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INFORMAL REPORT

**IN SITU VITRIFICATION LABORATORY-SCALE
TEST WORK PLAN**

**P. K. Nagata
N. L. Smith**

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LABORATORY-SCALE TEST
WORK PLAN

P. K. Nagata
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Published May 1991

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Idaho Operations Office
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IN SITU VITRIFICATION
LABORATORY-SCALE TEST WORK PLAN
EGG-WTD-9194

May 1991

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ABSTRACT

The Buried Waste Program was established in October 1987 to accelerate the studies needed to develop a long-term management plan for the buried mixed waste at the Radioactive Waste Management Complex at Idaho Engineering Laboratory. The In Situ Vitrification Project is being conducted in a Comprehensive Environmental Response, Compensation, and Liability Act feasibility study format to identify methods for the long-term management of mixed buried waste.

To support the overall feasibility study, in situ vitrification treatability investigations are proceeding along three parallel paths: laboratory-scale tests, intermediate field tests, and field tests. Laboratory-scale tests are being performed to provide data to mathematical modeling efforts, which, in turn, will support design of the field tests and to the health and safety risk assessment. This laboratory-scale test work plan provides overall testing program direction to meet the current goals and objectives of the in situ vitrification treatability investigation.

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CONTENTS

ABSTRACT	v
ACKNOWLEDGMENTS	vi
ACRONYMS	x
1. INTRODUCTION	1
2. SITE BACKGROUND AND PROJECT DESCRIPTION	3
2.1 Site Background	3
2.2 Laboratory-scale Test Background	3
2.3 ISV Description	6
3. TEST OBJECTIVES	8
4. SPECIALIZED EQUIPMENT AND MATERIALS	9
5. LABORATORY TEST PROCEDURES	11
6. TREATABILITY TEST PLAN MATRIX AND MEASURED PARAMETERS	21
7. ANALYTICAL METHODS	22
8. DATA MANAGEMENT	24
9. DATA ANALYSIS AND INTERPRETATION	25
10. HEALTH AND SAFETY	26
11. RESIDUALS MANAGEMENT	27
12. REFERENCES	28

FIGURES

1. ISV-LS equipment top view.	10
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TABLES

1. Testing units for developing ISV technology	6
2. List of buried contaminated items	11
3. Variables per EG&G Drawing AC0489, Revision 0	12
4. Test matrix for three variables at two levels	15
5. Input variables for any ISV process	18
6. Input variables for the laboratory-scale tests at INEL	18
7. List of output variables	21

ACRONYMS

BST	bench-scale test
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
DOE	Department of Energy
DOE-ID	Department of Energy, Idaho Operations Office
EPA	Environmental Protection Agency
FT	field test
H&S	health and safety
IFT	Intermediate Field Test
INEL	Idaho National Engineering Laboratory
IST	intermediate-scale test
ISV	in situ vitrification
LS	laboratory-scale
LST	laboratory-scale test
PNL	Pacific Northwest Laboratories
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
TRU	transuranic

IN SITU VITRIFICATION LABORATORY-SCALE TEST WORK PLAN

1. INTRODUCTION

The Buried Waste Program at Idaho National Engineering Laboratory (INEL) is conducting a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study for the U. S. Department of Energy, Idaho Operations Office (DOE-ID). The scope of the study includes the remediation of mixed low-level waste and mixed transuranic (TRU) waste^a buried at the Subsurface Disposal Area (SDA) located at the Radioactive Waste Management Complex (RWMC).¹ Remediation alternatives include, but are not limited to, the following: (a) leave the waste in place with enhanced monitoring; (b) leave waste in place after treatment via some enhanced confinement or in situ immobilization technique and perform enhanced monitoring; and (c) retrieve, process, and dispose of the wastes in a final repository.²

The In Situ Vitrification (ISV) Project is a form of alternative (b) above. The current ISV effort comprises three concomitant test programs: the laboratory-scale tests (LSTs), the Intermediate Field Tests (IFTs), and the field tests (FTs); a mathematical modeling effort; and a product evaluation effort.

