Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

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CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Benito J. Garcia, Chief
Hazardous and Radioactive
Materials Bureau
2044 Galisteo St., Building A
P. O. Box 26110
Santa Fe, New Mexico 87505

Dear Mr. Garcia:

Subject: Research, Development, and Demonstration (RD&D) Permit Application: Electrochemical Treatment Unit (ETU)

The purpose of this letter is to request approval of the enclosed application for a RD&D Permit for the Los Alamos National Laboratory (LANL) ETU. The ETU is an experimental pilot scale unit to demonstrate the technical feasibility and performance capability of electrochemical treatment for existing LANL low-level mixed waste streams.

The permit application has been prepared in accordance with the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20 NMAC 4.1), as revised November 1, 1995, Subpart IX, §270.65, which provides for RD&D permits for those hazardous waste management facilities that propose to use innovative and experimental hazardous waste treatment technology for which permit standards have not been promulgated. The research objective of the work to be conducted under this proposed RD&D permit is to experimentally define waste streams that are amenable for electrochemical treatment recently developed at LANL, to determine conditions for electrolysis of these waste streams, and to assess the feasibility of processing larger batch waste quantities than allowed under treatability studies.

The ETU will be located at Technical Area 50, Building 37, Room 117, to utilize the existing mixed waste container storage area. A certification statement is provided for the additional information presented in this permit application. Electronic copies of the submittal have also been included.

8814

If you should have any questions or comments concerning this permit application, please contact Jody Plum, Office of Environment and Projects, at (505) 665-5042.

Sincerely,

G. Thomas Todd
Area Manager

LAAMEP:9JP-038

Enclosures

cc w/enclosures:
Ms. Barbara Hoditschek, Program Manager
RCRA Permitting Program
Hazardous and Radioactive Materials
Bureau
New Mexico Environment Department
2044 Galisteo Street, Building A
P. O. Box 26110
Santa Fe, NM 87505

RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) PERMIT APPLICATION

ELECTROCHEMICAL TREATMENT UNIT

Submitted by:

Los Alamos National Laboratory
Los Alamos, New Mexico 87545
EPA I.D. No. NM0890010515

Prepared by:

A.T. Kearney, Inc.
101 California Street, 16th Floor
San Francisco, California 94111

August 1, 1996

RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) PERMIT APPLICATION

ELECTROCHEMICAL TREATMENT UNIT

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 GENERAL FACILITY INFORMATION 3
- 2.1 RCRA Permit Status 3
- 2.2 Site Location 4
- 2.3 RD&D Unit Location 5
- 2.4 RD&D Project Description 10

3.0 WASTE CHARACTERIZATION AND ANALYSIS 12
- 3.1 Waste Characteristics 12
  - 3.1.1 Waste to be Treated in the RD&D Unit 15
  - 3.1.2 Wastes Generated by RD&D Treatment 16
- 3.2 Waste Analysis 18
  - 3.2.1 Parameters and Rationale 18
  - 3.2.2 Test Methods 20
  - 3.2.3 Sampling Methods 22
  - 3.2.4 Sampling Frequency 22
  - 3.2.5 Waste Analysis Requirements for Compliance with Land Disposal Restrictions 22
- 3.3 Waste Transportation 23

4.0 PROCESS ENGINEERING 25
- 4.1 Description of Treatment Unit 25
  - 4.1.1 Waste Feed System Components 25
  - 4.1.2 Electrochemical Treatment Unit Components 26
    - 4.1.2.1 Undivided Electrochemical Cell System 26
    - 4.1.2.2 Divided Electrochemical Cell System 27
- 4.2 Ancillary Waste Storage Area 29
- 4.3 Pollution Control 31
- 4.4 Compliance with Air Emissions Standards 32

TABLE OF CONTENTS (Cont'd.)

Page

5.0 RESEARCH PLAN 33
5.1 Objective 33
5.2 Operating Parameters and Monitoring Frequency 33
5.3 Monitoring Plan 34
5.3.1 Process Monitors 34
5.3.2 Effluent Analysis 35
5.3.3 Equipment Shut Down 36
5.4 Inspection Procedures 36

6.0 QUALITY ASSURANCE/QUALITY CONTROL 38
6.1 Calibration Procedures 39
6.2 Equipment Cleaning Procedures 39

7.0 DATA AND RECORDKEEPING 40

8.0 SAFETY PLAN 42

9.0 PERSONNEL QUALIFICATIONS AND TRAINING 46

10.0 CLOSURE PLAN 48
10.1 Introduction 48
10.2 Closure Performance Standard 48
10.3 Maximum Waste Inventory 48
10.4 Procedures to Close the Unit 49
10.5 Date and Schedule for Closure 50

11.0 DURATION OF PERMIT 52

12.0 CERTIFICATION 53

TABLE OF CONTENTS (Cont'd.)

