completion of the WRAP 2A conceptual design effort.

3.0 SCOPE OF WORK

The scope of work includes the following work elements:

3.1 Prepare a plan to perform all elements of the work described for approval by WHC prior to the start of work.

3.2 Prepare a quality assurance plan for approval by WHC prior to the start of work.

3.3 Develop optimum formulations for the immobilization of the surrogate wastes supplied by WHC.

3.4 Prepare waste form qualification specimens as necessary to complete all required laboratory tests.

3.5 Perform laboratory qualification testing and analyses of immobilized waste forms.

3.6 Support the conceptual design effort for the WRAP 2A polymer immobilization process facilities.

3.7 Prepare progress reports and a final report to fully document all development and testing activities associated with this work.

4.0 DESCRIPTION OF TESTING

Thirty (30) pounds each of the four surrogate waste simulants will be prepared and furnished by WHC for use in the testing. Table 1 summarizes the approximate chemical compositions of the surrogate wastes. The surrogates will be prepared by dissolving the required salts in water and evaporating to the desired moisture content. A complete description of the procedures used to prepare the surrogates, and full chemical analysis of each surrogate waste shall be supplied by WHC, including material safety data sheets for all ingredients used to prepare the surrogates. The surrogate wastes will not contain any radionuclides.

The contractor shall be responsible for developing the optimum formulation to be used for preparing the qualification specimens. Qualification testing specimens shall then be prepared using the optimum formulation for each surrogate waste type.

A minimum of eight qualification specimens shall be prepared from each of the surrogate wastes supplied by WHC. All qualification specimens shall be prepared from a single batch of processed waste. The minimum batch size shall

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be one liter. The process shall be monitored for the parameters listed in Table 2 during the preparation of the qualification specimens.

The specimens shall be tested to determine the final waste form properties as listed in Table 3. Documentation supporting laboratory qualification to perform the required testing shall be included with the work plan. The vendor shall propose additional process parameters or waste form properties to be monitored or tested, as may be necessary or desirable to fully define the process or demonstrate superior waste form qualities.

5.0 ACCEPTANCE CRITERIA

Waste form testing acceptance criteria are shown in Table 3. Polymer waste forms which do not meet all of the test acceptance criteria will not be considered for further evaluation or for use in the WRAP 2A facility.

6.0 CONCEPTUAL DESIGN SUPPORT

The contractor shall provide support to WHC during the development of the conceptual design report (CDR) for the WRAP 2A facility. The contractor's technical staff shall be available for occasional telephone consultation as required to answer questions regarding the conceptual design. Support shall include providing process design parameters, recommendations for process equipment selection, and review of the immobilization process conceptual design documents. This design review will include a 2-day meeting at UE&C's offices in Denver. The contractor shall prepare and submit a summary letter report describing the conclusions and recommendations resulting from this design review.

7.0 TEST PROCEDURE

The work plan shall include complete detailed descriptions of all proposed processing equipment and laboratory apparatus to be used for preparation and testing of the qualification specimens. Laboratory testing procedures to be used shall conform with the methods shown in Table 3. The tests shall be performed by laboratories which are qualified in the required test methods. Laboratory qualification shall be demonstrated by an established QA/QC program and prior experience in the test methods specified. Any deviation from the test procedures listed in Table 3 must be approved in writing by WHC prior to performing the tests.

8.0 SAFETY

The contractor shall comply with all applicable safety regulations during the performance of the work. Any unusual safety hazards, such as flammability, chemical toxicity, or reactivity associated with the process technology shall be described in the work plan, along with the procedures and equipment which

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will be used to mitigate safety hazards. Material safety data sheets for all process reagents shall be submitted with the work plan.

9.0 QUALITY ASSURANCE

The contractor shall prepare a quality assurance plan describing the QA/QC activities to be performed during the work. WHC shall review and approve the QA plan prior to the start of testing. The plan shall include, but not be limited to, descriptions of laboratory instrument and equipment calibration, analysis of duplicates and blanks, and statistical validity of analytical results. All reported results shall be fully traceable to the original data sources. The testing laboratory shall follow QA/QC procedures that conform to the requirements of the testing methods in Table 3.

10.0 SCHEDULE

The schedule for performance of this work is shown in Figure 1. The contractor shall submit the work plan and quality assurance plan within two weeks after award of contract. WHC review and approval of these documents will require one week. The contractor shall submit interim progress reports on the work at four week intervals following approval of the work plan and release to proceed. The second progress report should contain the results of all laboratory testing with the exception of the long-term immersion, biodegradation, and leachability testing. Work shall be completed by October 16, with submittal of the final report no later than October 30, 1992.

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Waste Form Qualification Testing
Statement of Work W-277587
May 14, 1992

TABLE 1
Surrogate Wastes Approximate Composition

Component	Waste Type 1 LETF Salts	Waste Type 2 Basins #1,#2 Sludge	Waste Type 3 Basins #3,#4 Sludge	Waste Type 4 Basin Crystal Solids
Silver (ppm)		218	190	
Barium (ppm)			24	100
Beryllium(ppm)		6	2.3	
Cadmium (ppm)			6	
Chromium (ppm)	187.5	900	390	500
Copper (ppm)	201.0	130,000	112,000	63,000
Mercury (ppm)	9.2	1.3		
Nickel (ppm)	46.5	100	130	400
SUBTOTAL (ppm)	444.20	131,225.30	112,742.30	64,000.00
Ammonium (%)	22.83			
Fluoride (%)		6.0	1.3	7.1
Nitrate (%)	1.1	13.5	26	1.6
Sodium (%)		20.0	24	22.9
Sulfate (%)	64.61	20.2	3.7	35.5
Water (%)	10.0	21.58	25.03	24.5
SUBTOTAL (%)	98.54	81.28	80.03	91.60
Inerts (%)	1.42	5.6	8.7	2.0
TOTAL (%)	100.00	100.00	100.00	100.00

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Waste Form Qualification Testing
Statement of Work W-277587
May 14, 1992

TABLE 2
Key Process Parameters

PARAMETER	UNITS
Mixer speed	revolutions per minute
Mixer power	watts
Batch weight	grams
Batch volume	cubic centimeters
Curing exotherm	degrees Centigrade
Waste loading	weight percent
Matrix chemistry	weight percent

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Waste Form Qualification Testing
Statement of Work W-277587
May 14, 1992

TABLE 3
Immobilized Waste Testing Requirements

Waste Form Characteristic	Test Method	Acceptance Criteria
Compressive Strength	ASTM D695	Strength > 60 psi
Leachability Index	ANS 16.1	Leach Index > 6
Biodegradation	ASTM G21 & G22, ASTM D695	No growth, Strength > 60 psi
Thermal Cycling	ASTM B553, ASTM D695	Strength > 60 psi after 30 thermal cycles
Radiation Stability	ASTM D695	Strength > 60 psi after irradiation to 10^8 rad
Immersion	ASTM D695	Strength > 60 psi after 90-day water immersion
Free Liquids	ANS 55.1	Free liquid < 0.5%
Hazardous Characteristics	40 CFR 261	Not ignitible, not corrosive, not reactive
Toxicity Characteristics	EPA 1311 (TCLP), EPA 6010	TCLP leachable constituents below EPA limits[a],[b]

[a]Basin waste toxic constituents are Ag, Ba, Be, Cd, Cr, Cu, Hg, and Ni. LETF toxic constituents are Cr, Cu, Hg, and Ni.

[b]EPA limits as described in 40 CFR 268.41, Table CCWE.

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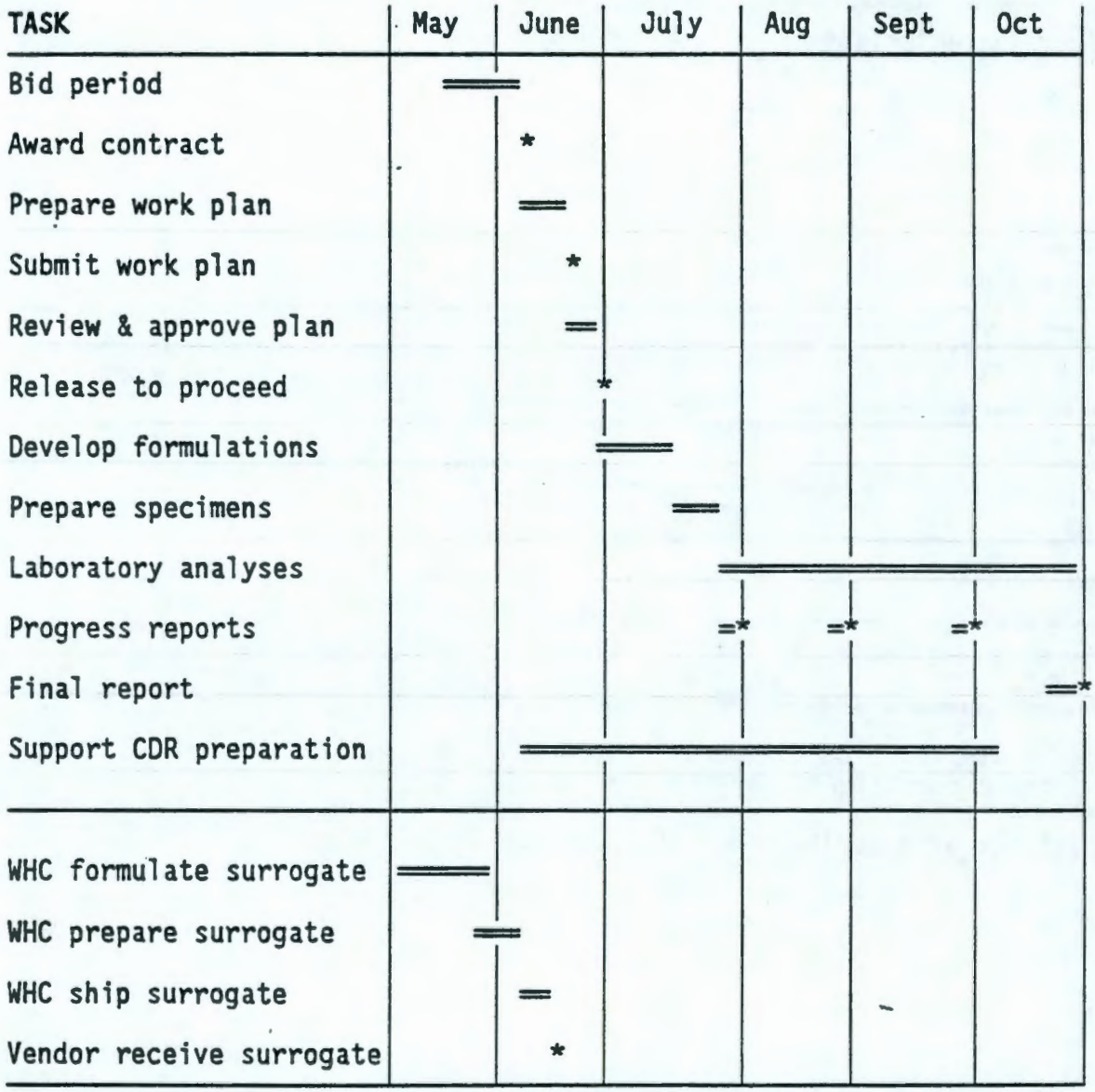
Waste Form Qualification Testing
Statement of Work W-277587
May 14, 1992

FIGURE 1
SCHEDULE



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APPENDIX B

TECHNICAL TASK PLAN — GROUT

Technical Task Plan (TTP) prepared by WHC for an "in-house" (WHC) testing program for waste form performance testing using cement-based waste forms and surrogate waste. Similar to the SOW for thermosetting polymer.

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TECHNICAL TASK PLAN — GROUT

FY 1992 Technical Task Plan

Support of the Waste Receiving and Processing (WRAP)
Module 2A

TIP #A5202

Principal Investigator	Date 5/29/92
Cost Account Manager	Date 5/29/92
WRAP Program Engineer	Date 6/3/92
WRAP Program Manager (Restoration Projects - Manager)	Date 6/8/92

Technical Task Plan

Date: 05/04/92

Title: Waste Disposal Studies in Support of WRAP (Module 2A)

Technical Manager: J. A. Hunter

Technical Investigator: W. O. Greenhalgh

Program Coordinator: J. L. Westcott

Fiscal Year: 1992

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Scope

Support WRAP validation (August 15, 1992) by providing the following:

- A waste characterization summary for all WRAP 2A feed streams including C-018H, L-045H, 183H basin, ash residue, etc.
- Immobilization technology literature search for these feeds.
- Cold laboratory testing of cement solidification systems on C-018H and 183H basin waste simulants.
- Publish status report to support validation application.

Budget

FY 1992 - $60K expense.

Objective

To prepare, in report form, waste characterization data and summary, immobilization candidates, and compatible immobilization options that can be applied in the Module 2A facility of WRAP to meet present and near future waste disposal criteria and regulations.

Background

The WRAP Module 2A facility is scheduled to be constructed as a 1994 Line Item Project Number W-100. The conceptual design is currently underway and scheduled for completion in July of 1992. The facility is to start operation in September 1999 in accordance with the Tri-Party Agreement Milestone M-19.

The Waste Receiving and Processing (WRAP) Module 2A facility conceptual design is a contact handled (CH) solid low-level radioactive mixed waste (LLMW) treatment facility. The facility will provide non-thermal (<500°F) treatment of CH LLMW to enable permanent disposal compliant with environmental regulations and DOE Orders at the Hanford Site. The design basis yearly facility processing rate is 29,200 cubic feet (CF) of received waste. The waste received will vary widely in form and hazardous characteristics.

The waste to be treated in WRAP Module 2A varies in form, radionuclide contamination, and hazardous constituents. The waste forms include salts, soils, debris, absorbed chemicals, sludges, ion exchange resins, metal, glass, incinerator ash, and HEPA filters. The hazardous characteristics include heavy metals, ignitables (oxidizers), corrosives (acids and bases), reactives, asbestos, and trace amounts of liquid organic contaminants. The wastes with significant liquid organic contamination will not be treated in this facility.

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Task Description

Sampling and characterization data already available for waste scheduled for treatment in the WRAP 2A module will be collected, evaluated, analyzed, and summarized. This data will form the basis for defining the required disposal criteria. Technical literature searches will be made to define waste immobilization and solidification options that can be applied to the different summarized waste streams. Lab screening tests will be made to verify application of immobilization or solidification options to the C-018H and 183H WRAP waste streams. This information and the status of the disposal work will be made available in a brief report prior to the validation application (August 15, 1992). The balance of FY 1992 will be devoted to resolving any validation questions.

Activities and Milestones

Waste activities and milestones are given in a chart on the following page. Costs and completion dates are given on a second chart.

Deliverables

The following deliverables are anticipated:

Date	Deliverable
05/31/92	Literature search results
06/01/92	Recommended solidification methods for lab screening
06/30/92	Waste characterization summary
07/15/92	Recommended solidification methods for all WRAP 2A wastes
08/01/92	Brief laboratory report • Recommended solidification methods for C-018H and 183H wastes. • Waste form characteristics

Activity and Milestone Chart (FY 1992)

Activity	Apr	May	Jun	Jul	Aug	Sep	FY 1993
1. Summarize Characterization Work							
• Collect Waste Data	-----Δ						
• Evaluate & Analyze Data	---	---Δ					
• Summarize Information			-----Δ				
2. Literature Search							
• Perform literature search	-----Δ						
• Review literature and summarize results	---	---Δ					
• Evaluate waste forms		----	-----Δ				
3. Laboratory Screening							
• Recommend lab tests		----	Δ				
• Initiate lab screen			Δ-----				
• Complete lab screen			-	--Δ			
• Write brief status report				-----Δ			
• Validation preparation/ response				--	--Δ		

August - Validation Approval

Activity	Completion Date	Cost ($K)
1. Summarize Characterization Work		
• Collect Waste Analysis Data	4/30	$ 5
• Evaluate and Analyze Data	5/31	10
• Summarize Information	6/30	10
2. Literature Search		
• Perform literature search for alternate waste forms	4/30	5
• Review literature and summarize results	5/31	5
• Evaluate candidate waste forms for screen tests	6/30	5
3. Laboratory Screening		
• Recommend waste forms to test	6/1	--
• Initiate lab screening	6/7	5
• Complete lab screening	7/15	10
• Write brief status report	8/1	5
• Resolve any validation questions	8/15	--
DOE PRESENTATION AUGUST 15		
TOTAL		$60

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Laboratory Screening Criteria (will make "best effort" try to perform the appropriate listed tests)

1. Must meet WHC-EP-0063-3 criteria.

   - Stable waste form
   - No free liquid
   - Not explosive, flammable, reactive, nor corrosive

2. Must pass TCLP test for any hazardous constituents.

3. Should appear to meet NRC waste form characteristics.

   - Compressive strength >500 psi for 28-day cure materials.
   - Leachability ANS 16.1 leach index >6, stop at 30 days (90-day is standard).
   - Immersion >60 psi after 30-day water immersion (90-day is standard).
   - Radiation stability
   - Thermal cycling
   - Biodegradation
   - Free liquid measurement

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Expected Results

The task plan is expected to provide the necessary support for successful WRAP (Module 2A) Facility validation application. A summary of the waste to be treated, general applicable treatment methods, and the basic equipment needed for the work is expected to be available for the validation application.

Issues

- It is assumed that sufficient waste sampling and characterization data is already available.

- Lab screening tests will verify laboratory solidification and immobilization methods.

- Certification of waste disposal compliance for specific waste streams will be estimated in FY 1992.

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APPENDIX C

THERMOSETTING POLYMER TEST PLAN

Detailed Test Plan prepared by the vendor awarded the contract for thermosetting polymer testing described in Appendix A. Outlines test procedures, quality control, and testing deliverables.

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THERMOSETTING POLYMER TEST PLAN

STOCK

EXPRESS 92RACWH002

DOCUMENT TRANSMITTAL
9202974

16490 Chillicothe Road
Chagrin Falls, Ohio 44022-4398
(216) 543-6000
Telex 196071
Telefax (216) 543-6678

Date July 23, 1992 Page 1 of 1

To: Westinghouse Hanford Company
2355 Stevens Drive
Richland, Washington 99352

Subject STOCK Polymer Immobilization
Tech. Waste Form Qualification Testing

Plant/Station

P.O. # MMW-SVV-277587

ATTN: Mr. Dewey Burbank
H1-60

Contract #

Req'n #

Stock Ref. S.O. 6996

9413221.0747

The following item(s) are enclosed for your review:

Drawing ☐ Document x Procedure ☐ Manuals ☐

__ Print __ Mylar __ Copies __ Copies
__ Sepia __ Vellum ___ Other-Specify
__ Apt. Card

Reference No.	Rev.	Description	*Purpose
6996-0	O	Quality Plan	1
90110	O	Test Procedure	1
		MSDS Documents	1
90109	O	Leaching Procedures	1

Comments: The above items are submitted for your approval in accordance with your order requirements. We respectfully request your approval on or before July 31, 1992. We confirm surrogate waste requirements of 25 to 30 pounds each.

If further information is required, please advise.

c: G.M. Wemhoff/G1-59 - W.H.C./Transmittal only
T. Litchney
S.O. 6996

RECEIVED
WRAP DMC
JUL 29 1992

*Purpose Code
1. First Issue, For Approval
2. Final Issue, For Records
3. Revision for Approval
4. Information Only
5. Other-Specify

Russell A. Czelláth, Manager
Contract Administration

Stock Equipment Company
A Unit of General Signal

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STOCK EQUIPMENT COMPANY
16490 Chillicothe Road
Chagrin Falls, Ohio 44022

RADWASTE TEST PROCEDURE
10 CFR 61 WASTE FORM
VERIFICATION PROGRAM

Prepared By: _____ Date: July 22, 1992
Fritz Podmore
Nuclear Engineering

Reviewed By: _____ Date: 7/22/92
Thomas C. Litchney, Manager
Nuclear Engineering

Approved By: _____ Date: 7/22/92
Michael J. Pavkov, Manager
Quality Assurance

Test Performed By: _____ Date: _____
Technician

_____ Date: _____
Technician

Test Reviewed By: _____ Date: _____
Quality Assurance Engineer

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VERIFICATION PROGRAM

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STOCK EQUIPMENT COMPANY

10 CFR 61 WASTE FORM
VERIFICATION PROGRAM

1.0 SPECIMEN PREPARATION

1.1 LAB SCALE, ONE (1) GALLON SPECIMENS

1.1.1 Specimen Preparation

Lab scale, one (1) gallon size specimens, will be prepared for this testing program.

The three (3) groups of specimens prepared for testing are listed in Table 1.3.

Table 1.1 - Labels, One (1) Gallon Specimen

	Group I Polymer Control	Group II Waste Stream Without Co, Sr, Cs	Group III Waste Stream With Co, Sr, Cs
Control	L1	--	--
Waste Number 1	--	L2	L3
Waste Number 2	--	L4	L5
Waste Number 3	--	L6	L7
Waste Number 4	--	L8	L9

The waste streams listed containing Co, Sr, Cs (Group III), will have between 0.20 and 0.25 weight percent (of the total solidification) as metal, added to them. The three (3) metal salts that will be added to each of the waste streams listed in Group III are:

Co (as $CoCL2 \cdot 6H_20$) ACS Reagent Grade,
Sr (as $SrCL2 \cdot 6H_20$) ACS Reagent Grade, and
Cs (as CsCL) ACS Reagent Grade.

Mixing of the waste streams and polymer will be accomplished using a high shear energy mixing technique.

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1.1.2 Sample Tube Insertion

Tubes with the nominal dimensions of 1-7/16" I.D. and two inches (2") ± 1/4" in length will be made. Maximum departure from perpendicularity to the axis by either end: 1.0 degree. Maximum out of plane allowance for ends: 0.025 inch. After the specimens have been cast, the test specimens will be sealed and allowed to remain undisturbed for a seven (7) day period to permit the polymer/waste mixture to cure. At the end of the curing period, each specimen will be opened and the core tube removed. Labeling will be accomplished using the procedure with the exception that each specimen is not directly labeled, but placed in a prelabeled, sealed container. For example, the second specimen from the tube of specimen L2 will carry a label L2A2 on the container. Six (6) specimens obtained from each solidification, three (3) will be leached in distilled water and three (3) will be leached in synthetic sea water (per ANSI 16.1 and Section 2.2). All six (6) samples per specimen will be used for the ninety (90) day immersion test (Section 2.3).

1.1.3 Mixing of the waste streams and polymer will be accomplished using a high shear energy mixing technique.

In preparing for the solidification, the polymer will be mixed. This is done to minimize introduction of a random variable into any solidification. The surrogated waste will be mixed to minimize introduction of a random variable into any solidification. All components will be preweighed prior to the start of solidification.

1.1.4 Specimen Cast Preparation

After mixing of all the components, the polymer/waste mixture will be poured into the tubes. All the specimens generated will be covered and allowed to cure for seven (7) days. The remainder of the polymer/waste mixture will be used to obtain a exotherm profile and to determine Free Liquids (Section 2.7).

Table 1.1a

Test Description	Test Procedure Section Number	Samples Required
Compressive Strength	2.1	
Biodegradation	2.5	3
Radiation	2.6	3
Thermal Cycle Degradation	2.4	3

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1.1.5 Laboratory Standard Compression Specimens

A gallon control specimen will prepared. It will yield at least twenty-four (24) specimens. The extended curing period will minimize differences in compressive strength. The standards will be used to minimize differences that may occur throughout the program due to uncontrollable variations in the experiment. At least three (3) standards will be selected at random and compression tested each day that compression testing is planned in the test program.

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PROCEDURE 90110-0

SPECIMEN PREPARATION DATA SHEET

Waste Type: _____

Specimen Size: _____ Gallon Specimen Label: _____

Waste Stream Data:

A. pH _____
B. Temperature _____ °C
C. % Total Solids _____ %
D. % Free Standing Water _____
E. Density _____ g/cc

Solidification Formula Used:

F.	Total Waste Volume	_____ l	_____ Gallons
G.	Polymer and Weight	_____ kg	_____ lbs
H.	Weight of Waste (F*1000cc/1*G)	_____ kg	_____ lbs
I.	Weight of Solidified Product (H+I+J)	_____ kg	_____ lbs

Weight of Metal Salts added to Waste Stream (.25% of K)

Weight ratio of Co in $CoCL2.6H_2O$ = 4.0375
Weight of $CoCL2.6H_2O$ required (.0025K*4.0375) _____ kg
Weight ratio of Sr in $SrCl2.6H_2O$ = 3.0429
Weight of Sr $CL2.H_2O$ required (.0025K*3.0429) _____ kg
Weight ratio of Cs in CsCL = 1.2668
Weight of CsCL required (.0025K*1.2668) _____ kg

Mixing Speed _____ rpm
Peak Exotherm _____ °C

Record additional solidification observations on reverse.

_____
Technician Date

_____
Technician Date

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2.0 TESTING PROCEDURES

2.1 COMPRESSIVE STRENGTH TEST PROCEDURE

This test will be performed as per ASTM D695 (Appendix A) for those samples requiring compressive strength testing.

2.1.1 Laboratory standard samples shall be chosen at random from the laboratory standard lot and compression tested. The compressive strength test data shall be recorded on the Compression Strength Data Sheet at the end of this section. The average compressive strength and density shall be calculated and recorded. One standard deviation value for the compressive strength and density will also be calculated and recorded on the Compressive Strength Data Sheets at the end of this section.

2.1.2 Prior to beginning the day's compressive strength testing, at least three (3) random samples from the laboratory standard lot shall be compression tested and recorded on the Compressive Strength Data Sheets at the end of this section.

2.1.3 For each sample to be tested, the height, diameter, and mass will be determined and recorded on the Compressive Strength Data Sheet at the end of this section.

2.1.4 The samples will be compressed individually using a Detroit testing machine (Model NTS-1, number 836) to determine the maximum load, in pounds, applied to the specimen. As the compressive strength tests shall be performed throughout the program, the Detroit testing machine shall be calibrated by a certified calibration technician or by the Stock laboratory technician using a calibration ring.

2.1.5 The compressive strength of each sample will be calculated by the formula.

$$C.S. = \frac{load}{(D/2)2\pi}$$

where C.S. = Compressive Strength, PSI
load = maximum load applied, in pounds
D = diameter of sample in inches

2.1.6 The density of each sample tested will be calculated by the equation.

$$p = m/(d/2)2h\pi$$

where p = density, g/cc
m = mass, g
h = height, cm
d = diameter, cm

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2.1.7 The following information will be entered onto the Compressive Strength Data Sheet at the end of this section.

a. Specimen Label
b. Diameter of Sample, inches/cm
c. Height of Sample, cm
d. Mass of Sample, g
e. Maximum Load Applied, lbs
f. Calculated Compressive Strength, psi
g. Density, g/cc

2.1.8 The average compressive strength and density will be calculated and recorded for each waste form solidification. One (1) standard deviation value will also be calculated and recorded for the compressive strength and density of each waste form solidification.

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PROCEDURE 90110-0

COMPRESSIVE STRENGTH DATA SHEET

Waste Type: LABORATORY STANDARD

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

COMPRESSIVE STRENGTH DATA SHEET

Waste Type: LABORATORY STANDARD

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician	Date	Technician	Date

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PROCEDURE 90110-0

COMPRESSIVE STRENGTH DATA SHEET

Waste Type: _____

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

COMPRESSIVE STRENGTH DATA SHEET

Waste Type: _____

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

LEACHABILITY TEST
COMPRESSIVE STRENGTH DATA SHEET

Leachant Solution: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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9413221.0760

PROCEDURE 90110-0

LEACHABILITY TEST
COMPRESSIVE STRENGTH DATA SHEET

Leachant Solution: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

THERMAL CYCLING
COMPRESSIVE STRENGTH DATA SHEET

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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9413221.0762

PROCEDURE 90110-0

THERMAL CYCLING
COMPRESSIVE STRENGTH DATA SHEET

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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2.2 LEACHABILITY TEST PROCEDURE

The following procedure will be performed for those specimens requiring leachability testing.

2.2.1 Leachant Solution Preparation

Two (2) leachant solutions will be used for the leachability testing portion of this program. The following procedures will be used to prepare the leachant solutions.

2.2.1.1 Distilled Water

1. Distilled water will be prepared using a corning Mega-Pure three (3) liter automatic distiller.

2. The distilled water obtained in Step 1 will be passed through an ion exchange resin column, and collected in fifty (50) liter carboys.

3. The carboys will be securely capped, labeled and stored until needed.

2.2.1.2 Synthetic Sea Water

1. The synthetic sea water leachant solution will be prepared as per ANS 16.1, Appendix D, Page 40.

2. The sea water leachant will be prepared in 20 liter batches and these batches will be combined and stored in fifty (50) liter carboys.

3. The carboys will be tightly capped, labeled, and stored until needed.

2.2.2 Specimen Preparation

2.2.2.1 The following information will be recorded on the Core Specimen Data Sheet at the end of this section, for each of the specimens obtained.

a. Label number
b. Height, cm
c. Diameter, cm
d. Calculated surface area, (cm^2)
e. Volume of leachant solution required, (ml).
f. Leachant time point

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2.2.2.2 If the height or diameter of a given core specimen has changed due to swelling, decomposition or any other affect, the surface area will have changed and the volume of leachant solution must be adjusted appropriately. In all cases, the ratio of the volume of leachant solution to surface area of the core specimen will be 10.0.

2.2.2.3 Prior to immersion in the leachant solution, the specimen will be attached to the container lid by the following method.

The specimen will have a plastic fishnet tied around its exterior surface. A length of dental floss will be used to suspend the specimen in the leachant solution. The dental floss will be attached to the container lid, and to the plastic fishnet around the specimen. See Figure 1a and 1b.

2.2.2.4 The following procedure will be followed for the insertion of the specimen into the leachant solution, and the storage of each container for the appropriate time period.

1. For each specimen, the appropriate amount of leachant solution will be determined from the Specimen Data Sheet.

2. The correct amount of leachant solution will be placed into the leachant container.

3. The leachant container and cap will be labeled with the following information.

   a. Specimen label
   b. Leachant solution (distilled water, sea water)
   c. Volume of leachant solution (ml)

4. At the start of any given leaching period, the specimen will be placed into the leachant solution. The top of the specimen will be covered by the leachant solution, while the bottom of the specimen will be suspended above the bottom of the leachant container, see Figure 1a and 1b.

5. The leachant container will be capped and allowed to remain undisturbed until the end of the leaching period.

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2.2.3 Leachant Sample Preparation

2.2.3.1 All liquid samples for the leachability test will be obtained by the use of a volumetric pipet. Prior to the pipetting of the liquid sample, the leachant solution will be stirred thoroughly. If necessary, the solution can also be shaken. Regardless of the mixing procedure used, the leachant solution must be thoroughly mixed.

2.2.3.2 If the leachant solution contains a precipitate, the precipitate must also be assayed (reference steps 2.2.3.7 through 2.2.3.9).

2.2.3.3 An aliquot of the liquid will be extracted from the leachant solution (minimum of five (5) ml) and deposited into a volumetric flask. The size (volume, mls) of the aliquot will be recorded on the Leachant Sample Preparation Data Sheet at the end of this section.

2.2.3.4 The aliquot of sample taken in Step 4 will be diluted volumetrically using 1% by weight Nitric Acid (HNO_3). The volume to which the aliquot of sample has been diluted will be recorded on the Leachant Sample Preparation Data Sheet at the end of this section.

2.2.3.5 A four (4) ounce (125 ml) polyethylene bottle to be used for storing the sample will be rinsed with the diluted liquid sample solution. From five (5) to ten (10) mls of the diluted liquid sample solution will be poured into the bottle. The bottle will be capped and shaken. The rinse liquid will then be discarded. The remaining diluted liquid sample will be poured into the rinsed bottle. The bottle will be tightly capped and stored upright in a cool dark place (cupboard).

2.2.3.6 Each sample bottle will be labeled with the following information.

a. Leach specimen label
b. Leachant solution (sea water or distilled water)
c. Date and time sample obtained
d. Dilution ratio

NOTE: Proceed only after steps 2.2.3.1 through 2.2.3.6 have been completed.

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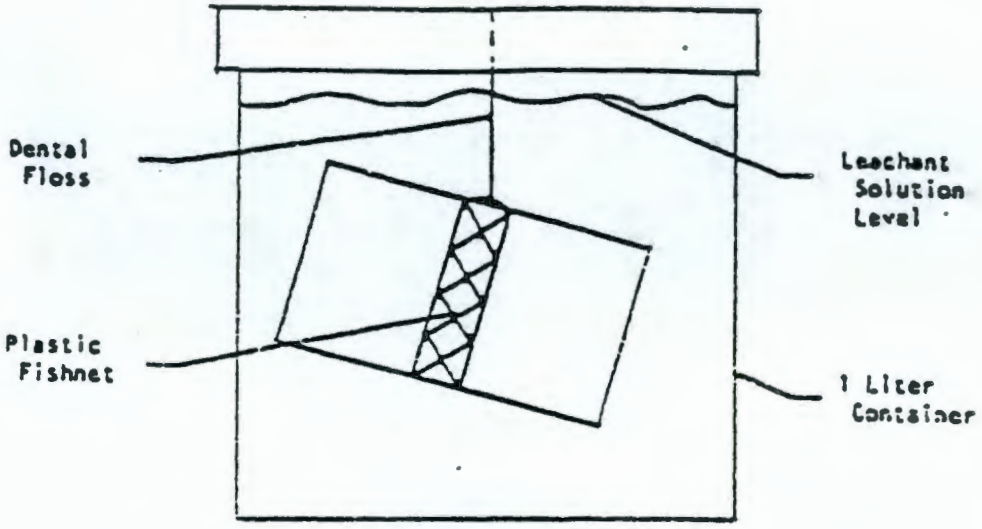

Figure 1a

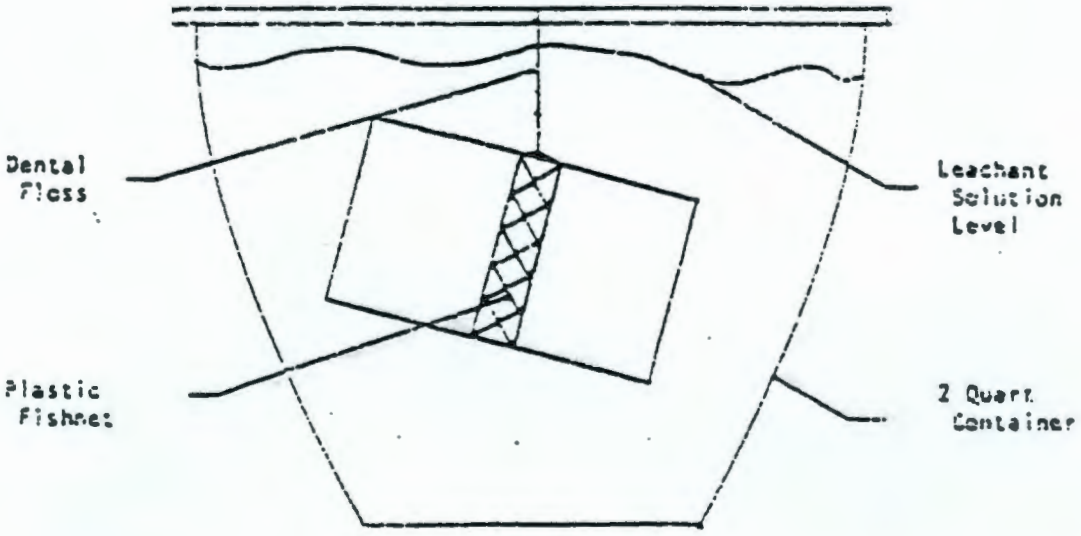

Figure 1b

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2.2.3.7 If the leachant solution contains a precipitate, the entire precipitate will be collected by filtration. The filter paper will be either a Whatman 2 or Whatman 5 qualitative filter paper. The precipitate will be gravity filtered and will not be washed.

2.2.3.8 After the filtration step, the precipitate will be oven dried at 50-60°C for at least three (3) hours. The precipitate will then be weighed, the mass of solids determined and recorded on the Leachant Sample Preparation Data Sheet at the end of this section. After weighing, the dried precipitate will be stored in a four (4) ounce polyethylene bottle. The bottle will be tightly capped and labeled with the following information:

a. Leach specimen label
b. Leachant solution (sea water or distilled water)
c. Date and time sample obtained
d. Mass of sample

2.2.3.9 The filtered leachant solution will then be discarded.

2.2.4 Leachability Specimen Compressive Strength Test

Upon completion of ninety (90) day leachability testing the leachability test specimens will be compression tested per Section 2.1 Compressive Strength Test Procedure. Compression test results will be recorded on the Leachability Test Compressive Strength Data Sheet at the end of Section 2.1.

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PROCEDURE 90110-0

SPECIMEN DATA SHEET

Waste Type: _____

Solidification Size: _____ gallon

Specimen Label: _____

Leachant Solution: _____

Height (cm)	Diameter (cm)	Surface Area (cm^2)	Leachant Volume(ml)	Time Point

Record Additional Observations on Reserve

Technician	Date	Technician	Date

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Stock Equipment Company
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PROCEDURE 90110-0

SPECIMEN DATA SHEET

Waste Type: _____

Solidification Size: _____ gallon

Specimen Label: _____

Leachant Solution: _____

Height (cm)	Diameter (cm)	Surface Area (cm^2)	Leachant Volume(ml)	Time Point

Record Additional Observations on Reserve

Technician	Date	Technician	Date

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PROCEDURE 90110-0

LEACHANT SAMPLE PREPARATION DATA SHEET

Date: _____

Leachability Time Point: _____

Leachant Sample Label	Aliquot (ml)	Diluted Volume (ml)	Solid Mass

Record Additional Observations on Reserve

Technician	Date	Technician	Date

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PROCEDURE 90110-0

LEACHANT SAMPLE PREPARATION DATA SHEET

Date: _____

Leachability Time Point: _____

Leachant Sample Label	Aliquot (ml)	Diluted Volume (ml)	Solid Mass

Record Additional Observations on Reserve

Technician	Date	Technician	Date

Stock Equipment Company
A Unit of General Signal

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2.3 Ninety (90) Day Immersion Test Procedure

2.3.1 The same specimens and data used in the Leachability Test will be used for the ninety (90) day immersion test.

2.3.2 For each specimen the following information will be collected from the Leachability Test Compressive Strength Data Sheets at the end of Section 2.1.

a. Specimen label
b. Diameter, in/cm
c. Height, cm
d. Mass, g
e. Load, lbs.
f. Compressive Strength, PSI

2.3.3 The average strength for each type of waste stream and leachant are also calculated and recorded on the Leachability Test Compressive Strength Data Sheet at the end of Section 2.1.

2.4 Thermal Degradation Test Procedure

2.4.1 Three (3) specimens will be obtained. These specimens will be 2 inches ± 1/4" high, and 1- 7/16" in diameter. Each specimen has been labeled.

2.4.2 All of the specimens to be tested will be placed on a metal (aluminum or steel) tray, and placed into an oven maintained at 60°C ± 1°C for one hour. The temperature of the oven at the start of the one (1) hour heating period, at thirty (30) minutes into the heating period and at the end of the one (1) hour heating period will be recorded on the Thermal Cycling Temperature Data Sheet at the end of this section. The samples will not be disturbed until the end of the one (1) hour heating period.

2.4.3 Upon completion of the one (1) hour period, the specimens will be removed from the environmental chamber and allowed to stand at room temperature for one (1) hour. The temperature of the room at the start, at thirty (30) minutes and at the end of the one (1) hour room temperature period will be recorded on the Thermal Cycling Temperature Data Sheet at the end of this section.

2.4.4 Upon completion of the room temperature period, the specimens will be placed into a cold chamber, maintained at -40° ± 1°C, for one (1) hour. The initial temperature, thirty (30) minute and final cold chamber temperatures will be recorded on the Thermal Cycling Temperature Data Sheet at the end of this section.

2.4.5 At the end of the cold chamber cycle, Step 2.4.3 will be repeated.

2.4.6 Steps 2.4.2 through 2.4.5 constitute a single thermal cycle. All of the specimens to be tested will be subjected to thirty (30) full thermal cycles.

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2.4.7 At the end of thirty (30) full thermal cycles, the Compressive Strength Test of each sample will be performed per Section 2.1. The following data will be recorded on the Thermal Cycling Compressive Strength Data Sheets at the end of Section 2.1.

a. Specimen label
b. Diameter, in/cm
c. Height, cm
d. Mass, g
e. Max. load, lbs.
f. Compressive Strength, psi

The average compressive strength for each waste type will be calculated and recorded on the Thermal Cycling Compressive Strength Data Sheets at the end of Section 2.1.

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PROCEDURE 90110-0

THERMAL CYCLING TEMPERATURE DATA SHEET

Specimen Labels _____

* Cycle	Initial Temp. °C	Thirty Minute Temp. °C	Final Temp. °C	Average °C

Record Additional Observations on Reserve

Technician _____ Date _____ Technician _____ Date _____

*a - Heating chamber temperature
b - Room temperatures
c - Cooling chamber temperatures
d - Room temperatures

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PROCEDURE 90110-0

THERMAL CYCLING TEMPERATURE DATA SHEET

Specimen Labels _____

* Cycle	Initial Temp. °C	Thirty Minute Temp. °C	Final Temp. °C	Average °C

Record Additional Observations on Reserve

Technician _____ Date _____ Technician _____ Date _____

*a - Heating chamber temperature
b - Room temperatures
c - Cooling chamber temperatures
d - Room temperatures

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2.5 BIODEGRADATION TEST PROCEDURE

2.5.1 These samples will be taken from each solidification prepared.

2.5.2 All test work, with the exception of compression strength testing, will be subcontracted. United States Testing Company, 1415 Park Avenue, Hoboken, New Jersey will perform this work.

2.5.3 The testing will be performed as per ASTM G22-76 and ASTM G21-70.

2.5.4 The incubation time for the samples will be at least thirty (30) days.

2.5.5 After the incubation period, the samples will be returned to Stock, where they will be compression tested, as per ASTM D695. Compression test results will be recorded on the Biodegradation Test Compressive Strength Data Sheet at the end of Section 2.1.

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PROCEDURE 90110-0

BIODEGRADATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

BIODEGRADATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

BIODEGRADATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

Stock Equipment Company

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PROCEDURE 90110-0

BIODEGRADATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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2.6 RADIATION TEST PROCEDURE

2.6.1 Three (3) samples from each solidification will be tested.

2.6.2 The samples will be sent to the Phoenix Memorial Laboratory, The University of Michigan.

2.6.3 The test procedure used by the Phoenix Memorial Laboratory will be returned with the samples upon completion of irradiation.

2.6.4 Each sample will be irradiated until all accumulated dose of one (1) x 10^8 rads of gamma radiation had been achieved.

2.6.5 The samples will be returned to Stock where they will be compression tested per Section 2.1 Compressive Strength Test Procedure. Compression test results will be recorded on the Radiation Test Compressive Strength Data Sheet at the end of Section 2.1.

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PROCEDURE 90110-0

RADIATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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PROCEDURE 90110-0

RADIATION TEST
COMPRESSIVE STRENGTH DATA SHEET

Date: _____

Specimen Label	Diameter inch/cm	Height cm	Mass g	Load lbs	C.S. psi	Density g/cc

Record Additional Observations on Reverse

Technician _____ Date _____ Technician _____ Date _____

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2.7 PRESENCE OF FREE LIQUID TEST PROCEDURE

2.7.1 The surface of the polymer matrix will be inspected for free liquid. If liquid is present it will be collected and the pH determined. The volume of liquid and pH will be recorded on the Presence of Free Liquid Data Sheet.

2.7.2 The ullage for that particular container will be measured and recorded on the Presence of Free Liquid Data Sheet.

2.7.3 A .125" hole will be drilled into the side of the container one inch (1") below the top of the polymer matrix. Any liquid that leaked from the hole will be collected, and the pH determined. The volume of liquid and pH will be recorded on the Presence of Free Liquid Data Sheet.

2.7.4 At increments of one inch (1"), a .125" hole will be drilled and any liquid present will be collected and the pH determined. The volume of liquid and pH will be recorded on the Presence of Free Liquid Data Sheet.

2.7.5 A final .125" hole will be drilled into the center of the bottom of the container. Any free liquid present will be collected and the pH determined. The volume of liquid and pH will be recorded on the Presence of Free Liquid Data Sheet.

2.7.6 The total volume of free liquid will be calculated and recorded on the Presence of Free Liquid Data Sheet.

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PROCEDURE 90110-0

PRESENCE OF FREE LIQUID
DATA SHEET

Specimen Label: _____

Date: _____

Ullage: _____ inches

Height of Polymer Matrix: _____ inches

	Liquid Volume (mls)	pH
1st Hole	_____	_____
2nd Hole	_____	_____
3rd Hole	_____	_____
4th Hole	_____	_____
5th Hole	_____	_____
6th Hole	_____	_____
Bottom Hole	_____	_____
Total Free Liquid Collected	_____	_____

Record additional observations on reserve

_____ Technician _____ Date

_____ Technician _____ Date

_____ Engineering _____ Date

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3.0 ASSAY FOR METALS

3.1 INSTRUMENTATION

The method chosen for the quantitive determination of cobalt, cesium, and strontium is atomic absorption spectrophotometry. An Instrumentation Laboratories Video 11 spectrophotometer, Model Number 07570, Serial Number 1207, will be used for all assay work. The appropriate hollow cathode lamps to be used are:

Cobalt	Cat. No. 62928-02
Cesium	Cat. No. 62823
Strontium	Cat. No. 62835

3.2 METHODS DESCRIPTION

The methods used to atomize the samples will be either flame or flameless. The flameless method involves aspirating the sample into a graphite furnace cuvette, which is electrically heated to the temperature required for atomization.

Due to the nature of the samples to be tested, it is not possible to provide a step-by-step procedure for the assay of these samples. However, the following procedure will be adhered to for all assays.

3.2.1 The use of Instrumentation Laboratories Methods Manual for flame and flameless operations will be used whenever possible.

3.2.2 A calibration curve of each metal of interest, in each matrix (D.I. water or sea water), will be prepared. These calibration curves will be replicated as often as necessary.

3.2.3 Any chemical matrix modifiers (i.e., ammonium nitrate) used in the assay will be identified and recorded on the Atomic Absorption Data Sheet.

3.2.4 The element, matrix, wavelength, bandwidth, deposition time and background correction will be recorded on the Atomic Absorption Data Sheet.

3.2.5 Any dilution required to bring the absorbance of a metal specie into the detection range of the instrument will be recorded. All dilutions will be volumetric dilutions.

3.2.6 The method of atomization, flame or flameless, will be recorded.

3.2.7 Any modifications to the Instrumentation Laboratories methods used will be recorded.

3.2.8 The Atomic Absorption Data Sheet will be kept in the separate binder. Each data sheet will be photocopies and stored in the Quality Assurance vault.

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3.2.9 For all assays, the original tape record of the values measure by the spectrophotometer will be labeled and stored with the Atomic Absorption Data Sheet in the Quality Assurance vault.

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PROCEDURE 90110-0

ATOMIC ABSORPTION DATA SHEET

Date:_____ Operators(s):_____

Element:_____ Matrix:_____

Wavelength:_____nM Bandwidth:_____nM

Disposition Time:_____sec. Background Correction:_____

Other:

S.N.	Specimen Label	Time Point	Average Concentration pb	Dilution	S.D.	R.S.D.

Stock Equipment Company

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4.0 LEACHABILITY INDEX CALCULATIONS

4.1 The method of calculating the leachability index will be the method used in ANS 16.1, June 20, 1984 Revision, Pages 20 to 33.

If the cumulative fraction released of a given element exceed 20% of the original amount of metal, the proper shape factor will be used in calculating the effective diffusivity.

4.2 DATA RECORDING

All leachability index calculations will be performed on the Leachability Index Calculations Forms (see example at the end of this section). When all leachability calculations for a specimen are complete, the form will be photocopied and stored in the Quality Assurance vault.

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LEACHABILITY INDEX CALCULATION FORM

Element _____ 30s Rinse Conc. (PPB) _____ Date _____

Matrix _____ a_n (30s) _____ g Operator: _____

Sample I.D. _____ Ao _____ g. _____

S.A. _____ cm^2 V _____ cc

Leach Interval	Date M/D/Y	Time In Out	(At)n S	t-Σ(At)n S	Conc. PPB	a_n g	a_n/Ao	Ea_n/Ao	DI	L
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

APPENDIX A

ASTM STANDARDS

ASTM B553-79	Standard Test Method for Thermal Cycling of Electroplated Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics.
ASTM G21-70	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
ASTM G22-76	Standard Practice for Determining Resistance of Plastic to Bacteria

These modifications are made for the following reason:

1. Since the compression test stand used is accurate to twenty (20) pounds load (approximately ten (10) psi compressive strength), the maximum accuracy in compressive strength is ± ten (10) psi. The above modifications do not cause the compressive strength to vary by more than ten (10) psi at one thousand (1,000) psi (0.1%). Reference Stock Equipment Company Calculation Number 058-O.

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APPENDIX B

SOLIDIFICATION GLOSSARY

CATALYST	Any substance of which a fractional percentage notably affects the rate of a chemical reaction without itself consumed or undergoing a chemical change.
COMPRESSIVE STRENGTH	The maximum load per unit area that an object can withstand prior to breaking.
SPECIMENS	Cylinders of the solidified produce with the nominal dimensions: 1-7/16" Dia., 2" Height. These cylinders are used for the testing of compressive strength.
DISSOLVED SOLIDS	In an aqueous system, the relative percentage of the total solids that exist in solution.
EXOTHERM	A plot of the temperature versus time.
FINES	Particles with a diameter less than 74 microns, as determined by a Tyler sleeve.
FREE STANDING LIQUID	Liquid that is either: 1. Visible on the surface of a solidification sample. 2. Pours or leaks from a container upon the containers being breached or punctured.
LAB SCALE	Approximately one (1) gallon in volume.
ONSET	The start of a reaction. When used in conjunction with the term "exotherm", the start of the rise in temperature as a function of time.
PARTS PER BILLION	ppb 1 microgram per liter or one (1) mg per kiloliter.
PARTS PER MILLION	ppm 1 milligram per gram, one (1) g per liter.
PEAK	The highest value attained. When used in conjunction with the term "exotherm", the highest temperature achieved.
PLATEAU	A region in the curve where $\frac{dv}{dx} = 0$.

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PROMOTER	A substance which, when added in relatively small quantities to a catalyst, increases the catalyst's activity.
SUSPENDED SOLIDS	In an aqueous system, the relative percentage of the total solids more or less uniformly dispersed in the water.
TOTAL SOLIDS	In an aqueous system, the residue left after the evaporation of all the water.

9413221.0795

STOCK EQUIPMENT COMPANY
16490 Chillicothe Road
Chagrin Falls, Ohio 44022

PROCEDURE NUMBER: 90109-0

Toxicity Characteristic Leaching Procedure
(TCLP)

Prepared By: _____ Date: July 22, 1992
Fritz Podmore
Nuclear Engineering

Reviewed By: _____ Date: 7/22/92
Thomas C. Litchney, Manager
Nuclear Engineering

Approved By: _____ Date: 7/22/92
Michael J. Pavkov, Manager
Quality Assurance

SECTION: PROCEDURE - GENERAL	Revision Letter — 0
SUBJECT: TOXICITY CHARACTERISTIC LEACHING PROCEDURE	Date Issued — July 22, 1992
	Page 1 of 22
Stock Equipment Company Standards	Number — 90109

Form No. 639-3-D-2/86

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(TCLP)

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Form 649B-SD-9/86

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STOCK EQUIPMENT COMPANY

Toxicity Characteristic Leach Procedure
(TCLP)

1.0 SCOPE AND APPLICATION

1.1 The TCLP is designed to determine the mobility of both organic and inorganic contaminates present in liquid, solid, and multiphasic wastes.

1.2 If a total analysis of the waste demonstrates that individual contaminates are not present in the waste, or that they are present but at such low concentrations that the appropriate regulatory thresholds could not possibly be exceeded, the TCLP need not be run.

2.0 SUMMARY OF METHOD

2.1 For liquid wastes (i.e., those containing insignificant solid material), the waste, after filtration through a 0.6-0.8 μm glass fiber filter, is defined as the TCLP extract.

2.2 For wastes comprised of solids or for wastes containing significant amounts of solid material, the particle-size of the waste is reduced (if necessary); the liquid phase, if any, is separated from the solid phase and stored for later analysis. The solid phase is extracted with an amount of extraction fluid equal to twenty (20) times the weight of the solid phase. The extraction fluid employed is a function of alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatiles (Reference Table 1, Page 17). Following extraction, the liquid extract is separated from the solid phase by 0.6 to 0.8 μm glass fiber filter filtration.

2.3 If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these liquids are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average connection.

3.0 INTERFERENCES

3.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 APPARATUS AND MATERIALS

4.1 AGITATION APPARATUS

An acceptable agitation apparatus is one which is capable of routing the extraction vessel in an end-over-end fashion (Reference Table 2, Page 18) at thirty (30) ± two (2) rpm. Suitable devices known to EPA are identified in Table 2.

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4.2 EXTRACTION VESSEL

4.2.1 When the waste is being evaluated for other than volatile contaminates, an extraction vessel that does not preclude headspace (e.g. a two (2)-liter bottle) is used. Suitable extraction vessels include bottles made from various materials, depending on the contaminants to be analyzed, and the nature of the waste. It is recommended that borosilicate glass bottles be used over other types of glass, especially when inorganics are of concern. Plastic bottles may be used only if inorganics are to be investigated. Bottles are available from a number of laboratory suppliers. When this type of extraction vessel is used, the filtration device discussed in Step 4.3.1 is used for initial liquid/solid separation and final extract filtration.

4.3 FILTRATION DEVICES

It is recommended that all filtrations be performed in a hood.

4.3.1 Filter Holder

When the waste is being evaluated for other than volatile compounds, a filter folder capable of supporting a glass fiber filter and able to withstand the pressure needed to accomplish separation is used. Suitable filter holders range from simple vacuum units to relatively complex systems capable of exerting pressures of up to fifty (50) psi or more. The type of filter holder used depends on the properties of the material to be filtered (Reference Step 4.3.2). These devices shall have a minimum internal volume of three hundred (300) mL and be equipped to accommodate a minimum filter size of forty-seven (47) mm. (Filter holders having an integral capacity of 1.5 liters or greater and equipped to accommodate a one hundred and forty two (142) mm diameter filter are recommended.) Vacuum filtration is only recommended for wastes with low solids content (less than ten percent (10%)) and for highly granular (liquid-containing) wastes. All other types of wastes should be filtered using positive pressure filtration. Filter holders known to EPA to be suitable for use are shown in Table 4 on Page 20.

4.3.2 Materials of Construction

Extraction vessels and filtration devices shall be made of inert materials which will not leach or absorb waste components. Glass, polytetrafluoroethylene (PTFE), or type 316 stainless steel equipment may be used when evaluating the mobility of both organic and inorganic components. Devices made of high-density polyethylene (HPDE), polypropylene, or polyvinyl chloride may be used only when evaluating the mobility of metals. Borosilicate glass bottles are recommended for use over other types of glass bottles, especially when inorganics are constituents of concern.

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4.4 FILTERS

Filters shall be made or borosilicate glass fiber, shall contain no binder materials, and shall have an effective pore size of 0.6-0.8 μm or equivalent. Filters known to EPA to meet these specifications are identified in Table 5 on Page 21. Prefilters must not be used. When evaluating the mobility of metals, filters shall be acid-washed prior to use by rinsing with 1.0N nitric acid followed by three (3) consecutive rinses with deionized distilled water (a minimum of one (1) liter per rinse is recommended). Glass fiber filters are fragile and should be handled with care.

4.5 pH METERS

Any of the commonly available pH meters are acceptable.

4.6 LABORATORY BALANCE

Any laboratory balance accurate within ±0.01 gram may be used (all weight measurements are to be within ±0.1 gram).

5.0 REAGENTS

5.1 REAGENT WATER

Reagent water is defined as water in which an interferant is not observed at or above the method detection limit of the analyte(s) of interest. For nonvolatile extractions, ASTM Type II water, or equivalent meets the definition of reagent water. For volatile extractions, it is recommended that reagent water be generated by any of the following methods. Reagent water should be monitored periodically for impurities.

5.2 1.0N hydrochloric acid (HCl) made from ACS reagent grade.

5.3 1.0N nitric acid (HNO_3) made from ACS reagent grade.

5.4 1.0N sodium hydroxide (NaOH) made from ACS reagent grade.

5.5 Glacial acetic acid (HOA_c) ACS reagent grade water.

5.6 EXTRACTION FLUID

5.6.1 Extraction Fluid Number 1

This fluid is made by adding 5.7 mL glacial HOA_c to five hundred (500) mL of the appropriate water (Reference Step 5.1), adding 64.3 mL of 1.0N NaOH, and diluting to a volume of one (1) liter. When correctly prepared, the pH of this fluid will be 4.93 ±0.05.

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5.6.2 **Extraction Fluid Number 2**

This fluid is made by diluting 5.7 mL glacial HOA_c with ASTM Type II water (Reference Step 5.1) to a volume of one (1) liter. When correctly prepared, the pH of this fluid will be 2.88 ±0.05.

NOTE: **It is suggested that these extraction fluids be monitored frequently for impurities. The pH should be checked prior to use to ensure that these fluids are made up accurately.**

5.7 Analytical standards shall be prepared according to the appropriate analytical method.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples shall be collected using an appropriate sampling plan.

6.2 At least three (3) separate representative samples of a waste should be collected. The first sample is used in several preliminary TCLP evaluations (e.g., to determine the percent solids of the waste; to determine if the waste contains insignificant solids (i.e., the waste is its own extract after filtration); to determine if a solid portion of the waste requires particle-size reduction; and to determine which of the two (2) extraction fluids are to be used for the nonvolatile TCLP extraction of waste). The preliminary evaluations are identified in Section 7.0.