This document describes the objective and resource needs of the LSTs. It will follow the suggested format for bench-scale work plans.³ This document provides an overview of the following:

- The purpose of the tests and demonstrations
- The anticipated input and output variables
- The engineering testing methodology

^a TRU waste as defined in DOE Order 5820.2 is radioactive material that, without regard to source or form, is contaminated with alpha-emitting radionuclides with an atomic number greater than 92, half-lives greater than 20 years, and concentrations greater than 100 nCi/g.

- The analytical laboratory resource needs
- The experimentation work supported by the government and private companies.

2. SITE BACKGROUND AND PROJECT DESCRIPTION

2.1 Site Background

The ISV treatability study considers the feasibility of ISV for the remediation of mixed wastes buried at INEL. Mixed waste was buried at the SDA from 1954 to 1970. TRU waste in drums, buried in Pit 9 from May to September 1968, was dumped directly into the pit from the truck rather than stacked.^b Further background on the history of waste disposal at the INEL is available.^c

2.2 Laboratory-scale Test Background

The ISV program comprises several concomitant efforts:

- Laboratory-scale Tests

The laboratory-scale tests (LSTs) are an outgrowth of the bench-scale tests (BSTs) that were performed at Pacific Northwest Laboratories (PNL). The primary objective of the LSTs is to provide data so that Pit 9 at the RWMC can be remediated. The subordinate objectives are to provide data to support facility and process performance assessments and to support evaluation of the off-gas processing system performance.^d Another objective is to

^b Unpublished research by T. E. Wierman of EG&G Idaho on ISV field test siting and source term, March 1990.

^c Unpublished research by the EG&G RWMC Operations Branch on the history of the INEL RWMC, July 1985.

^d Private communication between P. K. Nagata of EG&G Idaho and R. M. Neilson, Jr. on August 6, 1990 concerning technical issues for the ISV Project and their prioritization.

demonstrate process effectiveness for a wide range of unknown waste compositions.^e

There is a closely coupled relationship among the LSTs, FTs, and modeling effort. LST data will be used in the model to predict the behavior of the melt, ISV product, and hazardous contaminants. As this model is tested in the FTs, additional data needed from LSTs will be identified. A further series of LSTs will be performed to obtain these data.

Technical issues have been identified that may affect the viability of the ISV process for waste site remediation.^f Other LSTs (and BSTs) are being planned to determine the effects of these technical issues.

- Intermediate Field Tests

Previous plans called for only two IFTs to be performed--both of them in FY-1990. These tests were performed to determine the melt front behavior in the presence of scaled-down 55-gal drums filled with calcium silicate-immobilized machining oil. IFT data will be used in the modeling effort and in the FTs.

Currently, more IFTs are planned, but their exact nature has not been specified at this time.

- Field Tests

The FTs are the size of the proposed production ISV system and are the ultimate test of ISV's viability as a buried-waste

^e Private communication between W. J. Quapp and N. L. Smith both of EG&G Idaho, December 17, 1990.

^f Private communication between R. M. Neilson and S. K. Merrill both of EG&G Idaho, September 5, 1990.

immobilizing technology. As previously mentioned, operating parameters are determined by LST results and the mathematical model. The FT results will provide feedback to both the LST and mathematical model personnel regarding data needs.

- Mathematical Modeling

The mathematical model will predict the gas evolution, etc.⁴, from physical data gathered during the LST.⁹ Scaling factors will be used to predict FT behavior from observed LST behavior. After an FT, the results therefrom will be reviewed to determine whether the scaling factors were correct. The model will probably require more data input from LST experiments. Along with predicting the amount of gas evolved and the rate of evolution, a goal of the model is also to predict the behavior of the glasses during melting and the properties of the vitrified product given a set of melting parameters.

- Specialty Tests

These tests will be performed per the data needs identified in the analysis of prior tests and as determined by the modeling requirements. These will include BSTs and crucible tests.^h

Table 1 shows the relative sizes of the bench-scale tests, LSTs, IFTs, and FTs.

⁹ Some data on glasses made from RWMC soils and buried wastes already exist.

^h As of February 1991, the status of the specialty tests is not known.