Page

FIGURES

Figure 1	Site Location Map	5
Figure 2	Location of Building 37 at Technical Area 50	6
Figure 3	Layout of Building 37	8
Figure 4	Topographic Map	9
Figure 5	Location of RD&D Unit Relative to Nearby Fault Traces	10
Figure 6	Undivided Electrochemical Treatment System	27
Figure 7	Divided Electrochemical Treatment System	29
Figure 8	Unit-Specific Inspection Schedule - Electrochemical Treatment System Components	38

ATTACHMENTS

Attachment 1	LANL Waste Profile Form
Attachment 2	Mixed Wastes in Treatability Groups 15, 16, and 17
Attachment 3	Research Papers on Electrochemical Treatment
Attachment 4	Hazardous and Mixed Waste Facility Inspection Record Form
Attachment 5	LANL Mixed Waste Contingency Plan
Attachment 6	Resumes of Key Project Staff
Attachment 7	Summaries of Training Courses

LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO
EPA I.D. No. NM0890010515

RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) PERMIT APPLICATION

ELECTROCHEMICAL TREATMENT UNIT

1.0 INTRODUCTION

Environmental goals at Los Alamos National Laboratory (LANL) are to maintain and operate LANL facilities in an environmentally advantageous manner and to develop new technologies that will help the Department of Energy (DOE) in similar efforts at other facilities. New technologies are being developed to better meet the needs of corrective action, waste management, or environmental restoration. The principal mission of LANL is the application of science and technology to solve national problems including weapons development, energy supply, and conservation programs, while basic scientific research complements and strengthens its fundamental technical capabilities. LANL is owned by DOE, and is co-operated by DOE and the University of California.

LANL is requesting issuance of a Research, Development and Demonstration (RD&D) permit under Resource Conservation and Recovery Action (RCRA) as implemented under the New Mexico Hazardous Waste Act (§§ 74-4-1 *et seq.* NMSA 1978) from the New Mexico Environment Department for the operation of an electrochemical treatment unit. RD&D permits may be issued under the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20 NMAC 4.1), as revised November 1, 1995, Subpart IX §270.65. LANL is obligated by law under its Federal Facilities Compliance Order (FFCA) to treat the inventory of mixed waste generated and stored at the LANL facility. Issuance of a RD&D permit would allow LANL to investigate how versatile electrochemical treatment may be to treat the diversity of mixed wastes that are generated or have been generated at LANL.

Electrochemical treatment will involve use of two pilot-scale units to demonstrate the technical feasibility and performance capability of an innovative hazardous waste treatment technology. The research objective of the work to be conducted under a RD&D permit is to experimentally define waste streams that are amenable for electrochemical treatment, to determine the conditions of electrolysis for these waste streams, and to determine the feasibility of processing larger batch waste quantities than allowed under RCRA treatability studies. The successful completion of this project will be one step in the eventual

development of a full-scale treatment system capable of significantly reducing the volume and hazards of several mixed waste streams generated within the DOE production complex.

Electrochemical treatment consists of a stack of electrochemical cells and auxiliary equipment (such as pumps, agitators, pH meters, thermometers, alarm, power supplies, rectifiers, feed system, and a gas scrubbing system) used to treat mixed (radioactive and hazardous) wastes containing metals, cyanides, nitrates, sulfides, and low concentrations of organic constituents. Metals will be electrochemically extracted from the waste solutions and deposited on cathodes, cyanides are decomposed to carbon dioxide, nitrates will be reduced to nitrogen, sulfides will complex with other heavy metals in the waste stream and precipitate out of solution, and organics will be oxidized to carbon dioxide and water. The remaining wastewater solution will contain low level radioactivity and must continue to be managed as radioactive waste.

It is the intention of the electrochemical treatment process to assist LANL in compliance with the Land Disposal Restriction (LDR) Standards of 20 NMAC 4.1, Subpart VIII, §268. It is the goal of the treatment process to demonstrate that wastes that were originally characteristically hazardous under 20 NMAC 4.1, Subpart II, §261 Subpart C, no longer exhibit a hazardous characteristic. These treated wastes will no longer be required to be managed as hazardous waste. A secondary goal for wastes that are listed hazardous wastes under 20 NMAC 4.1, Subpart II, §261 Subpart D will be to use electrochemical treatment to meet LDR treatment standards for the listed waste. Listed wastes that are treated by electrochemical treatment will continue to be managed as listed wastes following treatment.

This RD&D application has been prepared in accordance with the requirements of Section 3005(g) of RCRA as promulgated in the Code of Federal Regulations (CFR) under 40 CFR §270.65 and under 20 NMAC 4.1, Subpart IX §270.65. The application also complies with general guidelines published by the U.S. Environmental Protection Agency (EPA), "Guidance Manual for Research, Development, and Demonstration Permits Under 40 CFR 270.65" (EPA Document No. EPA/530-SW-86-008, July 1986).

2.0 GENERAL FACILITY INFORMATION

The following section provides information on the general location of the LANL facility and the RD&D electrochemical treatment unit.

2.1 RCRA Permit Status

It is the intent of the Laboratory to perform all activities in compliance with applicable local, state, and federal regulations and orders. Wastes, effluents, and emissions associated with the RD&D project will be handled according to established LANL procedures developed to ensure compliance with these regulations.

In November 1989, the New Mexico Health and Environment Department, Environmental Improvement Division, issued a RCRA hazardous waste facility permit (No. NM 0890010515-1) to LANL. The RCRA permit covers the storage and treatment of a variety of on-site generated hazardous wastes. Regulated unit processes include storage in containers, treatment in tanks, and incineration. In March 1990, EPA issued the RCRA Hazardous and Solid Waste Amendments (HSWA) requirements portion of LANL's RCRA permit, which became effective on May 23, 1990. Several open burn/open detonation high explosive hazardous waste units originally included in the RCRA Part B permit application are currently operated under RCRA interim status.