6.3 Preservatives shall not be added to samples.

6.4 Samples can be refrigerated unless refrigeration results in irreversible physical change to the waste (e.g., precipitation).

6.5 TCLP extracts should be prepared for analysis and analyzed as soon as possible following extraction. If they need to be stored, even for a short period of time, storage shall be at 4°C, and samples for volatile analysis shall not be allowed to come into contact with the atmosphere (i.e. no headspace). Reference Section 9.0, Quality Assurance Requirements, for acceptable sample and extract holding times.

7.0 PRELIMINARY TCLP EVALUATION

The preliminary TCLP evaluations are performed on a minimum of one hundred (100) grams representative sample of waste that will not actually undergo TCLP extraction (designated as the first sample in Step 6.2). These evaluations include preliminary determination of the percent solids of the waste; determination of whether the waste contains insignificant solids, and is therefore, its own extract after filtration; determination of whether the solid potion of the waste required particle-size reduction; and determination of which of the two (2) extraction fluids are to be used for the nonvolatile TCLP extraction of the waste.

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7.1 PRELIMINARY DETERMINATION OF PERCENT SOLIDS

Percent solids is defined as that fraction of a waste sample (as a percentage of the total sample) from which no liquid may be forced out by an applied pressure, as described below.

7.1.1 If the sample is liquid or multiphasic, liquid/solid separation to make a preliminary determination of percent solids is required. This involves the filtration device described in Step 4.3.1 and is outlined in Steps 7.1.3 through 7.1.9.

7.1.2 Preweigh the filter and the container that will receive the filtrate.

7.1.3 Assemble the filter holder and fill following the manufacturer's instructions. Place the filter on the support screen and secure.

7.1.4 Weigh out a representative subsample of the waste (one hundred (100) grams minimum) and record the weight.

7.1.5 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration. Centrifugation is to be used only as an aid to filtration. If used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.1.6 Quantitatively transfer the waste sample to the filter holder (liquid and solid phases). If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature then allow the sample to warm up to room temperature in the device before filtering.

NOTE: **If waste material (greater than one percent (1%) of original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 7.1.5 to determine the weight of the waste sample that will be filtered.**

Gradually apply vacuum or gentle pressure of one (1) to ten (10) psi, until air or pressurizing gas moves through the filter. If this point is not reached under ten (10) psi, and if no additional liquid has passed through the filter in any two (2) minute interval, slowly increase the pressure in ten (10) psi increments to a maximum of fifty (50) psi. After each incremental increase of ten (10) psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any two (2) minute interval, proceed to the next ten (10) psi increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at fifty (50) psi (i.e., filtration does not result in any additional filtrate within any two (2) minute period), filtration is stopped.

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NOTE: **Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.**

7.1.7 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

7.1.8 Determine the weight of the liquid phase by subtracting the weight of the filtrate container (Reference Step 7.1.2) from the total weight of the filtrate-filled container. The weight of the solid phase of the waste sample is determined by subtracting the weight of the liquid phase from the weight of the total waste sample, as determined in Step 7.1.4 or 7.1.6. Record the weight of the liquid and solid phases. Calculate the percent solids using the following.

$$\text{Percent Solids} = \frac{\text{Weight of Solid (Step 7.1.9)}}{\text{Total Weight of Waste (Step 7.1.5 x 7.1.7)}} \times 100$$

7.2 Determination of Whether Waste is Liquid or Has Insignificant Amounts of Solid Material

If the sample obviously has a significant amount of solid material, the solid phase must be subjected to extraction; proceed to Step 7.3 to determine if the waste requires particle-size reduction (and to reduce particle-size, if necessary). Determine whether the waste is liquid or has insignificant amounts of solid material (which need not undergo extraction) as follows.

7.2.1 Remove the solid phase and filter from the filtration apparatus.

7.2.2 Dry the filter solid phase at one hundred (100) ±20°C until two (2) successive weighings yield the same value within ±1%. Record final weight.

NOTE: **Caution should be taken to ensure that the subject solid will not flash upon heating. It is recommended that the drying oven be vented to a hood or appropriate device.**

7.2.3 Calculate the percent dry solids as follows:

$$\text{Percent Dry Solids} = \frac{\text{Weight of Dry Waste and Filter} - \text{Tared Weight of Filter}}{\text{Initial Weight of Waste (Step 7.1.4)}} \times 100$$

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7.2.4 If the percent dry solids is less than 0.5%, consult Step 6.2 and proceed to Section 8.0 if nonvolatiles in the waste are of concern. In this case, the waste, after filtration is defined as the TCLP extract. If the percent dry solids is greater than or equal to 0.5%, and if the nonvolatile TCLP is to be performed, return to the beginning of this Section 7.0 with a new representative waste sample, so that it can be determined if particle-size reduction is necessary (Step 7.3), and so that the appropriate extraction fluid may be determined (Step 7.4) on a fresh portion of the solid phase of the waste. If only the volatile TCLP is to be performed, reference the NOTE in Step 7.4.

7.3 Determination of Whether the Wastes Require Particle-Size Reduction (Particle-Size is Reduced During this Step)

Using the solid portion of the waste, evaluate the solid for particle-size. If the solid has a surface area per gram of material equal to or greater than 3.1 cm^2, or is smaller than one (1) cm in its narrowest dimension (e.g., is capable of passing through a 9.5 mm (0.375 inch) standard sieve), particle-size reduction is not required (Proceed to Step 7.4). If the surface area is smaller or the particle-size larger than described above, the solid portion of the waste is prepared for extraction by crushing, cutting, or grinding the waste to a surface area or particle-size as described above.

NOTE: **Surface area requirements are meant for filamentous (e.g., paper, cloth) and similar waste materials. Actual measurement of surface area is not required; nor is it recommended.**

7.4 Determination of Appropriate Extraction Fluid

If the solid content is greater than or equal to 0.5% of the waste and if TCLP extraction for nonvolatile constituents will take place (Section 8.0), determination of the appropriate fluid (Step 5.6) to use for the nonvolatiles extraction is performed as follows.

7.4.1 Weigh out a small subsample of the solid phase of the waste, reduce the solid, if necessary, to a particle-size of approximately one (1) mm in diameter or less, and transfer 5.0 grams of the solid phase of the waste to a five hundred 500 mL beaker of Erlenmeyer flask.

7.4.2 Add 96.5 mL of reagent waster (ASTM Type II) to the beaker, cover with a watchglass and stir vigorously for five (5) minutes using a magnetic stirrer. Measure and record the pH. If the pH is less than 5.0, extraction fluid number one (1) is used. Proceed to Section 8.0.

7.4.3 If the pH from Step 7.4.2 is greater than 5.0, add 3.5 mL 1.0N HCl, slurry briefly, cover with a watchglass, heat to 50°C, and hold at 50°C for ten (10) minutes.

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7.4.4 Let the solution cool to room temperature and record the pH. If the pH is less than 5.0, use extraction fluid number one (1). If the pH is greater than 5.0, use extraction fluid number 2. **Proceed to Section 8.0.**

7.5 The sample of waste used for performance of the section shall not be used any further. Other samples of the waste (Reference Step 6.2) should be employed for the Section 8.0.

8.0 PROCEDURE WHEN VOLATILES ARE NOT INVOLVED

Although a minimum sample size of one hundred (100) grams (solid and liquid phases) is required, a larger sample size may be more appropriate, depending on the solids content of the waste sample (percent solids, Reference Step 7.1) whether the initial liquid phase of the waste will be miscible with the aqueous extract of the solid, and whether inorganics, semivolatile organics, pesticides, and herbicides are all analytes of concern. Enough solids should be generated for extraction such that the volume of TCLP extract will be sufficient to support all of the analyses required. If the amount of the extract generated by the performance of a single TCLP extraction will not be sufficient to perform all of the analyses to be conducted, it is recommended that more than one (1) extraction be performed and that the extracts from each extraction be combined and then aliquoted for analysis.

8.1 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e. is one hundred percent (100%) solid Reference Step 7.1), weigh out a representative subsample of the waste (one hundred (100) grams minimum) and proceed to Step 8.9.

8.2 If the sample is liquid or multiphasic, liquid/solid separation is required. This involves the filtration device described in Step 4.3.2 and is outlined in Steps 8.3 to 8.8.

8.3 Preweigh the container that will receive the filtrate.

8.4 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid wash the filter if evaluating the mobility of metals (Reference Step 4.4).

NOTE: **Acid washed filters may be used for all nonvolatile extractions even when metals are not of concern.**

8.5 Weigh out a representative subsample of the waste (110 grams minimum) and record the weight. If the waste was shown to contain less than 0.5% dry solids (Step 7.2), the waste, after filtration is defined as the TCLP extract. Therefore, enough of the sample should be filtered so that the amount of filtered liquid will support all of the analyses required of the TCLP extract. For wastes containing greater than 0.5% dry solids (Step 7.1 or 7.2), use the percent solids information obtained in Step 7.1 to determine the optimum sample size (one hundred (100) grams minimum) for filtration. Enough solids should be generated after filtration to support the analyses to be performed on the TCLP extract.

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8.6 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration. Centrifugation is to be used only as an aid to filtration. If used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

8.7 Quantitatively transfer the waste sample (liquid and solid phases) to the filter holder (Reference Step 4.3.2). If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

NOTE: **If waste material (greater than one percent (1%) of the original sample weight) has obviously adhered to the container used to transfer the sample to the filtration apparatus, determine the weight of this residue and subtract it from the sample weight determined in Step 8.5, to determine the weight of the waste sample that will be filtered.**

Gradually apply vacuum or gentle pressure of one (1) to ten (10) psi, until air or pressurizing gas moves through the filter. If this point is not reached under ten (10) psi, and if no additional liquid has passed through the filter in any two (2) minute interval, slowly increase the pressure in ten (10), two (2) minute intervals, slowly increase the pressure in ten (10) psi increments to maximum of fifty (50) psi. After each incremental increase of ten (10) psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any two (2) minute interval, proceed to the next ten (10) psi increment. When the pressurizing gas begins to move through the filter, or when the liquid flow has ceased at fifty (50) psi (i.e., filtration does not result in any additional filtration within a two (2) minute period), filtration is stopped.

NOTE: **Instantaneous application of high pressure can degrade the glass fiber filter and may cause premature plugging.**

8.8 The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase. Weigh the filtrate. The liquid phase may now be either analyzed (Reference Step 8.13) or stored at 4°C until time of analysis.

NOTE: **Some wastes, such as oily wastes and some paint wastes, will obviously contain some material that appears to be a liquid. But even after applying vacuum or pressure filtration, as outlined in Step 8.7, this material may not filter. If this is the case, the material within the filtration device is defined as a solid and is carried through the extraction as a solid. The original filter is not to be replaced with a fresh filter under any circumstances. Only one (1) filter is used.**

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8.9 If the waste contains less than 0.5% dry solids (Reference Step 7.2), proceed to Step 8.13. If the waste contains greater than 0.5% dry solids (Reference Step 7.1 or 7.2), and if particle-size reduction of the solid was needed in Step 7.3, proceed to Step 8.10. If particle-size reduction was not required in Step 7.3, quantitatively transfer the solid material into the extractor vessel, including the filter used to separate the initial liquid from the solid phase. Proceed to Step 8.11.

8.10 The solid portion of the waste is prepared for extraction by crushing, cutting, or grinding the waste to a surface area of particle size as described in Step 7.3. When the surface area of particle-size has been appropriately altered, quantitatively transfer the solid material into the extractor vessel, including the filter used to separate the initial liquid from the solid phase.

NOTE: **Sieving of the waste through a sieve that is not Teflon coated should not be done due to avoiding possible contamination of the sample. Surface area requirements are meant for filamentous (e.g. paper, cloth) and similar waste materials. Actual measurement of surface area is not recommended.**

8.11 Determine the Amount of Extraction Fluid to Add to the Exterior Vessel

20 x Percent Solids (Step 7.1) x Weight of Waste Filtered

$$\text{Weight of Extraction Fluid} = \frac{\text{Step 8.5 or 8.7}}{100}$$

Slowly add this amount of appropriate extraction fluid (Reference Step 7.4) to the extractor vessel. Close the extractor bottle tightly (it is recommended that Teflon tape be used to ensure a tight seal), secure in rotary extractor device, and rotate at 30 ±2 rpm for 18 ±2 hours. Ambient temperature (i.e., temperature of room in which extraction is to take place) shall be maintained at 22° ±3°C during extraction period.

NOTE: **As agitation continues, pressure may build up within the extractor bottle for some type of wastes (e.g., limed or calcium carbonate waste may evolve gases such as carbon dioxide). To relieve excess pressure, the extractor bottle may be periodically opened (e.g., after fifteen (15) minutes, thirty (30) minutes, and one (1) hour) and vented into a hood.**

8.12 Following the 18 ±2 hour extraction, the material in the extractor vessel is separated into its component liquid and solid phases by filtering through a new glass fiber filter, as outlined in Step 8.7. For final filtration of the TCLP extract, the glass fiber filter may be changed, if necessary, to facilitate filtration. Filter(s) shall be acid washed (Reference Step 4.4) if evaluating the mobility of metals.

8.13 The TCLP Extract is Now Prepared

8.13.1 If the waste contained no initial liquid phase, the filtered liquid material obtained from Step 8.12 is defined as the TCLP extract. Proceed to Step 8.14.

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8.13.2 If compatible (e.g. multiple phases will not result on combination), the filtered liquid resulting from Step 8.12 is combined with the initial liquid phase of the waste as obtained in Step 8.7. This combined liquid is defined as the TCLP extract. **Proceed to Step 8.14.**

8.13.3 If the initial liquid phase of the waste, as obtained from Step 8.7, is not or may not be compatible with the filtered liquid resulting from Step 8.12, these liquids are not combined. The liquids collectively defined as the TCLP extract, are analyzed separately, and the results are combined mathematically. **Proceed to Step 8.14.**

8.14 Following collection of the TCLP extract, it is recommended that the pH of the extract be recorded. The extract should be immediately aliquoted for analysis and properly preserved (metal aliquots must be acidified with nitric acid to pH ±2; all other aliquots must be stored under refrigeration (4°C) until analyzed). The TCLP extract shall be prepared and analyzed to appropriate analytical methods. TCLP extracts to be analyzed for metals, other than mercury shall be acid digested. If the individual phases are to be analyzed separately, determine the volume of the individual phase (to ±0.5%), conduct the appropriate analyses, and combine the results mathematically by using a simple volume weighted average.

$$\text{Final Analyte Concentration} = \frac{(V_1)(C_1) + (V_2)(C_2)}{V_1 + V_2}$$

Where:

V_1 = The volume of the first phase (liters).
C_1 = The concentration of the contaminant of concern in the first phase (mg/liters).
V_2 = The volume of the second phase (liters).
C_2 = The concentration of the contaminant of concern in the second phase (mg/liters).

8.15 The contaminant concentrations in the TCLP extract are compared with the thresholds identified in the appropriate regulations. Refer to **Section 9.0, Quality Assurance Requirements.**

9.0 QUALITY ASSURANCE REQUIREMENTS

9.1 All data, including quality assurance data, should be maintained and available for reference or inspection.

9.2 A minimum of one (1) blank (extraction fluid number 1) for every ten (10) extractions that have been conducted in an extraction vessel shall be employed as a check to determine if any memory effects from the extraction equipment are occurring.

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9.3 For each analytical batch (up to twenty (20) samples), it is recommended that a matrix spike be performed. Addition of matrix spikes should occur once the TCLP extract has been generated (i.e., should not occur prior to performance of the TCLP procedure). The purpose of the matrix spike is to monitor the adequacy of the analytical methods used on the TCLP extract and for determining if matrix interferences exist in analyte detection.

9.4 All quality control measures described in the appropriate analytical methods shall be followed.

9.5 The method of standard addition shall be employed for each analyte if:

1. recovery of the compound from the TCLP extract is not between 50% and 150%; or

2. if the concentration of the constituent measured in the extract is within 20% of the appropriate regulatory threshold. If more than one (1) extraction is being run on samples of the same waste (up to twenty (20) samples), the method of standard addition need be applied only once and the percent recoveries applied to the remainder of the extractions.

9.6 Samples must undergo TCLP extraction within the following time period after sample receipt.

Volatiles - Fourteen (14) Days
Semivolatiles - Forty (40) Days
Mercury - Twenty-Eight (28) Days
Other Metals - One Hundred and Eighty (180) Days

Extraction of the solid portion of the waste should be initiated as soon as possible following initial solid/liquid separation. TCLP extracts shall be analyzed after generation and preservation within the following periods.

Volatiles - Fourteen (14) Days
Semivolatiles - Forty (40) Days
Mercury - Twenty-Eight (28) Days
Other Metals - One Hundred and Eighty (180) Days

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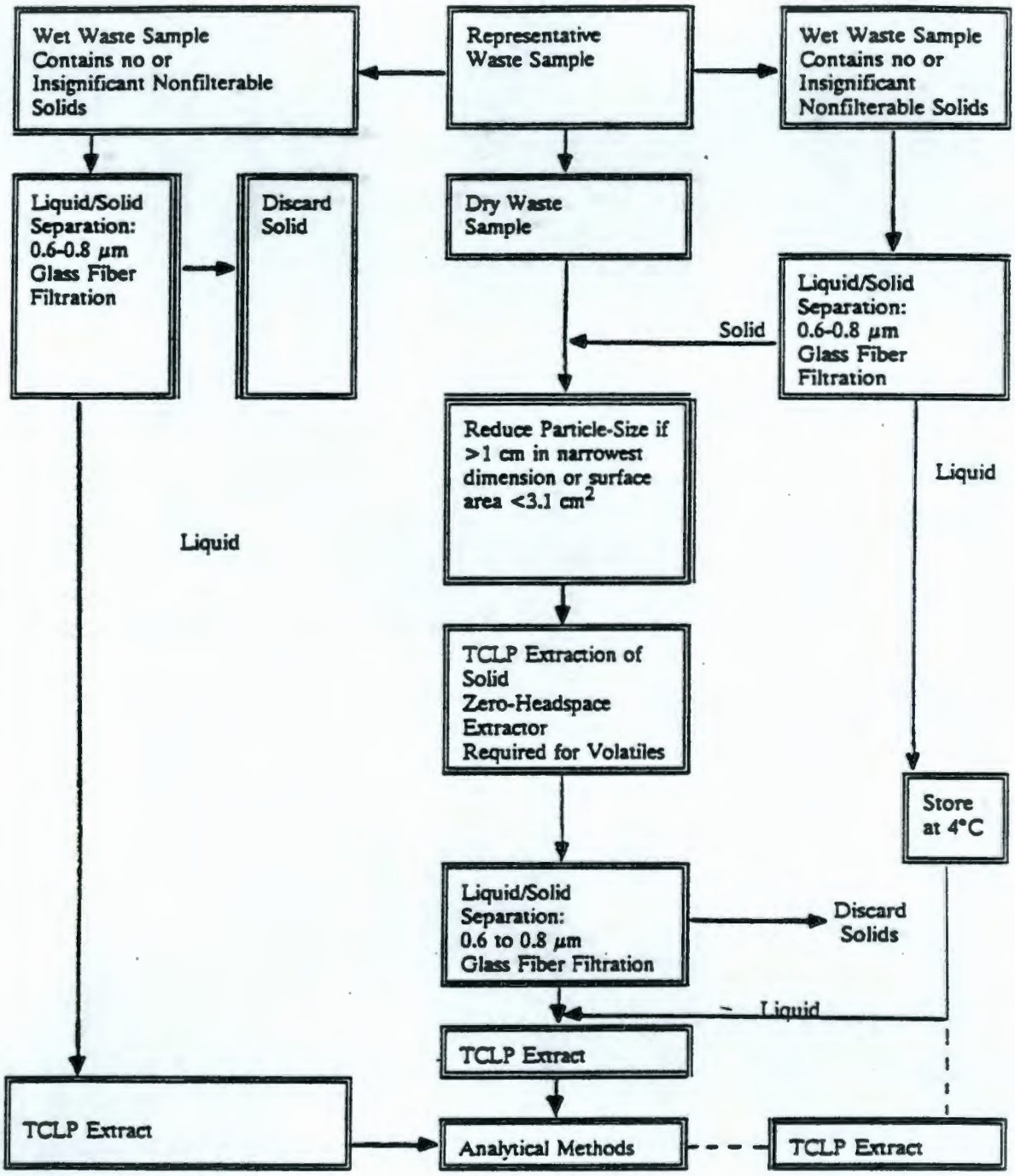
FIGURE NUMBER 1
TCLP FLOWCHART



THE EXTRACTION FLUID EMPLOYED IS A FUNCTION OF THE ALKALINITY OF THE SOLID PHASE OF THE WASTE.

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FIGURE 2
ROTARY AGITATION

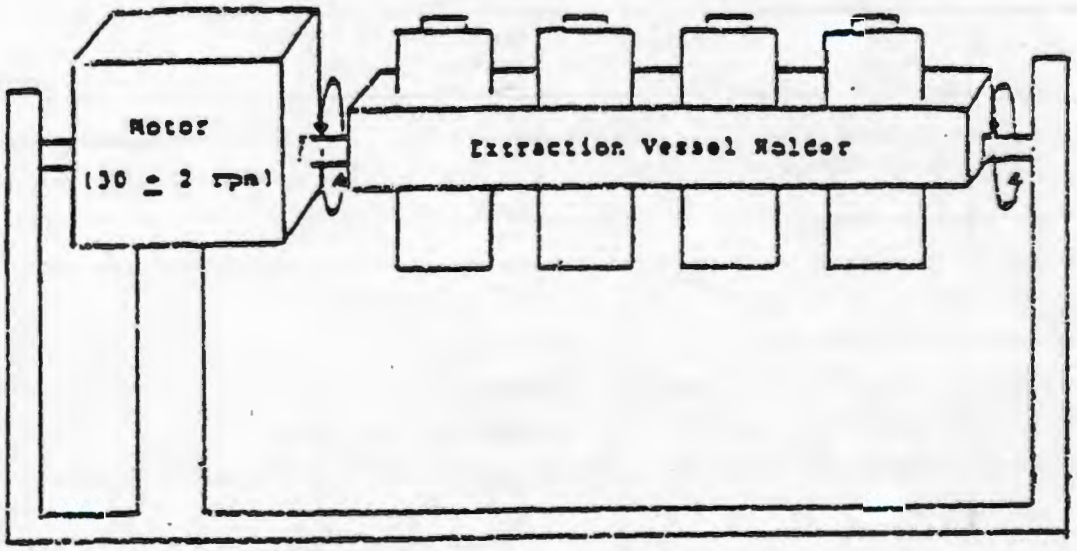

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TABLE 1
VOLATILE CONTAMINANTS

COMPOUND	CAS NUMBER
ACETONE	67-64-1
N-BUTYL ALCOHOL	71-36-6
CARBON DISULFIDE	75-15-0
CARBON TETRACHLORIDE	56-23-5
CHLOROBENZENE	108-90-7
METHYLENE CHLORIDE	75-09-2
METHYL ETHYL KETONE	78-93-3
METHYL ISOBUTYL KETONE	108-10-1
TETRACHLOROETHYLENE	127-18-4
TOLUENE	108-88-3
1.1.1 - TRICHLOROETHANE	71-55-6
TRICHLOROETHYLENE	79-01-6
TRICHLOROFLUOROMETHANE	75-69-4
XYLENE	1330-20-7

Includes compound identified in the Land Disposal Restrictions Rule. If any or all of these compounds are of concern, the zero-headspace extractor vessel shall be used. If other (nonvolatile) compounds are of concern, the conventional bottle extractor shall be used.

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9413221.0812

TABLE 2
SUITABLE ROTARY AGITATION APPARATUS[1]

COMPANY	LOCATION	MODEL
Associated Design and Manufacturing Company	Alexandria, Virginia (703) 549-5999	4-Vessel Device 6-Vessel Device
Lars Lande Manufacturing	Whitmore Lake, Michigan (313) 449-4116	10-Vessel Device 5-Vessel Device
IRA Machine Shop and Laboratory	Santurce, Puerto Rico (809) 752-4004	16-Vessel Device
EPRI Extractor	------	6-Vessel Device[2]
Rexnord	Milwaukee, Wisconsin (414) 643-2850	6-Vessel Device
Analytical Testing and Consulting Services, Inc.	Warrington, Pennsylvania (215) 343-4490	4-Vessel Device

1 Any device that rotates the extraction vessel in an end-over-end fashion at 30 ±2 rpm is acceptable.

2 Although this device is suitable, it is not commercially made. It may also require retrofitting to accommodate ZHE devices.

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TABLE 3
SUITABLE ZERO-HEADSPACE EXTRACTOR VESSELS

COMPANY	LOCATION	MODEL
Associated Design and Manufacturing Company	Alexandria, Virginia (703) 549-5999	3740-ZHB, Gas Pressure Device
Millipore Corporation	Bedford Massachusetts (800) 225-3384	SD1 P581 C5, Gas Pressure Devices
Analytical Testing and Consulting Services, Inc.	Warrington, Pennsylvania (215) 343-4490	C102, Mechanical Pressure Device

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TABLE 4
SUITABLE FILTER HOLDERS[1]

COMPANY	LOCATION	MODEL	SIZE
Nuclepore Corporation	Pleasanton, California (800) 882-7711	425910 410400	142 mm 47 mm
Micro Filtration Systems	Dublin, California (415) 828-6010	302400	142 mm
Millipore Corporation	Bedford, Massachusetts (800) 225-3384	YT30142HW XX1004700	142 mm 47 mm

[1] Any device capable of separating the liquid from the solid phase of the waste is suitable, providing that it is chemically compatible with the waste and the constituents to be analyzed. Plastic devices (not listed above) may be used when only inorganic contaminants are of concern. The 142 mm size filters are recommended.

TABLE 5
SUITABLE FILTER MEDIA

COMPANY	LOCATION	MODEL	PORE SIZE[1]
Whatman Laboratory Products, Incorporated	Clifton, New Jersey (201) 773-5800	GFF	0.7

[1] Nominal Pore Size

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APPENDIX A

Hazardous characteristics of the solidified specimens will be performed per 40 CFR 261. The following characteristics will be determined:

Flammability,
Corrosiveness, and
Reactivity.

PURCHASER: Westinghouse Hanford Company PROJECT: Waste Form Qualification Testing PURCHASE ORDER NO.: MMW-SW-277587 STOCK S. O. NO.: 06996-0000	Quality Plan for the Polymer Immobilization Technology Waste Form Qualification Testing	Prepared By: Honor H. Widdolm 7/23/92 Quality Assurance Engineer Date Reviewed By: Thomas [illegible] 7/23/92 Nuclear Engineering Manager Date Approved By: Michael J. Parker 7/23/92 Quality Assurance Manager Date	QUALITY PLAN NUMBER: 6996-0 REVISION NUMBER: 0 REVISION DATE: 07/23/92 PAGE 1 OF 4

ITEM	OPERATION	CHARACTERISTIC	VERIFICATION	QUANTUM	STANDARDS	DOCUMENT OF RECORDS	COMMENTS
1.0	Submit Work Plan to Buyer for Approval	1. Detailed descriptions of all proposed processing equipment and laboratory apparatus. 2. Testing procedures conform to methods in Table 3. 3. Material Safety Data Sheets	Customer's Approval	All	Per buyer's statement of work, Section 7 and Table 3.	Customer Approval Document	
2.0	Review of Buyer's Material Safety Data Sheets for the four (4) waste samples.	Handling and Storage Requirements Waste Disposal Requirements	Approval by environment and safety officers	All	EPA and OSHA	Memorandum	
3.0	Receive Waste Samples from Buyer	Type Condition Material Safety	Table 1 Visual Inspection Document Review	All All Lot	W-277587 EPA and OSHA M.S.D.S.	Packing List N/A M.S.D.S.	
4.0	Lab Qualifications	QA/QC System Test Procedures Prior Experience	Buyer Approval Buyer Approval Document	Each Each Each	W-277587	Record of Buyer Approval Approved Vendors List	
5.0	Identification of Laboratory Instructions and Test Equipment	Type Manufacturer Model Number Serial Number Calibration Standard	Log Log Log Log Log	All All All All All	W-277587 Table 3 Test Method	Test Report Test Report Test Report Test Report Test Report	

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PURCHASER: Westinghouse Hanford Company PROJECT: Waste Form Qualification Testing PURCHASE ORDER NO.: MMW-SW-277587 STOCK S. O. NO.: 06996-0000	Quality Plan for the Polymer Immobilization Technology Waste Form Qualification Testing	Prepared By: Thomas H Widdekind 7/23/92 Quality Assurance Engineer Date Reviewed By: _____ Nuclear Engineering Manager Date Approved By: Michael J Parker 7/23/92 Quality Assurance Manager Date	QUALITY PLAN NUMBER: 6996-0 REVISION NUMBER: 0 REVISION DATE: 07/23/92 PAGE 2 OF 4

ITEM	OPERATION	CHARACTERISTIC	VERIFICATION	QUANTUM	STANDARDS	DOCUMENT OF RECORDS	COMMENTS
6.0	Calibration of Laboratory Instruments and Test Equipment	Physical/Mechanical Chemical as applicable	Equipment List Table 3 Test Method - Test Requirements	All All All	W-277587 ACS	Vendor Certificate of Compliance Stock Calibration Record	
7.0	Develop Formulation	Ascertain maximum waste load per waste form and polymer type.	Test Records	All	Laboratory Standard Practices	Test Report	
8.0	Laboratory Analysis General Requirements	Table 3 Test Method	Table 3 Acceptance Criteria	All	W-277587 ASTM, EPA, ANS, and CFR Method Requirements	Test Report	
8.1	Compressive Strength Test	Compressive Strength of Samples	Greater than 60 psi	Ten (10) samples per waste form (40).	ASTM D695	Test Report	
8.2	Leachability Index and Immersion Tests	Leachability and Immersion	Leach Index is greater than six (6) and strength is greater than 60 psi after ninety (90) day immersion.	Six (6) samples per waste form (24).	ANS 16.1 and ASTM D695	Test Report	
8.3	Biodegradation Tests	No growth. Strength is greater than 60 psi.	Resistance to biological infestation and verification of compressive strength.	Three (3) samples per waste form (12).	ASTM G21 and G22 ASTM D695	Lab Report Test Report	

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PURCHASER: Westinghouse Hanford Company PROJECT: Waste Form Qualification Testing PURCHASE ORDER NO.: MMW-SW-277587 STOCK S. O. NO.: 06996-0000	Quality Plan for the Polymer Immobilization Technology Waste Form Qualification Testing	Prepared By: Thomas H. Widing/dm, 7/23/92 Quality Assurance Engineer Date Reviewed By: _____ Nuclear Engineering Manager Date Approved By: Michael J. Parker 7/23/92 Quality Assurance Manager Date	QUALITY PLAN NUMBER: 6996-0 REVISION NUMBER: 0 REVISION DATE: 07/23/92 PAGE 3 OF 4

ITEM	OPERATION	CHARACTERISTIC	VERIFICATION	QUANTUM	STANDARDS	DOCUMENT OF RECORDS	COMMENTS
8.4	Radiation Stability Test	Maintenance of compressive strength after exposure to high doses of gamma radiation.	Strength is greater than 60 psi after irradiation to 10^8 rad.	Three (3) samples per waste form (12).	ASTM D695	Lab Report Test Report	
8.5	Thermal Cycling Test	Maintenance of compressive strength after exposure to cycle temperature change.	Strength is greater than 60 psi after thirty (30) thermal cycles.	Three (3) samples per waste form (12).	ASTM B553 ASTM D695 10 CFR 61	Test Report	
8.6	Free Liquids Test	Percentage of free liquids after solidification and seven (7) day cure.	Less than 0.5% free liquids.	Balance of solidification per each waste form (4).	ANS 55.1	Test Report	
8.7	Hazardous Characteristics	Flammability Corrosiveness Reactivity	Not Ignitable Not Corrosive Not Reactive	Three (3) samples per waste form (12).	40 CFR 261	Lab Report	
8.8	Toxicity Characteristics Test	Volume of TCLP Leachable Toxic Constituents	Ag, Ba, Be, Cd, Cr, Cu, Hg, Ni, within proscribed limits	Four (4) samples per waste form (16).	40 CFR 261 and 40 CFR 268.41 Table CCWE EPA 1311 (TCLP) EPA 6010	Lab Report	
9.0	Duplicates and Blanks	Positive and Negative Test Control	Per Test Verification Requirements	All	Per Test Standards Requirements	Applicable Test Reports	
10.0	Confirmation of Statistical Validity	Statistical Validity	Test Report Results	Each Test by Waste Form	Per Specified Test Standards	Test Reports	

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PURCHASER: Westinghouse Hanford Company PROJECT: Waste Form Qualification Testing PURCHASE ORDER NO.: MMW-SW-277587 STOCK S. O. NO.: 06996-0000	Quality Plan for the Polymer Immobilization Technology. Waste Form Qualification Testing	Prepared By: [signature] 7/23/92 Quality Assurance Engineer Date Reviewed By: _____ Nuclear Engineering Manager Date Approved By: [signature] 7/23/92 Quality Assurance Manager Date	QUALITY PLAN NUMBER: 6996-0 REVISION NUMBER: 0 REVISION DATE: 07/23/92 PAGE 4 OF 4

ITEM	OPERATION	CHARACTERISTIC	VERIFICATION	QUANTUM	STANDARDS	DOCUMENT OF RECORDS	COMMENTS
11.0	Final Test Report	Comprehensive final report indicating optimum formulations per waste form.	Review for correlation to individual test report data.		W-277587	Final Test Report	

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DOW

Dow U.S.A.

Material Safety Data Sheet

The Dow Chemical Company
Midland, Michigan 48674
Emergency 517 · 636-4400

Product Code: 19631 Page: 1

Product Name: DERAKANE (R) 411-50 VINYL ESTER RESIN

Effective Date: 06/18/91 Date Printed: 07/14/92 MSDS:000660

1. INGREDIENTS: (% w/w, unless otherwise noted)

Styrene monomer	CAS# 000100-42-5	35-50%*
Vinyl ester resin	CAS# 036425-16-8	BAL.

*for specific percentage of styrene monomer found in this product, see section 9.

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

2. PHYSICAL DATA:

BOILING POINT: 294F, 146C*
VAP. PRESS: 7 mmHg @20C*
VAP. DENSITY: 3.6*
SOL. IN WATER: Insoluble.
SP. GRAVITY: 1.025-1.075
APPEARANCE & ODOR: Straw yellow, viscous liquid - pungent
ODOR: Pungent styrene odor.

*Based on styrene

3. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT: 74-84F
METHOD USED: PMCC, ASTM D-93

FLAMMABLE LIMITS
LFL: 1.1%
UFL: 6.1%

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3. FIRE AND EXPLOSION HAZARD DATA: (CONTINUED)

EXTINGUISHING MEDIA: Water fog, foam, alcohol foam, CO2, dry chemical.

FIRE & EXPLOSION HAZARDS: Upon exposure to heat or flame, an exothermic reaction can develop, followed by decomposition of product. Keep vapors away from possible ignition sources.

FIRE-FIGHTING EQUIPMENT: Wear goggles and positive pressure, self-contained breathing apparatus.

4. REACTIVITY DATA:

STABILITY: (CONDITIONS TO AVOID) Avoid storage in direct sunlight and at temperatures above 120F, 49C.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Oxidizing material

HAZARDOUS DECOMPOSITION PRODUCTS: Pyrolysis products such as CO.

HAZARDOUS POLYMERIZATION: May occur. Avoid contact with metal salts such as ferric and aluminum chlorides, unintended contact with peroxides, and depletion of inhibitor levels. Avoid exposure to direct sunlight or temperatures above 120F (49C).

5. ENVIRONMENTAL AND DISPOSAL INFORMATION:

ACTION TO TAKE FOR SPILLS/LEAKS: Treat as flammable liquid; keep heat, flame, or spark producing equipment away. Protect personnel from styrene vapors. Soak up spills in absorbent material such as sand and collect in suitable containers. Residual resin may be removed using steam or hot soapy water. Solvents are not recommended for cleanup unless the recommended

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5. ENVIRONMENTAL AND DISPOSAL INFORMATION: (CONTINUED)

exposure guidelines and safe handling practices for the specific solvent are followed. Consult appropriate solvent MSDS for handling information and exposure guidelines. For large spills, evacuate upwind of spills and contain with dike.

DISPOSAL METHOD: Resin can be disposed of through burning in an adequate incinerator or burying in an approved landfill in accordance with federal, state and local regulations.

6. HEALTH HAZARD DATA:

EYE: May cause moderate irritation with corneal injury. Vapors may irritate eyes. May cause lachrymation (tears).

SKIN CONTACT: Prolonged or repeated exposure may cause skin irritation. Material may stick to skin causing irritation upon removal.

SKIN ABSORPTION: A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. The LD50 for skin absorption in rabbits is expected to be >2000 mg/kg.

INGESTION: Single dose oral toxicity is low. The oral LD50 for rats is >4000 mg/kg. If aspirated (liquid enters the lung), may be rapidly absorbed through the lungs and result in injury to other body systems.

INHALATION: Excessive vapor concentrations are attainable and could be hazardous on single exposure. Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. Excessive exposure may cause irritation to upper respiratory tract.

(Continued on page 4)

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6. HEALTH HAZARD DATA: (CONTINUED)

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS:
Repeated excessive exposures to high amounts may cause central nervous system, liver, kidney effects and respiratory or eye irritation. Repeated excessive exposures to smaller amounts may cause central nervous system effects and respiratory or eye irritation. Styrene is reported to have caused hearing loss in laboratory animals upon exposure to high concentrations (sixteen times the TLV and higher); however, the relevance of this to humans is unknown.

CANCER INFORMATION:
This mixture contains a component which is listed as a potential carcinogen for hazard communication purposes under OSHA Standard 29 CFR 1910.1200. Components listed by IARC: styrene. Neither the data from various long-term animal studies nor from epidemiology of workers exposed to styrene provide an adequate basis to conclude that styrene is carcinogenic.

TERATOLOGY (BIRTH DEFECTS):
In laboratory animals, styrene did not produce any effects on the fetus even at exposure concentrations having an adverse effect on the mother.

REPRODUCTIVE EFFECTS:
In animal studies, styrene has been shown not to interfere with reproduction.

MUTAGENICITY (EFFECTS ON GENETIC MATERIAL):
Results of in vitro ('test tube') and animal mutagenicity tests on styrene have been inconclusive.

(Continued on page 5)
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DOW

Dow U.S.A.

Material Safety Data Sheet

The Dow Chemical Company
Midland Michigan 48674
Emergency 517 - 636-4400

Product Code: 19631 Page: 1

Product Name: DERAKANE (R) 411-50 VINYL ESTER RESIN

Effective Date: 06/18/91 Date Printed: 07/14/92 MSDS:000660

1. INGREDIENTS: (% w/w, unless otherwise noted)

Styrene monomer	CAS# 000100-42-5	35-50%*
Vinyl ester resin	CAS# 036425-16-8	BAL.

*for specific percentage of styrene monomer found in this product, see section 9.

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

2. PHYSICAL DATA:

BOILING POINT: 294F, 146C*
VAP. PRESS: 7 mmHg @20C*
VAP. DENSITY: 3.6*
SOL. IN WATER: Insoluble.
SP. GRAVITY: 1.025-1.075
APPEARANCE & ODOR: Straw yellow, viscous liquid - pungent
ODOR: Pungent styrene odor.

*Based on styrene

3. FIRE AND EXPLOSION HAZARD DATA:

FLASH POINT: 74-84F
METHOD USED: PMCC, ASTM D-93

FLAMMABLE LIMITS
LFL: 1.1%
UFL: 6.1%

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3. FIRE AND EXPLOSION HAZARD DATA: (CONTINUED)

EXTINGUISHING MEDIA: Water fog, foam, alcohol foam, CO2, dry chemical.

FIRE & EXPLOSION HAZARDS: Upon exposure to heat or flame, an exothermic reaction can develop, followed by decomposition of product. Keep vapors away from possible ignition sources.

FIRE-FIGHTING EQUIPMENT: Wear goggles and positive pressure, self-contained breathing apparatus.

4. REACTIVITY DATA:

STABILITY: (CONDITIONS TO AVOID) Avoid storage in direct sunlight and at temperatures above 120F, 49C.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Oxidizing material

HAZARDOUS DECOMPOSITION PRODUCTS: Pyrolysis products such as CO.

HAZARDOUS POLYMERIZATION: May occur. Avoid contact with metal salts such as ferric and aluminum chlorides, unintended contact with peroxides, and depletion of inhibitor levels. Avoid exposure to direct sunlight or temperatures above 120F (49C).

5. ENVIRONMENTAL AND DISPOSAL INFORMATION:

ACTION TO TAKE FOR SPILLS/LEAKS: Treat as flammable liquid; keep heat, flame, or spark producing equipment away. Protect personnel from styrene vapors. Soak up spills in absorbent material such as sand and collect in suitable containers. Residual resin may be removed using steam or hot soapy water. Solvents are not recommended for cleanup unless the recommended

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5. ENVIRONMENTAL AND DISPOSAL INFORMATION: (CONTINUED)

exposure guidelines and safe handling practices for the specific solvent are followed. Consult appropriate solvent MSDS for handling information and exposure guidelines. For large spills, evacuate upwind of spills and contain with dike.

DISPOSAL METHOD: Resin can be disposed of through burning in an adequate incinerator or burying in an approved landfill in accordance with federal, state and local regulations.

6. HEALTH HAZARD DATA:

EYE: May cause moderate irritation with corneal injury. Vapors may irritate eyes. May cause lachrymation (tears).

SKIN CONTACT: Prolonged or repeated exposure may cause skin irritation. Material may stick to skin causing irritation upon removal.

SKIN ABSORPTION: A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. The LD50 for skin absorption in rabbits is expected to be >2000 mg/kg.

INGESTION: Single dose oral toxicity is low. The oral LD50 for rats is >4000 mg/kg. If aspirated (liquid enters the lung), may be rapidly absorbed through the lungs and result in injury to other body systems.

INHALATION: Excessive vapor concentrations are attainable and could be hazardous on single exposure. Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. Excessive exposure may cause irritation to upper respiratory tract.

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6. HEALTH HAZARD DATA: (CONTINUED)

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS:
Repeated excessive exposures to high amounts may cause central nervous system, liver, kidney effects and respiratory or eye irritation. Repeated excessive exposures to smaller amounts may cause central nervous system effects and respiratory or eye irritation. Styrene is reported to have caused hearing loss in laboratory animals upon exposure to high concentrations (sixteen times the TLV and higher); however, the relevance of this to humans is unknown.

CANCER INFORMATION:
This mixture contains a component which is listed as a potential carcinogen for hazard communication purposes under OSHA Standard 29 CFR 1910.1200. Components listed by IARC: styrene. Neither the data from various long-term animal studies nor from epidemiology of workers exposed to styrene provide an adequate basis to conclude that styrene is carcinogenic.

TERATOLOGY (BIRTH DEFECTS):
In laboratory animals, styrene did not produce any effects on the fetus even at exposure concentrations having an adverse effect on the mother.

REPRODUCTIVE EFFECTS:
In animal studies, styrene has been shown not to interfere with reproduction.

MUTAGENICITY (EFFECTS ON GENETIC MATERIAL):
Results of in vitro ('test tube') and animal mutagenicity tests on styrene have been inconclusive.

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7. FIRST AID:

EYES: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Wash off in flowing water or shower.

INGESTION: Do not induce vomiting. Call a physician and/or transport to emergency facility immediately.

INHALATION: Remove to fresh air. If not breathing, give mouth-to-mouth resuscitation. If breathing is difficult, give oxygen. Call a physician.

NOTE TO PHYSICIAN: The decision of whether to induce vomiting or not should be made by the attending physician. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

8. HANDLING PRECAUTIONS:

EXPOSURE GUIDELINE(S): Styrene, monomer: ACGIH TLV and OSHA PEL are 50 ppm TWA, 100 ppm STEL.

VENTILATION: Provide general and/or local exhaust ventilation to control airborne concentrations below the exposure guideline.

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator.

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8. HANDLING PRECAUTIONS: (CONTINUED)

SKIN PROTECTION: For brief contact, no precautions other than clean body-covering clothing should be needed. When prolonged or frequently repeated contact could occur, use protective clothing impervious to this material. Selection of specific items such as gloves, boots, apron or full-body suit will depend on operation.

EYE PROTECTION: Use chemical goggles. If vapor exposure causes eye discomfort, use a full-face respirator.

9. ADDITIONAL INFORMATION:

SPECIAL PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Practice good care and caution to avoid skin and eye contact and to avoid breathing vapors. For additional precautions, see Dow Bulletin, DERAKANE (R) Vinyl Ester Resins - Fabricating Tips.

MSDS STATUS: Revised section 9.

The following products are represented by master #660. The specific composition of styrene monomer found within each product is indicated as follows:

Derakane 411-35 VER (19691).....35%
Derakane 411-35 Low Inhibitor VER (19774).....35%
Derakane 411-45 VER (19633).....45%
Derakane 411-45 Low Inhibitor VER (19678).....45%
Intermediate Vinyl Ester Resin 145 (08808).....45%
Derakane 411-50 (19631).....50%
Intermediate Vinyl Ester Resin 150 (08809).....50%

For information regarding state/provincial and federal regulations see
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Dow Chemical U.S.A.* Midland, MI 48674 Emergency Phone: 517-636-4400

Product Code: 19631 Page: R-1

Product Name: DERAKANE (R) 411-50 VINYL ESTER RESIN

Effective Date: 06/18/91 Date Printed: 07/14/92 MSDS:000660

REGULATORY INFORMATION: (Not meant to be all-inclusive--selected regulations represented.)

NOTICE: The information herein is presented in good faith and believed to be accurate as the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numberous federal, state or provincial, and local laws and regulations. See MSD Sheet for health and safety information.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER	CONCENTRATION
STYRENE	000100-42-5	35 -50 %

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard
A fire hazard
A reactive hazard

(Continued on page R-2)
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REGULATORY INFORMATION (CONTINUED)

CANADIAN REGULATOINS

The Workplace Hazardous Materials Information System (W.H.M.I.S.) Classification for this product is:

B2
D2A
D2B

The Transportation of Dangerous Goods Act (T.D.G.A.) classification for this product is:

Resin Solution/Class 3.3/UN1866/III

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The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult The Dow Chemical Company For Further Information.

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AGA GAS, INC. (216) 642-6600
6225 OAKTREE BOULEVARD
P.O. BOX 94737
CLEVELAND, OH 44101-4737

MATERIAL SAFETY DATA SHEET
NO. 15

PRODUCT NAME Carbon Dioxide	CAS # 124-38-9
TRADE NAME AND SYNONYMS Carbon Dioxide; Carbonic Anhydride	DOT I.D. No.: UN 1013
CHEMICAL NAME AND SYNONYMS Carbon Dioxide	DOT Hazard Class: Division 2.2
ISSUE DATE AND REVISIONS Revised February 1991	Formula: CO_2
	Chemical Family: Carbonate

HEALTH HAZARD DATA

TIME WEIGHTED AVERAGE EXPOSURE LIMIT

5,000 Molar PPM; STEL = 30,000 Molar PPM (ACGIH 1990-1991). OSHA 1989 TWA = 10,000 Molar PPM; STEL = 30,000 Molar PPM

SYMPTOMS OF EXPOSURE

Inhalation: Low concentrations (3-5 molar %) cause increased respiration and headache.

Eight to 15 molar % concentrations cause headache, nausea and vomiting which may lead to unconsciousness if not moved to open air or given oxygen.

High concentrations cause rapid circulatory insufficiency leading to coma and death.

TOXICOLOGICAL PROPERTIES

Carbon dioxide is the most powerful cerebral vasodilator known. Inhaling large concentrations causes rapid circulatory insufficiency leading to coma and death. Chronic, harmful effects are not known from repeated inhalation of low (3-5 molar %) concentrations.

Carbon dioxide is not listed in the IARC, NTP or by OSHA as a carcinogen or potential carcinogen.

Persons in ill health where such illness would be aggravated by exposure to carbon dioxide should not be allowed to work with or handle this product.

RECOMMENDED FIRST AID TREATMENT

PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO CARBON DIOXIDE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS.

Inhalation: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted respiration and supplemental oxygen. Assure that vomited material does not obstruct the airway by use of positional drainage. Further treatment should be symptomatic and supportive.

Information contained in this material safety data sheet is offered without charge for use by technically qualified personnel at their discretion and risk. All statements, technical information and recommendations contained herein are based on tests and data which we believe to be reliable, but the accuracy or completeness thereof is not guaranteed and no warranty of any kind is made with respect thereto. This information is not intended as a license to operate under or a recommendation to practice or infringe any patent of this Company or others covering any process, composition of matter or use.
Since the Company shall have no control of the use of the product described herein, the Company assumes no liability for loss or damage incurred from the proper or improper use of such product.

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APPENDIX D

CHARACTERIZATION DATA

A. An overview of characterization data used in this stage of Waste Form Qualification testing.

B. Two memos prepared by WHC Chemical Process Engineering Group. The first summarizes the "to date" characterization data on the 183H Basin wastes — the largest volume of the currently stored low level mixed waste types. The second memo describes the recommended waste forms for the various basin wastes and some to the future generated waste streams (LETF and Incinerator Ash).

   Memo 1: JBW-183-001
   Memo 2: CPE-WOG-002

C. Four WHC generated Internal Letter Reports reviewing the records of the contents of all currently stored low-level mixed waste at the Hanford Site. The characterization data and the EPA waste codes were used to group the containers into lots of similar waste types for processing. A technical evaluation was then performed (by a solidification technology expert) as to the best treatment approach for each lot. The rationale for the treatment selection is included.

   Memo numbers: 87330-92-MLS-023, -025, -026, and -028.

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CHARACTERIZATION DATA

Part A: Overview of Characterization Data

The purpose of the WRAP 2A facility is to receive and process for disposal mixed radioactive-hazardous wastes received at the Hanford Site. These wastes include a wide variety of materials from a number of different facilities. Many of these wastes are already in storage, but some are anticipated from near-term future facilities. The largest volume generators include the following: 183-H Basin, the C-018 Liquid Effluent Treatment Facility (LETF) to treat the 300 Area Process Sewer, the Low Level Mixed Waste (LLMW) thermal treatment facility, and the L-045 LETF (treat or stabilize evaporator overheads). This represents roughly 80% of the waste expected at WRAP 2A. A detailed search of the waste generating and receiving records have been made to collect and summarize the available waste characterization data.

183-H Basin Wastes

A summary of the basin wastes (in dry form) is given below. It includes the basin sand blasting grit from cleaning up the basins after removal of basin solid and liquid wastes.

Basin 1 - Inner Sludge

Sodium	29%	Zirconium	4%
Sulfate	29%	Silica	1%
Copper	17%	Uranium	trace
Nitrate	11%	Technetium-99	trace
Fluoride	9%		

Basin 1 - Outer Sludge

Sodium	29%	Silicon	3%
Sulfate	46%	Nitrate	2%
Fluoride	9%	Uranium	trace
Copper	8%	Technetium-99	trace
Zirconium	3%		

Basin 1 - Sorbed Liquid

The liquid, wet sludge, and crystalline material was removed and sorbed onto probably a diatomaceous earth absorbent. The liquid fraction was probably mostly sodium nitrate, possibly some sodium sulfate, with a slight trace of uranium and possibly technetium.

Basin 2 - Sludge

Copper	28%	Zirconium	6%
Nitrate	30%	Silicon	4%
Sodium	21%	Fluoride	2%
Sulfate	9%	Uranium	trace

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Basin 3 - Sludge

Sodium	31%	Sulfate	5%
Nitrate	35%	Fluoride	2%
Copper	15%	Uranium	trace
Zirconium	12%		

Basin 3 - Crystals

Sodium	62%	Nitrate	2%
Sulfate	30%	Uranium	slight trace
Fluoride	6%		

Basin 4 - Sludge

Sodium	38%	Fluoride	2%
Nitrate	47%	Uranium	trace
Sulfate	13%		

Basin 4 - Crystals

Sodium	38%	Sulfate	3%
Nitrate	35%	Fluoride	2%
Copper	16%	Uranium	slight trace
Zirconium	6%		

Basin 2 - Sorbed Liquid

The liquid and entrained solids was thought to be sorbed on to Sorbond LPC-II, a calcium type absorbent. The chemical content of the liquid is given below:

Sodium	27%	Uranium	trace
Nitrate	73%	Technetium	slight trace possible

Sand Blast Grit

The grit is at least 90% grit, the balance being a mixture of basin salt, sludge, dirt and sand, and liner material.

Wastes designated Grit 1 and Grit 2 constitute a large volume of drummed basin wastes at the present time. The grit wastes were generated from cleaning basins 1 and 4. Grit 1 was a mixture of sand blast grit plus the residual basin sludge. Grit 2 was a mixture of sand blast grit plus basin 4 sludge. These wastes are top priority for WRAP 2A processing. The waste compositions and representative surrogate wastes composition procedure for cement based testing is given below:

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Grit 1:

Specie or Material	Overall Content
Sand Blast Grit	90%
Basin 1 Sludge	10%

- Sodium - 29%
- Sulfate - 29%
- Copper - 17%
- Nitrate - 11%
- Fluoride - 9%
- Zirconium - 4%
- Silica - 1%
- Molybdenum - 0.05% (uranium stand-in)
- Ruthenium - 0.05% (technetium stand-in)
- Chromium VI - 0.05%

Grit 2:

Specie or Material	Overall Content
Sand Blast Grit	90%
Basin 4 Crystal	10%

- Sodium - 38%
- Nitrate - 47%
- Sulfate - 13%
- Fluoride - 2%
- Molybdenum - 0.05% (uranium stand-in)
- Chromium VI - 0.05%
- Cobalt II - 0.01%
- Strontium II - 0.01%

The basin sludge portion of the Grit 1 surrogate was produced by weighing the appropriate amount of copper metal powder and dissolving it in dilute nitric acid which provided the nitrate. Zirconium powder, sulfuric acid, and hydrofluoric was added and mixed with the liquid in the preceding sequence. Sodium carbonate was used to neutralize the liquid, and then the chemical tracer compounds were added. The final pH was adjusted to a neutral value with nitric acid and sodium carbonate as appropriate. The liquid was dried, milled, sieved to -20 mesh, and blended prior to use.

The basin crystal portion of Grit 2 surrogate waste was made by weighing and dissolving the appropriate proportions of sodium nitrate, sodium sulfate, sodium fluoride, and sodium carbonate in water. The trace compounds were also added and stirred into the mixture. The liquid was then dried, milled, sieved to -20 mesh, and blended prior to use. Some carbonate was added as a source of sodium.

L-045 LETF (300 Area Process Sewer Treatment Sludge)

The 300 Area, in the past, has typically generated in excess of a million gallons per day of process water. The process sewer stream is monitored

for radioactivity at key locations and diversion capability is available to prevent all but very low level contamination in the stream. There has been and continues to be some light chemical contamination of the system at times, making the waste stream hazardous. A waste minimization effort is presently in place to reduce the overall volume by a factor of 5 to 10 by eliminating cooling water and other large volume flows. However, this is expected to increase chemical concentrations in the stream increasing the risk of it being hazardous more of the time. A LETF is planned that will use a ferric-hydroxide-sulfide flocculation water treatment method to remove the bulk of the chemical contaminants and any residual radionuclides that might be present. This proposed facility has yet to define exactly what volume or composition of mixed waste might be generated. However, ferric hydroxide is unstable in air to decomposition to ferric oxide hydrate (rust). A surrogate waste composition of ferric (iron) oxide, sodium sulfide, polymer flock, and trace chemicals was weighed, milled, and blended. The chemicals were all dry (water free) so no drying was performed. There was a batch of ferric-hydroxide-sulfide flock produced, washed, dried, and milled. A sample of the flock was submitted for analysis and two test cubes were made to verify the ferric oxide surrogate mixture.

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The actual ferric oxide mixture used is given below:

Ferric Oxide Sludge Mix

98.7% - ferric oxide reagent
1.3% - sodium sulfide
0.07%- Polymer flock
0.01%- mercury chloride
0.01%- trichlorethylene
0.01%- chromium oxide

Low-Level Mixed Waste Incinerator

A LLMW incinerator or similar equipment is planned for future installation at the WRAP facility. The primary waste generated by the incinerator is ash. The composition of the ash is very dependent upon the materials to be processed. Rubber products such as gloves have a high solids residue (>5%). Plastic materials and resins have a very low residue content (<0.5%) which is generally exceeded by dirt, sand, and other environmental contaminants. Thus, it is difficult to define a representative ash content until characterization of the processed wastes are determined. Since the wastes to be processed have not been characterized, a commercial fly ash mixed with a small quantity of clay (dirt substitute) and sand was used for the surrogate mix. The ingredients were all weighed dry, milled if needed, and blended to make up the mix.