Table 1. Testing units for developing ISV technology

<u>Equipment Size</u>	<u>Electrode Separation</u>	<u>Vitrified Mass</u>
Bench-scale	0.36 ft	2 to 22 lb
Laboratory-scale	0.67 to 1.0 ft	100 to 2000 lb
Intermediate-scale	3.0 to 4.9 ft	10 to 50 ton
Large-scale	11.5 to 18 ft	400 to 800 ton

2.3 ISV Description

ISV is a thermal treatment process that converts contaminated soil and waste to a chemically inert, stable glass and crystalline product. The process was originally developed by Battelle at PNL for DOE, with emphasis on the in-place stabilization of TRU-contaminated soils.⁵ A square array of four electrodes (graphite with or without molybdenum core) is inserted into the ground to the desired treatment depth. Because dry soil is a poor electrical conductor, a conductive mixture of flaked graphite and glass frit is placed between the electrodes to act as a starter path. An electrical potential is applied to the electrodes to establish an electrical current in the starter path. The resultant current heats the starter path and surrounding soil initially to 3600°F, well above soil-melting temperatures of 2000 to 2550°F. The graphite starter path is eventually consumed by oxidation, and the current then flows through the molten soil, with operating temperatures being between 2650 and 3600°F. As the molten zone grows, it incorporates radionuclides (e.g., uranium) and nonvolatile hazardous elements, such as chromium, that may be present.

In theory, the high temperature of the process will destroy organic compounds by pyrolysis. The by-products of pyrolysis migrate to the surface of the molten zone, where they burn in the presence of air.ⁱ A hood placed

ⁱ The exact behavior of underground unpyrolyzed and pyrolyzed gases during ISV processing is not known and is one of the things being studied in the LSTs.

over the area being vitrified directs the gaseous effluents to an off-gas treatment system (see Reference 2).

The technical issues of concern in developing this technology are discussed by Shade et al.⁶ and are the primary ones addressed in the tests described in this work plan.

3. TEST OBJECTIVES

The primary objective of the LST is to provide data demonstrating that ISV is a viable remediation technology to address either all of the SDA or a portion thereof.^j The subordinate objectives are to provide data to support facility and process performance assessments and to support evaluation of the off-gas processing and other systems performance.

To achieve the above, the following characteristics of any proposed process must be assessed:

- Off-gas generation (i.e., species, volume, etc.)
- Off-gas behavior in confinement hood
- Off-gas migration and retention in the surrounding soil
- Off-gas processing system corrosion
- Contaminant retention in the vitrified mass and in the surrounding soil
- Power requirements.

^j Private communication between S. K. Merrill and N. L. Smith both of EG&G Idaho, July 30, 1990. Documented in a letter to N. L. Smith from P. K. Nagata of EG&G Idaho on August 1, 1990, which listed topics discussed during a telephone conference between N. L. Smith, M. Johnson, and P. K. Nagata.

4. SPECIALIZED EQUIPMENT AND MATERIALS

Figure 1 shows the flow process equipment that will be used in the LST program. This equipment will be housed in TAN 633.

Figure 1. ISV-LS equipment, top view.

5. LABORATORY TEST PROCEDURES

The most important part of the LST (or any) experimental program is to determine what data are needed. Once this is decided, the instrumentation and test procedure follow quite naturally. The general list of data can be inferred from Section 3 (see p. 8).

Another important part of the LST experiments is to determine the major input variables. To illustrate the problem, 22 buried contaminated items are listed in Pit 9 (as shown in Table 2).^k Another list of 102 variables is presented in a drawing, AC0489, Rev. 0 (shown in Table 3).⁷ Table 2 contains a generic category, "Metal (includes Pb)," in addition to beryllium and mercury. Table 3 lists an additional seven metals as well as "Metal Scrap," which is probably iron. Table 3 also lists "Wood," "Vehicles," and "Depth of Waste Material." Neither Table 2 nor Table 3 mentions Portland cement or calcium silicate, the immobilizing agent for Regal Oil. Furthermore, the mixing of metal and organic compounds is not mentioned. If the 14 aforementioned items are added to the 22 in Table 2, there is a total of 36 potential input variables.