LANL is also regulated under the 20 NMAC 4.1, Subpart VI with respect to the facility's mixed waste storage and treatment operations. Mixed waste units at LANL include container storage areas, surface impoundments, tanks, cementation units for process residue, and five open burning/open detonation units for treatment of high explosive mixed waste.

As a result of these RCRA permitted and interim status waste management activities, LANL already has in place comprehensive and approved environmental and health management programs meeting RCRA requirements. These programs address overall facility procedures for proper characterization and management of wastes, security, inspection, personnel training, preparedness and prevention, contingency procedures, and facility closure. Operation of the electrochemical treatment unit for RD&D purposes will not require development of any additional facility-wide programs or procedures to protect human health and the environment at the LANL facility. Waste analysis, inspection, training, safety, and closure procedures described in this permit application, therefore, are focused on operation of the RD&D unit itself.

The names and telephone numbers of the appropriate facility owner and operator contacts are provided below.

Facility Owner/Operator:	Mr. G. Thomas Todd Area Manager U.S. Department of Energy Albuquerque Operations Office Los Alamos, New Mexico 87544 505/667-5105
Facility Operator:	Mr. Dennis J. Erickson Director Environment, Safety, and Health Division Los Alamos National Laboratory Los Alamos, New Mexico 87545 505/667-4218

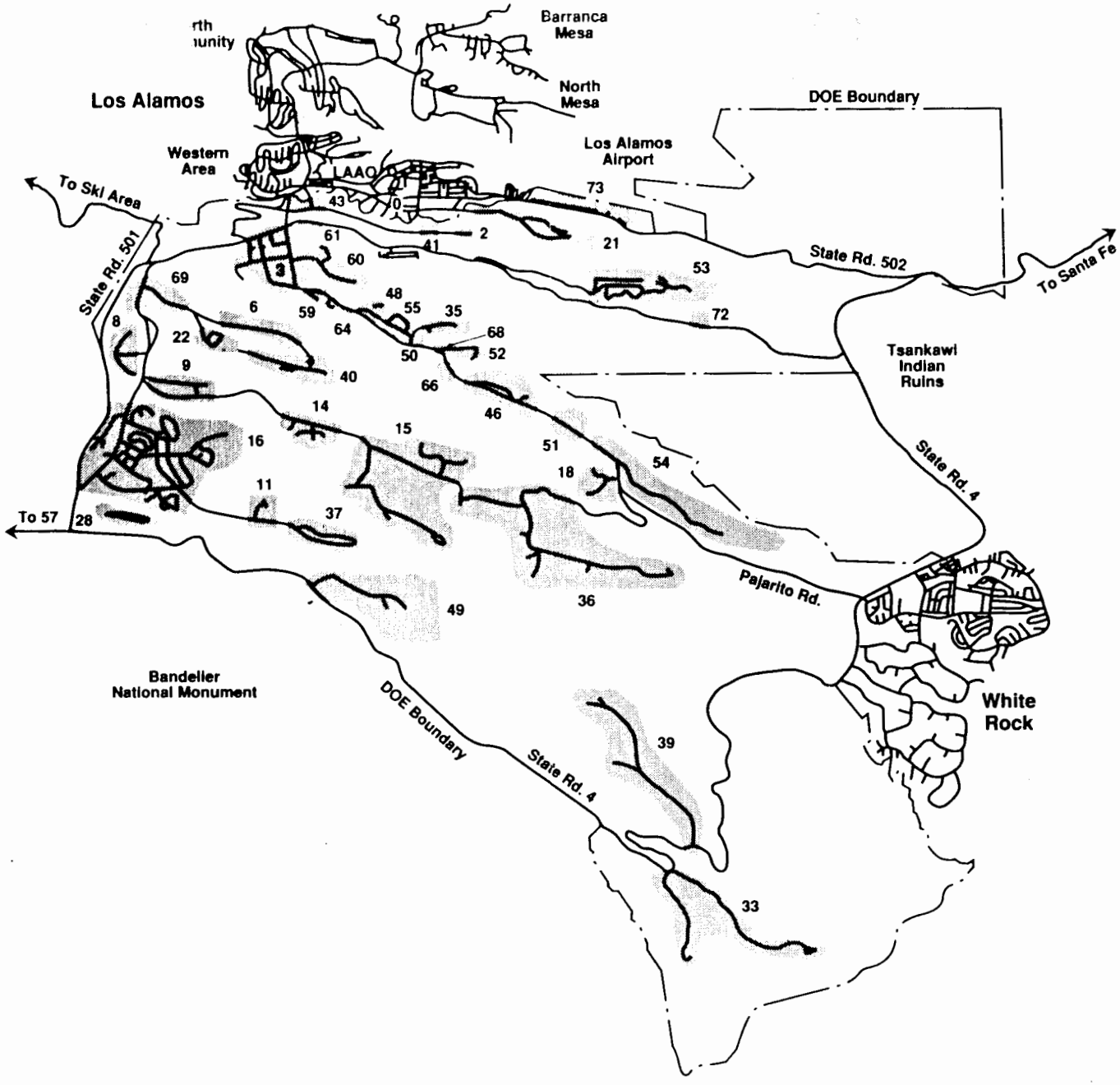
2.2 Site Location

LANL and the residential communities of Los Alamos and White Rock are located in north central New Mexico on the Pajarito Plateau, situated west of the Rio Grande on the eastern slopes of the Jemez Mountains. The Pajarito Plateau consists of a series of finger-like mesas separated by deep eastward oriented canyons cut by intermittent streams. Mesa tops range in elevation from approximately 2,400 meters (7,800 feet) above sea level on the flank of the Jemez Mountains to about 1,900 meters (6,200 feet) above sea level at the eastern termination above the Rio Grande Valley. The LANL facility covers approximately 111 square kilometers (43 miles^2) in and adjacent to Los Alamos County, and includes 34 active Technical Areas. A site map is provided as Figure 1.