The incinerator ash mix used is given below:

Incinerator Ash Mix

Specie or Material	Overall Content
Fly ash	90%
Clay 8%	
Sand	2%
Chromium VI	0.01%
Copper II	0.01%
Cesium	0.01%
Cerium	0.01% (transuranic stand-in)
Ruthenium	0.01% (technetium stand-in)
Mercury II	0.01%
Barium	0.01%
Lead	0.01%
Silver	0.01%
Selenium	0.01%
Cadmium	0.01%

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C-018 LETF

The C-018 LETF is planned to treat the evaporator overhead liquids. The primary waste in the overheads is ammonia plus residues of organics. The LETF facility will be designed to stabilize the ammonia as ammonium sulfate using sulfuric acid to neutralize it and destroy the organics chemically (ozone, ultraviolet). The ammonium sulfate will likely contain a slight trace of radioactivity (tritium and volatile radionuclides) plus some trace chemicals making it a candidate mixed waste material. A representative surrogate waste mixture is given below:

C-018 LETF:

Specie or Material	Overall Content
Ammonium Ion	26%
Sulfate	72%
Nitrate	1.2%
Silicon	0.6%
Chromium VI	0.07%
Fluoride	0.05%
Copper II	0.02%
Cerium	0.02% (transuranic stand-in)
Nickel II	0.005%
Mercury II	0.001%
Cesium	0.001%
Strontium	0.001%

The materials were weighed in the dry form milled to -20 mesh, and blended. Commercial grade fertilizer was used for the basic ammonium sulfate material.

From: Chemical Process Engineering JWB-183H-001
Phone: 6-1778 L5-31
Date: June 25, 1992
Subject: 183-H Solar Basin Waste Characterization

To: J.L. Wescott H2-58

cc: D.A. Burbank H1-60
W.O. Greenhalgh L5-31
J.A. Hunter L5-31
C.A. Petersen H1-60
J.G. Riddelle H2-58
K.M. Weingardt H1-60
E.A. McDaniel ORNL

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Attached is the "to date" characterization data for the 183-H Basin wastes. With the characterization data is a summary chronology, as best as can be determined, of events involved in the cleanup of the 183-H Basins.

The information contained in the attachment was gathered from several sources. The primary source for the characterization data was the 183-H Solar Evaporization Basins Closure/Post-Closure Plan (Rev. 2). Other information was obtained from various letters and field notes generated during the cleanup operations.

Since some of the information is 6 to 7 years old it is very difficult to verify any of the information. Therefore, all data should be viewed with some degree of uncertainty.

As more information is found it will be transmitted as an update to this letter.

John W Biglin

John Biglin

6-25-92

183-H BASINS
CLEANUP CHRONOLOGY

Oct 1984 — Basin 1 sampled
Wet sludge (inner basin)
Dry crystalline (outer basin)
Liquid phase

BASIN 1 SOLID SAMPLES
CONTSTITUENTS GREATER THAN 1%
(Table I.A-5 183-H Basin Closure Plan)

	'Inner' Basin Sludge content (%)		'Outer' Basin Sludge content (%)	
Constituent	Average	Range	Sample 0-0	Sample 0-9
Sodium	20.0	17.7 - 23.5	20.5	22.9
Copper	11.9*	10.0 - 11.2	5.4	6.3
Zirconium	3.2	1.9 - 3.9	1.6	1.8
Flouride ion	6.0	5.4 - 6.4	7.1	6.7
Nitrate ion	8.0	6.1 - 10.4	1.4	1.6
Sulfate ion	20.2	17.7 - 23.5	35.5	32.7
Water (dried to 105° C)	22.2	18.7 - 24.5	22.8	23.1
Silicon	<1	<1	2.8	0.6
pH range	9.3 - 9.7		9.3 - 9.6	

(* number does not fit with range)

BASIN 1 SOLIDS
TRACE CONSTITUENTS DETECTED
(Table I.A-6 183-H Basin Closure Plan)

	'Inner' Basin Sludge content (ppm)		'Outer' Basin Sludge content (ppm)	
Constituent	Average	Range	Sample 0-0	Sample 0-9
Aluminum	2100	1800 - 2400	7900	1300
Barium	a	a	100	50
Boron	a	a	100	100
Calcium	800	700 - 1000	3100	500
Chromium	900	700 - 1000	400	500
Iron	1700	1300 - 1900	3400	1000
Lithium	a	a	100	60
Mananese	1200	1000 - 1400	700	800
Magnesium	a	a	1200	<500
Nickel	100b	<100 - 200	400	<400
Phosphorous	1100	900 - 1300	a	a
Silicon	8100	7200 - 9300	a	a
Titanium	100	70 - 200	400	<100
Zinc	300	300 - 400	300	300
Uranium	420	390 - 530	82	155

a Constituent not detected
b Nickel undetected in one sample in the inner basin sludge.

BASIN 1 SOLIDS SAMPLES
EXTRACTION PROCEDURE TOXICITY RESULTS
(Table I.A-21 183-H Basin Closure Plan)

Constituent	'Inner' Basin Sludge content (mg/l) Average	Range	'Outer' Basin Sludge content (mg/l) Sample 0-0	Sample 0-9
Arsenic	<0.5	<0.5	<0.5	<0.5
Barium	0.02a	<0.02 - 0.03	0.05	0.07
Cadmium	0.06b	<0.04 - 0.07	0.05	0.05
Chromium	6.1	3.7 - 9.9	8.4	9.2
Chromium VI c	1.4	0.8 - 2.2	1.7	1.7
Lead	<0.6	<0.6	<0.6	<0.6
Selenium	<0.1	<0.1	<0.1	0.2
Silver	<0.1	<0.1	<0.5	<0.5

a Barium level below detection limit in 2 samples.
b Cadmium level below detection limit in 1 sample.
c Chromium VI (Hexavalent chromium) analysis per EPA Method 7196 (EPA 1982)

BASIN 1 RADIONUCLIDE CONTENT

LIQUID PHASE

Constituent	Average	Range
Uranium	275.9 µg/ml	238 - 329 µg/ml
Technetium-99	748,000 pCi/L	494,000 - 890,000 pCi/L

SOLID PHASE

Constituent	'Inner Basin' Average	Range	'Outer Basin' Average	Range
Uranium	0.042	0.039 - 0.053 wt %	0.012	0.0082 - 0.016 wt %

Basin 1 Solid Sample I-2 - Isotopic Uranium Analysis

* Sample I-2 total uranium content 0.053 wt. %

Isotope	Content (wt. %)
U-238	98.940 ± 0.004
U-235	1.006 ± 0.004
U-236	0.044 ± 0.001
U-234	0.009 ± 0.001

Above results reported as analysis attachment to letter from M.A. Mihalic to Ralph Maffeo dated December 26, 1985. Letter was cover to sampling analysis report for 183-H Basin 1 waste material.

WASTE DESIGNATIONS: Basin 1 solids; WT01 - Toxicity (EHW)
U123, P029, P030, P098, P120

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June - Sept 1985 Basin 1 liquids transfered to adjacent basins.

Wet sludge and crystalline material removed from basin. Materials were not segregated. Absorbant used. Waste volume estimated at 7,646 cubic feet (1700 barrels). Barrels contain 4.5 cu ft of waste and 3 cu ft of absorbant (type of absorbant unknown - probably diatomaceous earth).

Jan 1986 Basin 2 sampled
Wet sludge
Liquid phase

BASIN 2 SLUDGE SAMPLES
CONSTITUENTS GREATER THAN 1%
(Table I.A-7 183-H Basin Closure Plan)

Constituent	Average content (%)	Range (%)
Copper	13.0	9.9 - 15.4
Sodium	9.7	4.2 - 15.9
Silicon	2.4	0.06 - 9.3
Zirconium	3.2	2.8 - 3.5
Flouride ion	1.1	0.57 - 1.81
Nitrate ion	13.5	8.2 - 17.5
Sulfate ion	3.8	0.65 - 15.2
Moisture	52.7	45.7 - 57.7

pH range 10.8 - 11.9 (liquid phase in contact with sludge)

BASIN 2 SLUDGE SAMPLES
TRACE CONSTITUENTS DETECTED
(Table I.A-8 183-H Basin Closure Plan)

Constituent	Average content (ppm)	Range (ppm)
Aluminum	1950	540 - 4470
Beryllium	6	4.4 - 7.8
Calcium	334	158 - 634
Chromium	450	292 - 727
Mercury	1.3a	<0.4 - 3
Iron	1066	641 - 1559
Silver	218b	119 - 308
Uranium	1250	28 - 2500
Vanadium	2.5c	<1.25 - 3.13
Total organic carbon	1905	237 - 3828

a Constituent above detection limit in 1 sample.
b Constituent below detection limits in 2 samples.
c Constituent below detection limits in 3 samples.

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BASIN 2 SLUDGE RADIONUCLIDE CONTENT

Constituent	Average	Range (ppm)
Uranium	1,250 ppm	28 - 2,500
Technetium-99	1.170 pCi/l	

WASRE DESIGNATIONS: Basin 2 sludge; WT02 - Toxicity (DW), D007 - EP TOX (Cr) U123,P029, P030, P098, P120

July - Sept 1986 Liquid from Basin 2 transfered to Basins 3 & 4.
Basin 2 sludge packaged.
Est. 8,955 cubic feet (1990 barrels - 4.5 cu ft waste and 3 cu ft of absorbant).
Basin 2 sludge PIN #'s:
183H-86-0001S thru 183H-86-0026S 48 drums/number
183H-86-0027S thru 183H-86-0035S 72 drums/number
183H-86-0036S 48 drums
183H-86-0037S 46 drums

36 mil Hypalon liner installed in Basin 2.

Liquids from Basins 3 & 4 transfered to relined Basin 2.

March 1987 Basins 3 & 4 sampled
Wet sludge
Crystalline

BASINS 3 & 4 SAMPLES
MAJOR INORGANIC CONSTITUENTS
(Table I.A-9 183-H Basin Closure Plan)

	Basin 4 Sludge (%)		Basin 3 Sludge (%)	
Constituent	Average	Range	Average	Range
Copper	10.3	9.7 - 12.0	11.2	8.8 - 14.0
Sodium	24.0	23.0 - 26.0	23.0	20.0 - 30.0
Zirconium	4.4	0.34 - 13.0	8.7	2.2 - 22.0
Flouride ion	1.1	0.98 - 1.2	1.3	0.98 - 1.5
Nitrate ion	22.0	20.0 - 24.0	26.0	17.0 - 29.0
Sulfate ion	1.9	1.3 - 3.9	3.7	1.9 - 5.3
Moisture	46.0	43.0 - 51.0	42.0	35.0 - 51.0
pH		9.7 - 9.9		10.2 - 12.1

	Basin 4 Crystalline (%)		Basin 3 Crystalline (%)	
Constituent	Average	Range	Average	Range
Sodium	38.0	30.0 - 50.0	42.0	35.0 - 55.0
Sulfate ion	13.0	1.5 - 31.0	20.0	16.0 - 26.0
Flouride ion	2.2	0.28 - 5.8	3.6	2.9 - 4.9
Nitrate ion	46.6	7.1 - 71.0	<1.0	<1.0
Moisture	6.6	1.1 - 25.0	1.1	0.55 - 1.8
pH		9.2 - 9.9		9.0 - 10.0

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BASINS 3 & 4 SLUDGE SAMPLES
TRACE INORGANIC CONSTITUENTS DETECTED
(Table I.A-10 183-H Basin Closure Plan)

	Concentration in Basin 4 sludge content (ppm)		Concentration in Basin 3 sludge content (ppm)	
Constituent	Average	Range	Average	Range
Aluminum	430	390 - 490	8900	1100 - 17000
Barium	24a	<1 - 39	6b	<1 - 22
Beryllium	0.4b	<0.09 - 1.8	2.3	<0.5 - 3.8
Boron	31	26 - 38	40b	<20 - <60
Cadmium	3.8	2.9 - 4.5	6d	3.6 - <9
Chlorine ion	210	170 - 230	310	150 - 410
Calcium	84	67 - 110	290	180 - 650
Chromium	260	210 - 340	390	290 - 530
Cobalt	2a	0.66 - 3.1	5b	<3 - <9
Iron	2100	1200 - 3800	710	540 - 1000
Lead	36c	14 - <50	<80	<80
Magnesium	21	15 - 32	67a	39 - 120
Manganese	760	680 - 890	970	800 - 1100
Nickel	96	81 - 110	130	96 - 180
Nitrite ion	390	330 - 460	660	430 - 790
Potassium	330	78 - 430	680a	<300 - 1600
Silver	170	140 - 220	190	120 - 290
Strontium	4.0	3.5 - 4.7	17	11 - 36
Tin	600	470 - 680	480	360 - 750
Vanadium	4c	<2 - <10	<30	<30
Zinc	360	310 - 420	370	280 - 520

a Constituent less than detection limit in 1 sample.
b Constituent less than detection limit in 4 samples.
c Constituent less than detection limit in 3 samples.
d Constituent less than detection limit in 2 samples.

BASIN 3 & 4 SLUDGE SAMPLE EXTRACTION PROCEDURE TOXICITY RESULTS
(Table I.A-22 183-H Basin Closure Plan)

	Basin 3 (ppm)		Basin 4 (ppm)	
Constituent	Average	Range	Average	Range
Arsenic	<0.04	<0.04	<0.02	<0.02
Barium	<0.09	<0.09	<0.003	<0.003
Cadmium	<0.02	0.035 - 0.057	0.062	0.056 - 0.069
Chromium	0.26	0.12 - 0.33	0.51	0.19 - 0.66
Lead	<0.08	<0.08	<0.08	<0.08
Mercury	0.003a	<0.002 - 0.005	0.009	0.004 - 0.011
Selenium	0.09a	0.04 - <0.1	0.04a	0.02 - <0.05
Silver	<0.09	<0.09	<0.08	<0.08

a Less than detection limit for 4 samples.

BASINS 3 & 4 CRYSTALLINE SAMPLES
TRACE INORGANIC CONSTITUENTS DETECTED
(Table I.A-11 183-H Basin Closure Plan)

Constituent	Concentration in Basin 4 crystalline content (ppm) Average	Range	Concentration in Basin 3 crystalline sample (ppm) Average	Range
Aluminum	440	200 - 610	810	780 - 880
Barium	2.3	0.96 - 3.4	8b	2.5 - <10
Beryllium	0.4a	<0.09 - 0.6	1c	<4 - 1.3
Boron	1400	300 - 2700	2700	2200 - 3000
Calcium	61	43.9 - 100	83	48 - 140
Chlorine ion	110b	<20 - 330	50b	<10 - 180
Chromium	5.8	3.4 - 11	21	6.6 - 40
Cobalt	3a	0.8 - <6	<3	<3
Copper	2600	1700 - 4500	9900	4200 - 18000
Iron	77	77 - 150	97	48 - 180
Lead	14a	<5 - <20	<30	<30
Magnesium	26b	13 - 35	29a	<20 - 37
Manganese	20c	9.8 - 34	66	31 - 140
Nickel	7a	<2 - <10	11a	<10 - 13
Potassium	56b	<20 - 130	<100	<100
Silver	11.6c	1.6 - 32	11c	<5 - 17
Strontium	2.3b	1 - <3	3.4b	<3 - 4.8
Thallium	34a	<10 - <50	<50	<50
Tin	58c	<5 - 150	39d	<20 - 73
Zinc	12	7 - 20	33	17 - 52
Zirconium	1300	290 - 3300	6200	560 - 15000

a Constituent less than detection limit in 1 sample.
b Constituent less than detection limit in 4 samples.
c Constituent less than detection limit in 3 samples.
d Constituent less than detection limit in 2 samples.

BASIN 3 & 4 CRYSTALLINE SAMPLES
EXTRACTION PROCEDURE TOXICITY RESULTS
(Table I.A-23 183-H Basin Closure Plan)

Constituent	Basin 3 (ppm) Average	Range	Basin 4 (ppm) Average	Range
Arsenic	<0.2a	<0.2 - <0.7	0.08a	<0.01 - 0.2
Barium	0.09b	<0.003 - 0.43	<0.007	<0.007
Cadmium	<0.02	<0.02	<0.009	<0.009
Chromium	0.3	0.12 - 0.53	0.15	0.074 - 0.27
Lead	<0.08	<0.08	<0.2	<0.2
Mercury	<0.02	<0.02	0.003a	<0.002 - 0.006
Selenium	0.13a	<0.01 - 0.30	0.2	0.1 - 0.2
Silver	<0.4	<0.4	<0.4	<0.4

a Constituent not detected in 2 samples.
b Constituent not detected in 4 samples.

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BASINS 3 & 4 RADIONUCLIDE CONTENT
URANIUM RESULTS
(Table I.A-15 183-H Basin Closure Plan)

Sample stratum	Average content (pCi/g) * dry weight	Range (pCi/g)
Basin 3 sludge	870	320 - 1,560
Basin 3 crystalline	25	8 - 62
Basin 4 sludge	520	44 - 820
Basin 4 crystalline	12	7 - 20

NOTE: Technetium-99 believed to be present but was not analyzed for.

WASTE DESIGNATION : Basins 3 & 4 sludge/crystalline; WT01 - Toxicity (EHW)
U123, P029, P030, P098, P120

March 1987 Basin 2 liquid sampled.
Estimated volume of Basin 2 is 470,000 gallons. Estimate is by extrapolation backwards from later volume estimates and estimates of evaporation rates.

BASIN 2 LIQUID SAMPLES
MAJOR INORGANIC CONSTITUENTS
(Table I.A-16 183-H Basin Closure Plan)

Constituents	Average concentration (mg/l)	Range (mg/l)
Sodium	140,000	120,000 - 160,000
Nitrate ion	380,000	310,000 - 430,000
Moisture	(57%)	(57 - 58%)
pH		10.5 - 10.7

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BASIN 2 LIQUID SAMPLES
TRACE INORGANIC CONSTITUENTS
(Table I.A-17 183-H Basin Closure Plan)

Constituents	Average contents (mg/l)	Range (mg/l)
Aluminum	36	30 - 44
Boron	63a	<30 - 97
Calcium	9a	<5 - 13
Chlorine ion	290	260 - 320
Chromium	20	16 - 23
Cobalt	0.6	<0.4 - 0.77
Copper	410	120 - 940
Fluorine ion	1500	1400 - 1600
Iron	7	2.8 - 14
Manganese	7a	<4 - 13
Molybdenum	1b	<1 - <2
Nickel	9	8.3 - 10
Nitrite ion	890	790 - 1020
Potassium	720	670 - 820
Silver	1.8	1.1 - 2.8
Strontium	0.6c	<0.5 - 0.81
Tin	15	10 - 25
Sulfate	8000	7800 - 8300
Zinc	2.8	1 - 5.4
Zirconium	780	320 - 1500

a Constituent less than detection limit in 1 sample.
b Constituent less than detection limit in 4 samples.
c Constituent less than detection limit in 3 samples.

BASIN 2 LIQUID SAMPLES
EXTRACTION PROCEDURE TOXICITY RESULTS
(Table I.A-24 183-H Basin Closure Plan)

	Content (ppm)	
Constituent	Average	Range
Arsenic	0.08	0.04 - 0.1
Barium	0.63	0.47 - 0.89
Cadmium	<0.02	<0.02
Chromium	5.9	4.6 - 7.1
Lead	<0.2	<0.2
Mercury	0.017	0.005 - 0.035
Selenium	0.04a	<0.02 - 0.07
Silver	<0.2	<0.2

a Constituent below detection limit in 2 samples.

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BASIN 2 LIQUID RADIONUCLIDE CONTENT

Constituent	Average pCi/l	Range pCi/l
Uranium	82,400	74,000 - 94,000 ± 5,000
Technetium - believed present but not analyzed for.		

WASTE DESIGNATIONS: Basin 2 liquid; WT01 - Toxicity (EHW)
U123. P029, P030, P098, P120

May - Sept 1987 — Basin 3 sludge and crystalline material removed.
Volume - 14,535 cubic feet (3230 barrels - 4.5/3 ratio).

36 mil Hypalon liner installed in Basin 3.

Jan 1988 — Status - Basin 1 Empty except for rainwater
Basin 2 Liquids - volume unknown
Basin 3 Empty except for rainwater
Basin 4 Sludge and crystalline material remain.

May - Sept 1988 — Basin 4 sludge and crystalline material removed.
Volume - 6,259 cubic feet (1391 barrels - 4.5/3 ratio).

Sept 1988 — All original sludge/crystalline material removed and packaged.

1988/1989 — Basins 1 & 4 sandblasted.

Basin 1 approximately 1/8 to 1/4 inch of concrete was removed during sandblasting.

Basin 4 original liner (Gray butyl material with white Hypalon sprayed cover remained after sandblasting).

All sandblast materials were packaged. Sampling data of sandblast grit unknown. Packaging requirements unknown.

Volume of sandblast waste unknown.

Evaporation of approximately 33,760 gallons of liquid with a resultant crystallized solid with a volume of approximately 21,900 cubic feet.

Solidified 60,000 gallons of liquid from Basins 2 & 3. Liquid solidification - 40 gallons liquid mixed with 290.4 lbs of Sorbond LPC-II absorbant.

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Sorbond LPC-II Formula

Componds	Range (%)
Silicon dioxide	14.4 - 15.6
Aluminum oxide	3.1 - 3.5
Ferous oxide	1.6 - 1.9
Calcium oxide	63.2 - 73.2
Manganese oxide	5.1 - 6.0
Sulfate ion	1.4 - 1.8
Potassium	0.4 - 0.7
Sodium oxide	0.8 - 1.2
Calcium carbonate	0.3 - 0.5

Bulk density = 70 - 80 pounds per cubic foot.

183-H Basin 2
Absorbed Aqueous Waste

Waste mixture: Waste per barrel - 40 gallons.
Assumed bulk density of waste is 9.2 lbs. per gallon.
Weight of 40 gallons waste = 368 lbs.

Sorbond LPC-II used per barrel - 290.4 lbs.

Total weight of absorbed waste per barrel - 658.4 lbs.

Wt % of waste per barrel - 56%

Wt % of Sorbond LPC-II per barrel - 44%.

NOTE: 2 to 3 inches of absorbant was placed on top of cured waste to fill void space and absorb any condensate that formed.

Note: Records show 1616 barrels (@ 65,000 gallons of liquid) of material generated from 6/89 tO 12/89 during solidification of liquid. However, records at the Central Waste Complex show that there are 2767 barrels of solidified liquid. The extra 1151 barrels may be of material which solidified during evaporation stages of volume reduction that took place from 1987 to 1989. SWITS records indicate that all 2767 barrels are considered as solidified liquid.

Estimates of material in Basins 2 & 3 in Sept. 1989 were 111,142 gallons of liquid and crystalline evaporate. This would correspond with the amount needed to fill about 2767 barrels with 40 gallons of material each.

Basin 2 & 3 Liners removed and boxed up. Basins 2 & 3 were not sandblasted.

9413221.0852

Westinghouse Hanford Company — **Internal Memo**

From: Chemical Process Engineering — CPE-WOG-002
Phone: 6-9616 L5-31
Date: June 1, 1992
Subject: RECOMMENDED WASTE FORMS FOR WRAP 2A MODULE WASTES

To: J. L. Westcott H2-58

cc: J. W. Biglin L5-31
D. A. Burbank H1-60
J. A. Hunter L5-31
C. A. Petersen H1-60
J. G. Riddelle H2-58
WOG/File-LB

9413221.0853

The purpose of this letter is to recommend some waste forms to use to solidify WRAP 2A Module mixed wastes. The waste forms recommended here will undergo laboratory testing in the very near future to verify or negate their planned use. A comprehensive literature search has been performed during the last month to help assist with the effort. In addition, E. W. McDaniel of ORNL, a solidification consultant, will review this recommendation before the laboratory work gets very far.

The waste to be treated in WRAP 2A varies in chemical characteristics, physical characteristics, radionuclide contamination, and hazardous constituents. The bulk of the waste is expected to come from the 183-H Basin clean-up, the C-018 Liquid Effluent Treatment Facility (LETF), ash from thermal treatment of combustible low-level mixed waste (LLMW), and possibly some from the L-045H LETF. This represents about 80% of the waste, the balance will be varied mixed waste residues including soil, spent resin, salts, chemicals, etc. from facilities throughout the Hanford Site. The major waste streams are given below with their approximate chemical content in dry form:

1. Basin 1 - Inner Sludge

Sodium	29%	Zirconium	4%
Sulfate	29%	Silica	1%
Copper	17%	Uranium	trace
Nitrate	11%	Technetium-99	trace
Fluoride	9%		

2. Basin 1 - Outer Sludge

Sodium	29%	Silicon	3%
Sulfate	46%	Nitrate	2%
Fluoride	9%	Uranium	trace
Copper	8%	Technetium-99	trace
Zirconium	3%		

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9413221.0854

3. Basin 1 - Sorbed Liquid

The liquid, wet sludge, and crystalline material was removed and sorbed onto probably a diatomaceous earth absorbent. The liquid fraction was probably mostly sodium nitrate, possibly some sodium sulfate, with a slight trace of uranium and possibly technetium.

4. Basin 2 - Sludge

Copper	28%	Zirconium	6%
Nitrate	30%	Silicon	4%
Sodium	21%	Fluoride	2%
Sulfate	9%	Uranium	trace

5. Basin 3 - Sludge

Sodium	31%	Sulfate	5%
Nitrate	35%	Fluoride	2%
Copper	15%	Uranium	trace
Zirconium	12%		

6. Basin 3 - Salt

Sodium	62%	Nitrate	2%
Sulfate	30%	Uranium	slight trace
Fluoride	6%		

7. Basin 4 - Sludge

Sodium	38%	Fluoride	2%
Nitrate	47%	Uranium	trace
Sulfate	13%		

8. Basin 4 - Salt

Sodium	38%	Sulfate	3%
Nitrate	35%	Fluoride	2%
Copper	16%	Uranium	slight trace
Zirconium	6%		

9. Basin 2 - Sorbed Liquid

The liquid and entrained solids was thought to be sorbed on to Sorbond LPC-II, a calcium type absorbent. The chemical content of the liquid is given below:

Sodium	27%	Uranium	trace
Nitrate	73%	Technetium	slight trace possible

9413221.0855

10. Sand Blast Grit

    The grit is expected to be at least 90% grit, the balance being a mixture of basin salt, sludge, dirt and sand, and liner material. This is not expected to be designated hazardous from the contents, but if designated it would probably be by association.

11. C-018 LETF Facility (Stabilized Distillate Residue)

    Ammonium Sulfate (in dry form) > 95%
    Volatile Radionuclides - Trace levels

12. C-018 LETF Facility

    Spent ion exchange resin

13. C-045 LETF Facility (300 Area Process Sewer Treatment)

    Ferric Hydroxide Sludge (on Occasion)

14. C-045 LETF Facility

    Spent ion exchange resin (Duolite) - on Occasion

15. LLMW Incineration or Destruction Facility

    Ash Residue

RECOMMENDATIONS

The following recommended methods will made and the appropriate waste forms tested in the laboratory:

A. Cement is recommended and will be tested on the basin wastes numbered 1 through 10. Slag cement appears from the literature search to provide the best waste product performance in regards to leachability and EPA toxicity testing. Therefore, it is the prime candidate; however, portland cement type I-II, or type III will be used as back-up if any of the basin mixes appear to yield a poor product with slag cement. In addition, a cement modifier suggested by E. W. McDaniel of ORNL will be obtained and tested for its ability to increase retention of salt materials such as nitrates.

B. Gypsum cement is recommended for ammonium sulfate listed as waste no. 11. Slag and portland cements exhibit strongly basic slurries in the mixing stage, this would release ammonia gas. Gypsum cement however is neutral during mixing and stabilizes the ammonium sulfate in the ammonium ion form. Laboratory screening experiments will be used to determine whether plaster of paris or a modified gypsum cement is used. Gypsum cement can be handled in the same type equipment as slag cement if the set is retarded. Either a slow setting material or a retarder will be added to provide a reasonable set time.

C. Spent ion exchange resins (nos. 12 and 14) will be processed with cement after a pretreatment process wherein the resin beads or granules are destroyed. A chop blending method will be used for slurries or wet resin, and milling will be used for dry resin.

D. A lime or lime-flyash treatment will be used for ferric (iron) hydroxide flock (waste no. 13). The flock destroys cement setting properties and the flock is too basic for materials such as sulfur polymer cement. The use of trade mark Aquaset or Petroset from Fluid Tech, Inc. could be lab tested for this application.

E. The ash residue (no. 15) as well as the basin grit (no. 10) would best be used as blending agents to stretch the cement and improve its strength and containment characteristics. It will be tested in this manner. Ash is a good candidate for sulfur polymer cement, but this would require a different type of facility equipment. An effort will be made to provide some information on the use of sulfur polymer cement for ash immobilization. There are other miscellaneous wastes that would probably be immobilized better in sulfur polymer cement than the other cements.

Work on these waste immobilization methods will begin in the laboratory within the next week with the intent to show that they meet present and anticipated future waste disposal criteria.

W. O. Greenhalgh, Principal Scientist
Chemical Process Engineering

dfm

9413221.0856

Westinghouse Hanford Company

Internal Memo

From: Restoration Projects 87330-92-MLS-023
Phone: 372-1362, H2-58
Date: August 7, 1992
Subject: SOLID WASTE INFORMATION AND TRACKING SYSTEM LOW-LEVEL MIXED WASTE CHARACTERIZATION TO SUPPORT WASTE RECEIVING AND PROCESSING 2A

To: J. L. Westcott H2-58

cc:	S. R. Briggs	G6-47*	J. G. Riddelle	H2-58
	D. A. Burbank	H1-60	V. M. Weingardt	H1-60
	W. O. Greenhulgh	L5-31	RP Characterization File	
	R. S. Kelley	H2-58*	MLS File/LB	
	D. R. Lucas	G6-46*	*w/o attachment	

9413221.0857

Per your request on June 9, 1992 a Solid Waste Information and Tracking System (SWITS) data run was pulled on all low-level mixed waste (LLMW) in storage except the 183H basin. This data summed up to some 2547 containers. The raw data was analyzed to determine that which was to be treated at WRAP 2A. To determine this the data with <300 ppm organics was considered along with that containing no organics. Next the Environmental Protection Agency (EPA) codes of this data was analyzed to form treatment lots. The results of this process were 718 containers put into 14 treatment lots. The lots consist of waste with similar waste codes and compatible constituents.

To date ten lots have been arranged and seven of these are summarized and attached (lots WRAP 2A.1, WRAP 2A.3 through WRAP 2A.8). The seven lots have been reviewed by Earl McDaniel, on contract from Oakridge.
Mr. McDaniel has provided complete rationale for treatment which is attached with each summary cover sheet. The complete data to support the summarized cover sheet will be kept on file in my office.

The cover sheet gives information on containers pin number, size and dose; generators; EPA codes; physical description of contents; radionuclide distribution of containers; hazardous constituents within contents. The physical, radionuclide and hazardous sections lists the number of containers, average amounts, and range with the lot.

The remaining seven lots will be evaluated and summarized in the coming weeks.

If you have any questions or require additional information, please feel free to contact me on 372-1362.

Jeff Riddelle for
M. L. Sheriff
Engineering Technician

pss

Attachment

Hanford Operations and Engineering Contractor for the US Department of Energy

Attachment
87330-92-MLS-023

9413221.0858

Pages 1 through 16

SHEET5.XLS

LOT WRAP2A.1

7/27/92

CONTAINER INFORMATION

SIZE: 55 GAL
AMOUNT:63
DOSE:1mr
WASTE CODE:WT02

GENERATOR:313 BLDG. 300 AREA
FUEL FABRICATION OPERATION

GROSS WEIGHT: 281-345 KG

HAZARDOUS CONSTITUENTS	WEIGH (Kg)
CHROMIUM	0.23
COPPER	31.3
SODIUM FLUORIDE	49.89
SODIUM HYDROXIDE	36.29
SODIUM NITRATE	31.75
ZIRCONIUM	0.82
TOTAL HAZARDOUS WEIGHT	150.28

STATE OF CONSTITUENTS:
ACID NEUTRALIZATION CENTERFUGE SLUDGE ABSORBED IN POZZOLAN OR DIATAMACEOUS EARTH PER SDAR# 3-1B-7HM-2

PHYSICAL DESCRIPTION	%
ABSORBENT(POZZOLAN/ DIA.EARTH)	25
PLASTIC/POLY(90 MIL LINER)	5
SLUDGES(ABOVE)	70

PACKAGING INSTRUCTIONS:
17C GALV.DRUM, 90 MIL LINER ABSORBED WASTE DIRECT TO LINER

RADIONUCLIDE DISTRIBUTION
TOTAL BETA/GAMMA: .05 CURIES
ENRICHED URANIUM RANGE:159.2 g through 639.6 g
AVERAGE:362.12

EPA LABEL:
"WT02 TOXIC FOR NaF"

PIN #

364	365	368	369	376	388	398
366	367	370	371	391	395	402
387	372	374	404	392	397	412
389	373	375	405	399	401	413
390.B	378	377	406	403	408	414
393	379	380	407	423	409	415
394	382	381.B	420	424	410	416
396	383	384	421	425	411	417
400	386	385	422	426	419	418

RECOMMENDED TREATMENT:
1.TAILORED GROUT
2.POLYMER
3.GYPSUM CEMENT

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

9413221.0859

LOT WRAP 2A.1

SHEET 5.XLS

RECOMMENDED TREATMENT:

1. TAILORED GROUT

2. POLYMER

3. GYPSUM CEMENT

RATIONALE FOR TREATMENT RECOMMENDATION:

Tailored grout is a convient waste form in that: (1) tha waste exists a a sludge, (2) sodium salts are absorbed on either a pozzolan or dia. earth. (3) Total molarity of soluable salts are approx. 0.1 M. Nitrate conccentration is 0.03 M. Chromium concrentation is approx. 100 ppm which just makes material a mixed waste.

Polymer could also be used

.

Gypsum cement is aso acceptable

Major effort is t convert sludge to a solid form.

9413221.0860

SHEET3.XLS

LOT WRAP2A.3

07/27/92

CONTAINER INFORMATION:

SIZE	AMOUNT	GENERATOR:	WASTE CODE:
5 GAL	1	100N,100N AREA	D002,WT02
55 GAL	16	2ETF,200E AREA, TANK FARMS	
		163PA,100N AREA, WATER FILTER PLANT	

DOSE:	AMOUNT
0-1Mr	11
20Mr	1
25Mr	1
35Mr	2
36Mr	1
42Mr	1

PHYSICAL DESCRIPTION:

CONWED PADS: 1@ 53%, 6@ 26%, 1@ 27%, 1@ 28%, 1@ 29%, 4@ 12%, 2@ 14%
LIQUID: 1@ 12%, 6@ 7%, 1@ 6%, 1@ 4%, 1@ 3%, 3@ 20%, 1@ 19%, 1@ 17%, 1@ 14%, 1@ 40%
PLA/POLY: 1@ 35%, 9@ 1%, 6@ 3%
ABS/KITY LTR/VERM: 1@ 60%
ACID: 9@ 1%, 3@ 26%, 1@ 24%, 1@ 22%, 1@ 18%
DIRT/SOIL/DIA.EARTH: 5@ 61%, 1@ 60%, 3@ 62%, 3@ 39%, 1@ 42%, 1@ 44%, 1@ 51%
GLASS: 9@ 4%

HAZARDOUS CONSTITUENTS(Kg):

#OF	H2SO4	H2O	KOH	HNO3	H3PO4
1	0.0094	0.8904			
1			56.25		
9				0.12	
3					28.558
1					25.2015
1					21.2779
1					18.4793

RADIONUCLIDE DISTRIBUTION(curies):

# OF	TOTAL B/G	Co 60	Fe 59	Mn 54
1	0.002	0.00015	0.00002	0.00003
1	0.001			
9	0.00002	0.00002		
2	0.018	0.009		0.009
3	0.012	0.006		0.006
1	0.01	0.005		0.005

PIN #:

105N-90-220	105N-90-205	105N-90-219
105N-90-201	105N-90-206	105N-90-220
105N-90-201	105N-90-207	105N-90-221
105N-90-202	105N-90-208	105N-90-222
105N-90-203	105N-90-209	105N-90-223
105N-90-204	105N-90-218	2EFT-87-02285

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.

1.TAILORED GROUT 2.GYPSUM CEMENT
3.POLYMER

9413221.0861

LOT WRAP 2A.3

SHEET 3.XLS

RECOMMENDED TREATMENT

15 of the 17 drums are listed as containing significant amounts of H3PO4. It is best to neutralize this acid with lime prior to solidification.

1. TAILORED GROUT

2. GYPSUM CEMENT

3. POLYMER

RATIONALE FOR TREATMENT RECOMMENDATION:

When the H3PO4 is neutralized with lime it is no longer hazardous and can be solidified with either grout gypsum cement or polymer.

There should be no difficulty in passing TCLP.

9413221.0862

LOT WRAP2A.4

07/27/92

CONTAINER INFORMATION:

SIZE:	AMOUNT:
8 GAL	2
85 GAL	17
55 GAL	31

WASTE CODE:WT02

GENERATORS:

329,300 AREA CHEMICAL SCIENCE LAB
325,300 AREA APPLIED CHEMISTY LAB
1234,300 AREA PNL
202A,200E AREA PUREX
271B,200E AREA BPLANT
2345Z,200W AREA ZPLANT
163PA,100N AREA
NALAB, FERMI NATIONAL ACCELERATOR LABS

DOSE RATE:

1@ 12 Mr
BALANCE @ 0-1 Mr

PHYSICAL DESCRIPTION:

GLASS: 1@ 10%
CONWED: 1@ 22 %
DIRT/SOIL/DIA.EARTH: 1@ 48%, 1@ 57%, 1@33%, 1@ 16%, 1@ 24%, 15@ 100%
LIQUID: 1@ 26%,1@ 61%
PLA/POLY:25@ 1%, 1@ 8%, 1@ 47%, 2@ 12%, 1@ 20%, 1@ 5%
CLOTH/RAGS/NYLON: 1@ 34%, 1@ 61%
RUBBER: 1@ 3%, 1@ 4%
METAL/IRON/GALV./SHEET: 1@ 2%, 3@ 9%
CONCRETE: 3@ 60%
STAINLESS STEEL:3@ 10%
PAPER/CARDBOARD: 1@ 12%, 1@ 48%
CLAY:22@ 1%
RESINS: 24@ 2%
ASHES: 1@ 12%

RADIONUCLIDE:

	TOTALS
URANIUM/DEPLETED: 1@ .00012 grams	.00012 G
URANIUM/ENRICHED: 1@ 10530 grams	10530 G
Pu: 1@ .00004 grams	.00004 G
Co137/Ba137: 1@/00003 Ci	.00003 Ci
Se90/Y90: 1@ .00002 Ci	.00002 Ci
Co60: 20@ .0001Ci, 3@ .0002Ci, 1@ .00002Ci, 2@ .00015Ci	.00382 Ci
TOTAL B/G: 4@ .001 Ci, 1@ .00002 Ci, 1@ .00009 Ci, 20@ .0001 Ci, 2@ .00015 Ci, 16@ .005 Ci, 1@ .0005 Ci	.08351 Ci

HAZARDOUS CONSTITUENTS

NaNO3: 1@ .7498 Kg, 1@ 48.26 Kg
Oxalic Acid Crystals: 1@ .1 Kg, 1@ .3 Kg
NH4Fluozirco: 1@ 18.6 Kg, 1@ 7.48 Kg, 1@ 19.73 Kg,
KOH: 1@ 44.63 Kg, 1@ 17.96 Kg, 1@ 47.35 Kg
NaCO3: 1@ 1.7 Kg

NaOH: 1@ .7498 Kg
NH4F: 1@ 7.44 Kg, 1@ 2.99 Kg, 1@ 7.89 Kg
NH4NO3: 1@ 7.44 Kg, 1@ 2.99 Kg, 1@ 7.89 Kg
Sodium Silicate: 1@1.7 Kg
NaPO4: 1@ 1.7 Kg

LOT WRAP2A.4

HAZARDOUS CONSTITUENTS

NaCl2: 3@ 173.9971Kg, 3@ 172.0013 Kg, 1@ 155.9896 Kg, 2@ 187.0152 Kg, 1@186.0173 Kg, 1@ 199.9878 Kg, 1@ 179.9845 Kg, 1@ 175.9929 Kg, 1@ 172.9992 Kg, 2@ 182.9782 Kg, 1@ 190.0089 Kg, 1@ 178.9986 Kg, 1@ 170.0055 Kg, 1@ 180.9824 Kg, 2@ 184.0215 Kg, 1@ 193.0025 Kg, 1@ .92 Kg

NOTE: FOR HAZ. TOTALS SEE ATTACHED

Ferric Oxide: 15@ 5.62 Kg
Sodium Oxide: 15@48.26 Kg
HCl: 1@.1 Kg
HNO3: 1@ .9 Kg
SODA ASH: 1@3 Kg
NH4SO4: 1@1.18 Kg
FeOH: 1@ .2 Kg

PIN#

105N-90-155	9103-01-0014	9103-01-0024	9103-01-0034	PNL88013
211-089038	9103-01-0015	9103-01-0025	9103-01-0035	PNL88014
213-089002	9103-01-0016	9103-01-0026	PNL88005	PNL88015
271B-91-0135	9103-01-0017	9103-01-0027	PNL88006	PNL88016
325-88-03	9103-01-0018	9103-01-0028	PNL88007	PNL88017
325W88001	9103-01-0019	9103-01-0029	PNL88008	PNL88018
325W88002	9103-01-0020	9103-01-0030	PNL88009	PNL88019
329-90-022(12Mr)	9103-01-0021	9103-01-0031	PNL88010	RHZ-219-92--28
9103-01-0012	9103-01-0022	9103-01-0032	PNL88011	WHC-A-91-822
9103-01-0013	9103-01-0023	9103-01-0033	PNL88012	WHCA-91-000825

RECOMMENDED TREATMENT:
1.POLYMER
2.GYPSUM CEMENT

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

LOT WRAP 2A.4
SHEET 7.XLS

RECOMMENDED TREATMENT

1. POLYMER

2. GYPSUM CEMENT

RATIONALE FOR TREATMENT CHOICE:

Polymer is treatment of choice because: (1) 24 containers contain resins, resins are best stabilized by polymer in that resigns tend to swell in a cement-based matrix. (2) Oxalic acid crystals exist in at least one container, oxalate would cause a delay in set time of a cement matrix which could be excessive. (3) A number of containers contain ammonium salts. The high Ph of cement could liberate ammonia gas. (4) NaCl in a system such as cement containing pore fluids would react with encapsulated metals possibly causing expansion and cracking.

Gypsum cement could well serve as an alternate treatment for many of the above reasons. Also each represents a single component system which facilitates ease of handling.

9413221.0865

SHEET8.XLS

LOT WRAP2A.5

07/27/92

CONTAINER INFORMATION:

55 GAL 53

WASTE CODE:
F003,F005
<300 PPM

DOSE:	AMOUNT
0-10 Mr	43
13 Mr	2
60 Mr	1
70 Mr	1
80 Mr	1
95 Mr	1

GENERATOR:
241BY, 200E AREA, 241BY TANK FARM
222S, 200W AREA, 222S LABORATORY

PHYSICAL DESCRIPTION:	(4 CONTAINERS BLANK)	
CLOTH/RAGS/NYLON:	10@ 1-62 % AVG.:	7.34
METAL/IRON/GALV./SHEET:	42@ 1-88 % AVG.:	11.46
PAPER/CARDBOARD:	48@ 2-47 % AVG.:	20.06
PLAS./POLY:	47@ 6-92 % AVG.:	39.06
DIRT/SOIL/DIA.EARTH:	46@ 3-47 % AVG.:	17.41
GLASS:	32@ 1-11 % AVG.:	3.72
RUBBER:	45@ 2-23 % AVG.:	7.15
ASBESTOS:	3@ 1-19 % AVG.:	11
WOOD:	6@ 1-10 % AVG.	2.66
LEATHER:	3@ 1 %	
ALUMINUM:	1@ 15 %	
ABSORBENT:	1@ 19 %	
FLOOR TILE:	1@ 13 %	
CORK:	1@ 1 %	
RESIN:	1@ 11 %	

HAZARDOUS CONSTITUENTS:

ACETONE: 18@ .0001 Kg
METHYL ETHYL KETONE: 18@ .0001 Kg
METH.ISOBUTYLKETONE: 18@ .0001 Kg
HEXONE: 35@ 0 Kg
ISOBUTANOL: 35@ 0 Kg
PYRIDINE: 35@ 0 Kg
TOLUENE: 35@ 0 Kg
XYLENE: 35@ 0 Kg

PIN#

222S-92-000038	222S-92-000159	222S2W-91-0306	222S2W-91-0465	222S2W-91-0491
222S-92-000044	222S-92-000160	222S2W-91-0395	222S2W-91-0466	222S2W-91-0492
222S-92-000047	222S-92-000161	222S2W-91-0406	222S2W-91-0467	222S2W-91-0493
222S-92-000063	222S-92-000277	222S2W-91-0418	222S2W-91-0470	222S2W-91-0495
222S-92-000065	222S-92-000278	222S2W-91-0439	222S2W-91-0472	222S2W-91-0496
222S-92-000069	222S2W-90-1525	222S2W-91-0459	222S2W-91-0474	222S2W-91-0500
222S-92-000072	222S2W-90-1582	222S2W-91-0460	222S2W-91-0479	222S2W-91-0502
222S-92-000074	222S2W-91-0113	222S2W-91-0462	222S2W-91-0487	222S2W-91-0503
222S-92-000140	222S2W-91-0206	222S2W-91-0463	222S2W-91-0488	222S2W-91-0506
222S-92-000144	222S2W-91-0215	222S2W-91-0464	222S2W-91-0489	222S2W-91-0549
222S-92-000145				EFT-91-085-03
222S-92-000154				

RECOMMENDED TREATMENT:

1.POLYMER
2.TAILORED GROUT

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

9413271.0866

LOT WRAP 2A.5

SHEET 8.XLS

RECOMMENDED TREATMENT

1. POLYMER 2. TAILORED GROUT

RATIONALE FOR TREATMENT RECOMMENDATION:

A tailored grout could be used if the aluminum were removed from one drum. The high caustic content of cement would react with aluminum metal to produce hydrogen gas. One drum contains 11 % resin which is incompatible with cement. Waste form would likely swell.

9413221.0867

SHEET9.XLS

LOT WRAP2A.6

07/27/92

CONTAINER INFORMATION:

55 GAL 22
DOSE: 1 Mr

GENERATORS:
202A,200W AREA
PUREX

WASTE CODES:
D001,D002,WT02

PHYSICAL DESCRIPTION:

CLOTH/RAGS/NYLON:	1@ 40 %,1@ 25 %,1@ 5%
DIRT/SOIL/DIA.EARTH:	2@ 1%,6@ 3%,5@ 5%,5@ 8%,1@ 28%,1@ 33%,1@ 88%,1@ 93%
HAZARDOUS CONSTITUENT:	15@ 2%
PAPER/CARDBOARD:	1@ 15%,1@ 10%,1@ 30%
PLAS./POLY:	16@ 10%,3@ 35%,1@ 80%,1@ 90%
WOOD:	1@ 10%
ASBESTOS:	2@ 80%,5@ 83%,6@ 85%,2@ 87%

HAZARDOUS CONSTITUENTS:

NITRIC ACID: 6@ .05Kg,3@ .04Kg,3@ .06Kg,2@ .01Kg,2@ .02Kg,2@ .07Kg,1@ .08Kg,3@ .09Kg
URANYL NITRATE HEXAHYD.: 1@ 1.3898Kg
ASBESTOS: 15@ 11-23Kg AVG: 15.93

PIN #:

WHC-A-89-820
WHC-A-89-821
WHC-A-89-822
WHC-A-89-823
WHC-A-89-824
WHC-A-89-825
WHC-A-89-826
WHC-A-89-828
WHC-A-89-829
WHC-A-89-830
WHC-A-89-831
WHC-A-89-832
WHC-A-89-833
WHC-A-89-834
WHC-A-89-835
WHC-A-89-837
WHC-A-89-838
WHC-A-89-839
WHC-A-89-840
WHC-A-89-841
WHC-A-89-842
WHC-A-89-843

RECOMMENDED TREATMENT:
1.TAILORED GROUT
2.POLYMER
3.GYPSUM CEMENT

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

9413221.0868

LOT WRAP 2A.6

SHEET 9.XLS

RECOMMENDED TREATMENT

Code required that acid be deactivated prior to solidification/stabilization.

1. TAILORED GROUT
2. POLYMER
3. GYPSUM CEMENT

RATIONALE FOR TREATMENT RECOMMENDATIONS

Nitric acid which is most probably absorbed in the soil and/or dia. earth can be treated with either lime or caustic soda solution. the deactivated material then can be solidified in a cement-based matrix. Also Polymer or gypsum cement is suitable.

9413221.0869

SHEET10.XLS

LOT WRAP2A.7

07/27/92

CONTAINER INFORMATION:

55 GAL	15
20 GAL.	1
8 GAL	1

DOSE: 0-1 Mr

WASTE CODES:D009,WT01

GENERATORS:
225B,200E AREA BPLANT ENCASULATION
2345Z,200W AREA ZPLANT
202A,200E AREA PUREX
222S,200W AREA LABORATORY
340,300 AREA RETENTION & NUETRALIZATION
325,300 AREA APPLIED CHEMISTRY LABS

PHYSICAL DESCRIPTION:

ABSORBENT:	1@ 25%,1@ 60%,1@ 85%,1@ 30%
CLOTH/RAGS/NYLON:	1@ 5%,1@ 10%,1@ 60%
GLASS:	1@ 1%,4@ 7%,3@ 10%,3@ 90%
MET./IR./GALV/STEEL:	2@ 1%,1@ 3%,3@ 5%,1@ 10%,1@ 20%,1@ 28%,4@ 84%,1@ 90%
PLAS../POLY:	9@ 3%,2@ 10%,1@ 12%,1@ 21%,1@ 40%
RUBBER:	6@ 6%,1@ 4%
DIRT/SOIL/DIA.EARTH:	1@10 %,1@ 55%,1@ 80%,1@ 93%
MERCURY:	1@ 1%,2@ 2%,1@ 3%,1@ 5%,1@ 25%
FLOOR TILE:	1@ 26%
PAPER/CARDBOARD:	1@ 4%,1@ 5%,1@ 49%
CHARCOAL:	1@ 17%
MISC./UNKNOWN:	1@ 55%

HAZARDOUS CONSTITUENTS:

MERCURY: 1@ .01Kg,6@ .15Kg,1@ 20.41Kg,1@ .012Kg,2@ .4999Kg,1@ .4050Kg,1@ .45Kg,1@ .0007Kg,1@ 14.2019Kg,1@ 21.9991Kg,1@ .3Kg AVG.: 3.5 Kg

ZINC: 1@ 25%

PIN #:

211-089008
221U-90-0650
222S-89-006
222S2W-90-199
231-090048
271B-201R
325-91-006
A17328
A17330
A17331
A177715
A18325
A18449
WHA-88-304
WHC-00190-1
WHC-A-90-801
WHC-A89-801

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.
1.AMALGAMATION WITH SULFUR, ZINC, OR NICKEL

9413221.0870

LOT WRAP 2A.7

SHEET 10.XLS

RECOMMENDED TREATMENT

AMALGAMATION WITH SULFUR, ZINC OR NICKEL

RATIONALE FOR TREATMENT RECOMMENDATIONS

Waste code D009 requires that contained amount of mercury be amalgamated. It may be necessary to evaporate mercury from solid waste prior to amalgamation. Remainder of solid waste could be treated with a tailored grout.

9413221.0871

SHEET12.XLS

LOT WRAP2A.8

07/29/92

CONTAINER INFORMATION:

DOSE:	0-1 Mr
8 GAL.	3
30 GAL.	2
5 GAL.	3
55 GAL.	48

PIN#:

100K-92-003900
105N-89-1064
105N-89-1075
105N-89-741
105N-89-742
105N-89-743
105N-89-950
105N-90-12
211-089008
211-A18584
211-A18888
211-A19623
211-A19624
211-A19726
212-089006
221T-91-00065
222S-89-567
222S-89-1119
222S2W-90-661
222S2W-90-662
222S2W-90-685
222S2W-90-687
222S2W-90-689
222S2W-90-690
222S2W-90-692
222S2W-90-695
222S2W-90-969
222S2W-90-697
222S2W-90-713
222S2W-90-714
222S2W-90-715
222S2W-90-718
222S2W-90-719
224U-91-011
225B-90-20
271B-89-672
271U-91-90601
271U-91-90602
325-91-007
340-91-00031
ETF-241-901020
ETF-91-066-02
ETF-91-123-03
KEHN-91-52-001
KEHN-91-52-002
KEHN-91-52-003
KEHN-91-52-004
WHC-A-90-800
WHC-A-90-804
WHC-A-91-801
WHC-A-91-809
WHC-A-91-821
WHC-A89-805
WHC-A89-807
WHCA-91-000826
WHCA-91-000827

GENERATORS:	WASTE CODES:
340,300 AREA,RET.&NEUTRL.	U151,D009
100KE,100K AREA	D008,D009
221T,200W AREA,EQUIP.DECON	D005,D009,U151
202A,200E AREA, PUREX	D009,D005,D006
232Z,200W AREA,WST.INCINERAT.	D009
271U,200W AREA,U PLANT	D006,D009,WC02
241AW,200E AREA, TANK FARM	D005,D007,D008,D009, D010,D011,WT02
224U,200E,U PLANT	D002,D006,D009,WC01, WT01
241C,200E AREA,TANK FARM	D001,D006,D009,WT01
241BX,200E AREA,TANK FARM	D009,D002,WC01,WT01
222S,200W AREA,LABS	D005,D006,D009,WC02 WT01
221B,200E AREA, B PLANT	D006,D008,D009,WT02
163PA,100N AREA	D002,D009,WT02
225B,200E AREA, ENCAPSULATION	D002,D009
100N,100N AREA	D006,D009,WC02,WT01
2345Z,200W AREA, Z PLANT	D009,WT01
325,300 AREA, APP.CHEM.	D002,D003,D009,WT01
	D004,D005,D006,D007 D009,D010,D011

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.

1.MERCURY TO BE AMALGAMATED AND ENCAPSULATED
2.LEAD TO BE ENCAPSULATED
3.TAILORED GROUT FOR REMAINDER OF SOLIDS
4.POLYMER IS ALSO ACCEPTABLE

9413221.0872

SHEET12.XLS

LOT WRAP2A.8

PHYSICAL DESCRIPTION:

	RNG.	AVG.	# OF		RANGE	AVG.	# OF
CONWED	5-97%	AVG:14.7%	9	PAINTS	NA	@95%	1
DIRT,ETC.	2-97%	AVG:56.1%	10	ROCK	NA	@40%	1
HAZ.CONSTIT.	1-54%	AVG:7.6%	19	SILICA GEL	NA	@20%	1
METAL,ETC.	1-70%	AVG:12.8%	19	SLUDGE	NA	@30%	15
PLASTIC,ETC.	1-60%	AVG:10.9%	42	BATTERIE	NA	@24%	1
GLASS	1-97%	AVG:56.6%	24	LIQUID	4-25%	AVG:13.6%	3
Hg	1-70%	AVG:12.5%	6	CEMENT	NA	@10%	1
H20	NA	@15 %	1	CLOTH	1-15%	AVG:7%	4
RUBBER	2-76%	AVG:32.6%	3	MISC.,ETC.	2-58%	AVG.23%	12
OXIDES	1-3%	AVG:2.0%	2	ABSORB,ETC.	10-76%	AVG.30.6%	12
PAPER,ETC.	1-40%	AVG:17%	3	Al	NA	@1%	1

HAZARDOUS CONSTITUENTS:

	# OF	RANGE	AVG.		# OF	RANGE	AVG.
AMMAL. Hg	1	NA	@.028Kg	NaOH	1	NA	@.085Kg
Hg	55	0-24.1Kg	AVG:1.46Kg	ZnCl2	4	0-.22Kg	AVG:.16Kg
Pb	17	0-.113Kg	AVG:025Kg	Zn	2	NA	@.26Kg
Be OXIDE	1	NA	@2Kg	ANTIMONY	2	NA	@.02Kg
Be	30	0-38Kg	AVG:2.4Kg	Mg	1	NA	@.02Kg
Cd	19	0-13.2Kg	AVG:1.7Kg	CaCHL.FLU.	10	0-5.1Kg	AVG:2.7Kg
Cr	16	0-.014Kg	AVG:.0115Kg	MgO2	1	NA	@.95Kg
Se	16	0-.0003Kg	AVG:.00022Kg	HgTHIO.CYA.	1	NA	@.0004Kg
Ag	16	0-.003Kg	AVG:.002Kg	FeNO3	1	NA	@.0105Kg
NH4Cl2	4	0-.35Kg	AVG..21Kg	NO3	1	NA	@.1974Kg
CdOH	1	NA	@.205Kg	HNO3	1	NA	@.0315Kg
CoOH	1	NA	@.02Kg	BoTRIFLUO.	1	NA	@.0045Kg
HgOH	1	NA	@.2Kg	Mn	1	NA	@.06Kg
NiOH	3	0-.38Kg	AVG:.184Kg	ARSENIC	1	NA	@.0002Kg
KOH	3	0-.37Kg	AVG:.23Kg				

RADIONUCLIDE DISTRIBUTION:

	# OF	RANGE	AVG.		# OF	RANGE	AVG.
Cs137/Ba137	34	0-.0085Ci	5.7E-03	C-14	7	NA	@0.0Ci
TOTAL B/G	49	0-.1614Ci	5.5E-03	Sm-151	7	0-.0048Ci	1.14E-03
Sr90/Y90	14	0-.0073Ci	8.1E-04	U ENRICHED	2	0-12.42 Gr	6.235Gr
Co-60	26	0-.0002Ci	2.57E-05	Eu-155	1	NA	@0.0Ci
Ni-60	1	NA	0	Eu-154	1	NA	@1E-05
Ru106/Rh106	9	0-.0102Ci	1.77E-03	Am-241	15	0-.00002Ci	1.6E-05
Cs-134	1	NA	3E-05	Fe-59	2	NA	@2E-05
Ce144/Pr144	8	0-.0423Ci	8.25E-03	Mn-54	2	NA	@3E-05
PM-147	7	0-.0199Ci	4.44E-03	PU	3	0-.00132Gr	1.14E-03
H-3	7	0-.00004Ci	5.71E-06				

9413221.0873

LOT WRAP ~~2A.5~~ => Lot WRAP 2A.8

SHEET 12.XLS

RECOMMENDED TREATMENT

1. MERCURY TO BE AMALGAMATED AND ENCAPSULATED.

2. LEAD TO BE ENCAPSULATED

3. TAILORED GROUT FOR REMAINDER OF SOLIDS

4. POLYMER IS ALSO ACCEPTABLE

RATIONALE FOR TREATMENT RECOMMENDATIONS

Regulations require that mercury and lead be encapsulated. The drums containing these materials should be isolated and sorted to segregate as much of the mercury and lead bearing waste as possible. The mercury is then vacuum/thermally distilled and amalgamated prior to encapsulation. Assumption is that batteries in waste are lead storage batteries. These must also be sorted for encapsulation. After sorting and pretreatment to remove mercury, the residue can be stabilized in a tailored grout. Polymer encapsulation is also acceptable.