Table 2. List of buried contaminated items

Beryllium	Organic Acids	Hydrogen
Mercury	EDTA	Methane
Trichloroethane	Na Nitrate	Pu
Regal Oil	K Nitrate	Radioactive sources
CCl ₄	Graphite	Void Volume
Miscellaneous Oils	Paper	Hydrated Oxides
PCB	Metal (includes Pb)	Water
Alcohols		

^k See footnote b, p. 3.

Table 3. Variables per EG&G Drawing AC0489, Revision 0¹

<u>Input Variables</u>	
Electrode spacing	Amperes
Vertical rate of electrode insertion	Watts
Volts	Scrub tank volume
<u>Responses of System or Materials</u>	
Hood space temperature and pressure	Density of vitrified mass
Off-gas air flow rate (= release rate)	Morphology of vitrified mass
Temperature of off-gas	Major elements in vitrified mass
Interactions between ISV melts	Minor elements in vitrified mass
Melt conductivity	Trace elements in vitrified mass
Melt surface temperature	Corrosivity of vitrified mass
Melt mass temperature during melt	Ignitability of vitrified mass
Sediment build-up in scrub tank	Reactivity of vitrified mass
NO _x	Cooling rate of vitrified mass
SO _x	Comparison to naturally occurring analogues
CO _x	Mechanical properties of vitrified mass
Glass Transition (T _g)	
Physical boundaries of vitrified mass	

¹ Not all the items on Drawing AC0489 are input variables. Some are responses, e.g., properties of the vitrified product. Most are attributes--substances that can be in Pit 9 or weather conditions--things or conditions over which the ISV team has little or no control. The items in Drawing AC0489 are classified as to whether they are input variables, responses, or attributes.

Table 3. Continued

<u>Attributes</u>		
Carbon Tetrachloride	Chloroform	Ether
1,1,1-Trichloroethane	Trichloroethylene	Polyethylene Glycol
Tetrachloroethylene	Toluene	Ethylene Glycol
or perchloroethylene	Benzene	Alcohols
Benzene	Uranium	Waste composition with
Kerosene	Plutonium	associated materials
Xylene	Strontium-90	(nominal and ranges)
PCBs	Americium-241	Depth of waste
Oils	Cobalt-60	material
Resins	Cesium-137	Soil moisture
Arsenic	Cerium-144	Soil density
Beryllium	Niobium-95	Stratigraphy of soils in
Cadmium	Zirconium-95	SDA
Chromium	Tritium	Soil composition in
Lead	Radium	wt % oxides (nominal
Lithium	Gross Alpha	and ranges)
Sodium	Paper	Temperature profile
Mercury	Cloth	and thermal
Thallium (oxide)	Plastics	history of near-field
Zirconium	Wood	soil
HCl	Cardboard	Hydraulic conductivity
HF	Fiberboard	Wind speed
HNO ₃	Process machinery/	Wind direction (wind
NaOH	equipment	rose data)
Nitrates	Soil/waste component	Atmospheric stability
Cyanide	ratio	class data
Ammonia	Vehicles	Precipitation
Asbestos	Metal Scrap	Temperature
Perchloric filters	Depth to basalt	

The way to test the effect of a number of input variables on the output variables (e.g., amount of off-gassing) is to vary the level of each input variable. If each input variable is put in as only a low or high level, a linear cause-and-effect relationship between the input and output variables can be established.^m If each input variable is inserted as a high, medium, and low level, a second order relationship between the input and output variables can be established because with three datum points one can write a second-order equation.

However, inserting each input variable as a high or low level becomes expensive rapidly. To illustrate, examine the case of three input variables, each at two levels: low and high (Table 4 shows the number of tests that must be performed). Note that all possible low-high combinations are listed. When test designs use all possible combinations, they are said to be full factorial. Note also that there are eight or 2^3 possible low-high combinations. This means the number of tests for a full factorial experiment is $(\text{levels})^{\text{number of variables}}$. Applying this to the problem at hand, if just two levels were tested for all 36 variables, one would have 2^{36} or about 6.9×10^{10} experiments.ⁿ

A way around this problem is to perform fractional factorial experiments.^o As the name implies, not all the experiments for the full factorial design are performed. In the example above, one could perform four instead of eight experiments. However, the amount of information that could be extracted from the data would be less than that potentially obtainable from the full factorial experiment. Specifically, data on the interactions between

^m That is because only a straight line can be drawn between two points.