2.3 RD&D Unit Location

The electrochemical treatment unit will be located at the Radioactive Materials Research Operations and Demonstration (RAMROD) Facility. The RAMROD Facility is located in Technical Area 50 (TA-50) in Building 37. TA-50 is situated on approximately 15 acres of DOE-controlled land south of the Los Alamos townsite. It is located along Pajarito Road and Pecos Drive. Figure 2 shows the location of Building 37 at TA-50.

Room 117 in Building 37, where the electrochemical treatment unit will be located, is found in the southeast corner of Building 37. The area is currently permitted for storage of up to



Los Alamos
NATIONAL LABORATORY

Technical Area Locations

TA-0	Unassigned Land Reserve
TA-2	Omega Site
TA-3	South Mesa Site
TA-6	Two Mile Mesa Site
TA-8	Anchor Site West
TA-9	Anchor Site East
TA-11	K-Site
TA-14	Q-Site
TA-15	R-Site
TA-16	S-Site
TA-18	Pajarito Laboratory
TA-21	DP-Site
TA-22	TD-Site
TA-28	Magazine Area A
TA-33	HP-Site
TA-35	Ten Site
TA-36	Kappa Site
TA-37	Magazine Area C
TA-39	Ancho Canyon Site
TA-40	DF-Site
TA-41	W-Site
TA-43	Health Research Lab & DOE Headquarters
TA-46	WA-Site
TA-48	Radiochemistry Site
TA-49	Frijoles Mesa Site
TA-50	Waste Management Site
TA-51	Radiation Exposure Facility
TA-52	Reactor Development Site
TA-53	Meson Physics Facility
TA-54	Waste Disposal Site
TA-55	Plutonium Facility Site
TA-57	Fenton Hill Site
TA-59	OH-Site
TA-73	Airport

TA-60,61,64,66,68,72
(unnamed TAs)