AN AREA OF CONCERN IS DRUM CONTAINING MERCURY THIO CYANIDE.

9413221.0874

Westinghouse Hanford Company

Internal Memo

From: Restoration Projects 87330-92-MLS-026
Phone: 372-1362, H2-58
Date: August 17, 1992
Subject: SOLID WASTE INFORMATION AND TRACKING SYSTEM LOW-LEVEL MIXED WASTE CHARACTERIZATION TO SUPPORT WASTE RECEIVING AND PROCESSING 2A

To: J. L. Westcott H2-58

cc:

S. R. Briggs	G6-47*
D. A. Burbank, Jr.	H1-60
W. O. Greenhulgh	L5-31
R. S. Kelley	H2-58*
D. R. Lucas	G6-46*
J. G. Riddelle	H2-58
K. M. Weingardt	H1-60
RP Characterization File	H2-58
MLS File/LB	

*w/o attachment

Per your on June 9, 1992 a Solid Waste Information and Tracking System data run was pulled on all low-level mixed waste in storage except the 183H basin. Five of the last seven lots have been reviewed by Earl McDaniel and are attached. Once again a summary sheet along with rationale for treatment recommendations have been assembled. The lots are WRAP2A.9 through WRAP2A.12. The last two lots will be evaluation and summarized in the coming week.

If you have any questions or require additional information, please feel free to contact me on 372-1362.

M. L. Sheriff
Engineering Technician

pss

Attachment

9413221.0875

LOT WRAP2A.2

07/23/92

CODES: WT01,D008

CONTAINER INFORMATION:

SIZE:	AMOUNT:
55 GAL	260
2 GAL	1
85 GAL	28
10 GAL	1
8 GAL	1
4*4*8	1
4*4*7	18
UNKNOWN	1 (VOL.3.21 M3)

DOSE:Mr	AMOUNT:
0-10	301
11-20	1
21-30	3
31-40	1
41-50	0
51-100	5

GENERATORS:

202A,200E AREA,PUREX
SPAP,OFFSITE,SHIPPINGPORT
221B,200E AREA,PROCESS TREATMENT
AMES,OFFSITE,IOWA ST.UNIV.LAB
2345Z,200W AREA,ZPLANT
222S, 200W AREA, ANAL.LAB
324,300 AREA,WASTE TECH.ENG.LAB
2ETF,200W AREA, TANK FARMS
313,300 AREA,FUELS MANUF.
225B,200E AREA,ENCAPSULATION
209E,200E AREA,CRIT.MASS LAB
325,300 AREA,APPLIED CHEM. LAB
242B,200E AREA,CASK BLDG.BPLANT
2WB,200W AREA, BURIAL GROUNDS
221TS,200 W AREA,EQUIP.DECON
3720,300 AREA, CHEM. METALS LAB
305,300 AREA,HOT CELL VERIF.FAC.
NALAB,OFFSITE,FERMI NAT.ACCEL.LAB
100N,100NAREA
333,300 AREA,N FUELS MAN.
271B,200E AREA,ELEC.MAINTENANCE
224U,200W AREA,UO3

SEE ATTACHED FOR PIN #

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.

1. ENCAPSULATION FOR LEAD.
2. INCENERATION FOR SOLVENTS AND GREASE
3.TAILORED GROUT OR POLYMER FOR SHREDDED SOLIDS

LOT WRAP2A.2

PHYSICAL DESCRIPTION:

LEAD	275 CONT.	1-100%	AVG.84%
PAPER/ETC.	28 CONT.	1-30%	AVG.9%
PLASTIC/ETC.	143 CONT.	1-83%	AVG.7%
RUBBER	16 CONT.	1-17%	AVG.4%
METAL/ETC.	64 CONT.	1-100%	AVG.39.5%
STAINLESS/ETC.	13 CONT.	2-15%	AVG.6%
ABSORBENT/ETC.	39 CONT.	1-63%	AVG.16%
DIRT/ETC.	17 CONT.	6-90%	AVG.30%
CLOTH/ETC.	42 CONT.	1-90%	AVG.7%
ASBESTOS	1 CONT.	NA	AVG.1%
WOOD	27 CONT.	1-70%	AVG.36%
GLASS	16 CONT.	1-98%	AVG.22%
CONWED PADS	34 CONT.	1-72%	AVG.11%
FILTERS	1 CONT.	67%	NA
SAND/ETC.	2 CONT.	18+35%	NA
CU METAL	5 CONT.	1-20 %	7%
GREASE	1 CONT.	5%	NA
SOLV/THIN	1 CONT.	5%	NA
LIQUID	5 CONT.	ALL 1%	NA
OILS	8 CONT.	48-60%	AVG.55%
BATTERIES	3 CONT.	40-66%	AVG.52%
AIR	2 CONT.	40+49%	NA

HAZARDOUS CONSTITUENTS:

LEAD	274 CONT.	.0003-17640.12Kg	AVG.456Kg
LEAD SHEILDING	6 CONT	29.0978-91000Kg	AVG.47158.8169Kg
LEAD BRICK	32 CONT.	33.86-394.98Kg	AVG.248.969Kg
LEAD GLASS	3 CONT.	9.32-219.719Kg	AVG.112.71Kg
ASBESTOS	2 CONT.	4.08-122.47Kg	AVG.63.27Kg
LEAD PIG	1 CONT.	59.11Kg	NA
LEAD SALTS	1 CONT.	.04 Kg	NA
BUTOXYETHANOL	1 CONT.	.15Kg	NA
LEAD GLOVES	1 CONT.	4.45Kg	NA

RADIONUCLIDES:

Am-241	1 CONT.	.19Gr	NA
C-14	1 CONT.	NA	AVG.1.71Ci
Ce144/Pr14	35 CONT.	0-.148Ci	AVG..027Ci
Co-58	1 CONT.	NA	AVG.148Ci
Co-60	17 CONT.	.01-25000Ci	AVG1470Ci
Cr-51	1 CONT.	NA	AVG. .34Ci
Cs137/Ba13	72 CONT.	0-.51Ci	AVG..017Ci
Fe-55	1 CONT.	NA	AVG.18400Ci
Fe-59	1 CONT.	NA	AVG..39Ci
H-3	6 CONT.	0-72.4 Ci	AVG.12.06Ci
Mn-54	3 CONT.	.7-339Ci	AVG.113Ci
Mo-93	1 CONT.	NA	.02Ci
Nb-94	1 CONT.	NA	AVG..01Ci
Ni-59	1 CONT.	NA	AVG.127 Ci
Ni-63	1 CONT.	NA	AVG.18800Ci
Pm-147	35 CONT.	0-.069Ci	AVG..014Ci
Pu-239	1 CONT.	.0002Gr	NA
Ru106/Rh10	26 CONT.	0-.035Ci	AVG..008Ci
Sm-151	13 CONT.	0-.016Ci	AVG...005Ci
Sr90/Y90	23 CONT.	0-.03Ci	AVG..007Ci
Th-232	2 CONT.	ALL 5Gr	NA
TOTAL B/G	309 CONT.	0-62900Ci	AVG.203Ci
U DEPLETED	8 CONT.	0-.255 Gr	AVG...036Gr
U ENRICHED	11 CONT.	0-1.23Gr	AVG.231Gr
U NATURAL	2 CONT.	ALL 10Gr	NA
Zr95/Nb95	1 CONT.	NA	AVG..01Ci

LOT WRAP 2A,~~B~~2

SHEET 11.XLS

RECOMMENDED TREATMENT

1. ENCAPSULATION FOR LEAD.

2. INCINERATION FOR SOLVENTS AND GREASE

3. TAILORED GROUT OR POLYMER FOR SHREDDED SOLIDS

RATIONALE FOR TREATMENT RECOMMENDATION

Drums containing lead must be separated. After separation lead must be encapsulated per regulations. It is assumed that batteries are lead storage batteries also. They must be separated and encapsulated. containers with solvents and grease are best incinerated. However if this material proves to be absorbed on an inorganic sorbet it is acceptable to solidify/stabilize with either a tailored grout or polymer. Gypsum cement would be acceptable.

9413221.0878

LOT WRAP2A.9

07/31/92

CONTAINER INFORMATION:

DOSE:	SIZE:		GENERATORS:	CODES:
1@ 20 Mr	8 GAL	3	NALAB,FERMI NATIONAL ECC. LAB	D002
BAL.@ 1-6 Mr	30 GAL	5	271B,200E AREA,B PLANT	D002,WT01
	55 GAL	30	202A,200E AREA, PUREX	D001,WT02
			2345Z,200W AREA, Z PLANT	D001,WT01
			RTL,3000 AREA,PNL FACILITY	D002,WC02
			333,300 AREA,N FUELS MAN.	D001
			100N,100N AREA	
			202AL,200E AREA,PUREX ANAL.LAB	
			1706K,100K AREA	

PIN#:

100K-91-0092
105N-89-1117
105N-89-441
105N-89-442
105N-89-873
202L-92-000703
211-089005
211-090026.B
211-A21187
212-A18652
212-A19972
212-A200005
212-A21228
212-A21790
212-A21853
219-091247
220-A19943
271B-91-0026
271B-91-0156
9203-01-0001
PNL-89047
PNL-89048
RHZ-219-091321
WHC-A-89-845
WHC-A-89-846
WHC-A-89-847
WHC-A-90-805
WHC-A90-829
WHC-A90-844
WHC3-89-50
WHC3-89-51
WHC3-89-52
WHC3-89-53
WHC3-89-54
WHC3-89-55
WHC3-89-56
WHC3-89-57
WHC3-89-58

PHYSICAL DESCRIPTION:

	# OF	AVG.	RANGE
DIRT, ETC.	20	44.45%	7-95%
GLASS	5	4%	1-9%
HAZ.CONS.	23	11.78%	1-75%
ASBESTOS	11	9.818%	3-15%
CLOTH,ETC	18	20.2%	1-75%
PLAS. ETC.	22	23.63%	1-95%
KOTEX,ETC	1	@10 %	NA
RUBBER	9	'21.2%	1-60%
FILTERS	2	14.5%	5-24%
ABSORB.	5	33%	15-69%
SLUDGES	9	@90%	NA
LIQUID	4	7.25%	1-14%
ACID	2	13%	9-17%
METAL,ETC	8	36.5%	3-60%
WOOD	1	@15%	NA
H20	2	62.5%	60-65%
PAPER,ETC	2	8%	1-15%
CONWED	2	6%	5-7%

HAZARDOUS CONSTITUENTS:

URANYL NITRATE	4	.244Kg	.05-.69Kg
ASBESTOS	1	@.25Kg	NA
NaOH	7	3.83Kg	.1-11Kg
HNO3	5	1.54Kg	.46-4Kg
KNO3	1	@.47Kg	NA
AlNO3	1	@.4999	NA
NaCl2	2	@10.99Kg	NA
NaNO3	11	11.845Kg	.67-25.6Kg
NaF	9	3.306Kg	1.09-7.26Kg
HCl	2	.819Kg	.499-1.13Kg
ACID	1	@1.0002Kg	NA
H3PO4	3	.713Kg	.47-1Kg
KOH	4	3.6Kg	1-10Kg
H3PO4HCl	1	@19Kg	NA
K2S2O7	1	@.45Kg	NA
H2SO4	1	@.2Kg	NA
Na3PO4	1	@34.1Kg	NA
FeNO3	1	@.1Kg	NA

RECOMMENDED TREATMENT:
COMPLETE RATIONALE FOR
TREATMENT ATTACHED.
1. POLYMER

9413221.0879

LOT WRAP2A.9

RADIONUCLIDE DISTRIBUTIO	# OF	AVG.	RANGE
			0-.1504Ci
			0-10200Gr
		6.47E-03	0-6.8E-03Ci
TOTAL B/G	37	1905.6Gr	0-7.9E-03Ci
U DEPL.	14	1.35E-03Ci	0-9.5E-03Ci
Sr/Y 90	8	1.55E-03Ci	0-3.9E-02Ci
Cs/Ba 137	8	2.48E-03	0-1.9E-02Ci
Ru/Rh 106	6	1.03E-02Ci	0-4E-05Ci
Ce/Pr 144	6	4.86E-03Ci	0-4.5E-03Ci
Pm 147	6	2.5E-05Ci	0-5.1E-02Gr
H 3	2	1.23E-03Ci	0-3.3E-03Ci
Sm 151	6	2.27E-02Gr	0-4.5E-04Ci
Pu	4	1.11E-03Ci	0-6.7E-04Ci
Co 60	4	2.25E-04Ci	0-.9 Gr
Fe 59	2	3.65E-04Ci	
Mn 54	2	.7 Gr	
U ENRICH.	3		

9413221.0880

LOT WRAP 2A.9

SHEET 13.XLS

RECOMMENDED TREATMENT

1. POLYMER

RATIONALE FOR TREATMENT RECOMMENDATION

The drum containing acid must first be isolated and acid neutralized. The salts and shredded solids are then encapsulated in polymer. This solidification recommendation is consistent with plant design.

9413221.0881

LOT WRAP2A.10

08/03/92

CONTAINER INFORMATION

SIZE:		DOSE:		GENERATORS:
30 GAL.	1	0-10 Mr	17	221TS,200E AREA, EQUIP.DECON
55 GAL	22	11-50 Mr	6	244AR,200E AREA,VAULT
				222S,200W AREA,ANALYTICAL LAB

CODES: WT02,WC02,WP02,F001,F002
WC02,D018
F001,F002,F003,F005
D001,F005,WT02

ORGANICS <300PPM

PHYSICAL DESCRIPTION:

	# OF	AVG.	RANGE
HAZ.CON.	6	9.16 %	5-10%
DIRT,ETC.	22	28 %	4-46%
MISC.,ETC.	5	15%	@15%
SAND	5	30 %	@30 %
ABSORB.	1	40%	@40 %
CLOTH,ETC	11	11.2%	1-57%
METAL,ETC	15	5.7%	1-43%
PAPER,ETC	17	10.8%	3-31%
PLAST.,ETC	18	39.7%	10-60%
RUBBER	16	3.9%	1-10%
TAR	1	1 %	@1 %
GLASS	13	8.3%	2-25%
CONWED	1	56%	@56 %
LEAD	1	22%	@22 %
CORK	1	1%	@1 %

HAZARDOUS CONSTITUENTS:

	# OF	AVG.	RANGE
D-TAR	5	5.29 Kg	@5.29 Kg
KLEEN-O-BOWL	5	1.93Kg	@1.93 Kg
TURCO	5	5.29 Kg	@5.29 Kg
BENZENE	1	0 Kg	NA
CREOSOTE	1	.0013 Kg	@.0013 Kg
TAR	1	.0001Kg	@.0001Kg
1,1,1 TRICHLOROETHYL	16	.0001	@.0001Kg
ACETONE	16	.0001 Kg	@.0001 Kg
METH.ETH.KETONE	16	.0001 Kg	@.0001 Kg
METH.ISO.BUT. KETONE	16	.0001 Kg	@.0001 Kg
METHYLENE CHLORIDE	16	.0001 Kg	@.0001Kg
CARBON DISULFIDE	1	3.4Kg	@3.4Kg

RADIONUCLIDE DISTRIBUTION:

	# OF	AVG.	RANGE
TOTAL B/G	23	2.18E-01Ci	0-1.0Ci
Cs/Ba 137	17	4.62E-04Ci	0-3.6E-03Ci
Sr/Y 90	13	3.06E-04Ci	0-1.7E-03Ci
PM 147	11	7.8E-05Ci	0-3.8E-04Ci
H 3	9	4.8E-05Ci	0-2.0E-04Ci
U DEPL	15	6.8E-03Ci	0-4.6E-02Ci
Am 241	1	1.0E-05Ci	NA
Pu 239	4	2.0E-05Ci	0-4.0E-05Ci

PIN #:

221T-88-02-1
221T-88-02-2
221T-88-02-3
221T-88-02-4
221T-88-02-5
222S-91-0497
222S-92-000039
222S-92-000053
222S-92-000054
222S-92-000055
222S-92-000059
222S-92-000060
222S-92-000070
222S-92-000071
222S-92-000139
222S-92-000146
222S-92-000147
222S-92-000148
222S-92-000149
222S-92-000150
222S-92-000153
222S-92-000158
ETF-91-127-01

RECOMMENDED TREATMENT:
COMPLETE RATIONALE FOR TREATMENT ATTACHED.
1. ENCAPSULATION FOR LEAD
2. INCENERATION

9413221.0882

LOT WRAP 2A.10

SHEET 14.XLS

RECOMMENDED TREATMENT

1. ENCAPSULATION FOR LEAD

2. INCINERATION

RATIONALE FOR TREATMENT RECOMMENDATIONS

Regulations require that lead be encapsulated. Drums must first be sorted. Solvents are suited for incineration. Any solidification technology that produces heat will tend to volitize solvents. These materials could be encapsulated in polymer or gypsum cement but would tend to volatilize

IT IS NOTED THAT LISTED CODES F-001'-005 ADDRESS SPENT SOLVENTS

9413221.0883

LOT WRAP2A.11

8/6/92

CONTAINER INFORMATION:

SIZE:	DOSE:
30 GAL.	2 1@5 Mr
8 GAL.	1 BALANCE<=1 Mr
5 GAL.	1
85 GAL.	1
55 GAL.	12

CODES:
D002,D005,WT01
D002,D006,WT02
D001,D002,D011,WC02,WT02
D002,D011
D002,D007,D010,WT01
D002,D010,WT02
D002,D007,WT01
D001,D007
D002,D007,WT02
D002,D006,WT01,WC01
D001,D007,D011,WC02,WT02

GENERATORS:
202AL, 200E AREA, ANALYTICAL LAB
202A, 200E AREA,PUREX
221T, 200W AREA,EQIP.DECON
329, 300 AREA,CHEM.SCIENCE LAB
163PA, 100N AREA
333,300 AREA, N FUELS MANUFACT
241AY, 200E AREA, TANK FARM
105KE,100K AREA
100N, 100N AREA
1234, 3000 AREA, STORAGE

PHYSICAL DESCRIPTION:

	# OF	AVERAGE	RANGE
ABSORB.	3	48%	20-74%
CONWED	3	36%	7-90%
GLASS	4	8%	1-18%
HAZ.CONS.	10	16%	1-37%
PLAST.ETC	16	15%	1-99%
BATTERIES	1	9%	NA
DIRT,ETC	12	54%	1-93%
LIQUID	3	6%	2-14%
ACID	3	41%	4-95%
CLOTH,ETC	1	10%	NA
METAL,ETC	2	11%	1-20%
WOOD,ETC	1	20%	NA
EQUIPT.	3	57%	54-59%

HAZARDOUS CONSTITUENTS:

	# OF	AVERAGE	RANGE
ASBESTOS	1	.54 Kg	NA
BaOH	1	.45 Kg	NA
KF	1	1.35 Kg	NA
KOH	1	7.41 Kg	NA
SILICA	1	.04 Kg	NA
NaOH	1	5.22 Kg	NA
Cd	2	.07 Kg	.03-.11 Kg
Co	1	.002 Kg	NA
Ni	1	.05 Kg	NA
K	1	.004 Kg	NA
AlNO3	1	.2 Kg	NA
H2O2	2	.12875Kg	.1-.157 Kg
Mg(ClO4)2	1	.1 Kg	NA
KMnO4	1	.8 Kg	NA
AgNO3	2	.056 Kg	.01-.1 Kg
HCl	2	.904 Kg	.82-.98 Kg
HF	2	12.27 Kg	0-24Kg
HNO3	2	12.43 Kg	0-24 Kg
NaCO3	1	.027 Kg	NA
Cr	9	.0068 Kg	SEE ATT
H3PO4	8	14.29 Kg	.05-50 Kg
H2SO4	2	.049 Kg	.006-.09Kg
Na	1	2.56 Kg	NA
ZnCRO4	1	1.59 Kg	NA
Ni/Cd BATT.	1	7.73 Kg	NA
Cr2(SO4)3	1	.52 Kg	NA
CuSO4	1	.1 Kg	NA

RADIONUCLIDE DISTRIBUTION:

	# OF	AVERAGE	RANGE
TOTAL B/G	17	2.83E-02Ci	0-.43 Ci
U DEP.	3	3.5E-02 Gr	.001-.1 Gr
Sr/Y 90	3	4.3-04 Ci	0-.0005Ci
Ru/Rh 106	2	1.4E-03 Ci	.0008-.002Ci
Cs/Ba 137	6	2.7E-04 Ci	0-6E-09 Ci
Ce/Pr 144	2	3.5E-03 Ci	SEE ATT
Pm 147	2	1.75E-03 Ci	SEE ATT
H 3	2	2.05E-04 Ci	0-4E-04 Ci
I 129	1	.0001 Ci	NA
Tc 99	1	.0001 Ci	NA
Pd 107	1	.0001 Ci	NA
Cs 135	1	.0001 Ci	NA
Sm 151	2	.00025 Ci	SEE ATT
Zr 90	1	.0001 Ci	NA
Co 60	9	2.0E-04 Ci	0-4.0E-04 Ci
Ni 63	1	2.3E-04 Ci	NA
Fe 55	1	.433 Ci	NA
Pu	1	.00004 Gr	NA

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.
1. POLYMER
2. ENCAPSULATION FOR LEAD

9413221.0884

PIN #:

105N-89-1097
105N-89-1098
105N-89-1099
105N-89-1100
105N-89-1101
105N-89-1102
105N-89-1108
105N-90-337
202L-92-000702
221-T-91-00066
329-90-46
329-91-010
ETF-241-900722
PNL-88031
WHC-3-89-64.B
WHC-A-91-828
WHC-A89-802

9413221.0885

LOT WRAP 2A.11

SHEET 15.XLS

RECOMMENDED TREATMENT

1. POLYMER

2. ENCAPSULATION FOR LEAD

RATIONALE FOR TREATMENT RECOMMENDATION

Drums containing acid must be sorted, acid removed and neutralized. Drum containing hydrogen peroxide must be isolated and the peroxide which is a strong oxidizer should be treated as an acid and neutralized. Batteries are assumed to be lead storage batteries(D008 code is for lead). Plant design basis requires salt rich waste be encapsulated in polymer.

9413221.0886

LOT WRAP2A.12

8/10/92

CONTAINER INFORMATION:

SIZE:		DOSE:	GENERATORS:	CODES:
5 GAL	1	1@15 Mr	202AL,200E AREA,ANALYTICAL LAB	D007,WT01
30 GAL	1	4@3 Mr	325,300 AREA,APPLIED.CHEM.LAB	D006,WT02
10 GAL	2	BAL.@1Mr	221T,200W AREA,EQUIP.DECON	D006,D007,D011,WC02
85 GAL	1		202A,200E AREA,PUREX	WT02
55 GAL	10		2EBG,200E AREA,BURIEL GROUNDS	D004,D005,D010,WC01
			2345Z,200W AREA,Z PLANT	WT01
			1234,3000 AREA,STORAGE	D007
				D018,WC02
				D006
				D011
				D007,WC01,WT02
				D005,WT02
				D005,D007,D011,WC01
				D004

PHYSICAL DESCRIPTION:

	TOTAL	AVERAGE	RANGE
ABSOR.ETC	5	29 %	5-45%
CONWED	1	30 %	NA
GLASS	3	4.3 %	2-6 %
HAZ.CONS.	7	13.8 %	1-60 %
PLAST.ETC	9	11.1 %	1-50 %
METAL,ETC	2	25 %	10-40 %
DIRT,ETC	8	84.5 %	50-100 %
PAPER,ETC	1	15 %	NA
RUBBER	3	21.6 %	10-30 %
ACID	3	75 %	@75 %
NITRATE	3	25 %	@25 %
LIQUID	1	9 %	NA

HAZARDOUS CONSTITUENTS:

	TOTAL	AVERAGE	RANGE
ARSENAZO	1	.21 Kg	NA
BARIUM	2	.34 Kg	.2-.49 Kg
CHROMIUM	5	.1348 Kg	.008-.4 Kg
SILVER	3	1.49 Kg	.1-4.1 Kg
Na2Cr2O7	1	.9 Kg	NA
BaCO3	1	.1 Kg	NA
CADMIUM	1	.0014 Kg	NA
SELENIUM	1	1.0002 Kg	NA
COPPER	1	.1 Kg	NA
NiOH	1	.3 Kg	NA
NaCL2	1	.6001 Kg	NA
ZINC	1	.25 Kg	NA
Cd OXIDE	1	.44 Kg	NA
Cr OXIDE	1	1.49 Kg	NA
Ag OXIDE	1	.39 Kg	NA
Na OXIDE	1	.51 Kg	NA
CdNO3	2	.9001 Kg	.55-1.25 Kg

RADIONUCLIDE DISTRIBUTION:

	TOTAL	AVERAGE	RANGE
TOTAL B/G	15	8.48E-03Ci	0-.03 Ci
U DEPL.	1	5.5E-04 Gr	NA
Sr/Y 90	4	2.6E-03 Ci	.0005-.008
Co 60	1	3.6E-03 Ci	NA
Ru/Rh 106	3	1.0E-03 Ci	.0008-.0015
Ce/Pr 144	3	4.2E-03 Ci	.003-.0015
Pm 147	3	.002 Ci	.0003-.0015
H 3	1	1.0E-05 Ci	NA
Sm 151	3	5.0E-04 Ci	.0004-.0007
Th 232	3	5235 Gr	@5235 Gr
U 233	3	.007 Gr	@.007 Gr
Eu 155	3	6.0E-05 Ci	@6.0E-05
Pb 212	3	3.0E-04 Ci	@3.0E-04
Ac 228	3	4.0E-04 Ci	@4.0E-04
Ra 224	3	3.0E-04 Ci	@3.0E-04
Tl 208	3	1.0E-04 Ci	@1.0E-04
Bi 212	3	5.0E-04 Ci	@5.0E-04
Se 75	1	1.41E-03 Ci	NA
Ba 133	1	3.76E-03 Ci	NA

PIN #:

202L-92-000705	WHC-A-91-802	WHC-A89-804
325-91-008	WHC-A-91-803	
221-T-91-00072	WHC-A-91-804	RECOMMENDED TREATMENT:
221-T-91-00073	211-089036	COMPLETE RATIONALE FOR TREATMENT ATT.
221-T-91-00074	211-089065.A	1. TAILORED GROUT
WHC-A91-814	PNL88003	2. POLYMER
3314-90-001	WHC-A89-800	3. GYPSUM CEMENT

9413221.0887

LOT 2A.12

SHEET 16.XLS

RECOMMENDED TREATMENT

1. TAILORED GROUT

2. POLYMER

3. GYPSUM CEMENT

RATIONALE FOR TREATMENT RECOMMENDATIONS

Per regulations, drum containing acid must be identified, acid naturalized prior to solidification. As most materials are listed as oxides, either of the above waste forms would solidify materials. As most codes are for the hazardous materials, waste form must pass TCLP.

9413221.0888

Westinghouse Hanford Company

Internal Memo

From: Restoration Projects 87330-92-MLS-025
Phone: 372-1362, H2-58
Date: August 17, 1992
Subject: SOLID WASTE INFORMATION AND TRACKING SYSTEM LOW-LEVEL MIXED WASTE CHARACTERIZATION TO SUPPORT WASTE RECEIVING AND PROCESSING 2A

To: J. L. Westcott H2-58

cc:

S. R. Briggs	G6-47*
D. A. Burbank, Jr.	H1-60
W. O. Greenhulgh	L5-31
R. S. Kelley	H2-58*
D. R. Lucas	G6-46*
J. G. Riddelle	H2-58
K. M. Weingardt	H1-60
RP Characterization File	H2-58
MLS File/LB	

*w/o attachment

9413221.0889

Per your on June 9, 1992 a Solid Waste Information and Tracking System data run was pulled on all low-level mixed waste in storage except the 183H basin. The last two treatment lots have been reviewed by Earl McDaniel and are attached. Once again a summary sheet along with rationale for treatment recommendations have been assembled. The lots are WRAP2A.13 and WRAP2A.14.

If you have any questions or require additional information, please feel free to contact me on 372-1362.

Marnelle Sheriff

M. L. Sheriff
Engineering Technician

pss

Attachment

Hanford Operations and Engineering Contractor for the US Department of Energy

SHEET18.XLS

LOT WRAP2A.14

8/11/92

CONTAINER INFORMATION:

THREE 55 GAL.
ONE 10 GAL.

DOSE:
ALL AT 1 Mr

GENERATORS:
221T,200E AREA,EQUIP.DECON
202A,200E AREA,PUREX
2345Z,200W AREA,Z PLANT

CODES:
D002,D003,D009,WT01
D002,D003,D008,WT01
D001,D003,WT01
D002,D003

PHYSICAL DESCRIPTION:

	TOTAL	AVERAGE	RANGE
DIRT,ETC	2	70%	46-94%
HAZ.CON.	1	1%	NA
PLAS,ETC	4	5.75%	5-7%
CLOTH	1	95%	NA
BORON	1	1%	NA
LEAD	1	49%	NA
METAL,ETC	2	43%	NA
CONWED	1	5%	NA

HAZARDOUS CONSTITUENTS:

	TOTAL	AVERAGE	RANGE
Ca OXIDE	1	.5 Kg	NA
ALNO3	1	2.27 Kg	NA
BoFL3	2	.05 Kg	.004-.1 Kg
Pb	1	3.4 Kg	NA
MERCURY	1	.4999 Kg	NA

RADIONUCLIDE DISTRIBUTION:

	TOTAL	AVERAGE	RANGE
TOTAL B/G	4	3.25E-03 Ci	SEE ATT
Sr/Y 90	1	5.0E-04 Ci	NA
Ru/Rh 106	1	8.0E-04 Ci	NA
Cs/Ba 137	1	6.0E-04 Ci	NA
Ce/Pr 144	1	3.1E-03 Ci	NA
Pm 147	1	1.5E-03 Ci	NA
Sm 151	1	4.0E-04 Ci	NA

PIN #:
221-T-91-00069
WHC-A89-806
211-089-024
212-089006

RECOMMENDED TREATMENT: COMPLETE RATIONALE FOR TREATMENT ATTACHED.
1. ENCAPSULATION FOR LEAD AND MERCURY
2. TAILORED GROUT
3. POLYMER

9413221.0890

LOT WRAP A2.14

SHEET 18.XLS

RECOMMENDED TREATMENT

1. ENCAPSULATION FOR LEAD AND MERCURY

2. TAILORED GROUT

3. POLYMER

RATIONALE FOR TREATMENT RECOMMENDATIONS

Material containing lead and mercury must be sorted. The lead is then encapsulated. Mercury is distilled from material. Mercury is then encapsulated. Other material may be solidified in either a tailored grout or polymer.

9413221.0891

LOT WRAP2A.13

8/11/92

CONTAINER INFORMATION:

SIX 55 GAL.
ALL AT 1 Mr

GENERATORS:
202AL,200E AREA,ANALYTICAL LAB
2345Z,200W AREA,Z PLANT
218W2A,200W AREA,BURIEL GROUNDS

CODES:
D007,D008,WC01,WP01
WT01
D002,D008
D007,D008,WC01
D001,D008,WC01,WT02

PHYSICAL DESCRIPTION:

	TOTAL	AVERAGE	RANGE
ABSOR,ETC	3	73%	60-80%
GLASS	1	7%	NA
HAZ.CON.	1	25%	NA
PLAS,ETC	6	13%	5-34%
METAL,ETC	3	7%	5-9%
DIRT,ETC	3	55%	44-70%
PAINTS	3	11%	2-19%
WOOD,ETC	1	9%	NA
ACID	2	15%	10-20%
CLOTH,ETC	1	7%	NA
RUBBER	1	1%	NA

HAZARDOUS CONSTITUENTS:

	TOTAL	AVERAGE	RANGE
CERIUM NO3	1	.11 Kg	NA
PbO2	1	.45 Kg	NA
KBr2	1	.45 Kg	NA
KCl2	1	.45 Kg	NA
KNO2	1	.45 Kg	NA
K PERIODAT	1	.22 Kg	NA
KMNO4	1	.9 Kg	NA
ThNO3	1	.45 Kg	NA
PbCr2	3	.71 Kg	.064-1.9 Kg
Pb	2	50 Kg	16-84 Kg
H2SO4	2	.15 Kg	.1-.2 Kg

RADIONUCLIDE DISTRIBUTION:

	TOTAL	AVERAGE	RANGE
TOTAL B/G	6	2.5E-04 Ci	SEE ATT
U DEPL.	1	1.09E-03 Gr	NA
Sr/Y 90	2	1.0E-05 Ci	NA

PIN #:

202L-92-000704
RHZ-219-091442
RHZ-219-091443
S172-91-001
S172-91-002
219-A21581

RECOMMENDED TREATMENT:
1. ENCAPSULATION FOR LEAD
2. TAILORED GROUT
3. POLYMER

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

9413221.0892

LOT WRAP 2A.13

SHEET 17.XLS

RECOMMENDED TREATMENT

1. ENCAPSULATION FOR LEAD

2. TAILORED GROUT

3. POLYMER

RATIONALE FOR TREATMENT RECOMMENDATIONS

Regulations require that lead be encapsulated. Drums containing lead must be sorted and lead removed. Drum containing sulfuric acid must be segregated and acid neutralized prior to solidification/stabilization.

9413221.0893

From: Restoration Projects 87330-92-MLS-028
Phone: 372-1362, H2-58
Date: August 24, 1992
Subject: SOLID WASTE INFORMATION AND TRACKING SYSTEM LOW-LEVEL MIXED WASTE CHARACTERIZATION TO SUPPORT WASTE RECEIVING AND PROCESSING 2A

To: J. L. Westcott H2-58

cc:

S. R. Briggs	G6-47*
D. A. Burbank, Jr.	H1-60
W. O. Greenhulgh	L5-31
R. S. Kelley	H2-58*
D. R. Lucas	G6-46*
J. G. Riddelle	H2-58 gR
K. M. Weingardt	H1-60
RP Characterization File	H2-58
MLS File/LB	

*w/o attachment

9413221.0894

Per your request on June 9, 1992 a Solid Waste Information and Tracking System data run was pulled on all low-level mixed waste in storage except the 183H basin. This lot represents those containers that have only Washington State codes. Once again a summary sheet along with rationale for treatment recommendations have been assembled. The lot is WRAP2A.15.

If you have any questions or require additional information, please feel free to contact me on 372-1362.

Marnelle L Sheriff
M. L. Sheriff
Engineering Technician

pss

Attachment

Hanford Operations and Engineering Contractor for the US Department of Energy

SHEET19.XLS

LOT WRAP2A.15

8/20/92

CONTAINER INFORMATION:

SIZE:		DOSE:	GENERATORS:	WASTE CODES:
5 GAL.	2	1@4 Mr	326,300 AREA	WT01
8 GAL.	1	1@3 Mr	163PA,100N AREA	WT01,WC01
7.8*9.3*15	1	BAL.@1 Mr	331,300 AREA	WC02
55 GAL.	11		202AL,200E AREA,ANAL.LAB	
			241S,200W AREA	
			333,300 AREA	
			100N,100N AREA	
			202A,200E AREA,PUREX	
			TRWSG,OFFSITE,TRW INC.	

PHYSICAL DESCRIPTION:

	# OF	AVERAGE	RANGE
HAZ.CONS.	11	8.8%	1-20%
CLOTH	2	17.5%	10-25%
GLASS	8	5%	3-10%
METAL	5	10%	1-30%
PAPER	3	17%	10-23%
PLASTIC	10	13.7%	1-55%
DIRT	7	73%	65-93%
CONWED	5	33.8%	1-93%
ABSORB.	5	55.8%	1-100%
FIBERGLS.	1	20%	NA
LIQUID	3	3%	NA
BRICK	1	99%	NA

HAZARDOUS CONSTITUENTS:

	# OF	AVERAGE	RANGE
BERYLLIUM	2	3.5 Kg	.005-7 Kg
NiOH	2	.068 Kg	.002-.135 Kg
NaF	1	.9 Kg	NA
NAOH	1	.265 Kg	NA
NaNO2	1	.265 Kg	NA
HF	1	52.3 Kg	NA
KCl	1	1.5 Kg	NA
HNO3	3	2.11 Kg	1.8-2.3 Kg
H3PO4	2	24.5 Kg	20.29 Kg
ETHY.GLYCOL	1	36.29 Kg	NA
COPPER	1	8.35 Kg	NA

RADIONUCLIDE DISTRIBUTION:

	# OF	AVERAGE	RANGE
TOTAL B/G	15	9.8E-4 Ci	0-1.47E-3Ci
H-3	1	2.3E-4 Ci	NA
Mn-54	3	1.3E-4Ci	0-2.2E-4Ci
Fe-55	1	3.0E-5Ci	NA
Co-60	3	6.4E-4Ci	0-1.1E-3Ci
C-14	1	1.0E-4Ci	NA
U-DEPL.	2	12500 Gr	*0-2.5E+4Gr
U-ENR	1	.1 Gr	NA
Sr/Y-90	4	3.5E-5Ci	*0-4.0E-5Ci
Fe-59	2	1.3E-4Ci	0-1.5E-4Ci
U-NATR.	1	94300 Gr	NA

PIN #:

326-90-031	WHA-88-303
105N-90-231	6803-1-1-34
PNL-89019	
326-88-0012S	
202L-92-000706	
WTF-91-148-05	
WHC-3-90-63	
105N-90-232	
105N-90-157	
105N-90-158	
105N-90-159	
105N-89-874	
105N-89-875	

RECOMMENDED TREATMENT:
1. POLYMER
2. TAILORED GROUT

COMPLETE RATIONALE FOR TREATMENT ATTACHED.

LOT WRAP 2A.15

SHEET 19.XLS

TREATMENT RECOMMENDATIONS

1. POLYMER

2. TAILORED GROUT

RATIONALE FOR TREATMENT RECOMENDATIONS

Acids must be removed from containers and neutralized prior to treatment. Ethylene glycol should be removed and stored for incineration. Since material contains salt, polymer use is design basis.

9413272.0896

9413221.0897

APPENDIX E

LITERATURE SEARCH RESULTS

A. This WHC Letter Report (CEP-WOG-001) contains a thorough literature search and review of solidification technologies. This review was done in support of the WRAP 2A WFQ efforts. It included a review of all known solidification technologies.

B. This report (generated by solidification expert Earl McDanial, ORNL) is a review specifically of grouting technology (cement based solidification) used throughout the world. This report was done to support the selection of a grout technology in WRAP 2A.

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9413221.0899

Westinghouse Hanford Company **LITERATURE SEARCH RESULTS** Internal Memo

From: Chemical Process Engineering CPE-WOG-001
Phone: 6-9616 L5-31
Date: May 27, 1992
Subject: WRAP 2A LITERATURE SEARCH

To: J. L. Westcott H2-58

cc: J. W. Biglin L5-31
D. A. Burbank H1-60
J. A. Hunter L5-31
J. G. Riddelle H2-58
C. A. Petersen H1-60
WOG/File-LB

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A detailed literature search of waste solidification methods has been completed and several packets of information generated by the search are provided. The typically used materials such as portland cement and variations of it are still the primary referenced solidification material. However, a couple of new or newer materials are available. These include sulfur polymer cement, a thermosetting inorganic binder, Aquaset® and Petroset® inorganic binders used for aqueous and organic liquids respectively, and Syncrete® a synthetic concrete. These materials will be considered, evaluated, or tested along with the more familiar materials; information and test samples of all three have been requested.

To minimize cost and make processing as simple as possible, thermal processing was limited to ≤500°F for WRAP 2A. This eliminates vitrification, synthetic rocks, metal matrices, calcines and ceramic waste forms from consideration. Also, absorbent materials were not considered viable candidates since they could be used as solidification matrices for low-level waste, but not mixed waste since they are not expected to retain hazardous components and would not normally pass the TCLP test. Some searches were done for all solidification methods including vitrification so as not to exclude any references that are potentially useful. A summary of waste solidification agents is given in Table 1. Table 2 lists the solidification methods that are expected to be considered for application at the WRAP 2A Module.

The use of portland cement and similar materials continues to be the most referenced of solidification materials. Slag cement references, however, seem to indicate that it might retain radionuclide and hazardous elements more completely than cement. Pozzolan and latex cement might offer additional advantages over portland cement for certain chemicals or matrices. Likewise, Envirostone® and plaster of paris are gypsum cements that set well with neutral and acidic wastes. Other cementitious materials to consider include grout mixes, polymer modified cement, and Syncrete®. In contrast, organic binders offer solidification agents that are expected to form waste products exhibiting lower leach characteristics and higher waste loadings than cement products. Thus, they will be considered, but they will

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also be examined for unacceptable flammability or combustibility characteristics. The other class of solidifiers is inorganic binders which offer some of the characteristics of both cementitious agents and organic binders.

The most useful literature packet is one entitled "Literature Search for WRAP Solidifiers." It summarizes most of the important references. The literature pointed out a number of additives or modifiers that improve waste product performance particularly for cement. Materials such as lime, silica, or alumina can improve cement leachability. For gypsum cements, retardant modifiers are probably necessary for proper solidification of plaster of paris and Envirostone® waste products.* Also, materials or reagents to avoid are important in considering the use of organic binders or polymers. A number of these guidelines are included in the literature references and summaries.

This completes the initial phase of the WRAP literature search. We will attempt to keep the literature search current with time and periodically update to support the design work. If you have any questions or comments, please call me on 6-9616.

Wilbur O. Greenhalgh

W. O. Greenhalgh, Principal Scientist
Chemical Process Engineering

dfm

Attachments

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*Envirostone® is available in a slow set formulation. We have submitted a procurement request to obtain some for laboratory testing and evaluation.

Table 1

Candidate Waste Forms

Absorbents	Cementitious Materials	Organic Binders
•Vermiculite •Kitty Litter •Zeolites •Diatomaceous Earth •Calcium Sulfate Dissicants •Silica Gel •Agricultural Products (cellulose, corn cobs, etc.)	•Portland Cement Type I •Portland Cement Type III •Pozzolan Cement •Envirostone® •Plaster of Paris •Grout (Hanford Nitrate Mix) •Slag Cement •Polymer Modified Cement •Latex Cement •Syncrete® •FUETAP Concrete •Concreted Pellets •Grout Mixes -Salt Resistant -Sulfate Resistant -Weather Resistant -High Density -Epoxy Grout	•Bitumen •Cold Working Polymers -Dow Polymer® -Water Extended Polyester (WEP) -Epoxies, etc. •Heat Setting Polymers -Polyethylene -Polypropylene -Polyurethane -Polymethyl Methacrylate, etc. •Polymer Impregnated Concrete (PIC) or other waste form
Calcines	**Ceramics**	**Inorganic Binders**
•Salt Cake •Metal Oxides •Granules/Pellets	•Pellets •Alkali-Clay Fixation (Cancrinite) •Formed Clay •Fired Inorganic Resins	•Sulfur Polymer Cement •High Temp Sulfur •Water Glass (Sodium Silicate) •Acid Anhydride Melts •Aquaset® •Petroset®
Metal Matrices	**Synthetic Rocks**	**Vitrification**
•Alloy Melts •Hardware Fusion	•Titanates (Synroc) •Hydrothermal Process	•Borosilicate Glass •Phosphate Glass •Alumino Silicate Glass •Soda Glass •Other - Flint/ Borate/etc. •Fused Soils

®Envirostone is a trademark of U.S. Gypsum Company.
®Dow Polymer is a trademark of Dow Chemical Company.
®Aquaset is a trademark of Fluid Tech, Inc.
®Petroset is a trademark of Fluid Tech, Inc.
®Syncrete is a trademark of STMI of France.

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Table 2

Viable Candidate Waste Forms for WRAP 2A

Cementitious Materials	Organic Binders	Inorganic Binders
•Portland Cement Type I •Portland Cement Type III •Pozzolan Cement •Envirostone® •Plaster of Paris •Slag Cement •Polymer Modified Cement •Latex Cement •Syncrete® •Concreted Pellets •Grout Mixes -Salt Resistant -Sulfate Resistant -Weather Resistant -High Density -Epoxy Grout	•Bitumen •Cold Working Polymers -Dow Polymer® -Water Extended Polyester (WEP) -Epoxies, etc. •Heat Setting Polymers -Polyethylene -Polypropylene -Polyurethane -Polymethyl Methacrylate, etc. •Polymer Impregnated Concrete	•Sulfur Polymer Cement •High Temp Sulfur •Water Glass (Sodium Silicate) •Acid Anhydride Melts •Aquaset® •Petroset®

®Envirostone is a trademark of U.S. Gypsum Company.
®Dow Polymer is a trademark of Dow Chemical Company.
®Aquaset is a trademark of Fluid Tech, Inc.
®Petroset is a trademark of Fluid Tech, Inc.
®Syncrete is a trademark of STMI of France.

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LITERATURE SEARCH FOR WRAP SOLIDIFIERS

Aquaset and Petroset

1. "Aquaset and Petroset," Technical Data Sheet, Fluid Tech, Inc., Las Vegas, NV.

   Aquaset is designed for aqueous waste and Petroset is designed for organic liquids. Up to 40 to 48 gallons of liquid can be solidified in a 55 gallon drum.

Bitumen

1. S. Simpson, H. Vidal, and M. Morris, "Mixed and Chelated Waste Test Programs with Bitumen Solidification," Spectrum '88, September 11-15, 1988, Pasco, WA, pp 323-325.

   Bitumen solidification tests with mixed and chelated wastes were carried out. Test results are still being evaluated for 10 CFR-61 type analyses.

2. M. Snellman and M. Valkiainen, "Long Term Behavior of Bituminized Waste," Waste Management '86, Vol. 3, March 2-6, 1986, Tucson, AZ, pp 501-507.

   Water uptake by bitumen solidified ion exchange resin was studied. Water uptake corresponded to the resin content, but no unacceptable bitumen product long term effects were observed.

3. A. J. Mattus, R. D. Doyle, and D. P. Swindlehurst, "Asphalt Solidification of Mixed Wastes," Waste Management '88, Vol. 1, February 28 - March 3, 1988, Tucson, AZ, pp 229-234.

   Solidification of some mixed waste with bitumen can be used to "delist" the waste so it can be disposed of as a radioactive waste.

4. A. Bernard, A. C. Nomine, G. Cornec, A. Bonnet, and L. Farges, "Long Term Leaching Tests on Full-Scale Blocks of Radioactive Wastes," Nuclear and Chemical Waste Management, Vol. 3, pp 161-168, 1982.

   Leaching tests on full size waste blocks showed bitumen exhibited leach advantages over cement based waste products.

Cement

1. C. V. McIsaac, D. W. Akers, J. W. McConnell, and N. Morcos, "Leach Studies on Cement-Solidified Ion Exchange Resins from Decontamination Processes at Operating Nuclear Power Stations," EGG-M-92090, Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, ID.

   Tested Cemented resin samples against NRC requirements, the samples did not pass the tests.

2. L. Weitzman and L. E. Hamel, "Evaluation of Solidification/Stabilization as a Best Demonstrated Available Technology for Contaminated Soils," PB89-169908, Acurex Corporation, Research Triangle Park, NC, March 1989.

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Soils with metals and organics was solidified with cement, lime, and flyash.

The resulting TCLP tests showed metal leach rates were lowered but little or no retention effects were shown with the organics.

3. B. G. Place, "Treatment Technology for Transuranic Waste Streams--Cementation, Vitrification, and Incineration Testing for the Treatment of Spent Ion Exchange Media," WHC-EP-0462, Technical Report, Westinghouse Hanford Company, Richland, WA, April 1992.

   Physical pretreatment of ion exchange resin prior to cement solidification enhances product characteristics and waste packing efficiencies.

4. C. G. Howard, "Advanced Cementation Concepts Final Report," AEEW-R2398, Winfrith Technology Centre, Winfrith, United Kingdom, October 1989.

   The addition of limestone flour or microsilica to cement solidifications reduces the cesium leachability. Microsilica acts as a pore blocker, and limestone flour acts as a cesium absorber.

5. G. W. Veazey, "The Cement Solidification Systems at LANL," LA-UR-90-4161, Los Alamos National Laboratory, Los Alamos, NM.

   They used an "End Over End" mixer applying cement solidification to basic sludges, and Envirostone® solidification to acidic wastes and organic compounds.

6. S. Hoyle and M. W. Grutzeck, "Effects of Phase Composition on the Cesium Leachability of Cement-Based Waste Forms," Waste Management '86, Vol. 3, Tucson, AZ, pp 491-496.

   Cesium leachability performance is improved by increasing the silica or alumina content of the binding cement matrix.

7. S. L. Unger and R. W. Telles, "Surface Encapsulation Process for Managing Low-Level Radioactive Wastes," Waste Management '86, Vol. 1, Tucson, AZ, pp. 555-558.

   They applied surface encapsulation polymers namely polyethylene and poly butadiene to seal the cement solidified waste material.

8. D. F. Fischer and T. R. Johnson, "Immobilization of IFR Salt Wastes in Mortar," Spectrum '88, September 11-15, 1988, Pasco, WA, pp 102-104.

   The addition of flyash to the cement enhanced chloride leachability performance for calcium and potassium chloride salt wastes. Leach indices were above 7 for the 10% salt mixtures.

9. C. Jaouen and B. Vigreux, "Cement Solidification of Spent Ion Exchange Resins Produced by the Nuclear Industry," Spectrum '88, September 11-15, 1988, Pasco, WA, pp 105-108.

They chemically pretreated the resin wastes prior to solidification to enhance immobilization. They achieved a 40 to 75% encapsulation ratio.

10. B. M. Rzyski and A. A. Suarez, "Setting Temperature Evolution of Nitrate Radwaste Immobilized in Ordinary Portland Cement," Spectrum '88, September 11-15, 1988, Pasco, WA, pp 112-114.

    Nitrates change the cement hydration reaction and lower the hydration temperature.

11. J. W. McConnell, Jr., R. M. Neilson, Jr., and R. D. Rogers, "Testing Waste Forms Containing High Radionuclide Loadings," Waste Management '86, Vol.1, Tucson, AZ, March 2-6, 1986, pp 259-266.

    EPICOR II resins from TMI-2 were solidified with portland cement and Dow Polymer (vinyl ester-styrene). The waste forms were tested against NRC (10-CFR-61) requirements, the Dow polymer was attacked by fungus; otherwise all tests were positive.

12. T. F. Schuler and D. L. Charlesworth, "Solidification of Radioactive Incinerator Ash," Waste Management '86, Vol. 1, Tucson, AZ, March 2-6, 1986, pp 489-493.

    ASHCRETE. The ashcrete process uses an automatic tumbler mixer from Stock Equipment Co. that adds ash waste to cement, sand and water to form an ash concrete.

13. W. O. Greenhalgh, "The Immobilization of Organic Liquid Wastes," Waste Management '86, Vol.3, Tucson, AZ, March 2-6, 1986, pp 255-260.

    Report described immobilization of organic liquids (oil, NPH, etc.) using cement in combination with emulsifiers.

14. M. G. Cowgill, "A Comparison of Solidification Media for the Stabilization of Low-Level Radioactive Wastes," BNL-52304, Brookhaven National Laboratory, Upton, NY, October 1991.

    The document compares the solidification characteristics of Cement, thermoplastic polymers, Thermosetting polymers, and Gypsum. The binding of cesium and certain other elements is difficult for cement and gypsum; flammability and incorporation of oxidizing agents are difficult with the polymer media. A comparison table is included.

15. R. L. Gay and L. F. Grantham, "High Strength Cementized Dried Resins," Waste Management '86, Vol. 3, March 2-6, 1986, Tucson, AZ, pp 479-483.

    Chemically spent resins pretreated in a high efficiency drier were found to be nearly impermeable to water and therefore formed satisfactory products when solidified with cement. Swelling is often a problem when -H and -OH type resins are solidified with cement.

16. B. Siskind, J. W. Adams, J. H. Clinton, and P. L. Piciulo, "The Effect of Cure Conditions on the Stability of Cement Waste Forms after Immersion in Water," Waste Management '88, Vol. 1, February 28 - March 3, 1988, Tucson, AZ, pp 613-618.

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Some formulations exhibited typical cure patterns, others did not particularly those with high resin loadings.

17. B. L. Ganser, "Cementation - A Solution for Final Disposal," Waste Management '90, Vol. 2, February 25 - March 1, 1990, Tucson, AZ, pp 527-533.

    Blast furnace slag cement showed lower radionuclide leach results than portland cement. Cement products formed by direct cementation of liquid wastes showed excellent mechanical properties. Tong term stability of cement looked good except under unrealistic harsh conditions.

18. K. Sauda, F. Todo, T. Nakashima, T. Kagawa, and H. Kuribayashi, "Advanced Cement-Solidification Process for Spent Ion-Exchange Resins," Waste Management '90, February 25 - March 1, 1990, Tucson, AZ, pp 299-303.

    Spent ion-exchange resins were pretreated and modification made to enhance cement solidification. They included (1) adsorption of Na, Ca, and other ions, (2) improvement of the cement binder, (3) coating the resin with polyester or other sealant, and (4) resin pretreatment to increase the water content.

19. H. J. Funk and R. Pfeiffer, "Solidification by Cementation of Liquid Radioactive Primary Waste Mixes," Waste Management '90, February 25 - March 1, 1990, Tucson, AZ, pp 803-807.

    They used an in-drum cement mixing method to solidify evaporator and other process residues of primarily sodium nitrate. A water to cement ratio of 0.45 was used to yield a compressive strength product of 10 N/sq mm.

20. A. M. Boehmer and M. M. Larsen, "Solidification of Hazardous and Mixed Radioactive Waste at the Idaho National Engineering Laboratory," Waste Management '86, Vol. 1, March 2-6, 1986, Tucson, AZ, pp 635-642.

    Mixed wastes were successfully solidified using cement, cement-silicate, or Envirostone to produce non-toxic stable waste forms. In-drum mixers or rotary drum mixers were used to prepare the test drums.

21. J. A. Stone and P. D. d'Entremont, "Measurement and Control of Cement Set Times in Waste Solidification," DP-1404, Technical Report, Savannah River Laboratory, Aiken, SC, September 1976.

    The report addresses the use of set retarders particularly Pozzolith 122-R and showed that retarders could be used to control the cement-waste set times.

22. "Atcor Radwaste Solidification Systems," Technical Data Sheet, Atcor Engineered Systems, Inc., Chem-Nuclear Company, Avon, CT.

    Atcor has cement and Dow polymer feed storage systems, in-line or in-container (steel liners) mixer systems, and support systems to provide waste solidification services per customer needs.

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Dow Polymer

1. H. E. Filter and K. Roberson, "The Dow System for Solidification of Low Level Radioactive Wastes from Nuclear Power Plants," Technical Report, Dow Chemical Company, Midland, MI, May 1977.

   This is one of the initial Company reports describing Dow Polymer and it use as a solidification agent.

Envirostone

1. T. L. Rosenstiel, S. P. Bodett, and R. G. Lange, "Envirostone Gypsum Cement," 1984 Topical Report, United States Gypsum, Libertyville, IL.

   This report details the qualification of Envirostone Gypsum Cement per 10 CFR-61 type tests. Test samples include boric acid, ion exchange resin, and oil wastes; all waste products tested were qualified.

2. T. L. Rosenstiel and R. G. Lange, "The Solidification of Low Level Radioactive Organic Fluids with Envirostone Gypsum Cement," Waste Management '84, March 11-15, 1984, Tucson, AZ, pp 169-172.

   The report covers the successful solidification of oils using emulsifiers in conjunction with Envirostone cement.

Grout

1. E. L. Wilhite and R. L. Hooker, "Saltstone Processing Startup at the Savannah River Plant," Spectrum '88, September 11-15, 1988, Pasco, WA, pp 99-101.

   Predicted maximum ground-water concentration of all contaminants from saltstone disposal are below ground-water standards based on modeling studies.

2. T. M. Gilliam, R. D. Spence, B. S. Evans-Brown, I. L. Morgan, J. L. Shoemaker, and W. D. Bostick, "Performance Testing of Blast Furnace Slag for Immobilization of Technetium in Grout". Spectrum '88, September 11-15, 1988, Pasco, WA, pp 109-111.

   The addition of slag cement improved the retention of technetium and to a lesser extent nitrate.

3. C. A. Langton, "Metal Toxicity Evaluation of Savannah River Plant Saltstone Comparison of EP and TCLP Test Results," Waste Management '88, Vol. 1, February 28 - March 3, 1988, Tucson, AZ, pp 197-203.

   Based on EP and TCLP tests, chromium is chemically stabilized in slag based saltstone and physically entrapped in the cement based saltstone. The chemical stabilization is preferred (better)!

4. T. L. Sams and E. W. McDaniel, "Development of a Cement-Based Grout for Immobilization of a Low Level Waste Stream containing Sodium Sulfate," Waste Management '88, Vol. 1, February 28 - March 3, 1988, Tucson, AZ, pp 703-708.

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The grout contained cement type III, flyash, attapulgite clay, and indian red pottery clay. The formulations are on page 705.