ⁿ The approach of varying one input variable at a time would eventually result in performing at least as many (6.9×10^{10}) experiments.

^o Fractional factorial designs are the most practicable designs. However, other experimental designs are available.

Table 4. Test matrix for three variables at two levels

<u>Test Number</u>	<u>Variable 1</u>	<u>Variable 2</u>	<u>Variable 3</u>
1	Low	Low	Low
2	Low	Low	High
3	Low	High	Low
4	Low	High	High
5	High	Low	Low
6	High	Low	High
7	High	High	Low
8	High	High	High

the variables would be lost.^P However, their presence can be recognized during data analysis.

The first step in making the problem at hand a manageable one is to decrease the number of variables. To do this, one must make assumptions based on--among other things--past observations, equilibrium thermodynamics, and the gaseous phase constituents that must be handled in the off-gas system.

Some considerations are:

- For the first set of experiments, there should be a set mixture of organic compounds that will represent that group of chemicals. The compounds chosen for this set mixture should be chosen on the basis of the following criteria:^Q
 - Amount present
 - Volatility
 - Combustion characteristics

^P Interactions can occur between two or more variables. Interactions between two variables (low-order) can be common and are seen more often than interactions between three or more variables (high-order).

^Q These criteria are not exhaustive.

- Elements they contain (e.g., hydrocarbons containing chlorine)
 - Threat they present to the environment (e.g., PCBs).
- Most of the very active metals (e.g., the alkalis, alkaline earths, and actinides) will remain as oxides and will be incorporated into the glass.
 - The transition elements (e.g., iron, nickel, and chromium) will either remain as metals or be reduced. The extent of reduction is not known because the kinetics of the reaction are not known and the slowly moving melt front represents a nonequilibrium condition.
 - It is proposed that the organic compounds be the set mixture identified in PNL Laboratory Test Number 5.⁸ Solid inorganics (e.g., Portland cement and calcium silicate) were used to immobilize the machining oil; therefore, they will always be present with machining oil. A certain amount of solid organic compounds (e.g., wood and cardboard) should be part of the aforementioned mixture.
 - The depth of the waste should be an input variable because of off-gas volume considerations. Also, it can be varied by emplacing more overburden before one starts the ISV process.
 - The power input should be an input variable because it can be varied over a range.
 - Electrode feed rate is another input variable because it can be varied over a range.
 - A possible input variable is the soil under the graphite/glass frit starting mixture. It may be possible to replace some of the soil with low-melting, glass-forming compounds (i.e., those that

contain sodium or potassium) to help form the vitrified mass soon after startup.

Based on the above and other considerations, the input variables for virtually any ISV process are listed in Table 5. Of the 13 input variables, however, only the first seven are true input variables (i.e., ones over which ISV personnel will have control when remediating a site). The other six are covariates (i.e., ISV personnel have no control over these when remediating a site). For the LSTs, the list was pared down to that shown in Table 6. Note that only the first three are input variables; the last four are covariates. The bases for choosing the input variables and covariates in Table 6 are the assumptions that (a) the electrode spacing for the FT is 12 ft and (b) the presence of sodium and potassium nitrate is a special case.^r

Table 5 lists a maximum of seven true input variables. If each is at two levels (i.e., low and high), a total of 2^7 or 128 tests must be performed for a full factorial experiment. To decrease the number, handbooks on experimental design such as Hahn and Shapiro⁹ can be used. One of the designs in Reference 9 for seven input variables, each at two levels, requires 16 tests. This design will provide data on the effect each input variable has on any output variable. Also, it will provide data on six of the 21 two-variable interactions.^s For example, the interaction between depth of materials and power settings on the amount of off-gases can be estimated.

Another approach involves three steps. The first is to identify all the true input variables and perform a statistically designed experiment to determine which ones have a major effect on the output variables. The second step is to take the pared-down list from step one and perform two-level tests to determine whether there are any interactions between variables. The third

^r It is recognized that while the presence of potassium or sodium nitrate is a special case, it should be tested because it was listed as one of the critical technical issues (see footnote e, p. 4)--especially in conjunction with liquid organic compounds.