August 1991

Figure 1
Site Location Map

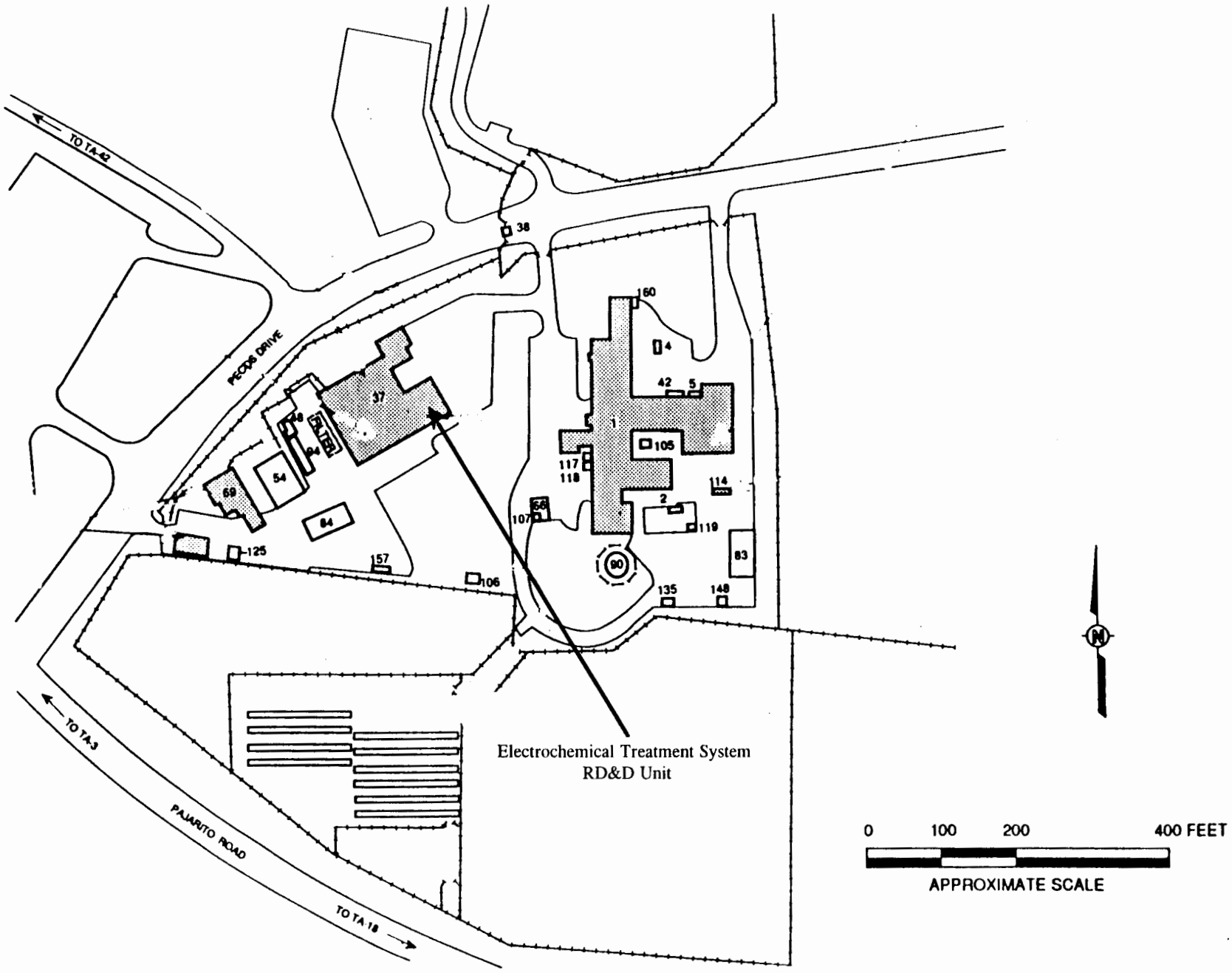


Figure 2
Location of Building 37 at Technical Area 50

3,630 gallons of hazardous waste in containers and is also currently used for RCRA interim status storage of mixed waste in containers. Figure 3 shows the location of Room 117 in Building 37.

A topographic map covering the RD&D unit location has been developed and included in the permit application as Figure 4. The topographic map has been prepared at a scale of 1 inch equal to 200 feet and with contour intervals of 2 feet. The map shows a 1000 foot radius around the RD&D unit.

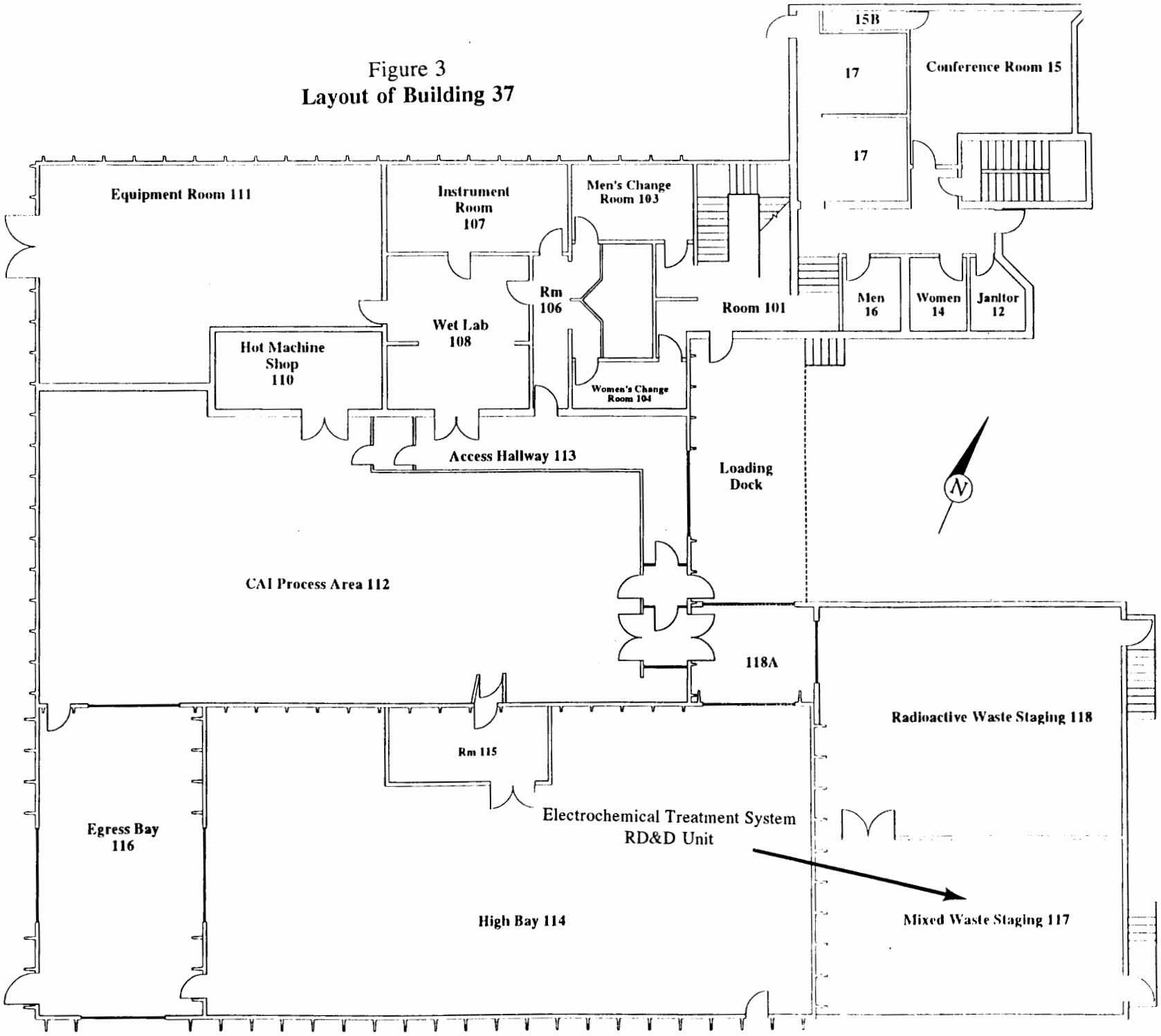
LANL is located in Los Alamos County, New Mexico, which is listed in 40 CFR Part 264 Appendix VI. The seismicity of LANL is discussed in detail in the Part B Application submitted to acquire the existing LANL facility-wide RCRA permit. In addition, a more recent study (Woodward-Clyde, *Seismic Hazards Evaluation of the Los Alamos National Laboratory*, 1993) was conducted that identified 26 faults and five seismic source zones. As shown in Figure 5, which is adapted from LANL's 1988 Part B Permit Application, no faults or fault traces with Holocene (or other) displacements have been located within 200 feet of the location of the RD&D unit at TA-50. The topographic map provided a Figure 4 also shows a projected fault line in the vicinity of TA-50. This projected fault lies approximately 1500 feet to the east of TA-50 Building 37, outside the 1000 foot facility radius.