5. E. G. Collins and G. Magnin, "Final Design and Start-up of the Transportable Grout Equipment Facility at Hanford," Waste Management '88, Vol. 1, February 28 - March 3, 1988, Tucson, AZ, pp 751-759.

   The TGE facility is a remote operating grout mixing facility.

6. J. E. Van Beek and D. D. Wodrich, "Grout Disposal System for Hanford Mixed Waste," Waste Management '90, Vol. 1, February 25 - March 1, 1990, Tucson, AZ, pp 797-802.

   The system has been designed to meet hazardous waste regulations and has initiated operations.

7. C. A. Langton, M. D. Dukes, and R. V. Simmons, "Cement-Based Waste Forms for Disposal of Savannah River Plant Low-Level Radioactive Salt Waste," DP-MS-83-71, Technical Report, Savannah River Laboratory, Aiken, SC, November 14-17, 1983.

   A cement based grout waste form has been designed to treat 100 million liters of soluble salt waste, the waste form is termed "salt stone".

8. O. K. Tallent, E. W. McDaniel, G. D. Del Cul, K. E. Dodson, and D. R. Trotter, "Immobilization of Technetium and Nitrate in Cement-Based Materials," Mat. Res. Soc. Symp. Proc., Vol 112, 1988, pp 23-32.

   The leachabilities of technetium and nitrate wastes immobilized in cement-based grouts have been investigated using ANS 16.1 test procedures. Factors found to affect the leachabilities include grout mix ratio, fluid density, blend composition, and waste composition.

9. W. O. Greenhalgh, R. J. Cash, and M. A. Christie, "TRU Waste Immobilized in Grout," Waste Management '88, Vol. 2, Tucson, Arizona, February 28 - March 3, 1988, pp 309-316.

   Various portland cement based grout compositions mixed with shredded solid waste was tested for WIPP and NRC compliance criteria. Some compositions passed all tests.

<u>Hydrothermal Solidification Process</u>

1. Y. Nishihara, T. Kashiwai, and N. Yamazaki, "Development of the Waste Solidification Process Utilizing Hydrothermal Reaction," Waste Management '86, Vol. 3, March 2-6, 1986, Tucson, AZ, pp 485-490.

   The hydrothermal reaction is characterized by reacting mixed powders such as incinerator ashes, solidification material, and aqueous alkali at relatively high temperatures and pressures to form a synthesized rock.

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Lime

1. A. Dupont, "Lime Treatment of Liquid Waste Containing Heavy Metals, Radionuclides, and Organics", Technical Fact Sheet, National Lime Association, Arlington, Virginia, August 1, 1986.

Polyethylene

1. P. D. Kalb and P. Colombo, "Polyethylene Solidification of Low-Level Wastes," BNL 51867, Topical Report, Brookhaven National Laboratory, Upton, NY, October 1984.

   Polyethylene was tested and evaluated as a radwaste immobilization media, recommendations are given on sodium sulfate, boric acid, incinerator ash, and ion exchange resin wastes.

2. P. D. Kalb, J. H. Heiser, and P. Colombo, "Polyethylene Encapsulation of Nitrate Salt Wastes: Waste form Stability, Process Scale-Up, and Economics," BNL-52293, Topical Report, Brookhaven National Laboratory, Upton, NY, July 1991.

   A polyethylene encapsulation system for treatment of low-level radioactive, hazardous, and mixed waste has been developed and appears to offer several advantages over more conventional methods such as cement.

Polymer Impregnated Concrete (PIC)

1. Brookhaven National Laboratory Progress Reports for the Development of Durable Long-Term Radioactive Waste Composite Materials, No. 1-10, July 1972 - April 1975, Brookhaven National Laboratory, Upton, NY.

2. Brookhaven National Laboratory Progress Reports for the SRL Long-Term Waste Storage Support Progress, No. 1-8, July 1973 - January 1975, Brookhaven National Laboratory, Upton, NY.

   Cemented waste is impregnated with a low viscosity polymer such as styrene after the cement has been cured. The catalyst (benzoyl peroxide) is then added at 0.5 wt% and the material polymerized within 3 to 4 hours at 50 to 70°C. Product leaching performance is improved a factor of 100 and compression strengths are 3 to 10 fold higher.

Sulfur Polymer Cement

1. P. D. Kalb and P. Colombo, "Modified Sulfur Cement Solidification of Low-Level Wastes,"BNL 51923, Topical Report, Brookhaven National Laboratory, Upton, NY, October 1985.

   Sulfur Polymer Cement was tested as a radwaste solidification agent. It appears to produce an acceptable waste form and recommendations for sodium sulfate, boric acid, and incinerator ash wastes are provided.

2. P. D. Kalb, J. H. Heiser III, and P. Colombo, "Encapsulation of Mixed Radioactive and Hazardous Waste Contaminated Incinerator Ash in Modified Sulfur Cement," BNL-43691, Technical Report, Brookhaven National Laboratory, Upton, NY.

The sulfur polymer cement will hold about three times more incinerator ash than regular cement waste products.

3. P. D. Kalb, J. H. Heiser III, and P. Colombo, "Comparison of Modified Sulfur Cement and Hydraulic Cement for Encapsulation of Radioactive and Mixed Wastes," BNL-45163, Technical Report, Brookhaven National Laboratory, Upton, NY.

The report claims significantly greater waste loadings for the sulfur polymer cement versus the regular hydraulic cement for radwastes.

4. G. R. Darnell, W. C. Aldrich, and J. A. Logan, "Full-Scale Tests of Sulfur Polymer Cement and Non-Radioactive Waste in Heated and Unheated Prototypical Containers," Informal Report, EGG-WM-10109, Idaho National Engineering Laboratory, Idaho Falls, Idaho, February 1992.

They found sulfur polymer cement to be superior to portland cement in solidfying ash material.

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Syncrete

1. S. Cohen and P. Crouzet, "A High Efficient Polymer Cement Embedding Matrix for Waste Processing," Waste Management '86, Vol. 1, March 2-6, 1986, Tucson, AZ, pp 583-588.

Syncrete (synthetic concrete) is a composite matrix of ordinary hydraulic cement and a thermosetting polymer mixture. The Syncrete exhibits a significantly reduced water uptake.

Other

1. K. D. Wiemers, J. E. Mendel, A. A. Kruger, L. R. Bunnell, and G. B. Mellinger, "Preliminary Assessment of Candidate Immobilization Technologies for Retrieved Single-Shell Tank Wastes," PNL-7918, Technical Report, Pacific Northwest Laboratory, Richland, WA, January 1992.

It lists candidate waste forms for low-level, transuranic, and high-level wastes.

2. W. O. Greenhalgh, "Disposal Concepts for Wastes in Underground Single-Shell Storage Tanks at the Hanford Site," WHC-SA-1344-FP, Technical Report, Westinghouse Hanford Company, Richland, WA, January 1992.

Report lists candidate waste forms or methods being considered for immobilization of radioactive tank waste.

3. P. D. Kalb and P. Colombo, "Full Scale Leaching of Commercial Reactor Waste Forms," BNL 35561, Technical Report, Brookhaven National Laboratory, Upton, NY, September 1984.

The report compares the leachability of several cements, type I, III, and masonry cement versus Dow polymer. The cements showed lower leach rates for transition metal ions such as cobalt and higher ones for cesium. The Dow polymer showed similar leach rates for cesium and other radionuclides indicating an encapsulating mechanism.

4. Alternatives for Managing Wastes from Reactors and Fission Operations in the LWR Fuel Cycle, ERDA-76-43, Vol. 2, May 1976, Pacific Northwest Laboratories, Richland, WA, Sections 12.0 to 12.41.

The included Section provides a comprehensive summary of solidification methods used prior to 1976 for low-level wastes.

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Westinghouse Hanford Company — **Internal Memo**

From: Chemical Process Engineering
Phone: 6-9616 L5-42
Date: May 29, 1992
Subject: WRAP 2A LITERATURE SEARCH UPDATE - NOTE ON SULFUR POLYMER CEMENT

To: J. L. Westcott H2-58

cc: J. W. Biglin L5-31
J. A. Hunter L5-31
J. G. Riddelle H2-58
WOG/File-LB

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The hottest solidification media on the market in recent years is sulfur polymer cement, sold as CHEMENT 2000. It is elementary sulfur (approximately 95%) mixed with a thermosetting polymer (dicyclopentadiene) that melts at 119°C. The sulfur polymer cement (SPC) was developed by the Sulfur Institute of Washington D.C. to provide an additional market for sulfur materials. It was found to be very useful in coating, covering, or actually replacing concrete in applications where acidic or salt corrosion were severe. It has been shown in many of these applications to be superior to portland type concrete or cement products with the possible exception of polymer impregnated concrete. The reason for its enhanced performance in the above mentioned areas is probably the chemistry of the system.

Portland cement mixes and concrete matrices are basic exhibiting an initial pH of about 13. Sulfur on the other hand is probably best considered as an Arhennius type acid. This means that sulfur would likely provide an excellent solidification media for acidic materials or provide protection from attack by acidic materials, but would likely react with or be attacked by basic materials. Cement or concrete on the other hand stabilizes base type materials well and the product matrix is stable to attacks by bases. It turns out both materials are fairly compatible with neutral materials and are generally stable in a neutral environment. It is recommended that SPC not be used to solidify any base as strong or stronger than sodium carbonate to avoid forming an unstable product, particularly if water is present. An example of an acid-base reaction is given below.

$$Na_2CO_3 + H_2O + S == NaHCO_3 + NaHS + 1/2O_2$$

In addition to sulfur exhibiting acidic properties, sulfur is also a reducing agent. That means that it should not be mixed with, nor used to immobilize, oxidizing materials or materials with significant quantities of oxidants. The amounts of nitrite or nitrate material that can be present in SPC treated waste materials needs to be defined. In addition, sulfur is a combustible material (flashpoint 188°C) which burns with a very light blue,

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J. L. Westcott
Page 2
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almost invisible, flame that emits sulfuric acid type fumes. Care should be taken to limit SPC mixing or handling temperatures well below the flashpoint region.

W. O. Greenhalgh, Principal Scientist
Chemical Process Engineering

ldc

9413221.0913

MARTIN MARIETTA

ARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

April 24, 1992

Mr. J. L. Westcott
Westinghouse Hanford Company
Post Office Box 1970, H2-58
Richland, Washington 99352

Dear Jeff:

Reports and Papers Discussing Alternate Solidification Technologies

Enclosed is a list of the vendor reports, technical data sheets and papers that I am mailing to you as I promised to do when I returned from my vacation.

These are being mailed to you in two separate packages and will be labeled #1 and #2.

Best Regards,

Earl McDaniel

Earl W. McDaniel
Chemical Technology Division

EWM:jew

Enclosures

cc: C. H. Brown, Jr.
O. K. Tallent

9413221.0914

LIST OF REPORTS AND PAPERS

DISCUSSING ALTERNATE SOLIDIFICATION TECHNOLOGIES

Package #1:

(1) Nuclear Waste: Solidification Programs
(2) Lime Treatment of Liquid Waste Containing Heavy Metals, Radionuclides, and Organics - Part I - Processes for Treatment
(3) Immobilization of Rocky Flats Wastes Using the Inert Carrier Process
(4) Reaction of Formaldehyde and Nitric Acid in a Remotely Operated Thermosiphon Evaporator
(5) Envirostone - Gypsum Cement
(6) Waste Generation Reduction - Nitrates Comprehensive Report of Denitrification Technologies
(7) Syncrete - A High Efficient Polymer Cement Embedding Matrix for Waste Processing
(8) Solidification/Stabilization - Mechanisms & Applications
(9) Solidification of Nitrate Salt Wastes - RMN-15-86

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Package #2:

(10) VERI (Vinyl Ester Resin In Situ) Solidification Process for Low-Level Radioactive Waste
(11) Service Summary - Diversified Technologies
(12) A Waste Management System Utilizing WPS, HVV, and VERI Process Systems and Technology
(13) Radioactive Waste Management and Disposal
(14) Solid Solutions for Your Toxic Metal and Organic Wastes
(15) Report of Note (LLRW)
(16) Low-Temperature Ceramic Radioactive Waste Form Characterization of Supercalcine-Based Monazite-Cement Composites
(17) Operating Cost Estimate Low Level Radioactive Waste Volume Reduction and Packaging Options
(18) Abbreviated Statement of Qualifications

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

August 21, 1991

Mr. Jeff Wuestcott
Westinghouse Hanford Company
P. O. Box 1970, N3-12
Richland, Washington 99352

Dear Jeff:

Milestone Letter Report: Cement Grout Technology Final Report Due August, 1991

Enclosed is a copy of the above milestone titled, "Survey of Grouting Technology in Support of WRAP's Shred-Grout Module, Final Report."

If there are any questions or comments, please call FTS 624-0439.

Best Regards,

Earl W. McDaniel

Earl W. McDaniel, Manager
Hanford Grout Program
Chemical Technology Division

EWMcD:jen

Enclosure

9413221.0916

SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED GROUT MODULE

FINAL REPORT

9413221.0917

A Letter Report Prepared
for Westinghouse Hanford Company
Richland, WA

Earl W. McDaniel

Chemical Technology Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831-6044

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*Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400.

SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED-GROUT MODULE FINAL REPORT

Introduction

This final letter report in support of WRAP's shred-grout module is more an extension of the April 1991 draft report than a final version. The April 1991 report discussed grouting facilities at a variety of US DOE sites and provided information about the use of grouts in the UK, France, Germany, Korea, Japan, Finland, and Taiwan. Over fifty reports and papers were supplied as supporting documents. Very little information from the draft report will be repeated in this letter report, only the executive summary and the introduction. The draft report made no recommendations, drew no conclusions or discussed lessons learned. This report will address these topics. Also included are a number of additional reports and documents in support of WRAP's shred-grout module.

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LESSONS LEARNED

Process and formulation development in listed papers and reports described success stories. If you do things in the prescribed manner the end result will be an acceptable product. The major lesson learned was from information provided by the Martin Marietta Energy Systems K-25 Site Sludge Fixation Facility. The problems at this facility have received wide press coverage. This facility can serve as an example as what not to do or what happens when processes are not properly developed prior to plant operations.

Little process development was performed prior to plant design and construction. The feelings were that we were just making concrete, not doing brain surgery, and anyone can make good concrete. It is a well established art.

A summary of plant operations is as follows: the manner in which the sludge fixation facility was operated was generally sloppy and not governed by any established operating procedures. Training for the operators was on-the-job with no written tests or performance testing. Little attention was given to quality assurance planning or execution. There was no apparent effort in quality control of the product.

A minimal level of outside expertise and advice was sought throughout the project. No concrete batch experience was acquired or used in the development work and virtually none was sought for plant operations.

Pressures to keep cost of the sludge fixation facility operation down were immense. It should be noted that a development program costing between $0.75M and $1.5M up front could have avoided a $50-100M retrofit. The perception that the sludge fixation facility was not important affected both funding and operator attitude.

The principal causes of the problem were: (1) the process equipment utilized was inadequate to solidify low solids containing sludge, (2) no final product inspections of solidified waste forms were conducted, (3) a "self-inflicted" schedule for solidification was imposed, (4) there were no personnel primarily dedicated to managing the project, (5) there was no involvement of middle and upper management, and (6) the quality assurance program was ineffective.

Another example of failure is the Rocky Flats pondcrete problem, in which little or no development effort was done and no attention given to final product quality. The Rocky Flats issue appears to be headed for court, so little else will be said beyond there appears to be both a legal and technical problem there.

One example of well-developed processes is the Savannah River Site Saltcrete process, which was well developed and has been operating for several months with no problems. Support documentation is supplied in the April 1991 draft report. The Hanford Grout Treatment facility has also completed one successful campaign and is in the process of developing formulae for additional waste streams. This effort is also documented in the earlier letter report.

The above examples are listed only to serve as what can happen if proper attention is not devoted to up-front development and is not intended to be all-inclusive.

CONCLUSIONS AND RECOMMENDATIONS

The major conclusions to be drawn from the literature search are: (1) much development effort has been devoted to fixing a variety of waste in a cement-based matrix, and (2) each waste stream must be carefully characterized prior to any successful development effort.

The following recommendation is germane: a well defined technology development effort that starts with lab scale, progresses through pilot scale, and ends in full scale testing and demonstration is necessary to assure successful plant design and operation.

It is recommended that the Shred-grout development effort in support of WRAP start in FY-1992 to assure that adequate information in process development and equipment selection be available when needed.

It is recommended that a team be organized consisting of at least the following persons: (1) a R&D manager, (2) a R&D engineer, (3) a QA specialist, and (4) a compliance specialist.

The manager should be the point of contact for information flow and should be dedicated full-time to the effort. The (project) engineer should be responsible for any design, construction, or engineering work needed to support development work. The engineer should also be responsible for costs and budgets. The QA specialist will be necessary to insure quality is "built in" throughout the development effort. The compliance specialist will assure that the end product meets or exceeds regulatory requirements. The compliance specialist will be responsible for assuring that all activities are carried out in compliance with federal, state, and local regulations, laws, and standards for protection of the environment and the safety and health of involved employees and the public.
A closing statement would be that it is cheaper to do it correctly the first time.

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SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED GROUT MODULE

E. W. McDaniel

EXECUTIVE SUMMARY OF APRIL 1991 DRAFT REPORT

This letter report covers a wide variety of grouting and other information that may be applicable to WRAP's Shred-Grout Task. Very little information is available on past, or present, operations of fixing shredded solids in a cement-based matrix.

Information is provided about ORNL's Hydrofracture Process, the K-25 Site Sludge Fixation Facility, SRS Saltstone, Hanford's Grout Treatment Facility, and PPEPP at INEL. Limited information is provided on grouting efforts at Rocky Flats, West Valley, and Mound Labs.

Information is provided on cement-based fixation efforts in a number of European and Asian countries.

A literature search is included that addressed low-level waste solidification technology. Also, included is a strategic planning document on low-level waste disposal and demonstration programs at Oak Ridge, Tennessee. This report also contains a three volume report about waste management processes in the nuclear industry.

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INTRODUCTION FROM APRIL 1991 DRAFT REPORT

This letter report covers a variety of cement-based grouting technologies, both national and international, that may be applicable to Westinghouse Hanford Company's Waste Receiving and Processing (WRAP) Shred-Grout effort. WRAP's mission is to process past and currently generated solid low-level (SLLW), mixed (MLW), and transuranic (TRU) waste at the Hanford site, Richland, Washington. As this is an internal letter report, no background on WRAP is provided.

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The waste to be processed by WRAP has been generated in defense related efforts and are, in many cases, unique to this industry. However, the commercial sector of the nuclear industry has developed, both in the United States and abroad, grouting technology that, with modification, is applicable to WRAP (i.e., the solidification/stabilization of spent ion-exchange resins).

Information is provided on USDOE grouting efforts at Oak Ridge, Tennessee (Hydrofracture at ORNL and the Sludge Fixation Facility at the K-25 Site), PREPP at INEL, Saltstone at SRS, West Valley, NY, and Soilcrete at INEL. A brief description is given of the Rocky Flats plant inert carrier process. A manual laboratory process for making pellets of TRU waste is mentioned. It should be pointed out that little work has been reported on grouting shredded solids as is the mission of WRAP's shred-grout module.

Most of the international information reported is from nuclear utilities. It is difficult to obtain information on defense related efforts in countries that have nuclear weapons programs, such as the United Kingdom (UK), France, and the USSR. West Germany (now just Germany) has a small shred-grout facility at NUKEM's Hanau plant. This operation was covered in R. Wotojack's 1986 trip report and will not be repeated here.

It is noted that the majority of grouting information reported in the open literature addresses the use of cement-based materials (i.e., grouts) to solidify liquids and slurries. Most

commercial processes are in drum or batch type mixing. Larger operations are: the ORNL hydrofracture facility for liquid waste (which is no longer operational), the K-25 Sludge Fixation Facility, the SRS Saltcrete plant, the Hanford Grout Treatment Facility, PREPP at INEL, and West Valley's grout facility.

Information is also provided on the use of grouts in the UK, France, Germany, Korea, Japan, Finland, and Taiwan.

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Copies of all reports listed in the bibliography are included in this report.

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9413221.0927

DON'T SAY IT --- *Write It !*

DATE: May 6, 1991

TO: Distribution

FROM: L. A. Fort

cc E. P. Mertens N3-13
R. J. Roberts N3-13
J. L. Scott N3-12
J. A. Swenson G6-45

SUBJECT: E. W. McDANIEL LETTER REPORT "SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED GROUT MODULE"

Please find attached a copy of Mr. E. W. McDaniel's initial letter report dated April 29, 1991, on the subject of "Survey of Grouting Technology in Support of WRAP's Shred Grout Module."

This activity is to assess the international and DOE Complex waste immobilization technology development and defense waste management grout techniques applicable to the Waste Receiving and Processing (WRAP) Facility Shred-Grout operation. During the April 9, 1991 Exchange Meeting, Mr. E. W. McDaniel provided a preliminary draft letter report in compliance with the 5/24/91 milestone. The edited version of the earlier preliminary draft report is attached. The preliminary draft report was distributed as Attachment 2 to the April 9, 1991 Exchange Meeting report. Again, copies of the approximately 60 references identified within the draft report (over 15 inches of documents) are available in my office for referral.

As stated in the April 9, 1991 Exchange Meeting report, the draft report essentially formulates a "road map" to all the referenced documents. The evaluation does provide the current information on grout formulations, lessons learned at other DOE Sites, and any pertinent information relative to immobilization technology. The final Cementation/Grout Technology Evaluation report is due by 8/30/91. After the final report has been delivered, I will edit and format the formal report so it can be issued internally.

Have report be sent to the project in cementing the

RECEIVED
MAY 06 1991
E.P. MERTENS

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

April 29, 1991

Mr. L. A. Fort
Westinghouse Hanford Company
P.O. Box 1970, R2-87
Richland, Washington 99352

Dear Les:

Milestone Letter Report: Cement Grout Technology Evaluation Report due May 1991

Enclosed is a clean copy of the above milestone titled, "Survey of Grouting Technology in Support of WRAP'S Shred-Grout Module." I hope the fifty or so documents that I brought out to you in support of the above milestone provide you with much useful information.

Best Regards,

Earl W. McDaniel

Earl W. McDaniel, Manager
Hanford Grout Program
Chemical Technology Division

EWM:jml

cc: O. K. Tallent

9413221.0929

SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED GROUT MODULE

A Letter Report Prepared
for Westinghouse Hanford Company
Richland, WA

Earl W. McDaniel

Chemical Technology Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831-6044

*Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under contract DE-AC05-84OR21400.

SURVEY OF GROUTING TECHNOLOGY IN SUPPORT OF WRAP'S SHRED GROUT MODULE

E. W. McDaniel

EXECUTIVE SUMMARY

This letter report covers a wide variety of grouting and other information that may be applicable to WRAP's Shred-Grout Task. Very little information is available on past, or present, operations of fixing shredded solids in a cement-based matrix.

Information is provided about ORNL's Hydrofracture Process, the K-25 Site Sludge Fixation Facility, SRS Saltstone, Hanford's Grout Treatment Facility, and PPEPP at INEL. Limited information is provided on grouting efforts at Rocky Flats, West Valley, and Mound Labs.

Information is provided on cement-based fixation efforts in a number of European and Asian countries.

A literature search is included that addressed low-level waste solidification technology. Also, included is a strategic planning document on low-level waste disposal and demonstration programs at Oak Ridge, Tennessee. This report also contains a three volume report about waste management processes in the nuclear industry.

9413221.0931

1. INTRODUCTION

This letter report covers a variety of cement-based grouting technologies, both national and international, that may be applicable to Westinghouse Hanford Company's Waste Receiving and Processing (WRAP) Shred-Grout effort. WRAP's mission is to process past and currently generated solid low-level (SLLW), mixed (MLW), and transuranic (TRU) waste at the Hanford site, Richland, Washington. As this is an internal letter report, no background on WRAP is provided.

The waste to be processed by WRAP has been generated in defense related efforts and are, in many cases, unique to this industry. However, the commercial sector of the nuclear industry has developed, both in the United States and abroad, grouting technology that, with modification, is applicable to WRAP (i.e., the solidification/stabilization of spent ion-exchange resins).

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commercial processes are in drum or batch type mixing. Larger operations are: the ORNL hydrofracture facility for liquid waste (which is no longer operational), the K-25 Sludge Fixation Facility, the SRS Saltcrete plant, the Hanford Grout Treatment Facility, PREPP at INEL, and West Valley's grout facility.

Information is also provided on the use of grouts in the UK, France, Germany, Korea, Japan, Finland, and Taiwan.

2. NATIONAL

2.1 OAK RIDGE NATIONAL LABORATORY HYDROFRACTURE FACILITY

The concept of fluid waste disposal by hydraulic fracturing was borrowed from the petroleum industry and developed at ORNL for the disposal of liquid low-level waste (LLLW). The original pilot plant was modified into an operational facility and was used from 1966 to 1979 to routinely dispose of liquid waste.

In the mid-1970s, a new facility was built that was capable of processing both liquids and sludges. This facility was completed in 1981 and operated until 1984. The facility is described in "Conceptual Design Report New Hydrofracture Facility," by H. O. Weeren et al. (ORNL/TM-4826, July 1975) and in "Design Criteria for New Hydrofracture Facility," Project No. 78-18-d X-OE-57. For mix design and other details please refer to reports listed in literature search.

The facility is no longer used to dispose of waste at ORNL.

2.2 SLUDGE FIXATION FACILITY AT THE K-25 SITE

In the mid-1980s, a concrete batch plant surplused from the Clinch River Breeder Reactor (CRBR) Project was modified for solidifying a variety of pond sludges at the Oak Ridge K-25 Site, previously known as the Oak Ridge Gaseous Diffusion Plant (ORGDP).

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This plant experienced a variety of problems and presently is not operating. These problems are described in reports provided to Westinghouse Hanford Company in the first quarter of FY 1991 and will not be repeated here.

2.3 ORNL HLW CONCRETES FORMED UNDER ELEVATED TEMPERATURE AND PRESSURE

ORNL developed cement-based waste hosts that were formed under elevated temperatures and pressures, (FUETAP). FUETAP concretes were shown to be effective hosts for high-level radioactive defense waste and may even be considered for commercial HLW applications. The tailored formulas developed at ORNL were prepared from common portland cement, fly ashes, sand, and clays with wastes like calcines, frits, and sludges. These concretes are provided by an accelerated cure under mild autoclave conditions (85-200°C, 0.1-1.5 Mpa) for up to 24 h. The solids are subsequently dewatered at 250°C or 24 h to remove the unbound pore water.

The resulting products were strong (unconfined compressive strengths of 40-60 MPa), leach resistant (plutonium leaches at a rate of 10 $pg/cm^2 \cdot d$), and radiolytically stable, monolithic waste forms (total gas G-values of 0.005 molecule/100 eV). This study concluded that these dewatered, autoclaved, cement-based waste hosts were suited for the disposal of HLW.

Since 1981, no further development studies have been conducted at ORNL, and the DOE defense community has no plans to continue this work. However, a 1984 study by GA Technologies chose FUETAP as a potential process to stabilize High Temperature Gas Reactor (HTGR) fuel pellets. This study reaffirmed the cost-effectiveness of using cement-based waste forms and is the basis for a continuing development program. GA will use this ORNL process to perform a demonstration with unirradiated HTGR fuel pellets, and perhaps irradiated fuel from the Fort St. Vrain reactor.

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A report "Cement-Base Radioactive Hosts Formed Under Elevated Temperatures and Pressures (FUETAP Concretes) for Savannah River High-level Defense Waste," ORNL/TM-8579, March 1983, is included.

2.4 IDAHO NATIONAL ENGINEERING LABORATORY PROCESS EXPERIMENTAL PILOT PLANT (PREPP)

During the early 1980s, INEL embarked on an effort to develop a facility to treat past and future TRU solid waste at the INEL in order to certify it for disposal at the Waste Isolation Pilot Plant (WIPP).

The concept was to shred, incinerate, and solidify noncombustibles and ash residues in a cement matrix.

A report prepared by Ralph M. Parsons Co., "Study Report for RWMC Process Experimental Pilot Plant Cementing," is included. This report contains the results of a study on grout mixtures, mixing equipment, and methods to be used in the Process Experimental Pilot Plant (new building) conceptual design. Even though this report was prepared in the 1980-81 timeframe, it is still a valid document.

This report assumed a new building. INEL chose to build the facility in an existing building. The facility never became operational and is being closed out during FY 1991.

Also, included is "Conceptual Design Criteria for TAN:-5/607 Process Experimental Pilot Plant (PREPP) by EG&G Idaho, Inc.

2.5 SOILCRETE AT INEL

In the mid 1980s, INEL considered solidifying contaminated soil in a cement-based matrix. Mix design was performed at the Oak Ridge National Laboratory. No funds were appropriated for plant design.

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A report entitled "Grout Testing and Characterization for Shallow-Land Burial Trenches at the Idaho National Engineering Laboratory," ORNL/TM-9881, October 1986, is included.

2.6 SAVANNAH RIVER SITE (SRS)

SRS chose a cement-based matrix to solidify contaminated salt for disposal. This matrix is called saltstone and is described in the following handout provided by SRS. For additional information, see literature search and proceedings of Spectrum '88 folder which is included.

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2.7 ROCKY FLATS PLANT (RFP)

The Rocky Flats Plant, together with Quadrex, Inc., took a novel approach with some of their TRU streams that are difficult to process with standard processing equipment. Quadrex developed a processing technique that fluidizes both waste and cement-based components with an inert volatile halocarbon carrier, i.e., the "Inert Carrier Concrete process." This process is described in Dole and Row's "Development Programs in the United States of America for the Application of Cement-Based Grouts in Radioactive Waste Management." A copy of the report is included.

2.8 PONDCRETE

RFP chose to fix some of their pond sludge in a cement-based matrix. The waste form failed to meet necessary criteria. No report is available.

2.9 MOUND LABORATORY (ML) WASTE PELLETIZATION PROCESS DEMONSTRATION

Mound Laboratory (ML) developed a TRU waste immobilization method for the ML cyclone-incinerator ash, sludges, salt residues, and contaminated soil. The Materials Research Laboratory (MRL) at the Pennsylvania State University had shown that strong, dense, and

impermeable cement-based waste forms could be formed with radioactive wastes at moderate temperatures and high pressures [150-250°C and 177-344 Mpa (25,000-50,000 psi)]. Subsequently, ML developed and demonstrated a process that pressed 1 in.-diam pellets of waste and Portland cement at 177 Mpa (25,000 psi). This process was demonstrated with "hot" materials in 1982 and the leaching and radiolysis characteristics were studied and documented. Since 1982, no further development has been done, and there are no current applications of this technology.

2.10 HANFORD, WASHINGTON

In Fy 1983, waste management officials at the Hanford site chose cement-based grout as the method for fixation and disposal of low-level radioactive waste. This facility, first called the transportable grout facility (TGF) now the Grout Treatment Facility (GTF) has many features in common with the SRS Saltstone Process and ORNL's Hydrofracture Facility. It was developed in conjunction with PNL and ORNL. Both institutions continue to contribute to the GTF effort at Hanford. This facility is best described in a paper entitled "The Grout Treatment Facility Processing Facilities for Low-Level Waste Immobilization and Disposal" by R. H. Guyman et al. A copy of this paper is included (In the folder labeled Proceedings of Spectrum '88). Several other reports that discuss formulation development for a variety of waste streams are included.

2.11 WEST VALLEY DEMONSTRATION PROJECT

The West Valley Demonstration Project selected cement as the solidification medium for the disposal of liquid and wet solid low-level radioactive (LLW) as well as for transuranic (TRU) waste. The system is designed around a high-shear cement mixing system. The process is described in the paper by J. C. Cwynar et al., "Retrofit of Low-Level Radwaste Solidification System," which is included.

3. INTERNATIONAL

3.1 UNITED KINGDOM

British Nuclear Fuels, Ltd. (BNFL) is building encapsulation plants at Sellafield that will contain intermediate level waste (ILW) by encasing it first in cement then inside steel drums. The long-term solution adopted by BNFL is to store the encapsulated waste on site until the commissioning of permanent storage facilities. This facility was visited by Randy Roberts, WHC, in June 1989.

A more complete description is given in "Report of Foreign Travel" by Earl McDaniel (ORNL/FTR-3114, November 1988) which is included).

Also, included is "Flowsheet Finalization for Immobilization of SGHWR Wastes" by D. J. Lee, AEEW-R-1693, Mach 1983.

3.2 FRANCE

France uses a cement matrix to solidify a variety of waste. To my knowledge all processes are in drum mixing. Several papers are included in Spectrum '86 and '88 folders.

Also, included is a brochure describing ANDRA, the French government agency for managing radioactive waste.

3.3 GERMANY

German law requires that all radioactive waste be disposed of in a geologic repository. German waste is classified as heat producing, which will be disposed of in a salt mine, and non-heat producing, which will be disposed of in an iron mine. All radioactive waste in Germany is the result of nuclear utilities and institutional use. Germany has abandoned its plans for a fuel

reprocessing facility. Randy Roberts visited the KFK Facility at Karlshrue in June 1989. Please see his Foreign Trip Report for details.

A shred-grout facility for Alpha waste exists at NUKEM's Hanau plant. I am unable o find a paper describing this facility.

Several papers from Germany are included in the Spectrum '86 and '88 folders.

3.4 JAPAN

Japan has a very active nuclear energy program and, therefore, a very aggressive waste management effort. This program is best described in two enclosed documents:

1. Low-Level Radwaste Disposal Concepts in Japan
2. Outline of Radioactive Waste Management Center

Several papers related to Japan's waste disposal program are included in the Spectrum folders.

3.5 SOUTH KOREA

Even though South Korea has a very aggressive nuclear power program, little has been accomplished in efficient waste management. Most of the waste solidification systems are either bitumen or cement and have been bought from U.S. companies. A brochure "Nuclear Industry in the Republic of Korea" is included.

3.6 REPUBLIC OF CHINA (TAIWAN)

The Republic of China has a very aggressive nuclear energy development program. Their waste management practices are some of the safest in the world. A paper describing the National LAN-YU storage sites is included.

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3.7 FINLAND

Finland has two nuclear power plants, one of western design and one of USSR design. In Finland, all radioactive waste will be disposed of in an on-site repository. The Finnish program is described in the enclosed document "Radioactive Waste Management in Finland" (Status Report, August 1988). Also, included is a paper "Half -Scale Cementation of Spent Ion-Exchange Resins at the Louiisa Plant," by A. O. Dpatti, and "Disposal of Low and Intermediate Level Waste in Finland" by Esko Ruakola.

4.0 OTHER INFORMATION

A three volume report on Low-Level Waste from Commercial Nuclear Reactors is included:

Part 1. Open Literature Abstracts for Low-Level Waste, ORNL/TM-9846/V3-P1

Part 2. Bibliographic Abstracts of Significant Source References, ORNL/TM-98446/V3-P2

Part 3. Treatment, Storage, Disposal and Transportation Technologies and Constraints, ORNL/TM-9846/V2

Also, included is A. H. Kibbey and H. W. Godbee's report entitled "A State-of-the-Art Report on Low-Level Waste Treatment," ORNL/TM-7427, September 1980.

5.0 LITERATURE REVIEW

A draft report by A. J. Mattus, "A Literature Review of Potential Candidate Fixation Mediums for the Immobilization of Low-Level Waste," October 1985, is included.

A literature search by Earl W. McDaniel is included which lists 55 titles. Many of the reports and papers are being transferred to WHC as part of this milestone.

STRATEGIC PLANNING DOCUMENT

This document summarizes the process which will lead to an integrated strategy and associated implementation plan for LLW management on the ORR. It is not intended to be a final summary of actions needed to address the management of LLW on the ORR.

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APPENDIX F

THERMOSETTING POLYMER TEST RESULTS

Contained under four reports:

WHC Trip Report — Test Status (1)
Thermosetting Polymer Test Report (2) — Stock Equipment Company
Thermosetting Polymer Test Report (3) — Stock Equipment Company
Thermosetting Polymer Test Report (4) — Stock Equipment Company

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THERMOSETTING POLYMER TEST RESULTS

DON'T SAY IT --- *Write It!*

DATE: September 21, 1992

TO: C. A. Petersen
J. A. Swenson

FROM: Dewey A. Burbank, Jr.
Telephone: 2-0855

cc: C. J. Benar
D. L. Lamberd
D. R. Lucas
T. R. Pauly
J. G. Riddelle
W. R. Swita
K. M. Weingardt
J. L. Westcott
T. L. Yount

SUBJECT: Trip Report - Stock Equipment Company, Chagrin Falls, OH, 9/16/92

Attendees: Dewey Burbank, WHC
Rich Henkel, UE&C
Bill Phillips, Stock
Fred Podmore, Stock

The attendees met for breakfast and drove to the Stock Equipment Company facility in the Bainbridge district near Chagrin Falls. A brief meeting was held, where Stock reviewed the progress to date. Successful formulations have been developed for waste surrogates type 1 (LETF salts, ammonium sulfate) and type 3 (183H basin sludge, high nitrate), but problems have been encountered with types 2 (Basin sludge, nitrate/sulfate) and 4 (basin crystalline solids, high sulfate). The suspected reason is the presence of ionic copper in the surrogates. It was explained that transition metal ions are an inhibitor to the polymerization reaction due to thier ability to scavenge the free radicals that propogate the solidification reaction. Presumably, the copper in type 3 surrogate is in the non-ionic cupric oxide form.

Following a brief tour of the manufacturing facilities, we went to the laboratory to prepare the test specimens from types 1 and 3 surrogate, as well as a set of control specimens of neat polymer (zero waste loading). A total of 54 specimens were poured for each immobilization batch. The test specimen molds were made of polypropylene pipe sections, approximately 2 inches long by 1 inch inside diameter, glued to a plastic base.

Batch #1 was the control batch. The formulation for this batch was:

Binder, 5000 grams
Catalyst, 125 grams
Promoter, 5 grams

The batch was mixed in a plastic bucket using a Lightning lab mixer. A specimen was transferred to a paper cup for measurement of the exotherm, while the remainder was used to pour the test specimens. The batch began to gel after only about 20 specimens had been poured. It was decided that although

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the statement of work requires all specimens to be prepared from a single batch, this was not critical for the control specimens and preparation of the rest of the control samples could be completed later.

Batch #2 was the Type 1 surrogate LETF salt. The formula for this batch was:

Binder, 2000 grams
Catalyst, 50 grams
Promoter, 2 grams
Surrogate, 4000 grams
Spiking salts:
- Cobalt Chloride, 61.08 grams
- Strontium Chloride, 46.04 grams
- Cesium Chloride, 19.17 grams

The promoter and binder were mixed, then the spiking salts were added. The salts did not appear to get mixed very well, due to the small size of the mixer and large batch container size. the surrogate was then added in portions, until roughly halfway through, when the mixer stalled several times. After this point, mixing was only possible in the top few inches of the batch, since the mixer would stall if it was submerged more than about 2 to 3 inches. After about 20 minutes, the entire quantity of surrogate had been added, and the catalyst was added in two portions. The mix was then scooped into the specimen molds. A portion of the mix was placed in a paper cup for measurement of the exotherm.

Batch #3 was Type 3 surrogate basin sludge. The formula for this batch was the same as for Type 1 surrogate above. The mixing procedure was the same, with the exception that the spiking salts were added directly into the surrogate and mixed with a spatula, due to the semi-liquid consistency of the surrogate. No mixing problems were encountered, and the mixture was poured into the specimen molds and a paper cup for exotherm measurement.

After breaking for lunch, we met in the conference room to discuss the details of the formulation development work for types 2 and 4 surrogate. Various techniques had been attempted, including increasing the amount of promoter added, adding ammonium solutions to complex the copper, mixing types 1 and 2, changing the waste loading, roasting the surrogate, and changing order of addition of the polymer reagents and the waste. None of these techniques were successful. Detailed laboratory notes are attached, and the first progress report from Stock will include further discussion of this work.

After reviewing the results of the formulation work, we concluded that two additional attempts should be tried. The first test involves adjusting the pH of the surrogate type 2 to around 10. This should result in a surrogate that more closely resembles the pH of the actual waste. In the second test, a mixture of sodium fluoride and sodium sulfate will be processed to examine the possibility that fluoride may be interfering with the polymerization reaction. Verbal authorization to proceed with these trials was given by WHC.

Following the discussion of the polymer formulation development work, we were presented with information on Stock's equipment development work for in-drum mixing equipment, using preloaded waste and double planetary mixer equipment.

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The technology appears to be a very close match with the current conceptual design for WRAP 2A and this development work should be followed closely.

CONCLUSIONS

The formulation development work that Stock is performing is proceeding more slowly than expected for the type 2 and type 4 surrogates, due to apparent chemical interactions between the surrogate materials and the polymer system chemistry. Several different techniques have been attempted to address the problem, with no success. The interaction inhibits the polymerization reaction, resulting in a waste form with compressive strength below the acceptance criterion of 60 psi. Limited additional development work has been authorized to investigate the effects of surrogate pH and fluoride content on the final waste form. Successful formulations have been developed for type 1 and type 3 surrogates. Test specimens have been prepared and testing is proceeding as planned.

We observed three incidents that would indicate improvements could be made in the quality of the work being performed. First, the development work was performed under an erroneous identification of the waste types; the Stock technician had mistakenly transposed the identities of types 3 and 4 surrogates. Secondly, the unexpectedly quick gelling of the control batch indicates that not enough work had been done with this formula to realize that there would not be enough time to pour all of the specimens. Thirdly, the laboratory mixer used for mixing of Batch #2 (waste type 1) appeared to be inadequate to assure that a homogeneous mixture was obtained in the batch size used for specimen preparation.

The manufacturing facilities are quite modern, with state-of-the-art digitally controlled machine tools and fabrication capabilities. The machine design and fabrication capabilities are resources that should be considered for possible use in fabrication of WRAP facilities specialty mechanical equipment.

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CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
CZELLATH RA/STOCK	BURDANK DA/WHC	9205858

Subject: STOCK POLYMER IMMOBILIZATION TECH. WASTE FORM QUALIFICATION TESTING PURCHASE ORDER NO. MMW-SVV-277587 STOCK REFERENCE NO. 6996

MANAGEMENT			PROJECT ENGINEERING			WRAP PROJECT CONTROL		
JA Swenson	G6-46	X	TA Carlson	G6-46		KP Brown	G6-47	
DE Ball	G6-46		AW Hinkle	G6-46		SE Bussman	G6-47	
SR Briggs	G6-47		FH Lee	G6-46		C Malstrom	G6-47	
JE Filip	G6-47	X	JB Payne	G6-46		SW McKinley	G6-47	
DR Lucas	G6-46	X	JG Starkey	G6-46		GC Rice	G6-47	
CA Petersen	H1-60	X	WR Swita	G6-46	X	BL Trumpour	G6-47	
TL Yount	H1-60	X	RR Wyer	G6-46	X			

WRAP TECHNOLOGY			SW SYSTEMS ENGINEERING			SW SYSTEMS ENGINEERING		
CJ Benar	H1-60	X	EG Berglin	G6-46		VP Ocampo	G6-46	
DA Burbank	H1-60	X	KJ Hull	G6-46		DT Ruff	G6-46	
BF Campbell	H1-60		RM Horgus	H1-60		RA Sexton	H1-60	
JD Keck	G6-46		SL Kooiker	G6-46		JR Weber	G6-46	
CE McDonald	H1-60		DL Lamberd	H1-60		JR Weidert	G6-46	
JL Nelson	H1-60		ML Lee	G6-46		RH Winkleman	G6-46	
KE Parker	H1-60		KJ Leist	G6-46		A Zabarauskas	G6-46	
RM Ybarra	H1-60		NJ Monroe	H1-60				

SW INTEGRATION			SW PROJECTS			SUPPORT		
GF Booth	G6-46		DR Broz	G6-46		Corr Control		X
MD LeClair	H1-60	X	ML DeWitt	G6-46		WRAP DMC	G6-51	X
DW Mertz	H1-60		EG Erpenbeck	G6-46		JR McGee	G6-47	
CR Nash	H1-60		TM Greager	G6-46		E Pennala	E2-30	
TR Pauly	G6-46	X	RL Louie	G6-46		DR Porten	G6-47	
JL Stroup	G6-46		KE Smith	G6-46		JM Seimer	G6-47	
KM Weingardt	H1-60	X	HE Wellsfry	G6-46		WW Olson	N1-83	

SECRETARIES			PROGRAMS			OTHERS		
RL Anderson	G6-45		RJ Roberts	N3-13		DA Smith	G6-16	X
AI Ball	H1-60		JG Riddelle	H1-79	X			
BJ Gire	G6-46		BA Mayancsik	H1-79				
SA Niebel	G6-46		MM McCarthy	N3-13				
			JB Myers	G6-46				

QA RECORD ____ YES ____ NO

COMMENTS TO LEAD ENGINEER BY: _____

SPECIAL INSTRUCTIONS: _____

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STOCK

October 15, 1992

Westinghouse Hanford Company
2355 Stevens Drive
Richland, Washington 99352

Attention: Mr. Dewey Burbank, H1-60

Subject: STOCK Polymer Immobilization Tech.
Waste Form Qualification Testing
Purchase Order No. MMW-SVV-277587
Stock Reference No. 6996

Gentlemen:

Enclosed please find a copy of our Progress Report No. 2 for the subject project. This report represents progress through September, 1992.

Should additional information be required, please advise.

Very truly yours,

Russell A. Czellath
Manager-Contracts

RAC/kh
Enclosure

c: Westinghouse Hanford - Attn: G.M. Wemhoff, Buyer
S.O. 6996
T. Litchney
Tickler 11/1/92 w/report

RECEIVED
WRAP DMC
OCT 2 1 1992

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Stock Equipment Company • 16490 Chillicothe Road • Chagrin Falls, Ohio 44022-4398, U.S.A. • (216) 543-6000 • Telex 196071
A Unit of General Signal Telefax (216) 543-6678

WESTINGHOUSE HANFORD COMPANY

STOCK EQUIPMENT CO.

POLYMER IMMOBILLIZATION TECH.

WASTE FORM QUALIFICATION TESTING

9413221.0950

MONTHLY PROGRESS REPORT

NO. 2

THROUGH SEPTEMBER, 1992

Stock Equipment Company

Westinghouse Hanford Purchase Order No. MMW-SVV-277587

Stock Order No. 6996

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PROGRESS REPORT
SEPTEMBER 1992

1.0

SUMMARY

Define "Waste Loading" " wt% waste / wt Total ?

Week Number 1

Primary effort concentrated on optimizing waste loading of the four different surrogate waste forms. Type 1 LETF Salts successfully solidified at a loading ratio of 2:1 waste to polymer. Initial formulations for Type 2 (Basin #1, #2 Sludge) and Type 4 (Basin Crystal Solids) proved inconclusive. Successful solidification of Type 3 (Basins #3, #4 Sludge) at a loading ratio of 2:1 waste to polymer was achieved.

Below is a synopsis of the experiments to achieve polymer/Type 2 waste (Basin #1, #2 Sludge) solidification:

1. Reduced waste loading to 0.5:1 waste to polymer ratio.

2. Increased the amount of promotor to forty times the required amount.

3. Increased the amount of catalyst to twice the required amount, along with an increase in promotor (20 times).

4. Changing the sequence of addition (the standard way would be polymer and promotor mixed together first, add waste and mix, add the catalyst and finish mixing) the promotor and polymer were mixed first then catalyst was added and "mixed in" the waste.

5. Attempted mixing Type 1 and Type 2 waste together (equal weight ratios 1:1).

6. Experimented with ammonia water as a corrective additive to induce this type of waste to solidify.

These experiments produced unacceptable results. The samples gelled but did not get "rock hard".

All leach containers and bottles were acid rinsed in preparation for the leachability and immersion testing. The core samples were prepared. Fifty liter carboys of demineralized water and synthetic sea water were prepared.

Wednesday, September 16, 1992

Mr. Dewey Burbank, Westinghouse Hanford, and Mr. Richard Henkle, United Engineers & Constructors, visited Stock to observe the preparation of samples to be tested. In the morning they witnessed the making of the polymer control; Type 1 LETF Salts and Type 3 Basins #3,#4 Sludge. In the afternoon we discussed the complications with Type 2 and Type 3 surrogate waste streams

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and the following two-fold course of action for further testing of these waste streams.

1. Adjust the pH of Type 2 waste stream to 10.5 and then proceed with solidification. Actual pH of Type 2 waste was 3.5. Mr. Burbank indicated that the pH should be between 10 and 11. He also indicated that the color of the waste stream should be black and appear like surrogate waste stream Type 3.

2. Initially, copper ions were thought to be interfering with the polymerization of the polymer since we were able to solidify Type 3 waste (concentration of copper equal 112,000 ppm or 11.2%) and not able to solidify Type 4 waste which has less copper. The next consideration was that there is an interference from fluoride ion. We discussed trying a hydrated salt (sodium sulfate $10H_2O$) and adding 7% fluoride ion to it. Once the fluoride ion is evenly distributed in the sodium sulfate, try to solidify in polymer resin. This test is designed to indicate if the fluoride will inhibit polymerization. If it does, we can concentrate on isolating the fluoride or try to prevent it from interfering in the polymerization.

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Thursday, September 17, 1992

Control samples for the leachability/immersion testing were made. These samples will not contain any spiking salts.

Saturday, September 19, 1992

Samples were prepared for the leachability/immersion part of the testing. Weights, heights and diameters were recorded and the surface area of the samples were calculated so that the appropriate amount of leachant solution could be poured for the various time points. Leachant was poured for the following time points: 30 second rinse, 2 hours, 7 hours and 24 hours.

Monday, September 21, 1992

The leachability/immersion test was started at approximately 8:30 AM. Time points have been collected for the 30 second rinse, 2 hours, 7 hours, 24 hours, 2 days, 3 days, 4 days and 5 days. The specimens are currently in the 18 day segment of the test.

Samples were also taken for compressive strength testing.

Week of September 29, 1992

Analysis of the leach samples began.