^s Which 6 of the 21 two-variable interactions is determined depends on the experimental design.

Table 5. Input variables for any ISV process

1.	Depth of materials (1 ft versus 5 ft)
2.	Voltage and current input (low versus high)
3.	Electrode spacing
4.	Power settings
5.	Electrode diameter
6.	Electrode feed rate
7.	Heat transfer from the top of the melt (low versus high)
8.	Void-solid ratio (low versus high)
9.	Presence of sodium and potassium nitrates (low versus high quantities)
10.	Volume of wastes (one versus five layers)
11.	Sealed versus unsealed containers
12.	Random versus layered container disposition
13.	Solid and organic materials (e.g., wood, paper, oil) versus none

Table 6. Input variables for the laboratory-scale tests at INEL

1.	Depth of materials (1 ft versus 5 ft) ^t
2.	Power settings
3.	Electrode feed rate
4.	Volume of wastes (one versus five layers)
5.	Sealed versus unsealed containers
6.	Random versus layered container disposition
7.	Solid and organic materials (e.g., wood, paper, oil) versus none

^t These high and low values are for field tests. They and other input variables will be scaled down from the field test size to the LST.

step evaluates those input variables that interact with each other by performing three- (or higher-) level tests to determine the nature of the interaction more accurately.^u

Several things must be noted:

- Sampling plans in books like Reference 9 are ordered--i.e., there is a method by which they were composed. After settling on a sampling plan, the order in which the individual experiments are run must be randomized. The reason for this follows: Assume that the whole time the power settings were at a high level, the weather was very wet, and the off-gas effluent contained much carbon dioxide. One would not be able to distinguish the effect of an uncontrollable variable--the weather--on the amount of carbon dioxide in the effluent from the effect of high amounts of high power settings.
- The number of input variables and the input variables themselves are not "cast in concrete." Both may change.
- The data from the above tests will provide estimates of the cause-and-effect relationship between the input variables (e.g., amount of soil overburden) and the output variables (e.g., off-gas migration into soil). Experience has shown the results from experiments such as the one proposed will result in a number of input variables being proved to have no effect on any output variable. In this connection, a more refined experimental plan using the surviving input variables can be devised.
- The experiments for any other tests--bench, follow-on LSTs, etc.--should be planned and reviewed by the same group that collaborated to design this series of tests. This will enhance coordination

^u Private communications between M. D. Herd of EG&G and P. K. Nagata of EG&G Idaho, December 19, 1990.

and communication between (or among) the tests so that no technical issue is overlooked, optimum test efficiency is ensured, and the primary and secondary objectives are addressed.

6. TREATABILITY TEST PLAN MATRIX AND MEASURED PARAMETERS

The test plan matrix will be developed as the input variables are better defined. The output variables to be measured are listed in Table 7.

Table 7. List of output variables

1.	Gases
	Volume
	Species
	Rates of evolution
	Temperatures
	Pressure
	Inorganic gases (zinc, cadmium, mercury, and SO ₂)
2.	Hood material corrosion by off-gases (use coupons)
3.	Reflectivity of hood material after exposure to off-gases (use coupons)
4.	Migration of heavy metals such as lead, cadmium, zinc, and mercury
5.	Temperature of cold cap at various times
6.	Viscosity of glass products versus temperature
7.	Leachability of glass product (e.g., chromium, plutonium, uranium, thorium, and americium)
8.	Temperature of soil versus time (many places)
9.	Temperature of various parts of hood
10.	Void content of glass product
11.	Amount of subsidence
12.	Amount of side growth of melt
13.	Size of hole
14.	Velocity of melt front
15.	Velocity of electrode fall
16.	Particulates
17.	Chemical analysis of soil at various depths and locations
18.	Smear samples
19.	Color photographs

7. ANALYTICAL METHODS

Analytical methods will be addressed when the test matrix and list of required output measurements are finalized.

Arrenholz et al¹⁰ have indicated how sampling and analyses will be performed.