In accordance with 40 CFR 270.14(b)(11)(iii) and 20 NMED 4.1, Subpart IX, the electrochemical treatment unit is not located in the 100 year floodplain. As required under the Hazardous and Solid Waste Amendment Module VIII of LANL's RCRA Permit, LANL has mapped all 100-year floodplain boundaries within the LANL complex. The mapping procedures used techniques that comply with 40 CFR 270.14(b)(11)(iii). A report documenting these floodplain mapping procedures has been published. Final floodplain maps were submitted to NMED in June 1992. Building 37 at TA-50 is located in a surface graded area atop Mesita del Buey. Localized flooding from snow melt and rain does not occur in this area.

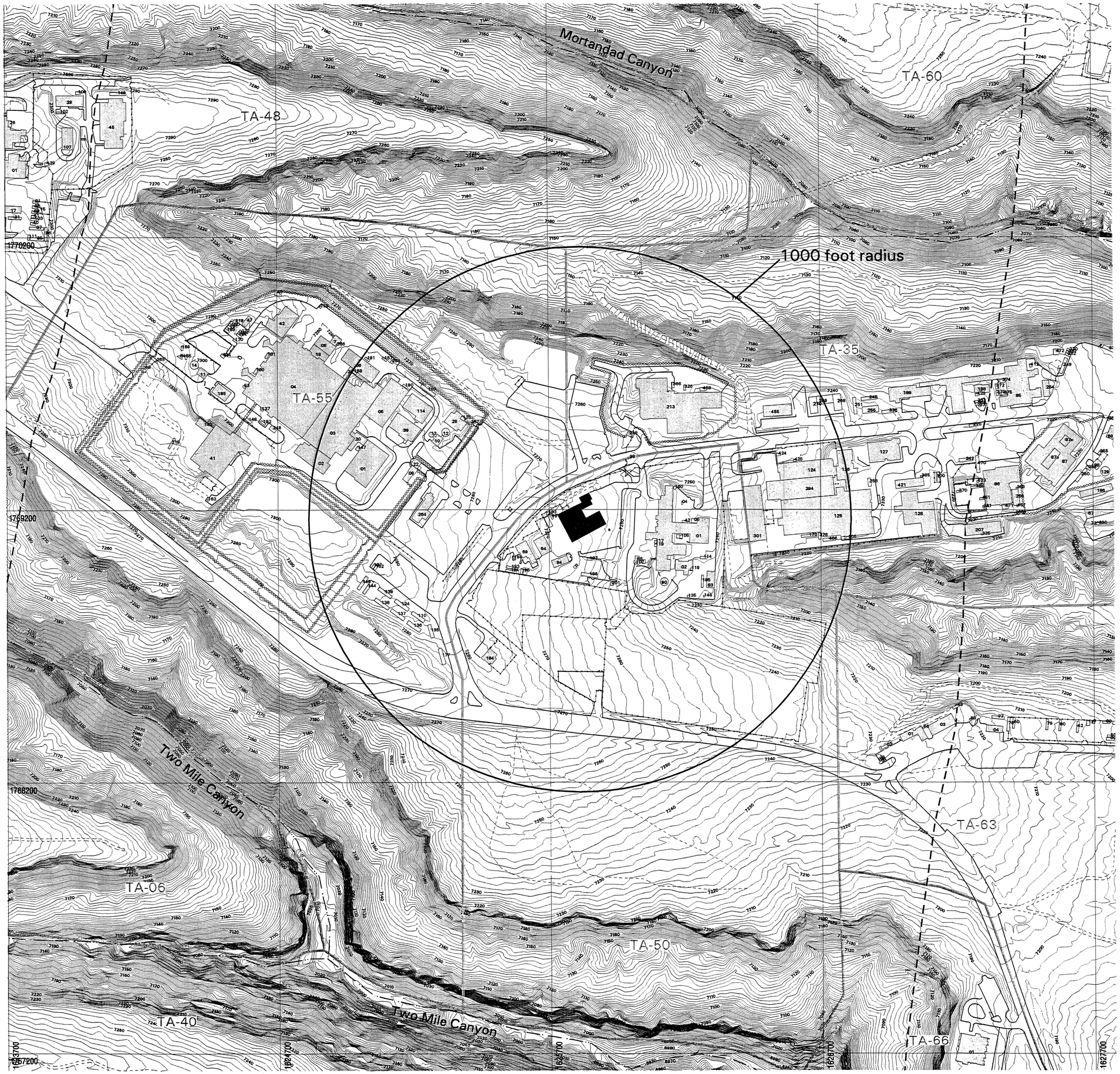
2.4 RD&D Project Description

Although the concept of constituent removal and chemical transformation of constituents in a liquid using an electrochemical process is not new, the use of electrochemical methods for treatment of mixed wastes with low concentrations of toxic constituents is new and innovative. Whereas industrial processes operate at high constituent concentrations (typically on the order of tens or even hundreds of grams per liter), electrochemical waste processing operations require treatment of concentrations down to part per million (ppm) or even part per billion (ppb) levels. Working at such low concentrations is difficult because of thermodynamic and kinetic limitations inherent in the chemistry of the waste stream. Proper selection of several factors are essential to the optimal operation of the electrochemical