2.0 SCHEDULE

Activity	Scheduled Date	Actual Date
- Prepare Work Plan	08/01/92	08/01/92
- Submit Work Plan	08/01/92	08/01/92
- Approve Plan	08/10/92	08/10/92
- Develop Formulations	08/21/92	08/21/92
- Prepare Specimens	09/01/92	09/16/92
- Lab - Analysis	12/10/92	
- Final Report	12/23/92	

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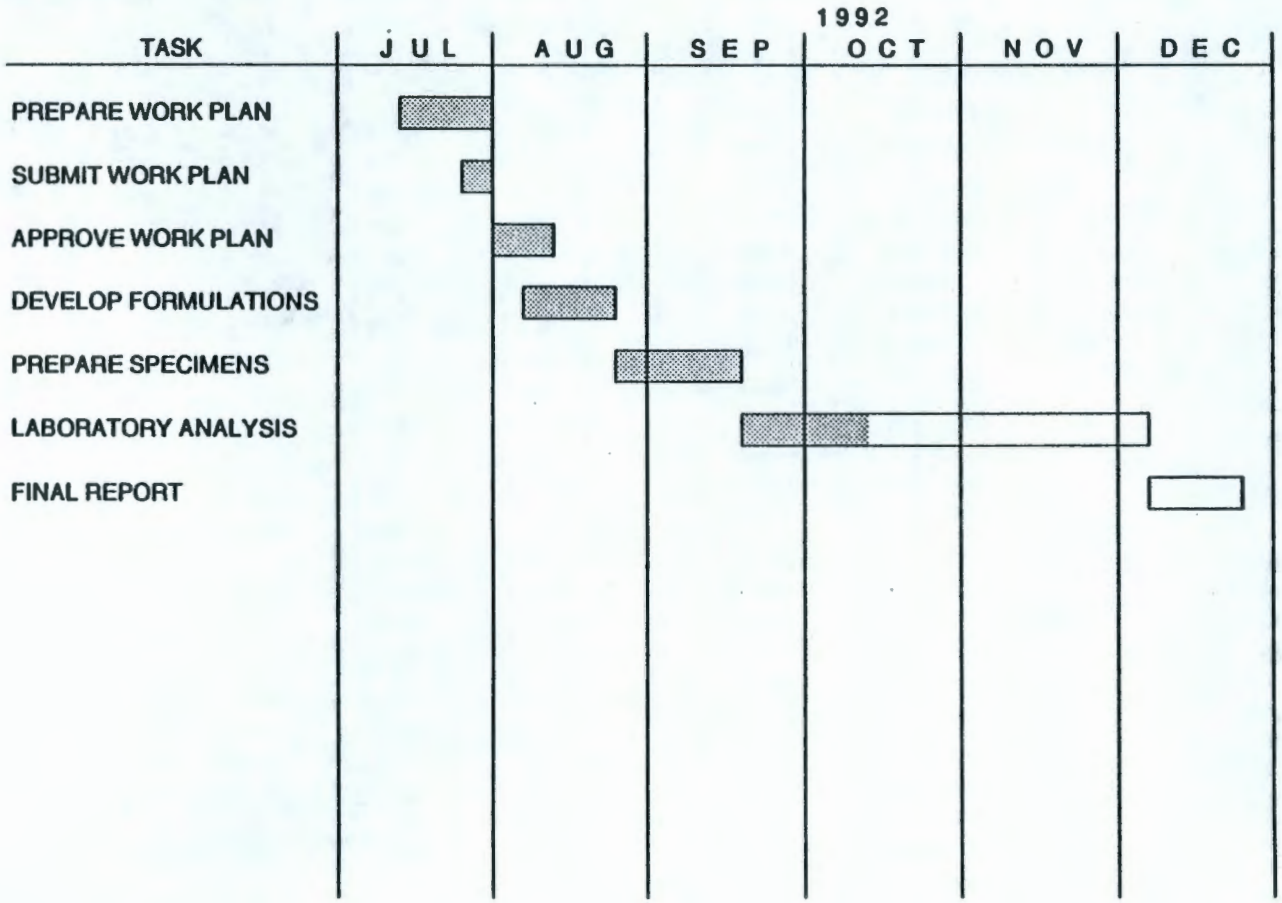
STOCK EQUIPMENT COMPANY

14-Oct-92

PROJECT SCHEDULE
WESTINGHOUSE
HANFORD COMPANY
P.O. MMW-SVV-277587
STOCK ORDER: 6996

MONTHLY PROGRESS REPORT

PREPARED BY: RUSS A. CZELLATH



sample#	WEIGHT grams	HEIGHT cm	DIAMETER cm	DENSITY grams/cc	AVG.	LOAD LBS	PSI five day compressive strenght	AVG.
L1-1	51.4	4.54	3.612	1.104897		17160	10804.37	
L1-2	58.8	5.116	3.612	1.12166		17160	10804.37	
L1-3	51	4.502	3.609	1.107391		17120	10797.11	
L1-4	55.3	4.869	3.611	1.109023		17360	10936.35	
L1-5	51.7	4.483	3.611	1.1261		17360	10936.35	
L1-6	58.9	5.024	3.609	1.146046	1.12	17400	10973.7	10926
L1-7	56.3	4.923	3.611	1.116693		17480	11011.94	
L1-8	54.9	4.798	3.611	1.117759		17480	11011.94	
L1-9	56.3	4.991	3.607	1.103923		17520	11061.64	
L1-10	56.7	4.968	3.609	1.115675		17320	10923.25	
L3-1	73.9	5.112	3.618	1.406134		3520	2208.936	
L3-2	72.5	5.23	3.616	1.349863		3600	2261.639	
L3-3	71.9	5.1	3.614	1.374335		3680	2314.457	
L3-4	71.1	5.067	3.678	1.320704		4320	2623.239	
L3-5	73.3	5.245	3.663	1.326156		4240	2595.79	
L3-6	71.7	5.108	3.668	1.328372	1.33	4280	2613.14	2472
L3-7	67.1	5.024	3.68	1.255704		3920	2377.76	
L3-8	72.9	5.212	3.653	1.334547		4160	2560.776	
L3-9	71.2	5.065	3.683	1.319493		4400	2664.568	
L3-10	72.3	5.194	3.665	1.319467		4080	2495.11	
L7-1	77.2	5.001	3.614	1.504854		2480	1559.743	
L7-2	72.8	4.829	3.615	1.468817		2440	1533.737	
L7-3	76.4	4.837	3.617	1.5372		2400	1506.925	
L7-4	75.9	4.935	3.611	1.501792		1600	1007.958	
L7-5	73.1	4.976	3.632	1.417932		2440	1519.413	
L7-6	72.6	4.724	3.627	1.487448	1.48	2200	1373.742	1411
L7-7	77.4	5.017	3.632	1.489071		2240	1394.671	
L7-8	75.8	5.076	3.627	1.444746		2360	1473.65	
L7-9	76	5.017	3.614	1.476738		1800	1132.071	
L7-10	72.6	4.956	3.617	1.425668		2560	1607.387	

LEACH / IMMERSION SAMPLES

SAMPLE	WEIGHT grams	HEIGHT cm	DIAMETER cm	surface area cm2	volume ml's	density gms/cc	AVG
L1A1	54.5	4.941	3.607	76.4268	764.268	1.07944	
L1A2	54.9	4.932	3.609	76.3785	763.785	1.08814	
L1A3	54.4	4.837	3.609	75.3014	753.014	1.09941	1.1
L1B1	56	4.946	3.61	76.5641	765.641	1.10619	
L1B2	55.2	4.833	3.611	75.3091	753.091	1.11526	
L1B3	53.4	4.722	3.611	74.0499	740.499	1.10426	
L2A1	71.5	5.002	3.615	77.3345	773.345	1.39269	
L2A2	76.2	5.222	3.617	79.8886	798.886	1.42014	
L2A3	73.4	5.113	3.617	78.65	786.5	1.39712	1.4
L2B1	70.7	4.941	3.616	76.6686	766.686	1.39334	
L2B2	71.1	4.942	3.616	76.68	766.8	1.40094	
L2B3	75.4	5.218	3.617	79.8431	798.431	1.40631	
L3A1	76.1	5.116	3.615	78.6292	786.292	1.44926	
L3A2	71.5	5.002	3.616	77.3616	773.616	1.39192	
L3A3	76	5.11	3.72	81.4565	814.565	1.36841	1.41
L3B1	71.1	4.948	3.616	76.7482	767.482	1.39924	
L3B2	75.6	5.117	3.614	78.6131	786.131	1.44026	
L3B3	71.3	5.002	3.618	77.4157	774.157	1.3865	
L6A1	74.8	4.721	3.616	74.1694	741.694	1.54284	
L6A2	73.1	4.508	3.614	71.6987	716.987	1.58076	
L6A3	72.5	4.507	3.615	71.7129	717.129	1.56727	
L6B1	70.5	4.443	3.616	71.0114	710.114	1.54513	1.56
L6B2	70.8	4.443	3.616	71.0114	710.114	1.55171	
L6B3	75.7	4.724	3.616	74.2035	742.035	1.56041	
L7A1	78.3	4.94	3.616	76.6573	766.573	1.50401	
L7A2	83.7	5.008	3.616	77.4298	774.298	1.62748	
L7A3	75.5	4.94	3.616	76.6573	766.573	1.48824	
L7B1	78.4	4.945	3.618	76.7679	767.679	1.54214	1.52
L7B2	76.4	4.941	3.614	76.6149	766.149	1.50734	
L7B3	77	5.11	3.614	78.5337	785.337	1.46894	

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Sample ID L7A1
Element COBALT
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1914

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.001	0.0000	0.0000	0.0000	7.61E-16	15.1184
2			18000	25200	0.5	0.0004	0.0020	0.0020	2.51E-10	9.6003
3			61200	86400	1	0.0008	0.0040	0.0060	3E-10	9.5230
4			86400	172800	0.5	0.0004	0.0020	0.0080	9.25E-11	10.0341
5			86400	259200	0.4	0.0003	0.0016	0.0096	1E-10	9.9978
6			86400	345600	0.8	0.0006	0.0032	0.0128	5.66E-10	9.2475
7			86400	432000	1.2	0.0009	0.0048	0.0176	1.64E-09	8.7853
8			1382400	1814400		0.0000	0.0000	0.0176	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0176	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0176	0	ERR

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Sample ID L7A2
Element COBALT
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.221

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.2	0.0002	0.0008	0.0008	3.05E-11	10.5163
2			18000	25200	0.6	0.0005	0.0024	0.0032	3.61E-10	9.4419
3			61200	86400	1.3	0.0010	0.0052	0.0084	5.07E-10	9.2951
4			86400	172800	0.6	0.0005	0.0024	0.0108	1.33E-10	9.8757
5			86400	259200	0.5	0.0004	0.0020	0.0128	1.57E-10	9.8040
6			86400	345600	0.9	0.0007	0.0036	0.0164	7.16E-10	9.1452
7			86400	432000	1.3	0.0010	0.0052	0.0216	1.92E-09	8.7157
8			1382400	1814400		0.0000	0.0000	0.0216	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0216	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0216	0	ERR

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Sample ID L7A3
Element COBALT
Matrix DI WATER

S.A.	V	Ao
76.7	50.7	0.1903

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.2	0.0002	0.0008	0.0008	3.05E-11	10.5163
2			18000	25200	0.4	0.0003	0.0016	0.0024	1.61E-10	9.7941
3			61200	86400	1.4	0.0011	0.0056	0.0080	5.88E-10	9.2307
4			86400	172800	0.5	0.0004	0.0020	0.0100	9.25E-11	10.0341
5			86400	259200	0.3	0.0002	0.0012	0.0112	5.65E-11	10.2477
6			86400	345600	1.1	0.0008	0.0044	0.0156	1.07E-09	8.9709
7			86400	432000	1.1	0.0008	0.0044	0.0200	1.38E-09	8.8608
8			1382400	1814400		0.0000	0.0000	0.0200	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0200	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0200	0	ERR

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Sample ID L7B1
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.8	50.8	0.1976

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.1	0.0001	0.0004	0.0004	7.61E-12	11.1184
2			18000	25200	0.3	0.0002	0.0012	0.0016	9.04E-11	10.0440
3			61200	86400	1.3	0.0010	0.0052	0.0068	5.07E-10	9.2951
4			86400	172800	0.3	0.0002	0.0012	0.0080	3.33E-11	10.4778
5			86400	259200	0.2	0.0002	0.0008	0.0088	2.51E-11	10.5999
6			86400	345600	1.1	0.0008	0.0044	0.0132	1.07E-09	8.9709
7			86400	432000	1.4	0.0011	0.0056	0.0188	2.23E-09	8.6514
8			1382400	1814400		0.0000	0.0000	0.0188	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0188	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0188	0	ERR

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Sample ID L7B2
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.6	50.7	0.1926

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.1	0.0001	0.0004	0.0004	7.61E-12	11.1184
2			18000	25200	0.1	0.0001	0.0004	0.0008	1E-11	10.9982
3			61200	86400	1.1	0.0008	0.0044	0.0052	3.63E-10	9.4402
4			86400	172800	0.1	0.0001	0.0004	0.0056	3.7E-12	11.4320
5			86400	259200	0.1	0.0001	0.0004	0.0060	6.28E-12	11.2020
6			86400	345600	1.1	0.0008	0.0044	0.0104	1.07E-09	8.9709
7			86400	432000	1.3	0.0010	0.0052	0.0156	1.92E-09	8.7157
8			1382400	1814400		0.0000	0.0000	0.0156	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0156	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0156	0	ERR

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Sample ID L7B3
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.5	52.4	0.1941

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.1	0.0001	0.0004	0.0004	7.61E-12	11.1184
2			18000	25200	0.2	0.0002	0.0008	0.0012	4.02E-11	10.3962
3			61200	86400	1.5	0.0012	0.0060	0.0072	6.75E-10	9.1708
4			86400	172800	0.2	0.0002	0.0008	0.0080	1.48E-11	10.8299
5			86400	259200	0.3	0.0002	0.0012	0.0092	5.65E-11	10.2477
6			86400	345600	1.2	0.0009	0.0048	0.0140	1.27E-09	8.8953
7			86400	432000	1.5	0.0012	0.0060	0.0200	2.56E-09	8.5914
8			1382400	1814400		0.0000	0.0000	0.0200	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0200	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0200	0	ERR

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Sample ID L7A1
Element CESIUM
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1924

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	15	0.0115	0.0600	0.0600	1.71E-07	6.7662
2			18000	25200	21	0.0161	0.0839	0.1439	4.43E-07	6.3538
3			61200	86400	43	0.0330	0.1719	0.3158	5.55E-07	6.2560
4			86400	172800	40	0.0307	0.1599	0.4756	5.92E-07	6.2279
5			86400	259200	26	0.0199	0.1039	0.5795	4.25E-07	6.3720
6			86400	345600	20.9	0.0160	0.0835	0.6631	3.86E-07	6.4134
7			86400	432000	24.8	0.0190	0.0991	0.7622	7E-07	6.1547
8			1382400	1814400		0.0000	0.0000	0.7622	0	ERR
9			2160000	3974400		0.0000	0.0000	0.7622	0	ERR
10			3888000	7862400		0.0000	0.0000	0.7622	0	ERR

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Sample ID L7A2
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.211

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	16	0.0123	0.0639	0.0639	1.95E-07	6.7101
2			18000	25200	24	0.0184	0.0959	0.1599	5.78E-07	6.2378
3			61200	86400	58	0.0445	0.2318	0.3917	1.01E-06	5.9961
4			86400	172800	56	0.0430	0.2238	0.6155	1.16E-06	5.9356
5			86400	259200	38	0.0291	0.1519	0.7674	9.07E-07	6.0424
6			86400	345600	27.9	0.0214	0.1115	0.8789	6.88E-07	6.1625
7			86400	432000	22.5	0.0173	0.0899	0.9688	5.76E-07	6.2393
8			1382400	1814400		0.0000	0.0000	0.9688	0	ERR
9			2160000	3974400		0.0000	0.0000	0.9688	0	ERR
10			3888000	7862400		0.0000	0.0000	0.9688	0	ERR

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Sample ID L7A3
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
76.7	50.7	0.1903

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	12	0.0092	0.0480	0.0480	1.1E-07	6.9600
2			18000	25200	18	0.0138	0.0719	0.1199	3.25E-07	6.4877
3			61200	86400	47	0.0360	0.1879	0.3078	6.63E-07	6.1788
4			86400	172800	41	0.0314	0.1639	0.4716	6.22E-07	6.2064
5			86400	259200	25	0.0192	0.0999	0.5716	3.93E-07	6.4061
6			86400	345600	21.1	0.0162	0.0843	0.6559	3.93E-07	6.4051
7			86400	432000	20.7	0.0159	0.0827	0.7386	4.88E-07	6.3117
8			1382400	1814400		0.0000	0.0000	0.7386	0	ERR
9			2160000	3974400		0.0000	0.0000	0.7386	0	ERR
10			3888000	7862400		0.0000	0.0000	0.7386	0	ERR

9413221.0960

DATE OCT 12 1992

Sample ID L7B1
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.8	50.8	0.1976

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	11	0.0084	0.0440	0.0440	9.21E-08	7.0356
2			18000	25200	14	0.0107	0.0560	0.0999	1.97E-07	6.7060
3			61200	86400	23	0.0176	0.0919	0.1918	1.59E-07	6.7995
4			86400	172800	23	0.0176	0.0919	0.2838	1.96E-07	6.7086
5			86400	259200	15	0.0115	0.0600	0.3437	1.41E-07	6.8498
6			86400	345600	10.8	0.0083	0.0432	0.3869	1.03E-07	6.9868
7			86400	432000	9.5	0.0073	0.0380	0.4249	1.03E-07	6.9882
8			1382400	1814400		0.0000	0.0000	0.4249	0	ERR
9			2160000	3974400		0.0000	0.0000	0.4249	0	ERR
10			3888000	7862400		0.0000	0.0000	0.4249	0	ERR

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Sample ID L7B2
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	50.7	0.1926

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	10	0.0077	0.0400	0.0400	7.61E-08	7.1184
2			18000	25200	13	0.0100	0.0520	0.0919	1.7E-07	6.7704
3			61200	86400	20	0.0153	0.0799	0.1719	1.2E-07	6.9209
4			86400	172800	22	0.0169	0.0879	0.2598	1.79E-07	6.7472
5			86400	259200	12	0.0092	0.0480	0.3078	9.04E-08	7.0436
6			86400	345600	9.5	0.0073	0.0380	0.3457	7.98E-08	7.0982
7			86400	432000	9.6	0.0074	0.0384	0.3841	1.05E-07	6.9791
8			1382400	1814400		0.0000	0.0000	0.3841	0	ERR
9			2160000	3974400		0.0000	0.0000	0.3841	0	ERR
10			3888000	7862400		0.0000	0.0000	0.3841	0	ERR

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Sample ID L7B3
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
78.5	52.4	0.1941

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	12	0.0092	0.0480	0.0480	1.1E-07	6.9600
2			18000	25200	13	0.0100	0.0520	0.0999	1.7E-07	6.7704
3			61200	86400	21	0.0161	0.0839	0.1839	1.32E-07	6.8785
4			86400	172800	20	0.0153	0.0799	0.2638	1.48E-07	6.8299
5			86400	259200	11	0.0084	0.0440	0.3078	7.6E-08	7.1192
6			86400	345600	10.3	0.0079	0.0412	0.3489	9.38E-08	7.0280
7			86400	432000	8.3	0.0064	0.0332	0.3821	7.84E-08	7.1055
8			1382400	1814400		0.0000	0.0000	0.3821	0	ERR
9			2160000	3974400		0.0000	0.0000	0.3821	0	ERR
10			3888000	7862400		0.0000	0.0000	0.3821	0	ERR

9413221.0961

DATE OCT 12 1992

Sample ID L7A1
Element STRONTIUM
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1924

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.38	0.0003	0.0015	0.0015	1.1E-10	9.9588
2			18000	25200	0.54	0.0004	0.0022	0.0037	2.93E-10	9.5335
3			61200	86400	0.9	0.0007	0.0036	0.0073	2.43E-10	9.6145
4			86400	172800	0.72	0.0006	0.0029	0.0102	1.92E-10	9.7173
5			86400	259200	0.87	0.0007	0.0035	0.0136	4.75E-10	9.3229
6			86400	345600	0.1	0.0001	0.0004	0.0140	8.84E-12	11.0537
7			86400	432000	0.007	0.0000	0.0000	0.0141	5.58E-14	13.2534
8			1382400	1814400		0.0000	0.0000	0.0141	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0141	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0141	0	ERR

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Sample ID L7A2
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.211

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.17	0.0001	0.0007	0.0007	2.2E-11	10.6575
2			18000	25200	0.33	0.0003	0.0013	0.0020	1.09E-10	9.9612
3			61200	86400	0.76	0.0006	0.0030	0.0050	1.73E-10	9.7613
4			86400	172800	0.41	0.0003	0.0016	0.0067	6.22E-11	10.2064
5			86400	259200	0.35	0.0003	0.0014	0.0081	7.69E-11	10.1138
6			86400	345600	0.15	0.0001	0.0006	0.0087	1.99E-11	10.7015
7			86400	432000	0.18	0.0001	0.0007	0.0094	3.69E-11	10.4331
8			1382400	1814400		0.0000	0.0000	0.0094	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0094	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0094	0	ERR

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Sample ID L7A3
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
76.7	50.7	0.1903

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.42	0.0003	0.0017	0.0017	1.34E-10	9.8719
2			18000	25200	0.22	0.0002	0.0009	0.0026	4.86E-11	10.3134
3			61200	86400	0.63	0.0005	0.0025	0.0051	1.19E-10	9.9243
4			86400	172800	0.57	0.0004	0.0023	0.0074	1.2E-10	9.9203
5			86400	259200	0.33	0.0003	0.0013	0.0087	6.84E-11	10.1649
6			86400	345600	0.4	0.0003	0.0016	0.0103	1.41E-10	9.8495
7			86400	432000	0.44	0.0003	0.0018	0.0120	2.2E-10	9.6567
8			1382400	1814400		0.0000	0.0000	0.0120	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0120	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0120	0	ERR

9413221.0962

DATE OCT 12 1992

Sample ID L7B1
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
76.8	50.8	0.1976

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.85	0.0007	0.0034	0.0034	5.5E-10	9.2595
2			18000	25200	1.23	0.0009	0.0049	0.0083	1.52E-09	8.8184
3			61200	86400	1.99	0.0015	0.0080	0.0163	1.19E-09	8.9253
4			86400	172800	1.43	0.0011	0.0057	0.0220	7.56E-10	9.1213
5			86400	259200	1.44	0.0011	0.0058	0.0277	1.3E-09	8.8852
6			86400	345600	0.79	0.0006	0.0032	0.0309	5.52E-10	9.2584
7			86400	432000	0.71	0.0005	0.0028	0.0337	5.74E-10	9.2411
8			1382400	1814400		0.0000	0.0000	0.0337	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0337	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0337	0	ERR

DATE OCT 12 1992

Sample ID L7B2
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	50.7	0.1926

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.99	0.0008	0.0040	0.0040	7.46E-10	9.1271
2			18000	25200	0.4	0.0003	0.0016	0.0056	1.61E-10	9.7941
3			61200	86400	1.87	0.0014	0.0075	0.0130	1.05E-09	8.9793
4			86400	172800	1.3	0.0010	0.0052	0.0182	6.25E-10	9.2041
5			86400	259200	1.07	0.0008	0.0043	0.0225	7.19E-10	9.1432
6			86400	345600	1.13	0.0009	0.0045	0.0270	1.13E-09	8.9475
7			86400	432000	0.94	0.0007	0.0038	0.0308	1.01E-09	8.9974
8			1382400	1814400		0.0000	0.0000	0.0308	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0308	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0308	0	ERR

DATE OCT 12 1992

Sample ID L7B3
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.5	52.4	0.1941

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	0.65	0.0005	0.0026	0.0026	3.22E-10	9.4925
2			18000	25200	0.39	0.0003	0.0016	0.0042	1.53E-10	9.8161
3			61200	86400	1.73	0.0013	0.0069	0.0111	8.98E-10	9.0469
4			86400	172800	1.1	0.0008	0.0044	0.0155	4.47E-10	9.3492
5			86400	259200	1.32	0.0010	0.0053	0.0207	1.09E-09	8.9608
6			86400	345600	1.03	0.0008	0.0041	0.0249	9.38E-10	9.0280
7			86400	432000	0.9	0.0007	0.0036	0.0285	9.22E-10	9.0351
8			1382400	1814400		0.0000	0.0000	0.0285	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0285	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0285	0	ERR

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Sample ID L3A1
Element COBALT
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1919

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	8.4	0.0064	0.0336	0.0336	5.37E-08	7.2698
2			18000	25200	7.5	0.0058	0.0300	0.0636	5.65E-08	7.2481
3			61200	86400	7.8	0.0060	0.0312	0.0947	1.82E-08	7.7388
4			86400	172800	10.7	0.0082	0.0428	0.1375	4.23E-08	7.3732
5			86400	259200	8.9	0.0068	0.0356	0.1731	4.98E-08	7.3032
6			86400	345600	9.2	0.0071	0.0368	0.2098	7.48E-08	7.1261
7			86400	432000	7.9	0.0061	0.0316	0.2414	7.11E-08	7.1484
8			1382400	1814400		0.0000	0.0000	0.2414	0	ERR
9			2160000	3974400		0.0000	0.0000	0.2414	0	ERR
10			3888000	7862400		0.0000	0.0000	0.2414	0	ERR

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Sample ID L3A2
Element COBALT
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1803

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	7.1	0.0054	0.0284	0.0284	3.84E-08	7.4159
2			18000	25200	6.3	0.0048	0.0252	0.0536	3.99E-08	7.3996
3			61200	86400	15.6	0.0120	C 0624	0.1159	7.3E-08	7.1367
4			86400	172800	11.4	0.0087	0.0456	0.1615	4.81E-08	7.3182
5			86400	259200	10	0.0077	0.0400	0.2014	6.28E-08	7.2020
6			86400	345600	9.9	0.0076	0.0396	0.2410	8.66E-08	7.0624
7			86400	432000	6.8	0.0052	0.0272	0.2682	5.26E-08	7.2786
8			1382400	1814400		0.0000	0.0000	0.2682	0	ERR
9			2160000	3974400		0.0000	0.0000	0.2682	0	ERR
10			3888000	7862400		0.0000	0.0000	0.2682	0	ERR

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Sample ID L3A3
Element COBALT
Matrix DI WATER

S.A.	V	Ao
81.5	55.5	0.1916

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	5.2	0.0040	0.0208	0.0208	2.06E-08	7.6864
2			18000	25200	6.1	0.0047	0.0244	0.0452	3.74E-08	7.4276
3			61200	86400	14.8	0.0114	0.0592	0.1043	6.57E-08	7.1824
4			86400	172800	10.2	0.0078	0.0408	0.1451	3.85E-08	7.4148
5			86400	259200	9.2	0.0071	0.0368	0.1819	5.32E-08	7.2744
6			86400	345600	12.6	0.0097	0.0504	0.2322	1.4E-07	6.8529
7			86400	432000	13	0.0100	0.0520	0.2842	1.92E-07	6.7157
8			1382400	1814400		0.0000	0.0000	0.2842	0	ERR
9			2160000	3974400		0.0000	0.0000	0.2842	0	ERR
10			3888000	7862400		0.0000	0.0000	0.2842	0	ERR

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Sample ID L3B1
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.6	50.8	0.1792

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	6.6	0.0051	0.0264	0.0264	3.32E-08	7.4793
2			18000	25200	6.8	0.0052	0.0272	0.0536	4.64E-08	7.3332
3			61200	86400	20	0.0153	0.0799	0.1335	1.2E-07	6.9209
4			86400	172800	19.4	0.0149	0.0775	0.2110	1.39E-07	6.8564
5			86400	259200	12.8	0.0098	0.0512	0.2622	1.03E-07	6.9875
6			86400	345600	14.6	0.0112	0.0584	0.3205	1.88E-07	6.7250
7			86400	432000	14.6	0.0112	0.0584	0.3789	2.43E-07	6.6149
8			1382400	1814400		0.0000	0.0000	0.3789	0	ERR
9			2160000	3974400		0.0000	0.0000	0.3789	0	ERR
10			3888000	7862400		0.0000	0.0000	0.3789	0	ERR

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Sample ID L3B2
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.6	52.5	0.1906

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	5.1	0.0039	0.0204	0.0204	1.98E-08	7.7032
2			18000	25200	5.6	0.0043	0.0224	0.0428	3.15E-08	7.5019
3			61200	86400	15.4	0.0118	0.0616	0.1043	7.11E-08	7.1479
4			86400	172800	10.2	0.0078	0.0408	0.1451	3.85E-08	7.4148
5			86400	259200	9.2	0.0071	0.0368	0.1819	5.32E-08	7.2744
6			86400	345600	8.6	0.0066	0.0344	0.2162	6.54E-08	7.1847
7			86400	432000	10.8	0.0083	0.0432	0.2594	1.33E-07	6.8768
8			1382400	1814400		0.0000	0.0000	0.2594	0	ERR
9			2160000	3974400		0.0000	0.0000	0.2594	0	ERR
10			3888000	7862400		0.0000	0.0000	0.2594	0	ERR

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Sample ID L3B3
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
77.4	51.4	0.1797

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	6.3	0.0048	0.0252	0.0252	3.02E-08	7.5197
2			18000	25200	4.1	0.0031	0.0164	0.0416	1.69E-08	7.7727
3			61200	86400	13.8	0.0106	0.0552	0.0967	5.71E-08	7.2432
4			86400	172800	11.8	0.0091	0.0472	0.1439	5.15E-08	7.2882
5			86400	259200	9.4	0.0072	0.0376	0.1815	5.55E-08	7.2557
6			86400	345600	12.4	0.0095	0.0496	0.2310	1.36E-07	6.8668
7			86400	432000	13.2	0.0101	0.0528	0.2838	1.98E-07	6.7025
8			1382400	1814400		0.0000	0.0000	0.2838	0	ERR
9			2160000	3974400		0.0000	0.0000	0.2838	0	ERR
10			3888000	7862400		0.0000	0.0000	0.2838	0	ERR

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Sample ID L3A1
Element CESIUM
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1919

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	23	0.0176	0.0919	0.0919	4.03E-07	6.3949
2			18000	25200	21	0.0161	0.0839	0.1759	4.43E-07	6.3538
3			61200	86400	29	0.0222	0.1159	0.2918	2.52E-07	6.5982
4			86400	172800	27	0.0207	0.1079	0.3997	2.7E-07	6.5693
5			86400	259200	23	0.0176	0.0919	0.4916	3.32E-07	6.4785
6			86400	345600	15.2	0.0117	0.0608	0.5524	2.04E-07	6.6900
7			86400	432000	12	0.0092	0.0480	0.6003	1.64E-07	6.7853
8			1382400	1814400		0.0000	0.0000	0.6003	0	ERR
9			2160000	3974400		0.0000	0.0000	0.6003	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6003	0	ERR

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Sample ID L3A2
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1803

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	19	0.0146	0.0759	0.0759	2.75E-07	6.5609
2			18000	25200	20	0.0153	0.0799	0.1559	4.02E-07	6.3962
3			61200	86400	28	0.0215	0.1119	0.2678	2.35E-07	6.6286
4			86400	172800	29	0.0222	0.1159	0.3837	3.11E-07	6.5072
5			86400	259200	24	0.0184	0.0959	0.4796	3.62E-07	6.4415
6			86400	345600	13.6	0.0104	0.0544	0.5340	1.63E-07	6.7866
7			86400	432000	8.6	0.0066	0.0344	0.5684	8.42E-08	7.0746
8			1382400	1814400		0.0000	0.0000	0.5684	0	ERR
9			2160000	3974400		0.0000	0.0000	0.5684	0	ERR
10			3888000	7862400		0.0000	0.0000	0.5684	0	ERR

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Sample ID L3A3
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
81.5	55.5	0.1916

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	19	0.0146	0.0759	0.0759	2.75E-07	6.5609
2			18000	25200	20	0.0153	0.0799	0.1559	4.02E-07	6.3962
3			61200	86400	29	0.0222	0.1159	0.2718	2.52E-07	6.5982
4			86400	172800	27	0.0207	0.1079	0.3797	2.7E-07	6.5693
5			86400	259200	23	0.0176	0.0919	0.4716	3.32E-07	6.4785
6			86400	345600	15.4	0.0118	0.0616	0.5332	2.1E-07	6.6786
7			86400	432000	14.1	0.0108	0.0564	0.5895	2.26E-07	6.6452
8			1382400	1814400		0.0000	0.0000	0.5895	0	ERR
9			2160000	3974400		0.0000	0.0000	0.5895	0	ERR
10			3888000	7862400		0.0000	0.0000	0.5895	0	ERR

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Sample ID L3B1
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	50.8	0.1792

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	31	0.0238	0.1239	0.1239	7.32E-07	6.1357
2			18000	25200	29	0.0222	0.1159	0.2398	8.44E-07	6.0734
3			61200	86400	55	0.0422	0.2198	0.4596	9.07E-07	6.0422
4			86400	172800	42	0.0322	0.1679	0.6275	6.52E-07	6.1855
5			86400	259200	31	0.0238	0.1239	0.7514	6.04E-07	6.2192
6			86400	345600	30.3	0.0232	0.1211	0.8725	8.11E-07	6.0908
7			86400	432000	18.4	0.0141	0.0735	0.9461	3.85E-07	6.4140
8			1382400	1814400		0.0000	0.0000	0.9461	0	ERR
9			2160000	3974400		0.0000	0.0000	0.9461	0	ERR
10			3888000	7862400		0.0000	0.0000	0.9461	0	ERR

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Sample ID L3B2
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
78.6	52.5	0.1906

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	20	0.0153	0.0799	0.0799	3.05E-07	6.5163
2			18000	25200	24	0.0184	0.0959	0.1759	5.78E-07	6.2378
3			61200	86400	36	0.0276	0.1439	0.3197	3.89E-07	6.4104
4			86400	172800	27	0.0207	0.1079	0.4277	2.7E-07	6.5693
5			86400	259200	22	0.0169	0.0879	0.5156	3.04E-07	6.5171
6			86400	345600	13.9	0.0107	0.0556	0.5712	1.71E-07	6.7676
7			86400	432000	11.4	0.0087	0.0456	0.6167	1.48E-07	6.8298
8			1382400	1814400		0.0000	0.0000	0.6167	0	ERR
9			2160000	3974400		0.0000	0.0000	0.6167	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6167	0	ERR

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Sample ID L3B3
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	51.4	0.1797

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	22	0.0169	0.0879	0.0879	3.69E-07	6.4335
2			18000	25200	20	0.0153	0.0799	0.1679	4.02E-07	6.3962
3			61200	86400	32	0.0245	0.1279	0.2958	3.07E-07	6.5127
4			86400	172800	29	0.0222	0.1159	0.4117	3.11E-07	6.5072
5			86400	259200	23	0.0176	0.0919	0.5036	3.32E-07	6.4785
6			86400	345600	19.3	0.0148	0.0771	0.5807	3.29E-07	6.4825
7			86400	432000	12.2	0.0094	0.0488	0.6295	1.69E-07	6.7709
8			1382400	1814400		0.0000	0.0000	0.6295	0	ERR
9			2160000	3974400		0.0000	0.0000	0.6295	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6295	0	ERR

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Sample ID L3A1
Element STRONTIUM
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1919

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	1.51	0.0012	0.0060	0.0060	1.74E-09	8.7604
2			18000	25200	1.88	0.0014	0.0075	0.0135	3.55E-09	8.4499
3			61200	86400	2.06	0.0016	0.0082	0.0218	1.27E-09	8.8952
4			86400	172800	1.92	0.0015	0.0077	0.0295	1.36E-09	8.8654
5			86400	259200	1.86	0.0014	0.0074	0.0369	2.17E-09	8.6629
6			86400	345600	1.32	0.0010	0.0053	0.0422	1.54E-09	8.8125
7			86400	432000	1.05	0.0008	0.0042	0.0464	1.26E-09	8.9013
8			1382400	1814400		0.0000	0.0000	0.0464	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0464	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0464	0	ERR

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Sample ID L3A2
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1803

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	1.75	0.0013	0.0070	0.0070	2.33E-09	8.6323
2			18000	25200	2.04	0.0016	0.0082	0.0151	4.18E-09	8.3790
3			61200	86400	2.15	0.0016	0.0086	0.0237	1.39E-09	8.8581
4			86400	172800	1.83	0.0014	0.0073	0.0311	1.24E-09	8.9071
5			86400	259200	1.48	0.0011	0.0059	0.0370	1.38E-09	8.8614
6			86400	345600	1.19	0.0009	0.0048	0.0417	1.25E-09	8.9026
7			86400	432000	1.31	0.0010	0.0052	0.0470	1.95E-09	8.7091
8			1382400	1814400		0.0000	0.0000	0.0470	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0470	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0470	0	ERR

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Sample ID L3A3
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
81.5	55.5	0.1916

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	1.21	0.0009	0.0048	0.0048	1.11E-09	8.9528
2			18000	25200	1.77	0.0014	0.0071	0.0119	3.15E-09	8.5023
3			61200	86400	2.02	0.0015	0.0081	0.0200	1.22E-09	8.9123
4			86400	172800	1.08	0.0008	0.0043	0.0243	4.31E-10	9.3652
5			86400	259200	1.35	0.0010	0.0054	0.0297	1.14E-09	8.9413
6			86400	345600	0.93	0.0007	0.0037	0.0334	7.64E-10	9.1167
7			86400	432000	1.36	0.0010	0.0054	0.0388	2.11E-09	8.6766
8			1382400	1814400		0.0000	0.0000	0.0388	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0388	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0388	0	ERR

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Sample ID L3B1
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
76.7	50.8	0.1792

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	2.46	0.0019	0.0098	0.0098	4.61E-09	8.3365
2			18000	25200	1.92	0.0015	0.0077	0.0175	3.7E-09	8.4316
3			61200	86400	3.32	0.0025	0.0133	0.0308	3.31E-09	8.4807
4			86400	172800	2.36	0.0018	0.0094	0.0402	2.06E-09	8.6862
5			86400	259200	1.83	0.0014	0.0073	0.0475	2.1E-09	8.6771
6			86400	345600	1.98	0.0015	0.0079	0.0554	3.46E-09	8.4603
7			86400	432000	1.9	0.0015	0.0076	0.0630	4.11E-09	8.3861
8			1382400	1814400		0.0000	0.0000	0.0630	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0630	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0630	0	ERR

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Sample ID L3B2
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.6	52.5	0.1906

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	2.99	0.0023	0.0120	0.0120	6.81E-09	8.1670
2			18000	25200	1.81	0.0014	0.0072	0.0192	3.29E-09	8.4829
3			61200	86400	2.45	0.0019	0.0098	0.0290	1.8E-09	8.7446
4			86400	172800	1.37	0.0011	0.0055	0.0345	6.94E-10	9.1586
5			86400	259200	1.65	0.0013	0.0066	0.0410	1.71E-09	8.7670
6			86400	345600	1.63	0.0013	0.0065	0.0476	2.35E-09	8.6293
7			86400	432000	1.7	0.0013	0.0068	0.0544	3.29E-09	8.4827
8			1382400	1814400		0.0000	0.0000	0.0544	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0544	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0544	0	ERR

DATE OCT 12 1992

Sample ID L3B3
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	51.4	0.1797

			(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1			7200	7200	3.05	0.0023	0.0122	0.0122	7.08E-09	8.1498
2			18000	25200	1.63	0.0013	0.0065	0.0187	2.67E-09	8.5739
3			61200	86400	2.81	0.0022	0.0112	0.0299	2.37E-09	8.6255
4			86400	172800	1.55	0.0012	0.0062	0.0361	8.88E-10	9.0513
5			86400	259200	1.3	0.0010	0.0052	0.0413	1.06E-09	8.9741
6			86400	345600	2.08	0.0016	0.0083	0.0496	3.82E-09	8.4175
7			86400	432000	1.79	0.0014	0.0072	0.0568	3.65E-09	8.4379
8			1382400	1814400		0.0000	0.0000	0.0568	0	ERR
9			2160000	3974400		0.0000	0.0000	0.0568	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0568	0	ERR

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
RA CZELLATH/STOCK	DA BURBANK/WHC	9205883

Subject: STOCK POLYMER IMMOBILIZATION TECH. WASTE FORM QUALIFICATION TESTING PURCHASE ORDER NO. MMW-SVV-277587 STOCK REFERENCE NO. 6996

MANAGEMENT			PROJECT ENGINEERING			WRAP PROJECT CONTROL		
JA Swenson	G6-46		TA Carlson	G6-46		KP Brown	G6-47	
DE Ball	G6-46		AW Hinkle	G6-46		SE Bussman	G6-47	
SR Briggs	G6-47		FH Lee	G6-46		C Malstrom	G6-47	
JE Filip	G6-47		JB Payne	G6-46		SW McKinley	G6-47	
DR Lucas	G6-46	X	JG Starkey	G6-46		GC Rice	G6-47	
CA Petersen	H1-60	X	WR Swita	G6-46	X	BL Trumpour	G6-47	
TL Yount	H1-60	X	RR Wyer	G6-46	X			

WRAP TECHNOLOGY			SW SYSTEMS ENGINEERING			SW SYSTEMS ENGINEERING		
CJ Benar	H1-60	X	EG Berglin	G6-46		VP Ocampo	G6-46	
DA Burbank	H1-60	X	KJ Hull	G6-46		DT Ruff	G6-46	
BF Campbell	H1-60		RM Horgus	H1-60		RA Sexton	H1-60	
JD Keck	G6-46		SL Kooiker	G6-46		JR Weber	G6-46	
CE McDonald	H1-60		DL Lamberd	H1-60		JR Weidert	G6-46	
JL Nelson	H1-60		ML Lee	G6-46		RH Winkleman	G6-46	
KE Parker	H1-60		KJ Leist	G6-46		A Zabarauskas	G6-46	
RM Ybarra	H1-60		NJ Monroe	H1-60				

SW INTEGRATION			SW PROJECTS			SUPPORT		
GF Booth	G6-46		DR Broz	G6-46		Corr Control		X
MD LeClair	H1-60		ML DeWitt	G6-46		WRAP DMC	G6-51	X
DW Mertz	H1-60		EG Erpenbeck	G6-46		JR McGee	G6-47	
CR Nash	H1-60		TM Greager	G6-46		E Pennala	E2-30	
TR Pauly	G6-46	X	RL Louie	G6-46		DR Porten	G6-47	
JL Stroup	G6-46		KE Smith	G6-46		JM Seimer	G6-47	
KM Weingardt	H1-60	X	HE Wellsfry	G6-46		WW Olson	N1-83	

SECRETARIES			PROGRAMS			OTHERS		
RL Anderson	G6-45		RJ Roberts	N3-13		DA Smith	G6-16	
AI Ball	H1-60		JG Riddelle	H5-33				
BJ Gire	G6-46		BA Mayancsik	H5-33				
SA Niebel	G6-46		MM McCarthy	N3-13				
			JB Myers	G6-46				
			OL Kruger	H5-33				

QA RECORD ____ YES ____ NO

COMMENTS TO LEAD ENGINEER BY: _____

SPECIAL INSTRUCTIONS: _____

9413221.0970

STOCK

November 4, 1992
92RAC WH008

Westinghouse Hanford Company
2355 Stevens Drive
Richland, Washington 99352

Attention: Mr. Dewey Burbank, H1-60

Subject: STOCK Polymer Immobilization Tech.
Waste Form Qualification Testing
Purchase Order No. MMW-SVV-277587
Stock Reference No. 6996

Gentlemen:

Enclosed please find a copy of our Progress Report No. 3 for the subject project. This report represents progress through October, 1992.

Should additional information be required, please advise.

Very truly yours,

Russell A. Czellath
Manager-Contracts

RAC/kh
Enclosure

c: Westinghouse Hanford - Attn: G.M. Wemhoff, Buyer
S.O. 6996
T. Litchney
Tickler 12/1/92 w/report

RECEIVED
WHP DMC
NOV 24 1992

9413221.0971

Stock Equipment Company • 16490 Chillicothe Road • Chagrin Falls, Ohio 44022-4398, U.S.A. • (216) 543-6000 • Telex 196071
A Unit of General Signal Telefax (216) 543-6678

WESTINGHOUSE HANFORD COMPANY

STOCK EQUIPMENT CO.

POLYMER IMMOBILLIZATION TECH.

WASTE FORM QUALIFICATION TESTING

9413221.0972

MONTHLY PROGRESS REPORT

NO. 3

THROUGH OCTOBER, 1992

Stock Equipment Company

Westinghouse Hanford Purchase Order No. MMW-SVV-277587

Stock Order No. 6996

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9413221.0974

1.0 SUMMARY

Weeks of September 28, 1992 and October 5, 1992

I started and completed the assays for the following leach time points: 30 second, 2 hour, 7 hour, 24 hour, 2 day, 3 day, 4 day, and 5 day. The leachants were assayed for the following elements: Cesium, Cobalt and Strontium. I have calculated the leachability index numbers for the above time points. The 18 day leach interval has arrived and the samples were changed. The samples are intact; no apparent degradation. I have assayed the 18 day leach interval. The leachability calculations have been updated with the 18 day leach interval.

Week of October 19, 1992

I started the thermal cycling portion of the test. The thermal cycling test will be complete early November. The compressive strength results will be noted in the November progress report.

Tuesday October 20, 1992

Stock contracted with a consultant from the University of Akron Polymer Department to discuss the problem in trying to solidify TYPE 2 & 4 surrogate waste streams. The consultant has suggested that we consider using a more reactive polymer and to minimize the effects of oxygen in the mixing procedure. Stock intends to pursue both of these recommendations.

Week of October 26, 1992

I have started to prepare the solidified samples for TCLP extraction.

I have forwarded the samples (control, waste type 1 and type 3) for the following sub-contracted tests to be performed: biodegradation and irradiation and the one sample (waste type 1 and type 3) for TCLP extraction as confirmation of in-house results.

I also tried more experiments involving TYPE 2 surrogate waste. I adjusted the pH of the waste to 10.5 and tried to solidified it. The best result obtained was a gell. I also tried the same thing to surrogate waste TYPE 4 with the same results. I tried to minimize the amount of energy input for mixing the waste. The theory here is that oxygen may inhibit polymerization, so I decided to hand mix two (2) solidifications, a type 2 (pH 10.5) and a type 4 (pH 10.5) surrogate. These solidifications have obtained the best gell of all the variations tried (these gells are very firm).

I ordered copper sulfate to attempt solidification with the derakane resin; it's possible the compound that the copper is in might be inhibiting the polymerization. I have ordered another polymer that is more reactive than the current polymer being used for this testing program. Early indications show that TYPE 4 surrogate waste can be solidified in this new polymer. I have been working on optimizing the loading ratio (waste to binder) for TYPE 4 surrogate waste. The following experiments have been performed:

ID	BINDER (gms)	CATALYST (gms)	PROMOTOR (gms)	WASTE (gms)	SPEED (rpm)	POWER (watts)
A	100	2.5	1.0	100	1800	6.1
B	100	2.5	0.2	200	1799	8.4
C	100	2.5	0.4	200	1815	8.1
D	100	2.5	1.0	200	1000	3.8
E	100	2.5	1.0	150	1000	2.2

Sample "A" set up rock hard in a very few minutes, this waste had a pH adjustment of 10.5. All the samples after "A" have no pH adjustment. Sample "B" has set up but not rock hard. Sample "C" a little better results than "B". Sample "D" results are the same as "C". Sample "E" set rock hard. I can only assume that the maximum waste to binder loading will be greater than 1.5/1 but less than 2/1. Type 2 surrogate waste solidification is promising but there still maybe the problem of copper concentration.

9413221.0975

I assayed type 2,3,4 surrogate waste for it's copper concentration. Type 2,3 surrogate wastes fall in line with the reported concentration supplied by Westinghouse Handford. Type 4 surrogate waste was approximately 30 percent higher than the reported concentration provided by Westinghouse Handford. The results are as follows:

TYPE 2 - 127,875 ppm
TYPE 3 - 108,747 ppm
TYPE 4 - 87,175 ppm

9413221.0976

2.0 SCHEDULE

Activity	Scheduled Date	Actual Date
- Prepare Work Plan	08/01/92	08/01/92
- Submit Work Plan	08/01/92	08/01/92
- Approve Plan	08/10/92	08/10/92
- Develop Formulations	08/21/92	08/21/92
- Prepare Specimens	09/01/92	09/16/92
- Lab - Analysis	12/10/92	
- Final Report	12/23/92	

9413221.0977

9413221.0978

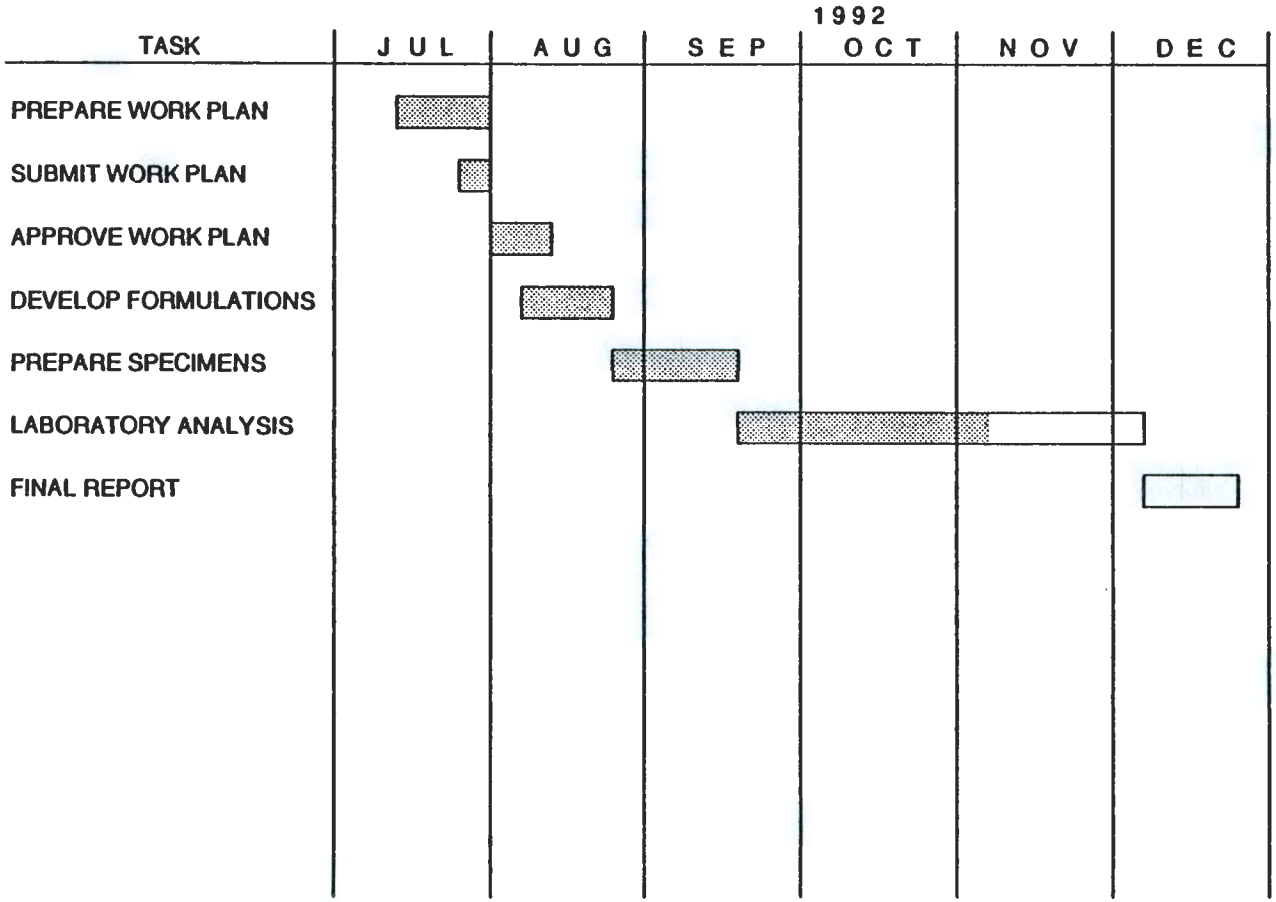
STOCK EQUIPMENT COMPANY

04-Nov-92

PROJECT SCHEDULE
WESTINGHOUSE
HANFORD COMPANY
P.O. MMW-SVV-277587
STOCK ORDER: 6996

MONTHLY PROGRESS REPORT

PREPARED BY: RUSS A. CZELLATH



THERMAL CYCLING SAMPLES
BEFORE THE START OF THE TEST

SAMPLE ID	HEIGHT (in)	DIAMETER (in)	WEIGHT (gms)	DENSITY (gms/cc)	DENSITY avg
L1-11	1.937	1.418	56.12	1.12	
L1-12	1.915	1.420	55.01	1.11	1.11
L1-13	1.919	1.423	54.85	1.10	
L3-11	2.039	1.452	78.09	1.41	
L3-12	2.063	1.445	77.96	1.41	1.41
L3-13	2.019	1.447	77.25	1.42	
L7-11	2.035	1.464	84.9	1.51	
L7-12	2.036	1.458	84.72	1.52	1.52
L7-13	2.009	1.455	83.65	1.53	

RADIATION SAMPLES BEFORE
THE START OF THE TEST

SAMPLE ID	DIAMETER (in)	HEIGHT (in)	WEIGHT (gms)	DENSITY (gms/cc	DENSITY (gms/cc) AVG
L1-17	1.424	1.884	54.67	1.11	
L1-18	1.426	1.839	53.64	1.12	1.11
L1-19	1.430	1.892	55.17	1.11	
L3-17	1.454	2.048	73.55	1.32	
L3-18	1.456	2.082	76.93	1.35	1.35
L3-19	1.454	2.076	77.67	1.38	
L7-17	1.464	2.052	82.68	1.46	
L7-18	1.461	2.049	86.57	1.54	1.51
L7-19	1.461	2.027	84.90	1.53	

BIODEGRADATION SAMPLES
BEFORE THE START OF TEST

SAMPLE ID	DIAMETER (in)	HEIGHT (in)	WEIGHT (gms)	DENSITY (gms/cc	DENSITY AVG
L1-14	1.423	1.846	53.38	1.11	
L1-15	1.422	2.022	56.84	1.08	1.08
L1-16	1.425	1.948	53.37	1.05	
L3-14	1.458	2.060	73.24	1.30	
L3-15	1.453	1.996	74.66	1.38	1.36
L3-16	1.451	2.023	76.85	1.40	
L7-14	1.430	1.981	78.31	1.50	
L7-15	1.425	2.006	81.68	1.56	1.47
L7-16	1.430	1.865	66.84	1.36	

30 Sec. Rinse Conc.(ppm) 0.3
Ao (30s) 2.30E-04

DATE OCT 27 1992

Sample ID L3A1
Element COBALT
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1917

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:33am	7200	7200	8.4	0.0064	0.0336	0.0336	5.384E-08	7.3
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	7.5	0.0056	0.0300	0.0636	5.66E-08	7.2
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	7.8	0.0060	0.0312	0.0948	1.629E-08	7.7
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	10.7	0.0082	0.0428	0.1376	4.243E-08	7.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	8.9	0.0069	0.0356	0.1732	4.986E-08	7.3
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	9.2	0.0071	0.0369	0.2101	7.466E-08	7.1
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	7.9	0.0061	0.0316	0.2417	7.121E-08	7.1
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	38.38	0.0294	0.1538	0.3952	1.701E-08	7.8
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.3952	0	ERR
10			3888000	7862400		0.0000	0.0000	0.3952	0	ERR

?

30 Sec. Rinse Conc.(ppm) 0.1
Ao (30s) 7.74E-05

DATE OCT 27 1992

Sample ID L3A2
Element COBALT
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1802

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:33am	7200	7200	7.1	0.0055	0.0305	0.0305	4.433E-08	7.4
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	6.3	0.0049	0.0271	0.0576	4.602E-08	7.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	15.6	0.0121	0.0670	0.1246	6.43E-08	7.1
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	11.4	0.0089	0.0490	0.1735	5.531E-08	7.3
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	10	0.0077	0.0430	0.2165	7.254E-08	7.1
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	9.9	0.0077	0.0425	0.2590	1E-07	7.0
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	6.8	0.0053	0.0292	0.2882	8.08E-08	7.2
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	20.64	0.0160	0.0887	0.3769	3.67E-08	8.2
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.3769	0	ERR
10			3888000	7862400		0.0000	0.0000	0.3769	0	ERR

30 Sec. Rinse Conc.(ppm) 0.1
Ao (30s) 8.15E-05

DATE OCT 27 1992

Sample ID L3A3
Element COBALT
Matrix DI WATER

S.A.	V	Ao
81.5	55.3	0.1913

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:33am	7200	7200	5.2	0.0042	0.0221	0.0221	2.334E-08	7.6
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	6.1	0.0050	0.0260	0.0481	4.238E-08	7.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	14.8	0.0121	0.0630	0.1111	7.446E-08	7.1
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	10.2	0.0083	0.0434	0.1545	4.302E-08	7.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	9.2	0.0075	0.0392	0.1938	6.026E-08	7.2
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	12.6	0.0103	0.0536	0.2473	1.561E-07	6.8
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	13	0.0106	0.0553	0.3026	2.192E-07	6.7
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	44.51	0.0363	0.1894	0.4920	2.589E-08	7.6
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.4920	0	ERR
10			3888000	7862400		0.0000	0.0000	0.4920	0	ERR

9413221.0982

30 Sec. Rinse Conc.(ppm) 0.1
Ao (30s) 7.66E-05

?

DATE OCT 27 1992

Sample ID L381
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.6	30.8	0.1791

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	08/21/92	8:33am	7200	7200	6.6	0.0051	0.0292	0.0292	3.798E-08	7.4
	08/21/92	10:33am								
2	08/21/92	10:33am	16000	23200	6.8	0.0052	0.0291	0.0573	3.316E-08	7.3
	08/21/92	3:33pm								
3	08/21/92	3:33pm	61200	86400	30	0.0153	0.0855	0.1428	1.374E-07	6.9
	08/22/92	8:33am								
4	08/22/92	8:33am	86400	172800	19.4	0.0149	0.0830	0.2258	1.594E-07	6.8
	08/23/92	8:33am								
5	08/23/92	8:33am	86400	259200	12.8	0.0089	0.0547	0.2806	1.178E-07	6.9
	08/24/92	8:33am								
6	08/24/92	8:33am	86400	345600	14.6	0.0112	0.0624	0.3430	2.157E-07	6.7
	08/25/92	8:33am								
7	08/25/92	8:33am	86400	432000	14.6	0.0112	0.0624	0.4055	2.779E-07	6.6
	08/26/92	8:33am								
8	08/26/92	8:33am	1382400	1814400	47.6	0.0365	0.2036	0.6090	2.69E-08	7.3
	10/09/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.6090	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6090	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
Ao (30s) 1.572E-04

?

DATE OCT 27 1992

Sample ID L382
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.6	32.5	0.1904

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	08/21/92	8:33am	7200	7200	5.1	0.0040	0.0211	0.0211	2.113E-08	7.7
	08/21/92	10:33am								
2	08/21/92	10:33am	16000	23200	5.6	0.0044	0.0231	0.0442	3.358E-08	7.5
	08/21/92	3:33pm								
3	08/21/92	3:33pm	61200	86400	13.4	0.0121	0.0636	0.1077	7.388E-08	7.1
	08/22/92	8:33am								
4	08/22/92	8:33am	86400	172800	10.2	0.0080	0.0421	0.1499	4.105E-08	7.4
	08/23/92	8:33am								
5	08/23/92	8:33am	86400	259200	9.2	0.0072	0.0380	0.1879	5.671E-08	7.2
	08/24/92	8:33am								
6	08/24/92	8:33am	86400	345600	8.6	0.0068	0.0355	0.2233	6.973E-08	7.2
	08/25/92	8:33am								
7	08/25/92	8:33am	86400	432000	10.0	0.0085	0.0446	0.2679	1.417E-07	6.8
	08/26/92	8:33am								
8	08/26/92	8:33am	1382400	1814400	61.85	0.0465	0.2543	0.5224	4.672E-08	7.3
	10/09/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.5224	0	ERR
10			3888000	7862400		0.0000	0.0000	0.5224	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
Ao (30s) 1.346E-04

?

DATE OCT 27 1992

Sample ID L383
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1790

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	08/21/92	8:33am	7200	7200	6.3	0.0049	0.0272	0.0272	3.517E-08	7.5
	08/21/92	10:33am								
2	08/21/92	10:33am	16000	23200	4.1	0.0032	0.0177	0.0449	1.994E-08	7.7
	08/21/92	3:33pm								
3	08/21/92	3:33pm	61200	86400	13.8	0.0107	0.0595	0.1043	6.646E-08	7.2
	08/22/92	8:33am								
4	08/22/92	8:33am	86400	172800	11.8	0.0091	0.0509	0.1552	5.693E-08	7.2
	08/23/92	8:33am								
5	08/23/92	8:33am	86400	259200	9.4	0.0073	0.0405	0.1956	6.40E-08	7.2
	08/24/92	8:33am								
6	08/24/92	8:33am	86400	345600	12.4	0.0096	0.0535	0.2492	1.502E-07	6.8
	08/25/92	8:33am								
7	08/25/92	8:33am	86400	432000	13.2	0.0102	0.0569	0.3062	2.306E-07	6.6
	08/26/92	8:33am								
8	08/26/92	8:33am	1382400	1814400	48.63	0.0384	0.2140	0.5202	3.304E-08	7.3
	10/09/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.5202	0	ERR
10			3888000	7862400		0.0000	0.0000	0.5202	0	ERR

9413221.0983

30 Sec. Rinse Conc.(ppm) 0.001
An (30s) 7.67E-07

DATE OCT 27 1992

Sample ID L7A1
Element COBALT
Matrix DI water

S.A.	V	Ae
76.7	50.7	0.1914

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ae	SUM an/Ae	Di	L
1	09/21/92	8:32am	7200	7200	0.001	0.0000	0.0000	0.0000	7.6344E-16	13.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.5	0.0004	0.0020	0.0020	2.523E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1	0.0008	0.0040	0.0060	3.0136-10	9.3
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.5	0.0004	0.0020	0.0080	9.294E-11	10.0
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.4	0.0003	0.0016	0.0096	1.01E-10	10.0
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	0.8	0.0006	0.0032	0.0128	5.686E-10	9.2
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.2	0.0009	0.0048	0.0176	1.048E-09	8.8
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	0.353	0.0004	0.0022	0.0198	2.943E-12	11.3
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0198	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0198	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
An (30s) 1.548E-04

?

DATE OCT 27 1992

Sample ID L7A2
Element COBALT
Matrix DI WATER

S.A.	V	Ae
77.4	31.4	0.221

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ae	SUM an/Ae	Di	L
1	09/21/92	8:32am	7200	7200	0.2	0.0002	0.0007	0.0007	2.339E-11	10.6
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.6	0.0005	0.0021	0.0028	2.775E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.3	0.0010	0.0046	0.0074	3.886E-10	9.4
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.6	0.0005	0.0021	0.0095	1.022E-10	10.0
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.5	0.0004	0.0016	0.0112	1.208E-10	9.9
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	0.9	0.0007	0.0032	0.0144	3.496E-10	9.3
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.3	0.0010	0.0046	0.0189	1.477E-09	8.9
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	0.627	0.0005	0.0022	0.0211	3.478E-12	11.3
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0211	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0211	0	ERR

30 Sec. Rinse Conc.(ppm) 0.4
An (30s) 3.088E-04

DATE OCT 27 1992

Sample ID L7A3
Element COBALT
Matrix DI WATER

S.A.	V	Ae
76.7	50.7	0.19

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ae	SUM an/Ae	Di	L
1	09/21/92	8:32am	7200	7200	0.2	0.0002	0.0008	0.0008	3.107E-11	10.5
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.4	0.0003	0.0016	0.0024	1.638E-10	9.8
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.4	0.0011	0.0057	0.0081	3.897E-10	9.2
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.5	0.0004	0.0020	0.0101	9.431E-11	10.0
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.3	0.0002	0.0012	0.0113	5.767E-11	10.2
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	1.1	0.0008	0.0044	0.0157	1.091E-09	8.0
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.1	0.0008	0.0044	0.0202	1.400E-09	8.9
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	0.56	0.0004	0.0023	0.0225	3.858E-12	11.4
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0225	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0225	0	ERR

30 Sec. Rinse Conc.(ppm) 0.7
An (30s) 9.276E-04

?

DATE OCT 27 1992

Sample ID L781
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.6	30.6	0.1971

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.237E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.3	0.0002	0.0012	0.0016	8.988E-11	10.1
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.3	0.0010	0.0051	0.0066	4.818E-10	9.3
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.3	0.0002	0.0012	0.0078	3.163E-11	10.5
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.2	0.0002	0.0008	0.0086	2.388E-11	10.6
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	1.1	0.0008	0.0043	0.0129	1.016E-09	9.0
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.4	0.0011	0.0055	0.0183	2.121E-09	8.7
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	0.89	0.0007	0.0034	0.0217	8.461E-12	11.1
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0217	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0217	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
An (30s) 1.332E-04

?