"...Methods for sampling will be approved procedures and will be documented accordingly. All samples will then be sent to a Contract Laboratory Program (CLP) approved lab for analysis of the necessary constituents (as determined prior to the test).

"All samples will be controlled and followed in a document management and tracking system utilizing appropriate labels and tagging with unique identifiers. Logbooks will be maintained and Chain of Custody procedures [Chain of Custody procedures are detailed in Anawalt¹¹] will be followed.^v Any special handling procedures will be identified for each test plan.

"All analytical analyses will be performed using EPA [Environmental Protection Agency] and ASTM [American Society for Testing and Materials] approved methods, as appropriate and/or available for each constituent to be analyzed. The data quality level will be determined for each test plan. In a majority of cases, the analytical level will be to EPA Quality Level 5 [EPA Quality Levels are discussed in detail in EPA/540/2-89/058¹²], which is for a nonstandard analysis where analytical procedures require sufficient precision and accuracy for the record of decision in evaluating remediation alternatives."

The output variables in Table 7 are the quantities or characteristics that should be measured to characterize the process and the product. The analytical methods for determining the output variables in Table 7 are fairly routine; so while they may not be written, they do exist. The actual EPA Quality Level used will be decided by the experiment design and coordination group mentioned in Section 5 (see p. 11).

^v Chain of Custody is used when there is a potential for litigation.

Visual examination techniques are not easily described by written procedures. Scanning electron microscopy is very routine, but the method of application cannot be written out like a recipe. Other than the usual steps of cleaning and mounting the specimen and focusing the electron beam, nothing in a scanning electron microscope examination is routine. An experienced microscopist will have a major objective in mind, but will not limit the examination to that one objective if he sees something of interest.

Another example of a non-EPA Quality Level NS is the gas sampling.^w As noted above, the real-time gas sampling to determine the species of off-gases is semi-quantitative at best and may be EPA Quality Level II.

The EPA Quality Levels for most of the product characterization tests will be decided by ISV Unit personnel.

^w The EPA Quality Levels are I, II, III, IV, and NS. Level NS is sometimes referred to as Level V (or Level 5 as in Reference 10).

8. DATA MANAGEMENT

A repository is being developed to store the ISV data.^x This database will store raw data in such a manner that while calculations may be performed on them (e.g., averages and standard deviations) they cannot be altered. The data upon which calculations have been made (or manipulated data) may be stored and recalled like the raw unaltered data.

^x Private communication between J. W. Owens of EG&G Idaho and P. K. Nagata of EG&G Idaho, November 30, 1990.

9. DATA ANALYSIS AND INTERPRETATION

The data will be analyzed by personnel whose specialties are in the fields of chemistry, geophysics, materials science, ceramics, metallurgy, and statistics. The analysis and results will be shared with PNL and Geosafe personnel for their comments.

Results from each of the tests in the statistically designed series will be evaluated individually. A "quick look" report will be issued within seven days of test completion. The final report for each test will be issued soon after the material tests are completed. An overall report on the findings of the statistical analysis of all the test results will be issued.

10. HEALTH AND SAFETY

The laboratory-scale (LS) ISV Health and Safety (H&S) Plan, which is required by CERCLA for treatability studies, discusses the plan for protecting personnel from Occupational Safety and Health Act-defined hazards that have been identified by the Safety Analysis. The LS-ISV H&S Plan will include the following sections:

- Site description
- Physical hazards
- Personal protection
- Medical surveillance requirements
- Training
- Emergency procedures
- Communications.

Additional H&S requirements unique to individual tests will be documented on a Safe Work Permit, reviewed in pretest training, and included in the Detailed Operating Procedures for that test or test series.

In addition to the LS-ISV H&S Plan, the safety analysis for the Laboratory Test Series will identify the hazard class and will further identify all the known hazards associated with the ISV process. An Operational Readiness Review will be conducted before any testing using the LS equipment and the proposed test facilities.

Emergency action and evacuation are addressed in the facility's (TAN Hot Shop) existing emergency procedures.^y

^y Private communication between B. M. Gardner and P. K. Nagata both of EG&G Idaho, September 1990.

11. RESIDUALS MANAGEMENT

To be determined.

12. REFERENCES

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