Figure 3
Layout of Building 37



TA-50, Building 37 with 1000 Foot Radius



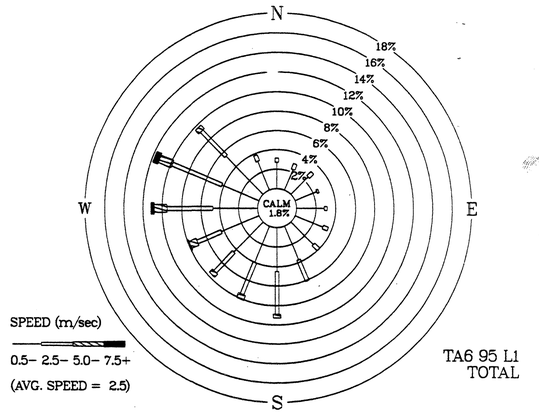
FIMAD Plot ID: G104946 24 Jul 96

LEGEND

- Boundary, TA
- Contours, 2 foot
- Contours, 10 foot
- Fault, Concealed
- Fence, Industrial
- Fence, Security
- Roads, Dirt
- Roads, Paved
- Road/Trail
- Stream, Intermittent
- Permanent Structure
- Temporary Structure
- Underground Structure
- Structure 50-37

WIND ROSE TA-6

Observed at 36ft



State Plane Coordinate System, New Mexico Central Zone.
1983 North American Datum

Grid provides NM State Plane coordinates in feet.
Grid interval, in feet: 1000
Feet per inch on map = 200

SCALE 1:2400

0 61 122 183 244

METERS

0 200 400 600 800

FEET

NOTICE: The information on this map is provisional. Feature locations are dependent on scale and symbology and their accuracy may not have been confirmed. Los Alamos National Laboratory boundary is based on legal description established in 1995. Other boundary, structure, and utility data are from Los Alamos National Laboratory Engineering Division and Los Alamos County Utility and Engineering Departments. Contour data are from Los Alamos National Laboratory Environmental Restoration Project aerial survey, September 1991.

University of California

Los Alamos National Laboratory

8814

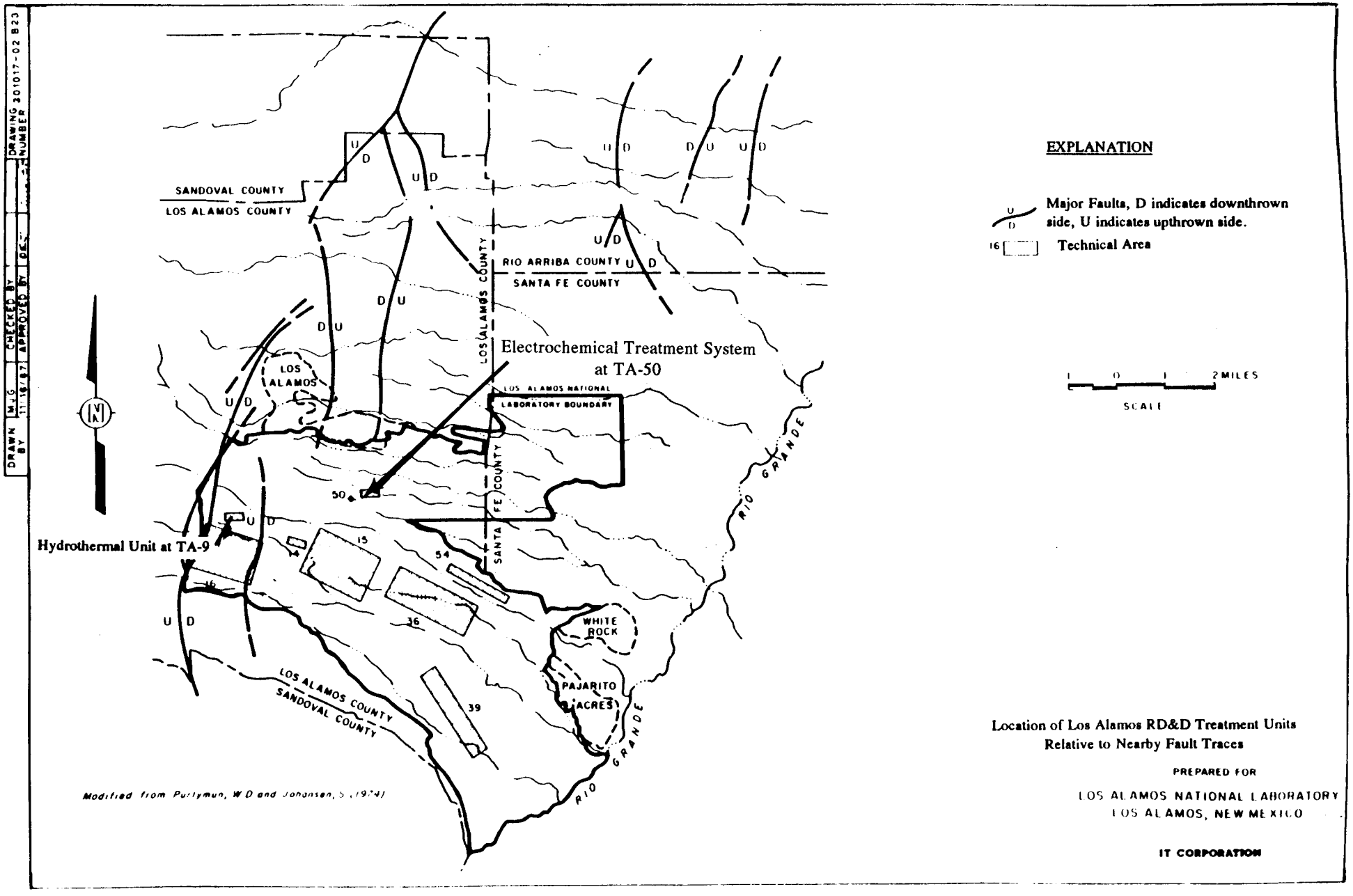
Earth and Environmental Sciences Division