DATE OCT 27 1992

Sample ID L782
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.6	30.7	0.1925

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.547E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.1	0.0001	0.0004	0.0008	8.932E-12	11.0
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.1	0.0008	0.0044	0.0052	3.567E-10	9.4
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.1	0.0001	0.0004	0.0056	3.068E-12	11.4
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.1	0.0001	0.0004	0.0060	6.226E-12	11.2
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	1.1	0.0008	0.0044	0.0103	1.08E-09	9.0
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.3	0.0010	0.0052	0.0156	1.907E-09	8.7
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	0.868	0.0007	0.0038	0.0193	1.042E-11	11.0
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0193	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0193	0	ERR

30 Sec. Rinse Conc.(ppm) 0.3
An (30s) 2.330E-04

?

DATE OCT 27 1992

Sample ID L783
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.5	32.4	0.1908

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.812E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.2	0.0002	0.0008	0.0012	4.121E-11	10.4
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.5	0.0012	0.0061	0.0073	6.824E-10	9.2
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	0.2	0.0002	0.0008	0.0081	1.518E-11	10.8
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	0.3	0.0002	0.0012	0.0093	3.6E-11	10.2
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	1.2	0.0009	0.0049	0.0142	1.308E-09	9.0
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	1.5	0.0012	0.0061	0.0202	2.626E-09	8.6
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	1.059	0.0009	0.0043	0.0246	1.351E 11	10.9
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.0246	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0246	0	ERR

9413221.0985

30 Sec. Rinse Conc.(ppm) 5.0
Ao (30s) 3.835E-03

DATE OCT 27 1992

Sample ID L3A1
Element CESIUM
Matrix DI water

S.A.	V	Ao
78.7	30.7	0.1881

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	23	0.0176	0.0936	0.0936	4.192E-07	6.4
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	21	0.0161	0.0856	0.1794	4.609E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	29	0.0222	0.1183	0.2977	2.625E-07	6.6
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	27	0.0207	0.1101	0.4078	2.606E-07	6.6
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	23	0.0176	0.0936	0.5015	3.456E-07	6.5
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	15.2	0.0117	0.0620	0.5635	2.125E-07	6.7
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	12	0.0092	0.0489	0.6125	1.706E-07	6.8
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	18.34	0.0142	0.0756	0.6881	4.123E-08	8.4
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.6881	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6881	0	ERR

30 Sec. Rinse Conc.(ppm) 8.0
? Ao (30s) 4.844E-03

DATE OCT 27 1992

Sample ID L3A2
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
77.4	31.4	0.1757

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	19	0.0147	0.0837	0.0837	3.339E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	20	0.0155	0.0881	0.1718	4.679E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	28	0.0217	0.1233	0.2950	2.867E-07	6.5
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	29	0.0224	0.1279	0.4229	3.778E-07	6.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	24	0.0185	0.1057	0.5286	4.385E-07	6.4
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	13.6	0.0105	0.0599	0.5885	1.966E-07	6.7
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	6.6	0.0067	0.0379	0.6264	1.023E-07	7.0
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	6.56	0.0066	0.0379	0.6642	1.031E-08	9.0
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.6642	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6642	0	ERR

30 Sec. Rinse Conc.(ppm) 5.0
Ao (30s) 4.075E-03

DATE OCT 27 1992

Sample ID L3A3
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
81.5	35.3	0.1875

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	18	0.0135	0.0720	0.0720	3.251E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	20	0.0163	0.0869	0.1589	4.75E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	28	0.0236	0.1261	0.2956	2.963E-07	6.5
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	27	0.0220	0.1174	0.4129	3.169E-07	6.5
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	23	0.0187	0.1000	0.5129	3.83E-07	6.4
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	13.4	0.0126	0.0669	0.5798	2.479E-07	6.6
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	14.1	0.0115	0.0613	0.6411	2.677E-07	6.6
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	19.1	0.0156	0.0830	0.7242	4.972E-08	8.3
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.7242	0	ERR
10			3888000	7862400		0.0000	0.0000	0.7242	0	ERR

9413221.0986

30 Sec. Rinse Conc.(ppm) 8.0
An (30s) 6.1298E-03

?

DATE OCT 27 1992

Sample ID L381
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
78.6	30.8	0.1731

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	31	0.0237	0.1372	0.1372	6.97E-07	6.0
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	29	0.0222	0.1283	0.2655	1.030E-06	6.0
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	89400	30	0.0421	0.2434	0.5089	1.112E-06	6.0
	09/22/92	9:33am								
4	09/22/92	9:33am	88400	177800	42	0.0322	0.1858	0.6948	7.597E-07	6.1
	09/23/92	9:33am								
5	09/23/92	9:33am	88400	266200	31	0.0237	0.1372	0.8310	7.359E-07	6.1
	09/24/92	9:33am								
6	09/24/92	9:33am	88400	345800	30.3	0.0232	0.1341	0.9650	9.040E-07	6.0
	09/25/92	9:33am								
7	09/25/92	9:33am	88400	433800	18.4	0.0141	0.0814	1.0474	4.725E-07	6.3
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1816400	25.46	0.0195	0.1126	1.1602	9.176E-08	8.0
	10/08/92	9:33am								
9			2160000	3974400		0.0000	0.0000	1.1602	0	ERR
10			3888000	7862400		0.0000	0.0000	1.1602	0	ERR

30 Sec. Rinse Conc.(ppm) 7.0
An (30s) 5.502E-03

?

DATE OCT 27 1992

Sample ID L382
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
78.6	32.5	0.1851

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	20	0.0157	0.0849	0.0849	3.438E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	24	0.0189	0.1018	0.1868	6.528E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	89400	30	0.0283	0.1529	0.3397	4.388E-07	6.4
	09/22/92	9:33am								
4	09/22/92	9:33am	88400	177800	27	0.0212	0.1147	0.4544	3.043E-07	6.5
	09/23/92	9:33am								
5	09/23/92	9:33am	88400	266200	22	0.0173	0.0934	0.5478	3.431E-07	6.5
	09/24/92	9:33am								
6	09/24/92	9:33am	88400	345800	13.9	0.0109	0.0590	0.6068	1.827E-07	6.7
	09/25/92	9:33am								
7	09/25/92	9:33am	88400	432200	11.4	0.0090	0.0484	0.6552	1.67E-07	6.8
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	37.11	0.0292	0.1578	0.8129	1.791E-08	7.7
	10/08/92	9:33am								
9			2160000	3974400		0.0000	0.0000	0.8129	0	ERR
10			3888000	7862400		0.0000	0.0000	0.8129	0	ERR

30 Sec. Rinse Conc.(ppm) 9.0
An (30s) 6.988E-03

?

DATE OCT 27 1992

Sample ID L383
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1727

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	22	0.0170	0.0986	0.0986	4.634E-07	6.3
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	20	0.0156	0.0893	0.1882	3.03E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	89400	32	0.0246	0.1434	0.3317	3.682E-07	6.4
	09/22/92	9:33am								
4	09/22/92	9:33am	88400	177800	29	0.0224	0.1300	0.4616	3.911E-07	6.4
	09/23/92	9:33am								
5	09/23/92	9:33am	88400	266200	23	0.0178	0.1031	0.5647	4.178E-07	6.4
	09/24/92	9:33am								
6	09/24/92	9:33am	88400	345800	18.3	0.0149	0.0865	0.6512	4.139E-07	6.4
	09/25/92	9:33am								
7	09/25/92	9:33am	88400	432200	12.2	0.0094	0.0547	0.7059	2.131E-07	6.7
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	29.30	0.0227	0.1317	0.8376	1.251E-08	7.9
	10/08/92	9:33am								
9			2160000	3974400		0.0000	0.0000	0.8376	0	ERR
10			3888000	7862400		0.0000	0.0000	0.8376	0	ERR

9413221.0987

30 Sec. Rinse Conc.(ppm) 5.0
An (30s) 4.602E-03

DATE OCT 27 1992

Sample ID L7A1
Element CESIUM
Matrix DI water

S.A.	V	Ao
78.7	50.7	0.1878

	Date	TIME IN OUT	(dt)n S	=sum(dt)n S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:32am	7200	7200	15	0.0115	0.0613	0.0613	1.799E-07	6.7
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	21	0.0161	0.0858	0.1470	4.623E-07	6.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	43	0.0330	0.1756	0.3226	5.791E-07	6.2
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	40	0.0307	0.1634	0.4860	6.178E-07	6.2
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	26	0.0199	0.1062	0.5922	4.430E-07	6.4
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	20.9	0.0160	0.0854	0.6776	4.031E-07	6.4
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	24.9	0.0190	0.1013	0.7789	7.312E-07	6.1
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	38.07	0.0292	0.1556	0.9343	1.744E-08	7.8
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.9343	0	ERR
10			3888000	7862400		0.0000	0.0000	0.9343	0	ERR

30 Sec. Rinse Conc.(ppm) 5.0
An (30s) 4.944E-03

?

DATE OCT 27 1992

Sample ID L7A2
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.2084

	Date	TIME IN OUT	(dt)n S	=sum(dt)n S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:32am	7200	7200	16	0.0124	0.0600	0.0600	1.716E-07	6.8
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	24	0.0186	0.0900	0.1500	5.091E-07	6.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	56	0.0449	0.2175	0.3675	6.982E-07	6.1
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	36	0.0433	0.2100	0.5775	1.021E-06	6.0
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	30	0.0294	0.1425	0.7200	7.994E-07	6.1
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	27.9	0.0216	0.1046	0.8246	6.056E-07	6.2
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	22.5	0.0174	0.0844	0.9090	5.074E-07	6.3
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	28.14	0.0218	0.1056	1.0145	8.033E-08	8.1
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	1.0145	0	ERR
10			3888000	7862400		0.0000	0.0000	1.0145	0	ERR

30 Sec. Rinse Conc.(ppm) 5.0
An (30s) 3.630E-03

DATE OCT 27 1992

Sample ID L7A3
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
78.7	50.7	0.1865

	Date	TIME IN OUT	(dt)n S	=sum(dt)n S	Conc. PPM	an g	an/Ao	SUM an/Ao	DI	L
1	09/21/92	8:32am	7200	7200	12	0.0092	0.0494	0.0494	1.161E-07	6.9
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	18	0.0138	0.0740	0.1234	3.444E-07	6.5
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	47	0.0360	0.1933	0.3167	7.015E-07	6.2
	09/22/92	8:32am								
4	09/22/92	8:32am	86400	172800	41	0.0314	0.1686	0.4853	6.362E-07	6.2
	09/23/92	8:32am								
5	09/23/92	8:32am	86400	259200	25	0.0192	0.1029	0.5881	4.156E-07	6.4
	09/24/92	8:32am								
6	09/24/92	8:32am	86400	345600	21.1	0.0162	0.0869	0.6749	4.186E-07	6.4
	09/25/92	8:32am								
7	09/25/92	8:32am	86400	432000	20.7	0.0159	0.0851	0.7600	3.165E-07	6.3
	09/26/92	8:32am								
8	09/26/92	8:32am	1382400	1814400	39.67	0.0304	0.1631	0.9232	1.92E-08	7.7
	10/08/92	8:32am								
9			2160000	3974400		0.0000	0.0000	0.9232	0	ERR
10			3888000	7862400		0.0000	0.0000	0.9232	0	ERR

9413221.0988

30 Sec. Rinse Conc.(ppm) 7.0
An (30s) 5.3766E-03

?

DATE OCT 27 1992

Sample ID L751
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.8	50.6	0.1922

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	11	0.0084	0.0440	0.0440	9.208E-08	7.0
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	14	0.0109	0.0569	0.0889	1.867E-07	6.7
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	23	0.0177	0.0919	0.1918	1.365E-07	6.8
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	23	0.0177	0.0919	0.2837	1.896E-07	6.7
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	15	0.0115	0.0599	0.3436	1.413E-07	6.9
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	10.8	0.0083	0.0432	0.3869	1.036E-07	7.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	9.5	0.0073	0.0380	0.4249	1.027E-07	7.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	48.72	0.0382	0.1987	0.6234	2.647E-08	7.5
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.6234	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6234	0	ERR

30 Sec. Rinse Conc.(ppm) 6.0
An (30s) 4.5960E-03

?

DATE OCT 27 1992

Sample ID L752
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	50.7	0.188

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	10	0.0077	0.0407	0.0407	7.913E-08	7.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	13	0.0100	0.0530	0.0937	1.763E-07	6.8
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	20	0.0153	0.0813	0.1732	1.247E-07	6.8
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	22	0.0169	0.0896	0.2648	1.88E-07	6.7
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	12	0.0092	0.0489	0.3137	9.399E-08	7.0
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	9.5	0.0073	0.0387	0.3524	8.288E-08	7.1
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	9.6	0.0074	0.0391	0.3916	1.08E-07	7.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	33.19	0.0407	0.2167	0.6083	3.388E-08	7.5
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.6083	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6083	0	ERR

30 Sec. Rinse Conc.(ppm) 6.0
An (30s) 4.7108E-03

?

DATE OCT 27 1992

Sample ID L753
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
78.3	38.4	0.1884

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	12	0.0094	0.0497	0.0497	1.179E-07	6.9
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	13	0.0102	0.0539	0.1036	1.825E-07	6.7
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	21	0.0165	0.0870	0.1907	1.422E-07	6.8
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	20	0.0157	0.0829	0.2735	1.561E-07	6.8
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	11	0.0086	0.0456	0.3191	8.173E-08	7.1
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	10.3	0.0081	0.0427	0.3618	1.008E-07	7.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	8.3	0.0065	0.0344	0.3962	8.425E-08	7.1
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	31.32	0.0403	0.2127	0.6089	3.264E-08	7.5
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.6089	0	ERR
10			3888000	7862400		0.0000	0.0000	0.6089	0	ERR

9413221.0989

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.67E-05

DATE OCT 27 1992

Sample ID L3A1
Element STRONTIUM
Matrix DI water

S.A.	V	Ao
76.7	50.7	0.1916

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	1.31	0.0012	0.0060	0.0060	1.738E-09	8.6
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.86	0.0014	0.0073	0.0136	3.562E-09	8.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.08	0.0016	0.0082	0.0219	1.274E-09	8.9
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	1.82	0.0013	0.0077	0.0296	1.363E-09	8.9
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.88	0.0014	0.0074	0.0369	2.175E-09	8.7
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	1.32	0.0010	0.0053	0.0422	1.341E-09	8.8
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.05	0.0008	0.0042	0.0464	1.257E-09	8.9
	09/26/92	8:33am								
8	09/26/92	9:33am	1382400	1814400	2.32	0.0019	0.0101	0.0565	7.329E-11	10.1
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.0565	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0565	0	ERR

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.74E-05

?

DATE OCT 27 1992

Sample ID L3A2
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1902

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	1.75	0.0014	0.0075	0.0075	2.893E-09	8.6
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	2.04	0.0016	0.0089	0.0163	4.629E-09	8.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.15	0.0017	0.0092	0.0255	1.601E-09	8.8
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	1.83	0.0014	0.0079	0.0334	1.43E-09	8.9
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.46	0.0011	0.0064	0.0397	1.589E-09	8.8
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	1.19	0.0008	0.0051	0.0448	1.445E-09	8.9
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.31	0.0010	0.0056	0.0503	2.257E-09	8.6
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	2.47	0.0019	0.0106	0.0611	8.119E-11	10.1
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.0611	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0611	0	ERR

30 Sec. Rinse Conc.(ppm) 0.21
An (30s) 1.712E-04

DATE OCT 27 1992

Sample ID L3A3
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
81.3	55.5	0.1914

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	1.21	0.0010	0.0052	0.0052	1.205E-09	8.9
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.77	0.0014	0.0075	0.0127	3.57E-09	8.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.02	0.0016	0.0086	0.0213	1.389E-09	8.9
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	1.09	0.0009	0.0046	0.0259	4.896E-10	9.3
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.36	0.0011	0.0057	0.0316	1.299E-09	8.9
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	0.93	0.0008	0.0040	0.0356	9.675E-10	9.1
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.36	0.0011	0.0058	0.0414	2.39E-09	8.6
	09/26/92	9:33am								
8	09/26/92	8:33am	1382400	1814400	2.32	0.0019	0.0099	0.0513	7.04E-11	10.2
	10/08/92	8:33am								
9			2160000	3974400		0.0000	0.0000	0.0513	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0513	0	ERR

9413221.0990

30 Sec. Rinse Conc./(ppm) 0.71
An (30s) 5.448E-04

DATE OCT 27 1992

Sample ID L381
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
76.7	30.8	0.1787

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	2.46	0.0019	0.0106	0.0106	5.314E-09	8.3
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.92	0.0015	0.0082	0.0188	4.268E-09	8.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	3.32	0.0025	0.0142	0.0330	3.613E-09	8.4
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	2.38	0.0018	0.0101	0.0432	2.375E-09	8.6
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.83	0.0014	0.0079	0.0510	2.426E-09	8.6
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	1.89	0.0015	0.0085	0.0595	3.865E-09	8.4
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.9	0.0015	0.0082	0.0677	4.74E-09	8.3
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	4.12	0.0032	0.0177	0.0854	2.296E-10	9.6
	10/09/92	9:33am								
9			2160000	3974400		0.0000	0.0000	0.0854	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0854	0	ERR

30 Sec. Rinse Conc./(ppm) 1.41
An (30s) 1.108E-03

?

DATE OCT 27 1992

Sample ID L382
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.6	32.5	0.1895

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	2.89	0.0024	0.0124	0.0124	7.331E-09	8.1
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.81	0.0014	0.0075	0.0199	3.542E-09	8.5
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.45	0.0019	0.0102	0.0301	1.939E-09	8.7
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	1.37	0.0011	0.0057	0.0358	7.475E-10	9.1
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.65	0.0013	0.0069	0.0426	1.842E-09	8.7
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	1.63	0.0013	0.0069	0.0494	2.529E-09	8.6
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.7	0.0013	0.0071	0.0564	3.544E-09	8.5
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	2.69	0.0021	0.0112	0.0676	8.98E-11	10.0
	10/09/92	9:33am								
9			2160000	3974400		0.0000	0.0000	0.0676	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0676	0	ERR

30 Sec. Rinse Conc./(ppm) 1.30
An (30s) 9.298E-04

?

DATE OCT 27 1992

Sample ID L383
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1788

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:33am	7200	7200	3.05	0.0024	0.0132	0.0132	8.309E-09	8.1
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.63	0.0013	0.0071	0.0203	3.129E-09	8.5
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.81	0.0022	0.0122	0.0324	2.778E-09	8.6
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	1.55	0.0012	0.0067	0.0391	1.042E-09	9.0
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.3	0.0010	0.0056	0.0446	1.246E-09	8.9
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	2.08	0.0016	0.0090	0.0536	4.465E-09	8.3
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.79	0.0014	0.0077	0.0613	4.279E-09	8.4
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	2.97	0.0023	0.0129	0.0744	1.182E-10	9.8
	10/09/92	9:33am								
9			2160000	3974400		0.0000	0.0000	0.0744	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0744	0	ERR

30 Sec. Rinse Conc.(ppm) 0.84
Ao (30s) 8.443E-04

DATE OCT 27 1992

Sample ID L7A1
Element STRONTRUM
Matrix DI water

S.A.	V	Ao
76.7	30.7	0.1918

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.38	0.0003	0.0015	0.0015	1.101E-10	10.0
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.54	0.0004	0.0022	0.0037	2.931E-10	9.5
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	0.9	0.0007	0.0036	0.0073	2.432E-10	9.6
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.72	0.0006	0.0029	0.0102	1.919E-10	9.7
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.67	0.0007	0.0030	0.0132	4.759E-10	9.3
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.1	0.0001	0.0004	0.0140	6.847E-12	11.1
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.007	0.0000	0.0000	0.0141	3.365E-14	13.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.84	0.0009	0.0034	0.0174	6.14E-12	11.1
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0174	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0174	0	ERR

30 Sec. Rinse Conc.(ppm) 0.94
Ao (30s) 7.279E-04

DATE OCT 27 1992

Sample ID L7A2
Element STRONTRUM
Matrix DI WATER

S.A.	V	Ao
77.4	31.4	0.2103

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.17	0.0001	0.0006	0.0006	1.888E-11	10.7
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.33	0.0003	0.0012	0.0018	8.271E-11	10.0
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	0.76	0.0006	0.0029	0.0046	1.469E-10	9.8
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.41	0.0003	0.0015	0.0061	5.271E-11	10.3
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.35	0.0003	0.0013	0.0074	6.524E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.15	0.0001	0.0006	0.0080	1.886E-11	10.8
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.18	0.0001	0.0007	0.0086	3.129E-11	10.5
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	1.33	0.0010	0.0049	0.0135	1.729E-11	10.8
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0135	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0135	0	ERR

30 Sec. Rinse Conc.(ppm) 1.19
Ao (30s) 9.127E-04

DATE OCT 27 1992

Sample ID L7A3
Element STRONTRUM
Matrix DI WATER

S.A.	V	Ao
76.7	30.7	0.1894

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.42	0.0003	0.0017	0.0017	1.278E-10	9.9
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.22	0.0002	0.0009	0.0026	4.269E-11	10.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	0.63	0.0005	0.0026	0.0051	1.222E-10	9.9
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.57	0.0004	0.0023	0.0075	1.233E-10	9.9
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.33	0.0003	0.0013	0.0088	7.022E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.4	0.0003	0.0016	0.0104	1.452E-10	9.8
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.44	0.0003	0.0016	0.0122	2.263E-10	9.6
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	1.14	0.0008	0.0046	0.0169	1.537E-11	10.8
	10/08/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0169	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0169	0	ERR

9413221.0992

30 Sec. Rinse Conc.(ppm) 2.01
An (30s) 1.344E-03

DATE OCT 27 1992

Sample ID L781
Element STRONTIUM
Matrix SEA WATER

S.A.	V	An
76.8	30.8	0.1981

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	9:32am	7200	7200	0.85	0.0007	0.0033	0.0033	5.282E-10	9.3
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	1.23	0.0009	0.0048	0.0081	1.436E-09	8.9
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.89	0.0015	0.0078	0.0159	1.14E-09	8.9
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	1.43	0.0011	0.0056	0.0215	7.261E-10	9.1
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	1.44	0.0011	0.0056	0.0272	1.251E-09	8.9
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.79	0.0009	0.0031	0.0303	5.296E-10	9.3
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.71	0.0008	0.0028	0.0331	3.511E-10	9.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	2.47	0.0019	0.0097	0.0427	6.75E-11	10.2
	10/09/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0427	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0427	0	ERR

30 Sec. Rinse Conc.(ppm) 1.84
An (30s) 1.298E-03

?

DATE OCT 27 1992

Sample ID L782
Element STRONTIUM
Matrix SEA WATER

S.A.	V	An
76.6	30.7	0.1913

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	9:32am	7200	7200	0.88	0.0008	0.0040	0.0040	7.46E-10	9.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.4	0.0003	0.0016	0.0056	1.812E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.67	0.0014	0.0075	0.0131	1.053E-09	9.0
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	1.3	0.0010	0.0052	0.0183	6.273E-10	9.2
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	1.07	0.0008	0.0043	0.0225	7.216E-10	9.1
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.13	0.0008	0.0045	0.0271	1.133E-09	8.9
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.84	0.0007	0.0038	0.0308	1.01E-09	9.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	3.39	0.0027	0.0144	0.0452	1.491E-10	9.9
	10/09/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0452	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0452	0	ERR

30 Sec. Rinse Conc.(ppm) 1.88
An (30s) 1.280E-03

DATE OCT 27 1992

Sample ID L783
Element STRONTIUM
Matrix SEA WATER

S.A.	V	An
78.5	32.4	0.1939

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	9:32am	7200	7200	0.68	0.0006	0.0029	0.0029	3.338E-10	9.5
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.39	0.0003	0.0016	0.0042	1.565E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.73	0.0014	0.0070	0.0113	9.316E-10	9.0
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	1.1	0.0009	0.0043	0.0156	4.844E-10	9.3
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	1.32	0.0010	0.0054	0.0211	1.136E-09	8.9
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.03	0.0008	0.0042	0.0253	9.73E-10	9.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	0.9	0.0007	0.0037	0.0290	9.571E-10	9.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	3.87	0.0030	0.0159	0.0447	1.791E-10	9.7
	10/09/92	9:32am								
9			2160000	3974400		0.0000	0.0000	0.0447	0	ERR
10			3888000	7862400		0.0000	0.0000	0.0447	0	ERR

9413221.0993

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
RA CZELLATH/STOCK	DA BURBANK/WHC	9208502

Subject: STOCK POLYMER IMMOLBILIZATION TECH. WASTE FORM QUALIFICATION TESTING PURCHASE ORDER NO. MMW-SVV-277587 STOCK REFERENCE NO. 6996

MANAGEMENT			PROJECT ENGINEERING			WRAP PROJECT CONTROL		
JA Swenson	G6-46		TA Carlson	G6-46		KP Brown	G6-47	
DE Ball	G6-46		AW Hinkle	G6-46		SE Bussman	G6-47	
SR Briggs	G6-47		FH Lee	G6-46		C Malstrom	G6-47	
JE Filip	G6-47		JB Payne	G6-46		SW McKinley	G6-47	
DR Lucas	G6-46	X	JG Starkey	G6-46		GC Rice	G6-47	
CA Petersen	H1-60	X	WR Swita	G6-46	X	BL Trumpour	G6-47	
TL Yount	H1-60	X	RR Wyer	G6-46	X			

WRAP TECHNOLOGY			SW SYSTEMS ENGINEERING			SW SYSTEMS ENGINEERING		
CJ Benar	H1-60	X	EG Berglin	G6-46		VP Ocampo	G6-46	
DA Burbank	H1-60	X	KJ Hull	G6-46		DT Ruff	G6-46	
BF Campbell	H1-60		RM Horgus	H1-60		RA Sexton	H1-60	
JD Keck	G6-46		SL Kooiker	G6-46		JR Weber	G6-46	
CE McDonald	H1-60		DL Lamberd	H1-60		JR Weidert	G6-46	
JL Nelson	H1-60		ML Lee	G6-46		RH Winkleman	G6-46	
KE Parker	H1-60		KJ Leist	G6-46		A Zabarauskas	G6-46	
RM Ybarra	H1-60		NJ Monroe	H1-60				

SW INTEGRATION			SW PROJECTS			SUPPORT		
GF Booth	G6-46		DR Broz	G6-46		Corr Control		X
MD LeClair	H1-60		ML DeWitt	G6-46		WRAP DMC	G6-51	X
DW Mertz	H1-60		EG Erpenbeck	G6-46		JR McGee	G6-47	
CR Nash	H1-60		TM Greager	G6-46		E Pennala	E2-30	
TR Pauly	G6-46	X	RL Louie	G6-46		DR Porten	G6-47	
JL Stroup	G6-46		KE Smith	G6-46		JM Seimer	G6-47	
KM Weingardt	H1-60	X	HE Wellsfry	G6-46		WW Olson	N1-83	

SECRETARIES			PROGRAMS			OTHERS		
RL Anderson	G6-45		RJ Roberts	N3-13		DA Smith	G6-16	X
AI Ball	H1-60		JG Riddelle	H5-33				
BJ Gire	G6-46		BA Mayancsik	H5-33				
SA Niebel	G6-46		MM McCarthy	N3-13				
			JB Myers	G6-46				
			OL Kruger	H5-33				

QA RECORD ____ YES ____ NO

COMMENTS TO LEAD ENGINEER BY: _____

SPECIAL INSTRUCTIONS: _____

9413221.0994

STOCK

December 1, 1992
92RAC WH007

Westinghouse Hanford Company
2355 Stevens Drive
Richland, Washington 99352

Attention: Mr. Dewey Burbank, H1-60

Subject: STOCK Polymer Immobilization Tech.
Waste Form Qualification Testing
Purchase Order No. MMW-SVV-277587
Stock Reference No. 6996

Gentlemen:

Enclosed please find a copy of our Progress Report No. 4 for the subject project. This report represents progress through November, 1992.

Should additional information be required, please advise.

Very truly yours,

Russell A. Czellath
Manager-Contracts

RAC/kh
Enclosure

c: Westinghouse Hanford - Attn: G.M. Wemhoff, Buyer
S.O. 6996
T. Litchney
Tickler 1/1/93 w/report

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DEC 14 1992

9413221.0995

Stock Equipment Company • 16490 Chillicothe Road • Chagrin Falls, Ohio 44022-4398, U.S.A. • (216) 543-6000 • Telex 196071
A Unit of General Signal
Telefax (216) 543-6678

WESTINGHOUSE HANFORD COMPANY

STOCK EQUIPMENT CO.

POLYMER IMMOBILLIZATION TECH.

WASTE FORM QUALIFICATION TESTING

MONTHLY PROGRESS REPORT

NO. 4

THROUGH NOVEMBER, 1992

Stock Equipment Company

Westinghouse Hanford Purchase Order No. MMW-SVV-277587

Stock Order No. 6996

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	BAR CHART SCHEDULE	5

1.0 SUMMARY

November 5, 1992

The 45 day leach interval.

The samples are in intact with no apparent degradation. They will be assayed for cesium, cobalt, and strontium. The current leachability calculations have been included.

November 6, 1992

The Thermal Cycling Test for samples L1, L3, and L7 were completed. The results are as follows:

SAMPLE ID	HEIGHT (inch)	DIA. (inch)	WEIGHT (grams)	DENSITY (gm/cc)	LOAD (lbs)	FORCE (psi)
L1-11	1.954	1.418	56.11	1.11	17,520	11,094
L1-12	1.926	1.425	55.01	1.09	17,560	11,010
L1-13	1.913	1.422	54.84	1.10	17,600	11,082
L3-11	2.046	1.453	77.51	1.39	7,200	4,342
L3-12	2.113	1.453	77.22	1.34	8,400	5,066
L3-13	2.044	1.454	76.71	1.38	9,840	5,926
L7-11	2.049	1.456	81.59	1.46	1,400	841
L7-12	2.025	1.446	81.01	1.49	1,720	1,047
L7-13	1.987	1.448	80.01	1.49	1,780	1081

November 17, 1992

Thermal cycling was initiated for the samples L5 (TYPE 2) and L9 (TYPE 4).

Week of November 9, 1992

Surrogate waste samples Type 2 and Type 4 were sent out to have the following tests performed:

irradiation,
biodegradation, and
TCLP.

9413221.0998

Due to combustible considerations the samples prepared for TCLP were ground at Stock prior to submittal to the contracted laboratory.

Samples L5 and L9 (Type 2 and Type 4) were spiked with cobalt, cesium, and strontium. Then casted into 1.5" by 2" cylinders. An exotherm profile on the prepared samples was obtain.

November 16, 1992

The leachability study was started for surrogate waste Types 2 and 4. The following time points have been pulled:

30 seconds,
2 hour,
5 hour,
24 hour,
2 day,
3 day,
4 day, and
5 day.

The 90 day sample will be pulled on February 15, 1993. An amendment to the original report will follow within a week of the 90 day leach interval for TYPE 2 and TYPE 4 surrogate waste streams.

All time points up to and including 5 days have been assayed. Leachability calculations are in progress.

Samples of surrogate wastes TYPE 1 and TYPE 3 were successfully solidified in the alternate polymer, exotherm data was recorded. The formulations are identical to the one used for the sample preparation for all the testing. I also have done an exotherm profile on TYPE 4 surrogate waste.

November 23, 1992

TCLP extraction was started on L3, L5, L7 and L9 samples. The samples will be assayed for their metals.

9413221.0999

FORMULATION DATA FOR EXOTHERMS

Sample	Binder (gms)	BPO (gms)	DMT (gms)	Waste (gms)	Speed (rpm)	Power watts	peak tmp °C
Control	100	2.58	0.1	0	500	0.1	105
LETF	100	2.53	0.1	200	1800	14.6	67
TYPE 2	100	7.50	2.0	100	1800	5.7	70
TYPE 3	100	2.60	0.1	200	1797	6.4	54
TYPE 4	100	5.16	1.1	150	1803	5.7	64

All the samples have been returned from the irradiation testing facility. The samples were tested for compressive strength. The compressive strength has increased for the samples tested. This increase is due to the probability of the embrittlement of the vinyl esther resin. Reference the attached Data Sheet for the results.

We are currently collecting data toward preparation of the final report which will include the December Monthly Report.

Awaiting purchase order revision concerning Westinghouse Hanford decision to proceed with additional testing.

9413221.1000

2.0 SCHEDULE

Activity	Scheduled Date	Actual Date
- Prepare Work Plan	08/01/92	08/01/92
- Submit Work Plan	08/01/92	08/01/92
- Approve Plan	08/10/92	08/10/92
- Develop Formulations	08/21/92	08/21/92
- Prepare Specimens	09/01/92	09/16/92
- Lab - Analysis	12/10/92	
- Final Report	12/23/92	

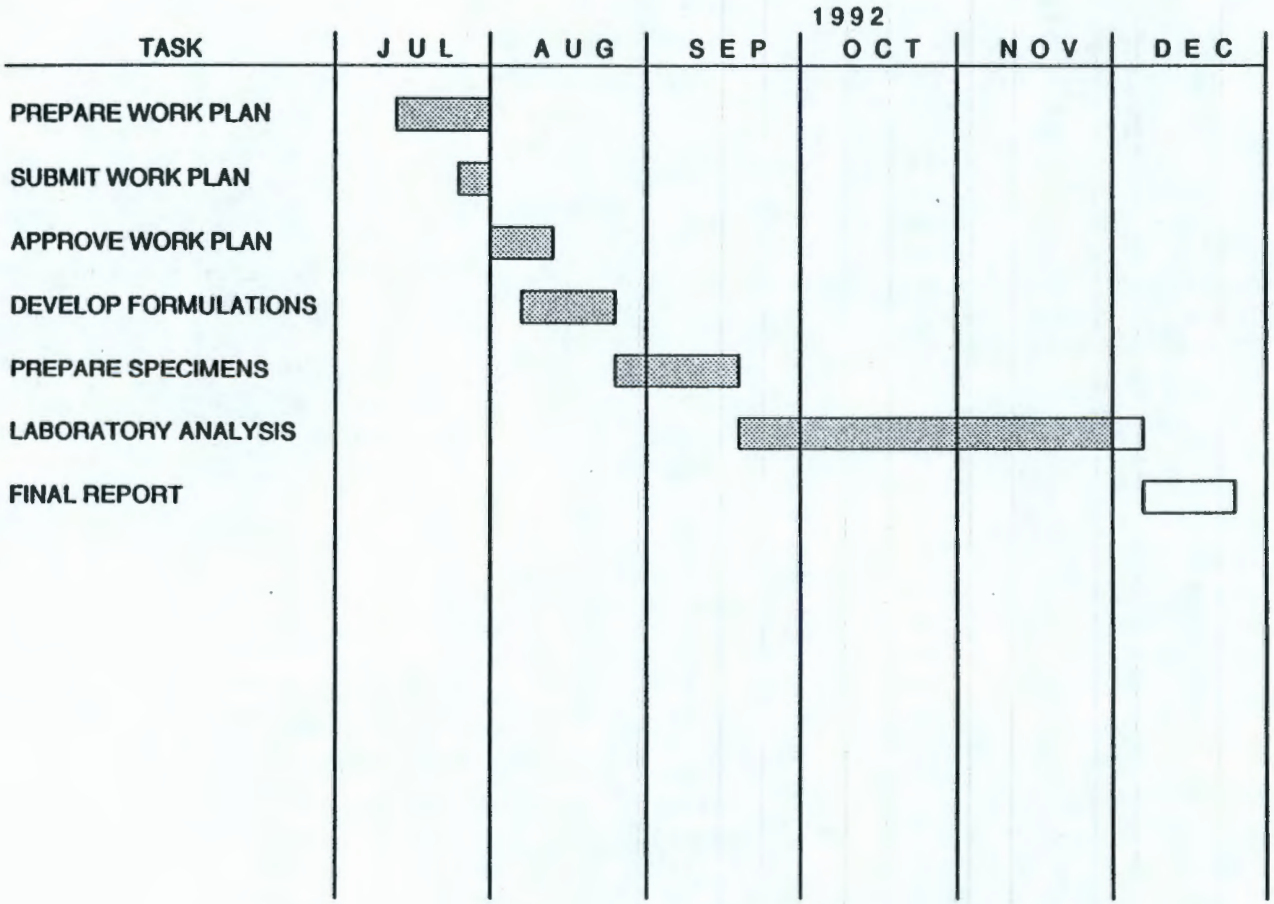
STOCK EQUIPMENT COMPANY

01-Dec-92

PROJECT SCHEDULE
WESTINGHOUSE
HANFORD COMPANY
P.O. MMW-SVV-277587
STOCK ORDER: 6996

MONTHLY PROGRESS REPORT

PREPARED BY: RUSS A. CZELLATH



THERMAL CYCLING SAMPLES
BEFORE THE START OF THE TEST

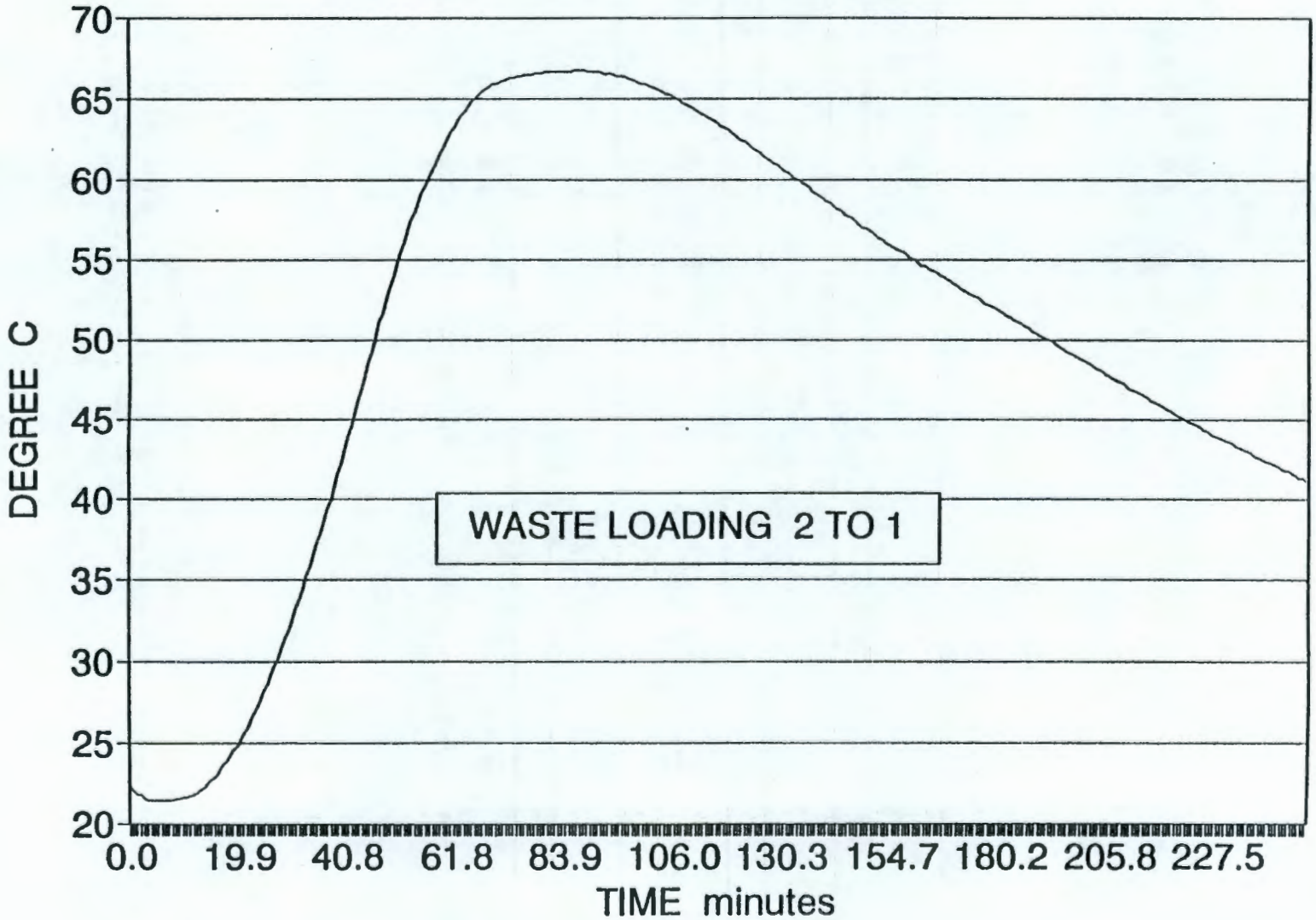
SAMPLE ID	HEIGHT (in)	DIAMETER (in)	WEIGHT (gms)	DENSITY (gms/cc)	DENSITY (gms/cc) avg
L1-11	1.937	1.418	56.12	1.12	
L1-12	1.915	1.420	55.01	1.11	1.11
L1-13	1.919	1.423	54.85	1.10	
L3-11	2.039	1.452	78.09	1.41	
L3-12	2.063	1.445	77.96	1.41	1.41
L3-13	2.019	1.447	77.25	1.42	
L7-11	2.035	1.464	84.9	1.51	
L7-12	2.036	1.458	84.72	1.52	1.52
L7-13	2.009	1.455	83.65	1.53	

THERMAL CYCLING SAMPLES
AT THE COMPLETION OF THE TEST

SAMPLE ID	HEIGHT (IN)	DIAMETER (IN)	WEIGHT (gms)	DENSITY (gms/cc)	LOAD (lbs)	COMPRESSIVE STRENGHT (psi)
L1-11	1.954	1.418	56.11	1.11	17520	11094
L1-12	1.926	1.425	55.01	1.09	17560	11010
L1-13	1.913	1.422	54.64	1.1	17600	11082
L3-11	2.046	1.453	77.51	1.39	7200	4342
L3-12	2.113	1.453	77.22	1.34	8400	5066
L3-13	2.044	1.454	76.71	1.38	9840	5926
L7-11	2.049	1.456	81.59	1.46	1400	841
L7-12	2.025	1.446	81.01	1.49	1720	1047
L7-13	1.987	1.448	80.01	1.49	1780	1081

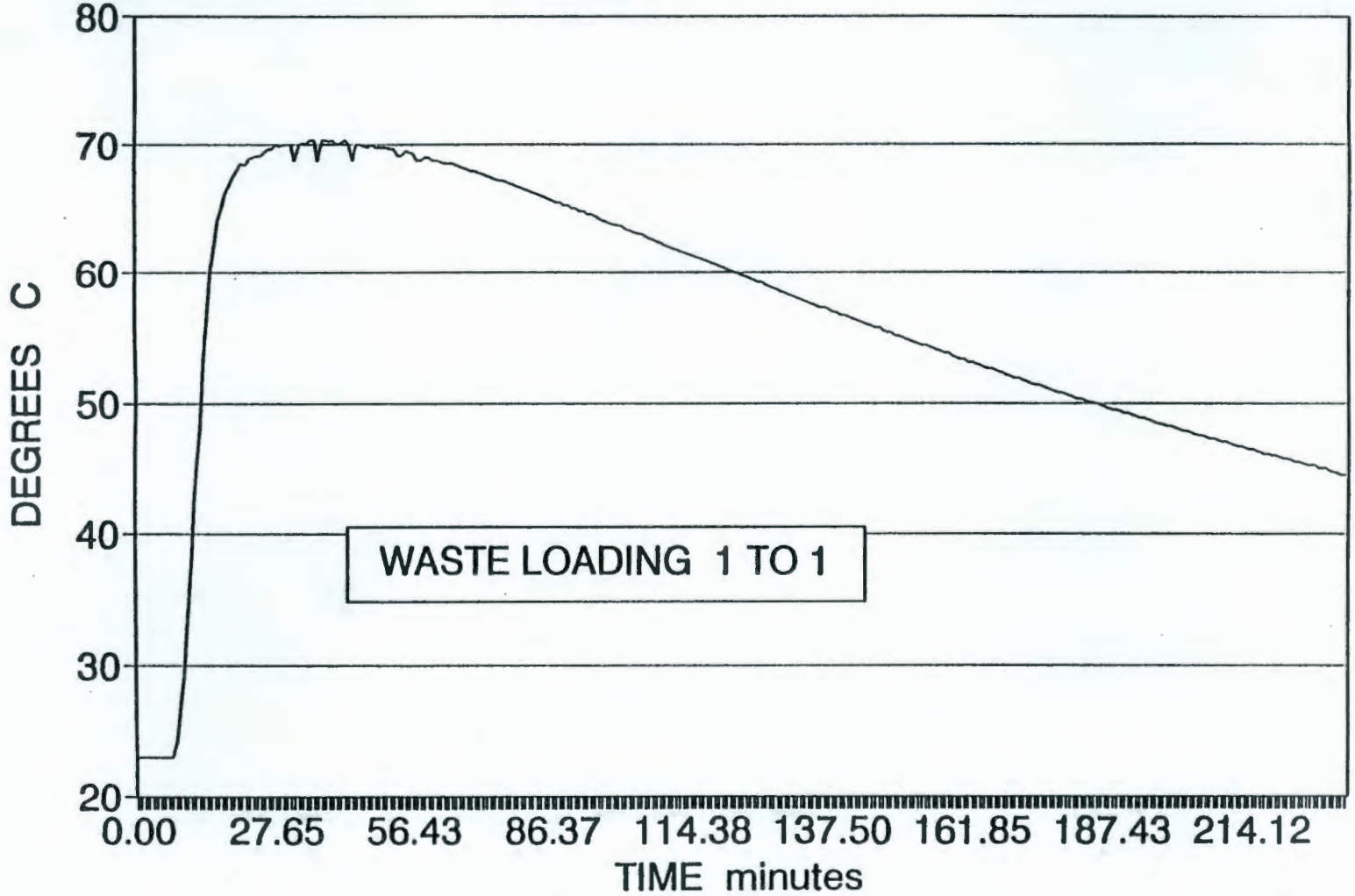
WESTINGHOUSE HANDFORD

LETF SURROGATE WASTE



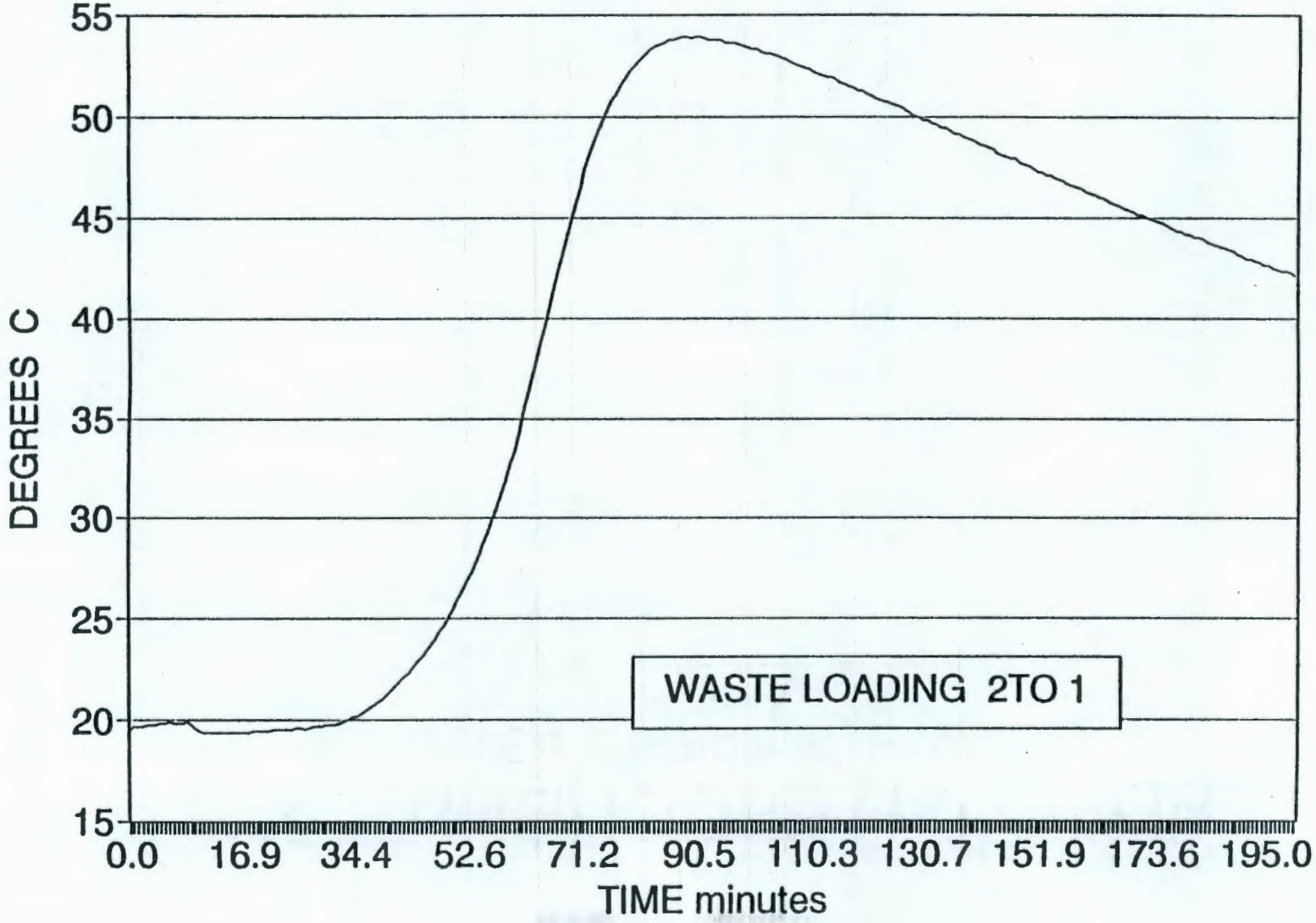
WESTINGHOUSE HANDFORD

TYPE 2 SURROGATE WASTE



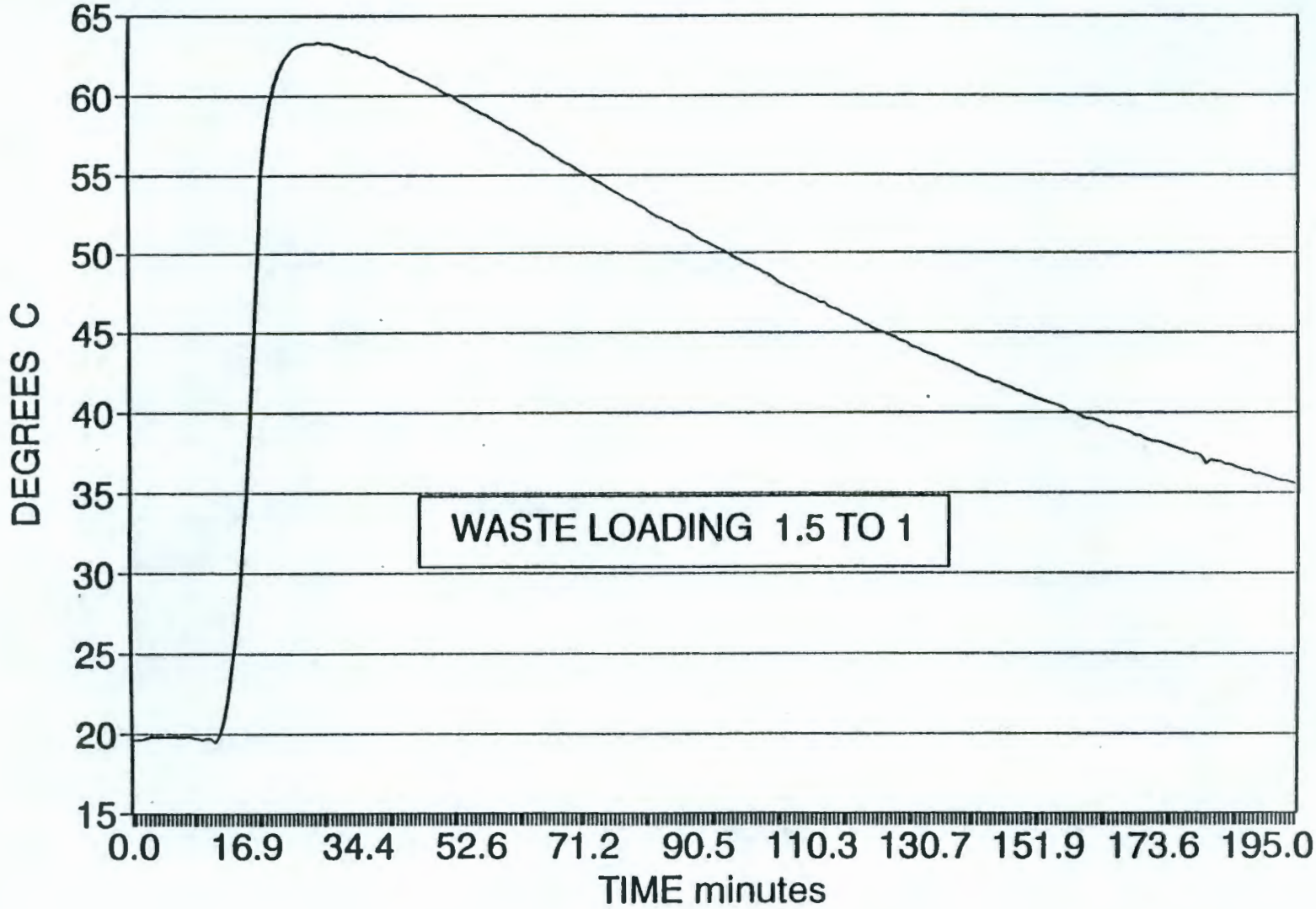
WESTINGHOUSE HANDFORD

TYPE 3 SURROGATE WASTE



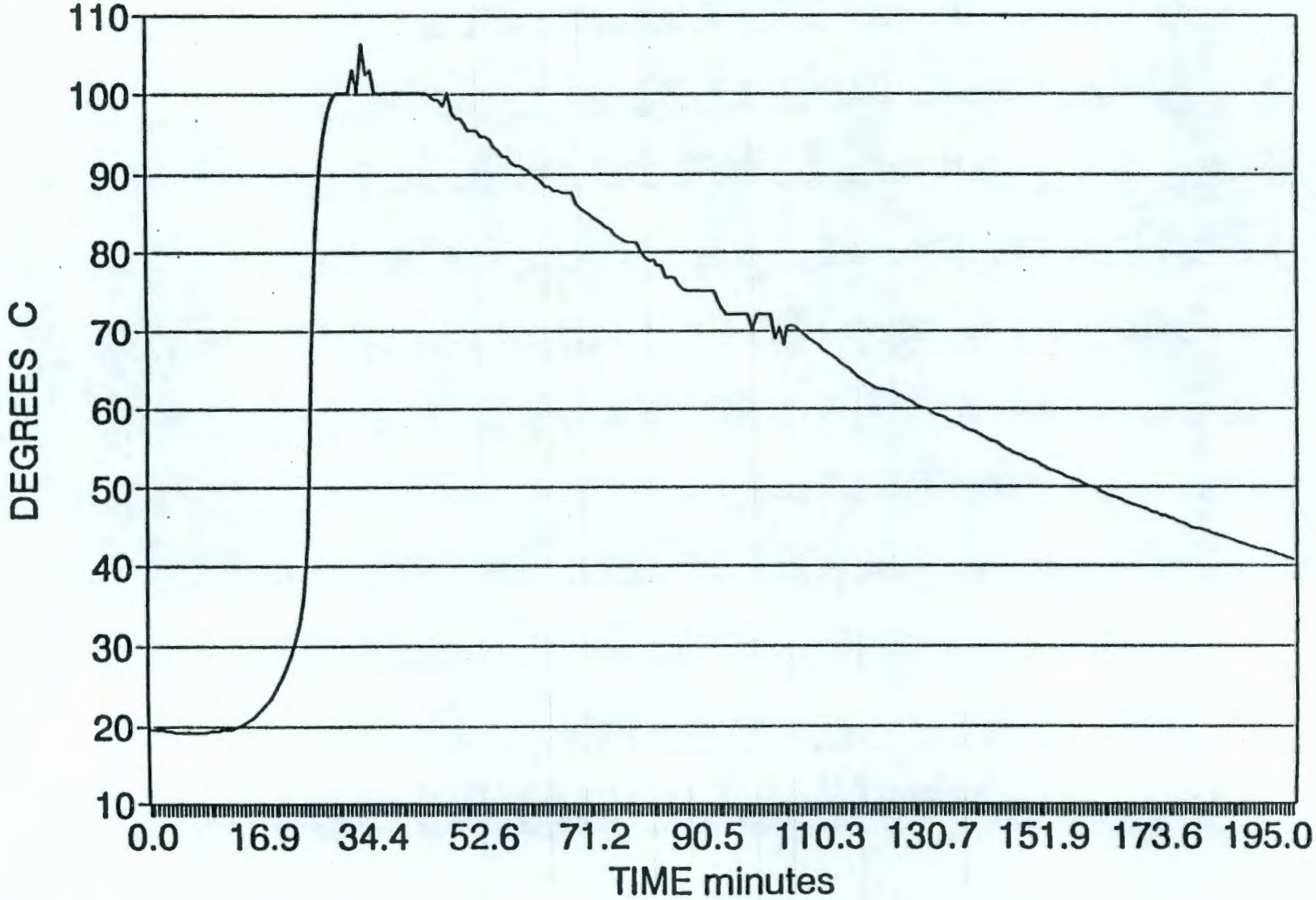
WESTINGHOUSE HANDFORD

TYPE 4 SURROGATE WASTE



WESTINGHOUSE HANDFORD

CONTROL 470-45 RESIN



RADIATION SAMPLES AFTER TEST

SAMPLE ID	DIAMETER (cm)	HEIGHT (cm)	WEIGHT (gms)	DENSITY (gms/cc)	AVG DENSITY (gms/cc)	LOAD (lbs)	COMPRESSIVE STRENGTH (psi)	AVG STRENGT
L1-17	3.640	4.830	54.64	1.0871		17720	10986	
L1-18	3.640	4.745	53.61	1.0857	1.0928	17520	10862	10954
L1-19	3.615	4.860	55.15	1.1056		17520	11013	
L3-17	3.670	5.250	72.79	1.3107		5920	3610	
L3-18	3.700	5.320	76.25	1.3330	1.3253	10320	6192	5127
L3-19	3.705	5.335	76.62	1.3321		9320	5577	
L5-17	3.635	4.965	63.43	1.2311		11400	7087	
L5-18	3.615	4.940	62.71	1.2368	1.2367	7880	4953	6028
L5-19	3.620	4.815	61.56	1.2422		9640	6043	
L7-17	3.710	5.230	80.95	1.4318		1480	883	
L7-18	3.690	5.215	84.07	1.5075	1.4801	1520	917	964
L7-19	3.680	5.160	82.39	1.5012		1800	1092	
L9-17	3.810	5.105	84.05	1.4441		3840	2173	
L9-18	3.820	4.850	79.23	1.4254	1.4409	3440	1936	2575
L9-19	3.765	5.050	81.70	1.4532		6240	3616	

sample#	WEIGHT grams	HEIGHT cm	DIAMETER cm	DENSITY grams/cc	AVG.	LOAD LBS	PSI five day compressive strenght	AVG.
L1-1	51.4	4.540	3.612	1.1049		17160	10804	
L1-2	58.8	5.116	3.612	1.1217		17160	10804	
L1-3	51.0	4.502	3.609	1.1074		17120	10797	
L1-4	55.3	4.869	3.611	1.1090		17360	10936	
L1-5	51.7	4.483	3.611	1.1261		17360	10936	
L1-6	58.9	5.024	3.609	1.1460	1.12	17400	10974	10926
L1-7	56.3	4.923	3.611	1.1167		17480	11012	
L1-8	54.9	4.796	3.611	1.1178		17480	11012	
L1-9	56.3	4.991	3.607	1.1039		17520	11062	
L1-10	56.7	4.968	3.609	1.1157		17320	10923	
L3-1	73.9	5.112	3.618	1.4061		3520	2209	
L3-2	72.5	5.230	3.616	1.3499		3600	2262	
L3-3	71.9	5.100	3.614	1.3743		3680	2314	
L3-4	71.1	5.067	3.678	1.3207		4320	2623	
L3-5	73.3	5.245	3.663	1.3262		4240	2596	
L3-6	71.7	5.108	3.668	1.3284	1.33	4280	2613	2472
L3-7	67.1	5.024	3.680	1.2557		3920	2378	
L3-8	72.9	5.212	3.653	1.3345		4160	2561	
L3-9	71.2	5.065	3.683	1.3195		4400	2665	
L3-10	72.3	5.194	3.665	1.3195		4080	2495	
L5-1	82.7	4.885	3.665	1.6047		1840	1125	
L5-2	80.7	4.745	3.655	1.6210		1760	1082	
L5-3	82.7	4.890	3.660	1.6075		1800	1104	
L5-4	80.6	4.865	3.645	1.5877		1800	1113	
L5-5	82.3	4.850	3.660	1.6129	1.63	1800	1104	1085
L5-6	90.3	5.175	3.650	1.6676		1680	1036	
L5-7	87.4	5.095	3.610	1.6760		1680	1059	
L5-8	84.9	5.000	3.640	1.6317		1720	1066	
L5-9	85.6	5.035	3.625	1.6473		1720	1075	
L5-10	77.3	4.690	3.695	1.5370		2680	1612	
L7-1	77.2	5.001	3.614	1.5049		2480	1560	
L7-2	72.8	4.829	3.615	1.4688		2440	1534	
L7-3	76.4	4.837	3.617	1.5372		2400	1507	
L7-4	75.9	4.935	3.611	1.5018		1600	1008	
L7-5	73.1	4.976	3.632	1.4179		2440	1519	
L7-6	72.6	4.724	3.627	1.4874	1.48	2200	1374	1411
L7-7	77.4	5.017	3.632	1.4891		2240	1395	
L7-8	75.8	5.078	3.627	1.4447		2360	1474	
L7-9	76.0	5.017	3.614	1.4767		1800	1132	
L7-10	72.6	4.956	3.617	1.4257		2560	1607	
L9-1	63.3	4.725	3.550	1.3535		1640	1069	
L9-2	58.3	4.890	3.595	1.1746		1640	1042	
L9-3	74.3	4.895	3.650	1.4506		1520	937	
L9-4	70.2	4.845	3.635	1.3962		1600	995	
L9-5	64.7	4.650	3.630	1.3445	1.36	1600	997	941.7
L9-6	55.6	4.500	3.570	1.2343		1360	877	
L9-7	78.7	4.990	3.660	1.4991		1320	809	
L9-8	70.6	4.990	3.595	1.3939		1400	890	
L9-9	74.7	4.950	3.660	1.4344		1400	859	
L9-10	69.9	4.990	3.575	1.3955		1400	900	

9413221.1010

30 Sec. Rinse Conc.(ppm) 0.0

Ao (30s) 3.838E-08

DATE NOV 25 1992

Sample ID L3A1
Element CESIUM
Matrix DI water

S.A.	V	Ao
76.7	30.7	0.1691

	Date	TIME IN OUT	(dtp) S	(t+count/dt) S	Conc. PPM	cm g	cm/Ao	SUM cm/Ao	Di	L
1	09/21/92	9:33am	7200	7200	23	0.0170	0.0930	0.0930	4.102E-07	6.4
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	21	0.0161	0.0880	0.1794	4.809E-07	6.3
	09/21/92	2:33pm								
3	09/21/92	2:33pm	61200	89400	29	0.0222	0.1183	0.2977	2.629E-07	6.6
	09/22/92	9:33am								
4	09/22/92	9:33am	89400	178800	27	0.0207	0.1101	0.4078	2.605E-07	6.6
	09/23/92	9:33am								
5	09/23/92	9:33am	89400	268200	23	0.0176	0.0936	0.5015	3.408E-07	6.5
	09/24/92	9:33am								
6	09/24/92	9:33am	89400	348600	16.2	0.0117	0.0620	0.5635	2.125E-07	6.7
	09/25/92	9:33am								
7	09/25/92	9:33am	89400	438000	12	0.0092	0.0489	0.6125	1.708E-07	6.8
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	10.34	0.0142	0.0756	0.6881	4.123E-09	9.4
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	1.38	0.0010	0.0005	0.6906	2.394E-11	10.8
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.6906	0	ERR

30 Sec. Rinse Conc.(ppm) 0.0

Ao (30s) 4.844E-08

DATE NOV 25 1992

Sample ID L3A2
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
77.4	31.4	0.1757

	Date	TIME IN OUT	(dtp) S	(t+count/dt) S	Conc. PPM	cm g	cm/Ao	SUM cm/Ao	Di	L
1	09/21/92	9:33am	7200	7200	19	0.0147	0.0837	0.0837	3.37E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	20	0.0156	0.0891	0.1718	4.084E-07	6.3
	09/21/92	2:33pm								
3	09/21/92	2:33pm	61200	89400	29	0.0217	0.1233	0.2952	2.863E-07	6.5
	09/22/92	9:33am								
4	09/22/92	9:33am	89400	178800	29	0.0224	0.1276	0.4229	3.813E-07	6.4
	09/23/92	9:33am								
5	09/23/92	9:33am	89400	268200	24	0.0185	0.1057	0.5286	4.436E-07	6.4
	09/24/92	9:33am								
6	09/24/92	9:33am	89400	348600	13.6	0.0105	0.0599	0.5885	2.004E-07	6.7
	09/25/92	9:33am								
7	09/25/92	9:33am	89400	438000	8.6	0.0067	0.0379	0.6264	1.038E-07	7.0
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	9.50	0.0068	0.0378	0.6642	1.04E-09	9.0
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	0.79	0.0006	0.0035	0.6677	1.003E-11	11.0
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.6677	0	ERR

30 Sec. Rinse Conc.(ppm) 3.0

Ao (30s) 4.075E-08

DATE NOV 25 1992

Sample ID L3A3
Element CESIUM
Matrix DI WATER

S.A.	V	Ao
81.5	35.5	0.1673

	Date	TIME IN OUT	(dtp) S	(t+count/dt) S	Conc. PPM	cm g	cm/Ao	SUM cm/Ao	Di	L
1	09/21/92	9:33am	7200	7200	19	0.0156	0.0934	0.0934	3.45E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	20	0.0163	0.0969	0.1903	5.041E-07	6.3
	09/21/92	2:33pm								
3	09/21/92	2:33pm	61200	89400	29	0.0236	0.1261	0.3164	3.168E-07	6.5
	09/22/92	9:33am								
4	09/22/92	9:33am	89400	178800	27	0.0220	0.1174	0.4120	3.394E-07	6.5
	09/23/92	9:33am								
5	09/23/92	9:33am	89400	268200	23	0.0187	0.1000	0.5120	4.171E-07	6.4
	09/24/92	9:33am								
6	09/24/92	9:33am	89400	348600	13.4	0.0126	0.0669	0.5788	2.631E-07	6.6
	09/25/92	9:33am								
7	09/25/92	9:33am	89400	438000	14.1	0.0115	0.0613	0.6411	2.841E-07	6.5
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	19.1	0.0156	0.0830	0.7242	3.277E-09	9.3
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	1.80	0.0015	0.0082	0.7323	3.817E-11	10.2
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.7323	0	ERR

9413221.1011

20 Std. Rinse Conc.(ppm) 0.0
An (20s) 6.1288E-03

DATE NOV 20 1992

Sample ID L381
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	30.8	0.1731

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	31	0.0237	0.1372	0.1372	9.288E-07	6.0
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	29	0.0222	0.1283	0.2655	1.042E-06	6.0
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	36	0.0421	0.2434	0.5089	1.12E-06	6.0
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	42	0.0322	0.1859	0.6946	8.046E-07	6.1
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	31	0.0237	0.1372	0.8319	7.448E-07	6.1
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	30.3	0.0232	0.1341	0.9660	1.601E-06	6.0
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	18.4	0.0141	0.0814	1.0474	4.798E-07	6.3
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	25.49	0.0195	0.1129	1.1602	9.239E-08	8.0
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	1.39	0.0011	0.0062	1.1664	3.126E-11	10.5
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	1.1664	0	ERR

20 Std. Rinse Conc.(ppm) 7.0
An (20s) 5.3021E-03

DATE NOV 20 1992

Sample ID L382
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
76.6	32.5	0.1651

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	30	0.0157	0.0949	0.0949	3.51E-07	6.5
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	24	0.0169	0.1019	0.1969	6.665E-07	6.2
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	36	0.0263	0.1589	0.3557	4.46E-07	6.3
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	27	0.0212	0.1147	0.4844	3.107E-07	6.3
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	22	0.0173	0.0934	0.5478	3.304E-07	6.3
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	13.8	0.0109	0.0660	0.6069	1.888E-07	6.7
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	11.4	0.0090	0.0484	0.6552	1.705E-07	6.8
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	37.11	0.0292	0.1576	0.8128	1.829E-08	7.7
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	2.40	0.0019	0.0104	0.8232	8.140E-11	10.0
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.8232	0	ERR

20 Std. Rinse Conc.(ppm) 8.0
An (20s) 6.988E-03

DATE NOV 20 1992

Sample ID L383
Element CESIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1727

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	22	0.0170	0.0985	0.0985	4.677E-07	6.3
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	30	0.0196	0.0986	0.1882	5.087E-07	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	32	0.0248	0.1434	0.3317	3.888E-07	6.4
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	29	0.0224	0.1300	0.4616	2.847E-07	6.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	23	0.0178	0.1031	0.5647	4.217E-07	6.4
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	18.3	0.0149	0.0863	0.6512	4.178E-07	6.4
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	12.2	0.0094	0.0547	0.7059	2.151E-07	6.7
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	29.39	0.0227	0.1317	0.8376	1.262E-08	7.9
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	1.89	0.0015	0.0089	0.8465	6.58E-11	10.2
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.8465	0	ERR

9413221.1012

30 Sec. Rinse Conc.(ppm) 0.3
An (30s) 2.32E-04

DATE NOV 20 1992

Sample ID L3A1
Element COBALT
Matrix DI water

S.A.	V	Ao
76.7	30.7	0.1917

	Date	Time In out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	8.4	0.0064	0.0335	0.0335	3.304E-08	7.3
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	7.5	0.0060	0.0300	0.0635	3.68E-08	7.2
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	7.8	0.0060	0.0312	0.0946	1.029E-08	7.7
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	10.7	0.0082	0.0426	0.1370	4.343E-08	7.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	8.9	0.0069	0.0356	0.1732	4.968E-08	7.3
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	346800	8.3	0.0071	0.0365	0.2101	7.498E-08	7.1
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432800	7.0	0.0061	0.0316	0.2417	7.121E-08	7.1
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	38.38	0.0884	0.1536	0.3953	1.701E-08	7.0
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	1.465	0.0011	0.0009	0.4011	2.88E-11	10.5
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.4011	0	ERR

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.74E-08

DATE NOV 23 1992

Sample ID L3A2
Element COBALT
Matrix DI WATER

S.A.	V	Ao
77.4	51.4	0.1802

	Date	Time In out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	7.1	0.0056	0.0305	0.0305	4.474E-08	7.3
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	6.3	0.0049	0.0271	0.0576	4.645E-08	7.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	15.6	0.0121	0.0670	0.1246	8.508E-08	7.1
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	11.4	0.0088	0.0480	0.1739	5.605E-08	7.3
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	10	0.0077	0.0430	0.2169	7.321E-08	7.1
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	346800	8.8	0.0077	0.0423	0.2592	1.01E-07	7.0
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432800	6.8	0.0053	0.0292	0.2884	6.137E-08	7.2
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	20.64	0.0160	0.0887	0.3769	5.722E-08	8.2
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	1.070	0.0008	0.0046	0.3815	1.778E-11	10.7
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.3815	0	ERR

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 8.15E-08

DATE NOV 23 1992

Sample ID L3A3
Element COBALT
Matrix DI WATER

S.A.	V	Ao
81.5	35.5	0.1815

	Date	Time In out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	5.2	0.0042	0.0231	0.0231	2.477E-08	7.6
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	6.1	0.0050	0.0280	0.0491	4.498E-08	7.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	14.8	0.0121	0.0630	0.1111	7.808E-08	7.1
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	10.2	0.0083	0.0434	0.1546	4.63E-08	7.3
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	9.2	0.0075	0.0392	0.1938	6.367E-08	7.2
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	346800	12.8	0.0103	0.0536	0.2473	1.688E-07	6.8
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432800	13	0.0106	0.0553	0.3026	2.315E-07	6.8
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	44.31	0.0363	0.1894	0.4920	2.747E-08	7.6
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	2.314	0.0019	0.0098	0.5019	0.446E-11	10.1
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.5019	0	ERR

9413221.1013

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.68E-08

DATE NOV 20 1992

Sample ID L381
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.6	30.8	0.1791

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	6.6	0.0051	0.0282	0.0282	3.623E-08	7.4
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	6.8	0.0052	0.0291	0.0573	5.351E-08	7.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	30	0.0193	0.0939	0.1439	1.383E-07	6.9
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	19.4	0.0149	0.0830	0.2269	1.604E-07	6.8
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	12.8	0.0099	0.0547	0.2816	1.198E-07	6.9
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	14.6	0.0112	0.0624	0.3439	2.171E-07	6.7
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	14.6	0.0112	0.0624	0.4063	2.797E-07	6.4
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	47.6	0.0365	0.2036	0.6099	3.009E-08	7.5
	10/08/92	8:33am								
9	10/08/92	9:33am	2160000	3974400	1.698	0.0014	0.0081	0.6171	3.393E-11	10.3
	11/5/92	8:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.6171	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
An (30s) 1.372E-04

DATE NOV 20 1992

Sample ID L382
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.6	32.5	0.1904

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	5.1	0.0040	0.0211	0.0211	2.137E-08	7.7
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	5.6	0.0044	0.0231	0.0442	3.43E-08	7.5
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	13.4	0.0121	0.0636	0.1077	7.748E-08	7.1
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	10.2	0.0080	0.0421	0.1499	4.181E-08	7.4
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	9.2	0.0072	0.0380	0.1879	3.791E-08	7.2
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	8.6	0.0068	0.0355	0.2233	7.12E-08	7.1
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	10.8	0.0085	0.0446	0.2679	1.447E-07	6.8
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	61.65	0.0485	0.2546	0.5224	4.771E-08	7.3
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	4.016	0.0032	0.0168	0.5390	2.304E-10	9.6
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.5390	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
An (30s) 1.346E-04

DATE NOV 20 1992

Sample ID L383
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1786

	Date	TIME in out	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	6.3	0.0049	0.0272	0.0272	3.558-08	7.4
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	4.1	0.0032	0.0177	0.0449	1.982E-08	7.7
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	13.8	0.0107	0.0595	0.1043	6.71E-08	7.2
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	11.8	0.0091	0.0509	0.1552	6.046E-08	7.2
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	9.4	0.0073	0.0405	0.1958	6.52E-08	7.2
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	12.4	0.0096	0.0535	0.2492	1.398E-07	6.9
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	13.2	0.0102	0.0569	0.3062	2.33E-07	6.6
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	46.63	0.0364	0.2140	0.5202	3.334E-08	7.5
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	3.03	0.0023	0.0131	0.5332	1.414E-10	9.8
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.5332	0	ERR

9413221.1014

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.67E-05

DATE NOV 29 1992

Sample ID L3A1
Element STRONTIUM
Matrix DI water

S.A.	V	Ae
76.7	30.7	0.1919

	Date	TIME IN OUT	(dt)n s	t=sum(dt) s	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:33am	7200	7200	1.31	0.0012	0.0060	0.0060	1.738E-09	6.8
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	1.88	0.0014	0.0073	0.0133	3.502E-09	6.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	85400	2.09	0.0016	0.0082	0.0215	1.274E-09	6.9
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	1.82	0.0019	0.0077	0.0888	1.369E-09	6.9
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.83	0.0014	0.0074	0.0369	2.175E-09	6.7
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	1.32	0.0010	0.0053	0.0422	1.541E-09	6.8
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.09	0.0008	0.0042	0.0464	1.237E-09	6.9
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	2.32	0.0019	0.0101	0.0565	7.386E-11	10.1
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	6.42	0.0066	0.0337	0.0901	6.308E-10	9.9
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.0901	0	ERR

30 Sec. Rinse Conc.(ppm) 0.1
An (30s) 7.74E-05

DATE NOV 29 1992

Sample ID L3A2
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ae
77.4	31.4	0.1902

	Date	TIME IN OUT	(dt)n s	t=sum(dt) s	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:33am	7200	7200	1.75	0.0014	0.0075	0.0375	2.718E-09	6.6
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	2.04	0.0016	0.0088	0.0163	4.87E-09	6.3
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	85400	2.13	0.0017	0.0092	0.0255	1.616E-09	6.8
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	1.83	0.0014	0.0079	0.0334	1.444E-09	6.8
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.46	0.0011	0.0064	0.0397	1.604E-09	6.8
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	1.19	0.0009	0.0051	0.0448	1.458E-09	6.8
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.31	0.0010	0.0056	0.0503	2.276E-09	6.6
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	2.47	0.0019	0.0106	0.0611	8.186E-11	10.1
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	12.4	0.0096	0.0533	0.1143	2.35E-09	6.6
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.1143	0	ERR

30 Sec. Rinse Conc.(ppm) 0.21
An (30s) 1.712E-04

DATE NOV 29 1992

Sample ID L3A3
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ae
81.3	35.5	0.1914

	Date	TIME IN OUT	(dt)n s	t=sum(dt) s	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:33am	7200	7200	1.21	0.0010	0.0052	0.0052	1.343E-09	6.9
	09/21/92	10:33am								
2	09/21/92	10:33am	16000	23200	1.77	0.0014	0.0075	0.0127	3.788E-09	6.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	85400	2.02	0.0016	0.0086	0.0213	1.474E-09	6.8
	09/22/92	9:33am								
4	09/22/92	9:33am	86400	172800	1.08	0.0009	0.0046	0.0259	3.188E-10	9.3
	09/23/92	9:33am								
5	09/23/92	9:33am	86400	259200	1.30	0.0011	0.0057	0.0316	1.279E-09	6.9
	09/24/92	9:33am								
6	09/24/92	9:33am	86400	345600	0.93	0.0008	0.0040	0.0356	9.207E-10	9.0
	09/25/92	9:33am								
7	09/25/92	9:33am	86400	432000	1.36	0.0011	0.0058	0.0414	2.537E-09	6.0
	09/26/92	9:33am								
8	09/26/92	9:33am	1382400	1814400	2.32	0.0019	0.0099	0.0513	7.472E-11	10.1
	10/09/92	9:33am								
9	10/09/92	9:33am	2160000	3974400	8.36	0.0070	0.0364	0.0877	1.157E-09	6.9
	11/5/92	9:33am								
10	11/5/92	9:33am	3888000	7862400		0.0000	0.0000	0.0877	0	ERR

9413221.1015

30 Sec. Rinse Conc.(ppm) 0.71
Ao (30s) 3.446E-04

DATE NOV 23 1992

Sample ID L381
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.7	30.8	0.1787

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	2.46	0.0019	0.0106	0.0106	3.348E-09	8.3
	09/21/92	10:33am								
2	09/21/92	10:33am	14000	25200	1.82	0.0015	0.0082	0.0189	4.298E-09	8.4
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	3.32	0.0020	0.0142	0.0330	3.606E-09	8.4
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	2.36	0.0018	0.0101	0.0432	2.301E-09	8.6
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.60	0.0014	0.0070	0.0510	2.462E-09	8.6
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	1.88	0.0015	0.0085	0.0595	4.022E-09	8.4
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.9	0.0015	0.0082	0.0677	4.771E-09	8.3
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	4.12	0.0032	0.0177	0.0854	2.271E-10	9.6
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	15.14	0.0118	0.0650	0.1504	3.489E-09	8.8
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.1504	0	ERR

30 Sec. Rinse Conc.(ppm) 1.41
Ao (30s) 1.108E-03

DATE NOV 23 1992

Sample ID L382
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.4	32.5	0.1985

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	2.89	0.0024	0.0124	0.0124	7.460E-09	8.1
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.81	0.0014	0.0073	0.0199	7.037E-10	9.1
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.46	0.0019	0.0102	0.0301	1.88E-09	8.7
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	1.37	0.0011	0.0057	0.0358	7.633E-10	9.1
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.65	0.0013	0.0068	0.0426	1.88E-09	8.7
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	1.63	0.0013	0.0068	0.0494	2.362E-09	8.6
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.7	0.0013	0.0071	0.0564	3.618E-09	8.4
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	2.69	0.0021	0.0112	0.0676	9.169E-11	10.0
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	10.39	0.0083	0.0439	0.1115	1.814E-09	8.8
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.1115	0	ERR

30 Sec. Rinse Conc.(ppm) 1.20
Ao (30s) 8.388E-04

DATE NOV 23 1992

Sample ID L383
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
77.4	31.4	0.1788

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	8:33am	7200	7200	3.08	0.0024	0.0132	0.0132	8.388E-09	8.1
	09/21/92	10:33am								
2	09/21/92	10:33am	18000	25200	1.63	0.0013	0.0071	0.0203	3.198E-09	8.5
	09/21/92	3:33pm								
3	09/21/92	3:33pm	61200	86400	2.81	0.0022	0.0122	0.0324	2.604E-09	8.6
	09/22/92	8:33am								
4	09/22/92	8:33am	86400	172800	1.30	0.0012	0.0057	0.0391	1.092E-09	8.9
	09/23/92	8:33am								
5	09/23/92	8:33am	86400	259200	1.3	0.0010	0.0056	0.0446	1.257E-09	8.9
	09/24/92	8:33am								
6	09/24/92	8:33am	86400	345600	2.08	0.0016	0.0090	0.0536	4.327E-09	8.3
	09/25/92	8:33am								
7	09/25/92	8:33am	86400	432000	1.79	0.0014	0.0077	0.0613	4.319E-09	8.4
	09/26/92	8:33am								
8	09/26/92	8:33am	1382400	1814400	2.97	0.0023	0.0129	0.0744	1.203E-10	9.9
	10/08/92	8:33am								
9	10/08/92	8:33am	2160000	3974400	12.5	0.0097	0.0541	0.1285	2.426E-09	8.6
	11/5/92	8:33am								
10	11/5/92	8:33am	3888000	7862400		0.0000	0.0000	0.1285	0	ERR

9413221.1016

30 Sec. Rinse Conc.(ppm) 0.0
Ao (30s) 4.602E-03

DATE NOV 25 1992

Sample ID L7A1
Element CESIUM
Matrix DI water

S.A	V	Ao
76.7	30.7	0.1670

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	15	0.0115	0.0513	0.0513	1.789E-07	5.7
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	21	0.0161	0.0856	0.1470	4.623E-07	6.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	43	0.0330	0.1756	0.3226	5.781E-07	6.2
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	40	0.0307	0.1634	0.4860	6.179E-07	6.2
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	28	0.0189	0.1062	0.5922	4.432E-07	6.4
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	20.8	0.0160	0.0854	0.6776	4.031E-07	6.4
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	24.8	0.0190	0.1013	0.7789	7.312E-07	6.1
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	30.07	0.0232	0.1236	0.9043	1.744E-06	7.0
	10/06/92	9:32am								
9	10/06/92	9:32am	2160000	3974400	3.30	0.0025	0.0134	0.9477	1.473E-10	9.0
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.9477	0	ERR

30 Sec. Rinse Conc.(ppm) 0.0
Ao (30s) 4.644E-03

DATE NOV 25 1992

Sample ID L7A2
Element CESIUM
Matrix DI WATER

S.A	V	Ao
77.4	31.4	0.2084

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	16	0.0124	0.0600	0.0600	1.732E-07	6.8
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	24	0.0186	0.0900	0.1300	3.135E-07	6.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	36	0.0446	0.2175	0.3475	6.865E-07	6.0
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	36	0.0433	0.2100	0.5775	1.03E-06	6.0
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	30	0.0294	0.1425	0.7200	6.096E-07	6.1
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	27.5	0.0214	0.1046	0.8246	6.112E-07	6.2
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	22.5	0.0174	0.0844	0.9090	3.121E-07	6.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	28.14	0.0216	0.1036	1.0146	6.108E-09	8.1
	10/06/92	9:32am								
9	10/06/92	9:32am	2160000	3974400	2.88	0.0021	0.0101	1.0246	6.388E-11	10.1
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	1.0246	0	ERR

30 Sec. Rinse Conc.(ppm) 0.0
Ao (30s) 3.838E-03

DATE NOV 25 1992

Sample ID L7A3
Element CESIUM
Matrix DI WATER

S.A	V	Ao
76.7	30.7	0.1665

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	12	0.0092	0.0464	0.0464	1.161E-07	6.9
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	18	0.0139	0.0740	0.1204	3.444E-07	6.3
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	47	0.0360	0.1933	0.3167	7.013E-07	6.2
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	41	0.0314	0.1686	0.4853	6.302E-07	6.2
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	25	0.0192	0.1029	0.5881	4.130E-07	6.4
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	21.1	0.0162	0.0868	0.6749	4.168E-07	6.4
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	20.7	0.0159	0.0851	0.7600	3.165E-07	6.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	30.87	0.0304	0.1631	0.9232	1.82E-08	7.7
	10/06/92	9:32am								
9	10/06/92	9:32am	2160000	3974400	3.37	0.0026	0.0139	0.9370	1.577E-10	9.8
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.9370	0	ERR

9413221.1017

30 Sec. Rinse Conc.(ppm) 7.0
An (30s) 5.376E-03

DATE NOV 25 1992

Sample ID L781
Element CESIUM
Matrix SEA WATER

E.A	V	An
76.9	30.8	0.1922

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	8:32am	7200	7200	11	0.0084	0.0440	0.0440	9.221E-08	7.0
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	14	0.0108	0.0560	0.0880	1.97E-07	6.7
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	23	0.0177	0.0919	0.1919	1.568E-07	6.6
	09/22/92	8:30am								
4	09/22/92	8:30am	86400	172800	23	0.0177	0.0919	0.2837	1.898E-07	6.7
	09/23/92	8:30am								
5	09/23/92	8:30am	86400	259200	15	0.0115	0.0599	0.3436	1.413E-07	6.9
	09/24/92	8:30am								
6	09/24/92	8:30am	86400	345600	10.6	0.0083	0.0432	0.3868	1.03E-07	7.0
	09/25/92	8:30am								
7	09/25/92	8:30am	86400	432000	8.5	0.0073	0.0380	0.4248	1.027E-07	7.0
	09/26/92	8:30am								
8	09/26/92	8:30am	1382400	1814400	46.72	0.0362	0.1887	0.6234	2.047E-08	7.3
	10/09/92	8:30am								
9	10/09/92	8:30am	2160000	3974400	34.84	0.0269	0.1399	0.7633	1.66E-08	7.8
	11/5/92	8:30am								
10	11/5/92	8:30am	3888000	7862400		0.0000	0.0000	0.7633	0	ERR

30 Sec. Rinse Conc.(ppm) 6.0
An (30s) 4.6860E-03

DATE NOV 25 1992

Sample ID L782
Element CESIUM
Matrix SEA WATER

E.A	V	An
76.6	30.7	0.168

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	8:32am	7200	7200	10	0.0077	0.0407	0.0407	7.933E-08	7.1
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	13	0.0100	0.0530	0.0937	1.788E-07	6.8
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	20	0.0153	0.0815	0.1752	1.23E-07	6.9
	09/22/92	8:30am								
4	09/22/92	8:30am	86400	172800	22	0.0169	0.0896	0.2648	1.805E-07	6.7
	09/23/92	8:30am								
5	09/23/92	8:30am	86400	259200	12	0.0092	0.0489	0.3137	8.424E-08	7.0
	09/24/92	8:30am								
6	09/24/92	8:30am	86400	345600	9.5	0.0073	0.0387	0.3524	8.31E-08	7.1
	09/25/92	8:30am								
7	09/25/92	8:30am	86400	432000	8.6	0.0074	0.0391	0.3916	1.082E-07	7.0
	09/26/92	8:30am								
8	09/26/92	8:30am	1382400	1814400	53.19	0.0407	0.2167	0.6083	3.397E-08	7.3
	10/09/92	8:30am								
9	10/09/92	8:30am	2160000	3974400	34.51	0.0264	0.1406	0.7489	1.627E-08	7.8
	11/5/92	8:30am								
10	11/5/92	8:30am	3888000	7862400		0.0000	0.0000	0.7489	0	ERR

30 Sec. Rinse Conc.(ppm) 6.0
An (30s) 4.710E-03

DATE NOV 25 1992

Sample ID L783
Element CESIUM
Matrix SEA WATER

E.A	V	An
76.5	32.4	0.1884

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/An	SUM an/An	DI	L
1	09/21/92	8:30am	7200	7200	12	0.0084	0.0467	0.0467	1.202E-07	6.9
	09/21/92	10:32am								
2	09/21/92	10:30am	16000	23200	13	0.0102	0.0535	0.1038	1.851E-07	6.7
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	21	0.0165	0.0870	0.1907	1.451E-07	6.8
	09/22/92	8:30am								
4	09/22/92	8:30am	86400	172800	20	0.0157	0.0829	0.2736	1.622E-07	6.9
	09/23/92	8:30am								
5	09/23/92	8:30am	86400	259200	11	0.0086	0.0456	0.3191	8.334E-08	7.1
	09/24/92	8:30am								
6	09/24/92	8:30am	86400	345600	10.3	0.0081	0.0427	0.3618	1.026E-07	7.0
	09/25/92	8:30am								
7	09/25/92	8:30am	86400	432000	8.3	0.0065	0.0344	0.3962	8.601E-08	7.1
	09/26/92	8:30am								
8	09/26/92	8:30am	1382400	1814400	51.32	0.0403	0.2137	0.6099	3.326E-08	7.3
	10/09/92	8:30am								
9	10/09/92	8:30am	2160000	3974400	33.59	0.0264	0.1392	0.7492	1.622E-08	7.8
	11/5/92	8:30am								
10	11/5/92	8:30am	3888000	7862400		0.0000	0.0000	0.7492	0	ERR

9413221.1018

30 Sec. Rinse Conc.(ppm) 0.001
An (30s) 7.57E-07

DATE NOV 25 1992

Sample ID L7A1
Element COBALT
Matrix DI water

S.A.	V	Ao
76.7	30.7	0.1914

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.001	0.0000	0.0000	0.0000	7.654E-16	15.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.6	0.0004	0.0020	0.0020	2.283E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1	0.0008	0.0040	0.0060	3.813E-10	9.5
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.5	0.0004	0.0020	0.0080	9.294E-11	10.0
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.4	0.0003	0.0016	0.0096	1.01E-10	10.0
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.8	0.0006	0.0032	0.0128	5.668E-10	9.2
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.2	0.0009	0.0048	0.0176	1.646E-09	8.8
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.582	0.0004	0.0022	0.0198	3.343E-12	11.5
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.857	0.0014	0.0074	0.0273	4.346E-11	10.3
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0273	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
An (30s) 1.548E-04

DATE NOV 25 1992

Sample ID L7A2
Element COBALT
Matrix DI WATER

S.A.	V	Ao
77.4	31.4	0.221

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.2	0.0002	0.0007	0.0007	2.36E-11	10.6
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.6	0.0005	0.0021	0.0028	2.601E-10	9.6
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.3	0.0010	0.0046	0.0074	3.828E-10	9.4
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.6	0.0005	0.0021	0.0095	1.032E-10	10.0
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.5	0.0004	0.0018	0.0112	1.217E-10	9.9
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	0.9	0.0007	0.0032	0.0144	3.548E-10	9.3
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.3	0.0010	0.0046	0.0189	1.491E-09	8.8
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.627	0.0005	0.0022	0.0211	3.311E-12	11.5
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	2.257	0.0017	0.0079	0.0290	3.178E-11	10.3
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0290	0	ERR

30 Sec. Rinse Conc.(ppm) 0.4
An (30s) 3.088E-04

DATE NOV 25 1992

Sample ID L7A3
Element COBALT
Matrix DI WATER

S.A.	V	Ao
76.7	30.7	0.19

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.2	0.0002	0.0008	0.0008	2.107E-11	10.5
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.4	0.0003	0.0016	0.0024	1.638E-10	9.8
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.4	0.0011	0.0057	0.0081	3.897E-10	9.2
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.3	0.0004	0.0020	0.0101	8.431E-11	10.0
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.3	0.0002	0.0012	0.0113	3.767E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.1	0.0008	0.0044	0.0157	1.091E-09	9.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.1	0.0008	0.0044	0.0202	1.405E-09	8.9
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.38	0.0003	0.0023	0.0225	3.935E-12	11.4
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.575	0.0012	0.0064	0.0289	3.316E-11	10.5
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0289	0	ERR

9413221.1019

30 Sec. Rinse Conc.(ppm) 0.7
Ao (30s) 3.376E-04

DATE NOV 23 1992

Sample ID L7B1
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.8	50.8	0.1871

	Date	TIME IN OUT	(dt)n S	N-count(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.246E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.3	0.0002	0.0012	0.0016	8.8E-11	10.1
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.3	0.0010	0.0051	0.0066	4.824E-10	9.3
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.3	0.0002	0.0012	0.0078	3.168E-11	10.5
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.2	0.0002	0.0009	0.0086	2.361E-11	10.6
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.1	0.0008	0.0043	0.0129	1.016E-09	9.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.4	0.0011	0.0066	0.0193	2.124E-09	8.7
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.88	0.0007	0.0034	0.0227	8.463E-12	11.1
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.587	0.0012	0.0061	0.0279	3.025E-11	10.5
	11/9/92	9:32am								
10	11/9/92	9:32am	3888000	7862400		0.0000	0.0000	0.0279	0	ERR

30 Sec. Rinse Conc.(ppm) 0.2
Ao (30s) 1.538E-04

DATE NOV 23 1992

Sample ID L7B2
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
76.6	50.7	0.1925

	Date	TIME IN OUT	(dt)n S	N-count(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.567E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.1	0.0001	0.0004	0.0008	9.978E-12	11.0
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.1	0.0008	0.0044	0.0052	3.607E-10	9.4
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.1	0.0001	0.0004	0.0056	3.675E-12	11.4
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.1	0.0001	0.0004	0.0060	6.242E-12	11.2
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.1	0.0008	0.0044	0.0103	1.063E-09	9.0
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.3	0.0010	0.0052	0.0155	1.912E-09	8.7
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.805	0.0007	0.0038	0.0193	1.044E-11	11.0
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.539	0.0012	0.0061	0.0254	3.082E-11	10.5
	11/9/92	9:32am								
10	11/9/92	9:32am	3888000	7862400		0.0000	0.0000	0.0254	0	ERR

30 Sec. Rinse Conc.(ppm) 0.3
Ao (30s) 2.355E-04

DATE NOV 23 1992

Sample ID L7B3
Element COBALT
Matrix SEA WATER

S.A.	V	Ao
78.5	52.4	0.1839

	Date	TIME IN OUT	(dt)n S	N-count(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.1	0.0001	0.0004	0.0004	7.988E-12	11.1
	09/21/92	10:32am								
2	09/21/92	10:32am	18000	25200	0.2	0.0002	0.0008	0.0012	4.302E-11	10.4
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	86400	1.5	0.0012	0.0061	0.0073	7.081E-10	9.2
	09/22/92	9:32am								
4	09/22/92	9:32am	86400	172800	0.2	0.0002	0.0008	0.0081	1.546E-11	10.8
	09/23/92	9:32am								
5	09/23/92	9:32am	86400	259200	0.3	0.0002	0.0012	0.0093	8.914E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	86400	345600	1.2	0.0008	0.0049	0.0142	1.331E-09	8.9
	09/25/92	9:32am								
7	09/25/92	9:32am	86400	432000	1.5	0.0012	0.0061	0.0202	2.68E-09	8.6
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	1.069	0.0008	0.0043	0.0246	1.379E-11	10.9
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.478	0.0012	0.0060	0.0306	2.957E-11	10.5
	11/9/92	9:32am								
10	11/9/92	9:32am	3888000	7862400		0.0000	0.0000	0.0306	0	ERR

9413221.1020

20 Sec. Rinse Conc.(ppm) 0.04
Ao (30s) 6.443E-04

DATE NOV 25 1992

Sample ID L7A1
Element STRONTIUM
Matrix DI water

S.A.	V	Ao
76.7	30.7	0.1919

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.28	0.0003	0.0015	0.0015	1.101E-10	10.0
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	0.54	0.0004	0.0022	0.0037	2.031E-10	9.5
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	0.9	0.0007	0.0036	0.0073	2.438E-10	9.6
	09/22/92	9:32am								
4	09/22/92	9:32am	85400	172800	0.72	0.0008	0.0039	0.0102	1.918E-10	9.7
	09/23/92	9:32am								
5	09/23/92	9:32am	85400	258200	0.67	0.0007	0.0035	0.0136	4.759E-10	9.3
	09/24/92	9:32am								
6	09/24/92	9:32am	85400	343600	0.1	0.0001	0.0004	0.0140	8.847E-12	11.1
	09/25/92	9:32am								
7	09/25/92	9:32am	85400	428000	0.007	0.0000	0.0000	0.0141	3.388E-14	13.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	0.84	0.0005	0.0034	0.0174	8.14E-12	11.1
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.25	0.0010	0.0050	0.0224	2.031E-11	10.7
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0224	0	ERR

20 Sec. Rinse Conc.(ppm) 0.06
Ao (30s) 7.278E-04

DATE NOV 25 1992

Sample ID L7A2
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
77.4	31.4	0.2103

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.17	0.0001	0.0006	0.0006	1.863E-11	10.7
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	0.33	0.0002	0.0012	0.0018	9.306E-11	10.0
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	0.76	0.0006	0.0029	0.0046	1.463E-10	9.8
	09/22/92	9:32am								
4	09/22/92	9:32am	85400	172800	0.41	0.0003	0.0013	0.0061	3.32E-11	10.3
	09/23/92	9:32am								
5	09/23/92	9:32am	85400	258200	0.35	0.0003	0.0013	0.0074	6.365E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	85400	343600	0.15	0.0001	0.0006	0.0080	1.702E-11	10.8
	09/25/92	9:32am								
7	09/25/92	9:32am	85400	428000	0.16	0.0001	0.0007	0.0086	3.157E-11	10.5
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	1.33	0.0010	0.0049	0.0135	1.745E-11	10.8
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.29	0.0010	0.0047	0.0183	1.867E-11	10.7
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0183	0	ERR

20 Sec. Rinse Conc.(ppm) 1.10
Ao (30s) 8.127E-04

DATE NOV 25 1992

Sample ID L7A3
Element STRONTIUM
Matrix DI WATER

S.A.	V	Ao
76.7	30.7	0.1964

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	cn g	cn/Ao	SUM cn/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.42	0.0003	0.0017	0.0017	1.378E-10	9.9
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	0.22	0.0002	0.0009	0.0026	4.898E-11	10.3
	09/21/92	2:32pm								
3	09/21/92	2:32pm	61200	85400	0.63	0.0003	0.0026	0.0051	1.222E-10	9.9
	09/22/92	9:32am								
4	09/22/92	9:32am	85400	172800	0.57	0.0004	0.0023	0.0075	1.230E-10	9.9
	09/23/92	9:32am								
5	09/23/92	9:32am	85400	258200	0.33	0.0003	0.0013	0.0088	7.022E-11	10.2
	09/24/92	9:32am								
6	09/24/92	9:32am	85400	343600	0.4	0.0003	0.0016	0.0104	1.402E-10	9.8
	09/25/92	9:32am								
7	09/25/92	9:32am	85400	428000	0.44	0.0003	0.0018	0.0122	2.243E-10	9.6
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	1.14	0.0009	0.0046	0.0169	1.537E-11	10.8
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.31	0.0010	0.0053	0.0221	2.31E-11	10.6
	11/5/92	9:32am								
10	11/5/92	9:32am	3888000	7862400		0.0000	0.0000	0.0221	0	ERR

9413221.1021

30 Sec. Rinse Conc.(ppm) 2.01
An (30s) 1.544E-03

DATE NOV 25 1992

Sample ID L781
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.8	30.8	0.1981

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.69	0.0007	0.0033	0.0033	3.268E-10	9.3
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	1.23	0.0009	0.0046	0.0091	1.46E-09	8.9
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	89400	1.98	0.0015	0.0076	0.0159	1.142E-09	8.9
	09/22/92	9:32am								
4	09/22/92	9:32am	69400	172800	1.43	0.0011	0.0056	0.0213	7.271E-10	9.1
	09/23/92	9:32am								
5	09/23/92	9:32am	69400	242200	1.44	0.0011	0.0056	0.0272	1.252E-09	8.9
	09/24/92	9:32am								
6	09/24/92	9:32am	69400	346800	0.79	0.0006	0.0031	0.0303	5.302E-10	9.3
	09/25/92	9:32am								
7	09/25/92	9:32am	69400	432000	0.71	0.0006	0.0028	0.0331	5.510E-10	9.3
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	2.47	0.0019	0.0097	0.0427	6.756E-11	10.2
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	2.12	0.0016	0.0083	0.0510	5.888E-11	10.2
	11/3/92	9:32am								
10	11/3/92	9:32am	3888000	7862400		0.0000	0.0000	0.0510	0	ERR

30 Sec. Rinse Conc.(ppm) 1.84
An (30s) 1.256E-03

DATE NOV 25 1992

Sample ID L782
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.8	30.7	0.1913

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.69	0.0009	0.0040	0.0040	7.51E-10	9.1
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	0.4	0.0003	0.0016	0.0056	1.617E-10	9.8
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	89400	1.67	0.0014	0.0073	0.0131	1.000E-09	9.0
	09/22/92	9:32am								
4	09/22/92	9:32am	69400	172800	1.3	0.0010	0.0052	0.0183	6.269E-10	9.2
	09/23/92	9:32am								
5	09/23/92	9:32am	69400	242200	1.07	0.0009	0.0043	0.0225	7.236E-10	9.1
	09/24/92	9:32am								
6	09/24/92	9:32am	69400	346800	1.13	0.0009	0.0045	0.0271	1.138E-09	8.9
	09/25/92	9:32am								
7	09/25/92	9:32am	69400	432000	0.94	0.0007	0.0039	0.0309	1.012E-09	9.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	3.59	0.0027	0.0144	0.0452	1.480E-10	9.8
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	2.11	0.0016	0.0084	0.0537	5.675E-11	10.2
	11/3/92	9:32am								
10	11/3/92	9:32am	3888000	7862400		0.0000	0.0000	0.0537	0	ERR

30 Sec. Rinse Conc.(ppm) 1.65
An (30s) 1.295E-03

DATE NOV 25 1992

Sample ID L783
Element STRONTIUM
Matrix SEA WATER

S.A.	V	Ao
78.3	30.4	0.1929

	Date	TIME IN OUT	(dt)n S	t=sum(dt) S	Conc. PPM	an g	an/Ao	SUM an/Ao	Di	L
1	09/21/92	9:32am	7200	7200	0.65	0.0008	0.0039	0.0039	3.404E-10	9.5
	09/21/92	10:32am								
2	09/21/92	10:32am	16000	23200	0.39	0.0003	0.0016	0.0042	1.616E-10	9.8
	09/21/92	3:32pm								
3	09/21/92	3:32pm	61200	89400	1.73	0.0014	0.0070	0.0113	9.5E-10	9.0
	09/22/92	9:32am								
4	09/22/92	9:32am	69400	172800	1.1	0.0009	0.0046	0.0158	4.735E-10	9.3
	09/23/92	9:32am								
5	09/23/92	9:32am	69400	242200	1.22	0.0010	0.0064	0.0211	1.158E-09	8.9
	09/24/92	9:32am								
6	09/24/92	9:32am	69400	346800	1.03	0.0008	0.0042	0.0253	9.922E-10	9.0
	09/25/92	9:32am								
7	09/25/92	9:32am	69400	432000	0.9	0.0007	0.0037	0.0290	9.76E-10	9.0
	09/26/92	9:32am								
8	09/26/92	9:32am	1382400	1814400	3.67	0.0030	0.0158	0.0447	1.699E-10	9.7
	10/09/92	9:32am								
9	10/09/92	9:32am	2160000	3974400	1.87	0.0015	0.0076	0.0524	4.852E-11	10.3
	11/3/92	9:32am								
10	11/3/92	9:32am	3888000	7862400		0.0000	0.0000	0.0524	0	ERR

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APPENDIX G

OVERVIEW OF SOLIDIFICATION TECHNOLOGIES

This is an internal WHC memo report that was prepared as a review of all available solidification technologies, important processing considerations, general advantages and disadvantages of various technologies. The report is not specific to WRAP 2A and is intended to provide general background needed to begin evaluating the various waste forms.

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OVERVIEW OF SOLIDIFICATION TECHNOLOGIES

Waste immobilization matrices fall into several general categories. Inorganic binders, thermoplastics, organic polymers, ceramics, and glasses are the matrices that have been widely used for radioactive waste immobilization.

Inorganic Binders

Inorganic binders are commonly used materials for waste stabilization and immobilization. They are inexpensive, readily available, and well established in the radioactive waste management field.

Portland cement

Portland cement is the most common immobilization matrix. It is the same material used in construction of concrete structures. Portland cement consists mostly of hydrated calcium silicates, with some aluminates and magnesium content. The calcium hydroxide content causes portland cement to exhibit a high pH. The three predominant types are described below.

Type I (ordinary)

Ordinary portland cement (OPC) is widely used for construction purposes. It requires about one month to cure to full strength.

Type II (sulfate-resistant)

Type II cement is resistant to sulfate ions. This gives increased durability in saline environments.

Type III (high-early-strength)

Type III cement is ground more finely thus increasing its reactivity. High early strength creates higher curing exotherms.

Pozzolanic cement additives

Pozzolanic additives are used to modify the reactivity, curing time, and ultimate strength of cement grout. Two commonly used additives are ground blast furnace slag, and pulverized coal fly ash.

Blast furnace slag

Blast furnace slag his a higher silica content that cement. This decreases the reactivity and eliminates the high curing exotherm. It also increases the curing time required to attain full strength.

Pulverized fly ash

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Pulverized fly ash contains mostly silica and alumina, with very little calcium. The lack of calcium requires addition of lime or cement to activate this material. Fly ash can be added in ratios as high as 10:1 and still obtain a suitable final waste form.

Gypsum cement

Gypsum cement is composed of hydrated calcium sulfate. It has a lower compressive strength than portland cement. The elimination of calcium hydroxide gives this material a lower pH than OPC.

Plaster of paris

Plaster of paris is the most recognizable gypsum cement. This same material is also used in wallboard.

Envirostone(tm)

This material is a proprietary mixture based on gypsum cement. The proprietary additives are claimed to make this mix more compatible with organic and acidic wastes.

Modified cements

Cement mixtures can be modified to enhance their ability to incorporate difficult wastes, and to increase their resistance to loss of soluble waste constituents through leaching.

Physical absorbents

Physical absorbents are used to incorporate non-hydraulic materials such as liquid organics into the waste matrix.

Polymer impregnated cement

Polymer impregnation is a method to decrease leachability be filling the interstitial pores with water-resistant polymer.

Thermoplastic Polymers

Thermoplastic polymers are a class of materials that melt at elevated temperatures. These matrices can be used to immobilize materials through micro- and macro- encapsulation.

Bitumen (asphalt)

Bituminous polymers are familiar materials used in the construction of roads, and in the roofing industry. They are produced from crude oil, and can have varying physical properties.

Straight run

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This is the raw material as is comes directly from the distillation column. It has a low softening temperature, high penetration, and low compressive strength.

Pitch

This is straight-run bitumen that has been liquefied by dilution with organic solvents. The material solidifies when the solvent evaporates. Solvent vapor controls are required.

Oxidized

Oxidized bitumen is produced by blowing air through straight-run material. It is commonly used for roofing applications. This material is stronger, harder, and less sensitive to temperature changes than straight-run. This results in higher melting point processing temperatures.

Cracked

Cracked bitumen is more sensitive to temperature changes than other types. This imparts a quick-hardening nature, giving high strength combined with low penetration and a high softening point. Cracked bitumens can become brittle at low temperature.

Emulsions

Bitumen emulsions are similar to pitch, except the solvent is aqueous with surfactants to prevent phase separation. The material solidifies when the water is evaporated.

Sulfur

Sulfur has several possible uses in radioactive waste treatment in WRAP Module 2A. It can be used as a solidification matrix, a hardener, and as an amalgam for mercury treatment.

Immobilization matrix

Sulfur "cement" can be used in a manner similar to other thermopolymers. It exhibits high strength and low penetration. Vapor controls are necessary and there is some concern about potential phase changes in the final waste form causing loss of structural properties over time.

Bitumen hardener

Sulfur can be added to straight-run bitumen to increase its hardness and compressive strength. Sulfur hardening of bitumen is a non-reversible process.

Polyethylene

Polyethylene (and other thermoplastics) can be used to encapsulate wastes, by using melt processes similar to those used for bitumens. The molten material is mixed with waste and allowed to cool, forming a solid plastic block.

Encapsulation

Macro-encapsulation is used to isolate large waste items from the surroundings by use of primary physical barriers. Thermoplastics are well suited for this application. Micro-encapsulation involves the intimate mixing of waste and polyethylene, as in a screw-type extruder, to form a thorough coating on particulate waste. Although such a process does not chemically bind the waste constituents, the coating would be complete enough to prohibit release by normal mechanisms (ie. leaching).

Chemical (Thermosetting) Polymers

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Thermosetting polymers are produced through chemical reaction between organic monomers. They are strong, tough, and are not adversely affected by high temperatures. The exact types and proportions of the raw materials is often proprietary information. Many of the raw materials are hazardous or toxic chemicals.

Polystyrene

Polystyrene is formed by adding a catalyst (i.e acrylonitrile) to styrene. The reaction is exothermic, producing a strong, brittle plastic matrix. The material is not useful for encapsulating water-bearing wastes.

Polyester resins

Polyester resins are formed by a chemical reaction between a resin (i.e. styrene), promoter (i.e. phthalic acid), and a catalyst (i.e organic peroxide), to form a encapsulating matrix around the waste. The reaction is exothermal and can produce temperatures around 60°C. Modified polyesters have been developed with enhanced water encapsulation abilities.

Urea-formaldehyde resin

Urea-formaldehyde polymers are created by adding a mineral acid catalyst to an aqueous emulsion of urea and formaldehyde. Water is a byproduct of the reaction, and this process has been used to encapsulate aqueous wastes. The material is susceptible to embrittlement by dehydration and "bleeding" over time.

Epoxy resins

Epoxies are produced by reactions between phenols and epoxides, in the presence of alkali to neutralize the HCl byproduct. Chemicals which enhance water compatibility and modify structural properties can be added. The reaction is only mildly exothermic, but the materials are generally more expensive than other polymers.

Other

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Ceramics and glass

Ceramic and glass matrices are formed by subjecting wastes to high temperature treatment. Ceramic aluminosilicates or vitreous borosilicates are added to produce a strong, almost impervious final waste form.

Calcination

Calcination refers to processes that heat the waste to just below the point of fusion (melting). The final product is a granular material that can be processed by ceramic and powder metallurgy techniques into a suitable final form.

Vitrification

Vitrification refers to processes where the waste is heated to a temperature above its melting point. Glass-forming minerals are often added to modify the properties of the final waste form.

IMMOBILIZATION PROCESSES

The physical and mechanical systems used to incorporate waste materials into the immobilization matrix are dependent on the chemical and physical properties of the waste, the type of immobilization matrix, and the treatment process. A brief description of process technologies follows.

Cementation

Cementation processes are typified by dry materials handling using bins, hoppers, and solids mixers. If properly configured, the same equipment may be used to prepare several different immobilization matrices (i.e. ordinary cement, pozzolanic cements, and gypsum cements).

Dry material handling

Bins & hoppers

Bulk and day storage equipment for dry solids require proper bin and hopper design to assure free flow of the powders. Storage facilities should be designed with mass flow hoppers to maximize storage capacity.

Pneumatic conveying

Most dry powder handling systems use pneumatic conveyors for unloading bulk trucks and transfer from storage to process units. Pneumatic conveyor systems are subject to erosion failure, and improper design can cause plugging or unsteady flow problems.

Dust control

The nature of cement raw materials requires the use of dust control equipment. The use of cyclones, bag filters and air recirculation are typical methods for controlling dust.

In-drum mixing

Drum tumbler

In this method of mixing, the materials to be mixed are added to the drum along with a dense mixing weight. The drum is then lifted and tumbled for several minutes while the weight mixes the contents. The weight remains inside the drum after mixing.

Lost-paddle mixing

In this method, a collapsible mixing blade is inserted through the bung hole and attached to a motor. the drum is stationary while mixing proceeds. The mixing blades remain in the drum following mixing.

Batch mixing

Screw mixers

A slow-speed screw is positioned at the bottom of a V-shaped trough. The dry materials are added to the trough and mixed.

Planetary mixers

Planetary mixers are used in vertical tanks to provide higher shear and more complete mixing than screw or paddle mixers.

Mixing pumps

Positive-displacement pumps which have been modified to provide enhanced mixing are available for processing high-viscosity grout mixtures.

Melt Processes

Melt processes are used with thermoplastic polymer matrices. These processes typically operate near 150°C and require control of gaseous effluents from the melter.

Batch melter/mixer

The batch process consists of a heated, stirred tank, where the matrix material is melted prior to addition of the waste. After the wastes are added, the mixture is transferred to disposal containers and allowed to cool and solidify.

Thin-film evaporator

The thin-film evaporator process is used with bitumen emulsions of aqueous wastes. As the emulsion passes through the evaporator, the water is driven off, and the remaining waste materials are mixed into the bitumen. The molten mixture then flows into disposal containers, where it solidifies upon cooling.

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Extruder/melter

In this process, the waste and matrix material are added to a screw-type extruder. The mechanical power applied to the extruder screws heats and melts the matrix, mixing it with the waste and evaporating any water that may be present. Some extruders also use external heating. The mixture is then transferred to the disposal container and allowed to cool and solidify.

Polymer Encapsulation

Polymer encapsulation processes require facilities to store, transfer, and mix the organic liquid reactants with the waste. Control of volatile vapors from the process is also required.

Liquid handling

The raw ingredients for thermosetting polymers are liquid organic chemicals. These chemicals may be flammable but can be handled with conventional processing equipment.

Tanks & pumps

Carbon steel tanks and centrifugal pumps are suitable for most applications. Some organic acids (promotors or catalysts) may require stainless steel equipment.

Pipes & valves

Materials are transferred through piping and control valves. Fugitive emissions from piping systems must be minimized.

Vent vapor control

Control of flammable or corrosive organic vapors from tank vents is required for raw materials storage systems.

In-drum mixing

In-drum mixing can be used when the waste is granular, powdery, or a reasonably fluid material. In-drum mixing methods are similar to those used for cementation.

High-shear mixing

The organic binder material is charged to the drum. The waste is added while the binder is mixed with a propeller type mixer. When mixing is complete, the mixer is withdrawn and excess binder is flung off into an empty drum.

Lost-paddle mixer

The collapsible mixer is inserted through the bung hole of the drum. Following mixing, the paddle remains in the drum.

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Batch processes

Thermosetting polymers can be processed in batch equipment with the capacity for filling large containers or many drums. There are two approaches for using batch mixers.

Microencapsulation

In this method, the waste and binder are mixed in a vessel. As the mixture is transferred to the drum, the catalyst and promotor are added and mixed in-line just before entering the drum.

Macroencapsulation

In this method, the mixing tank does not contain waste. The polymer mixture is added to the drum which contains large waste items. The drum is on a vibrating table to remove air bubbles.

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