FIMAD Facility for Information Management, Analysis, and Display
FIMAD is the electronic data repository for the Environmental Restoration Project at Los Alamos National Laboratory.

Produced by: Doug Walther

Date: July 24, 1996 FIMAD Plot ID: G104946

Figure 5
Location of RD&D Unit Relative to Nearby Fault Traces



Source: Los Alamos National Lab, Part B Permit Application, 1988

treatment unit including: electrode material and geometry, cell construction, applied electrical current and voltage, temperature, pH, addition of polarizers, and liquid flow control. Finding the right combination of these factors to run electrochemical treatment of a given waste composition constitutes the crux of research proposed under this RD&D permit.

Electrochemical treatment will be performed under two different configurations. The first experimental configuration includes an undivided cell where the waste solution circulates freely between the anodes and cathodes in the electrolytic cell. The second experimental configuration includes a divided cell, where a membrane permeable only to hydronium (H^+) ions separates the anodic and cathodic compartments of the electrolytic cell. Use of the divided or undivided cell depends on the constituent(s) of concern being removed or degraded in a particular waste stream, as well as the concentration of the constituent(s) in the waste. The divided cell is more effective at treating low concentration wastes.

The effectiveness of the electrochemical treatment process can be determined through a variety of combinations of operating parameters and controls. The major operating parameters that can be controlled and varied during the operation of the unit are:

- Choice of electrode material;
- Geometry (shape, thickness, etc.) of electrodes;
- Cell construction (size and geometry of treatment cell);
- Applied electrical current;
- Electrical voltage from anode to cathode;
- Total applied electrical voltage to the treatment cell;
- Treatment system pH;
- Addition of polarizers;
- Liquid flow control; and
- Treatment time.

Finding the right combination of these factors to run electrochemical treatment of a given waste composition constitutes the purpose of the research proposed under this RD&D permit.

A more detailed discussion of the design and operation of the RD&D unit is provided in Section 4 and Section 5 of this application.

3.0 WASTE CHARACTERIZATION AND ANALYSIS

The research objective of the work to be conducted under this permit is to experimentally define waste streams that are amenable for electrochemical treatment, to determine the optimal conditions of electrolysis for these waste streams, and to determine the feasibility of processing larger batch waste quantities than allowed under RCRA treatability studies. The successful completion of this project will be one step in the eventual development of a full-scale treatment system capable of significantly reducing the volume and hazards of several mixed waste streams generated within the DOE production complex.

LANL is obligated by law under its Federal Facilities Compliance Order (FFCA) to treat the inventory of mixed waste generated and stored at the LANL facility. Issuance of a RD&D permit would allow LANL to investigate how versatile the electrochemical treatment technology may be to treat the diversity of mixed wastes. Electrochemical treatment will also be used to investigate the treatment of mixed wastes that are generated at other research areas at LANL.

3.1 Waste Characteristics

Mixed waste contains both a hazardous wastes, as defined by and regulated under RCRA, and a radioactive waste. Mixed waste managed at LANL is comprised of four general types:

- Waste from research and development;
- Waste from process operations;
- Waste from decontamination and decommissioning projects; and
- Waste from environmental remediation/restoration activities.

The characterization of mixed waste is accomplished either by application of acceptable knowledge or through chemical and physical (i.e., laboratory) analysis of representative of representative samples of the waste. Acceptable knowledge is broadly defined by EPA guidance to include process knowledge, supplemental waste analysis data, and/or facility records of analysis.[1] Process knowledge is described in 20 NMAC 4.1, Subpart V, §264.13(a)(2) as data developed under 20 NMAC 4.1, Subpart II and existing published or

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[1] Reference: U.S. Environmental Protection Agency, *Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Waste*, (PB94-963603, OSWR 9938.4-03), April 1994. (EPA 1994).

documented data on a specific hazardous waste or hazardous waste generated from similar processes. Waste analysis data include concentration(s) of regulated hazardous constituents and/or results of tests for hazardous characteristics. These data are used to determine if wastes are regulated and to determine their Land Disposal Restriction (LDR) status. Facility records of analysis performed before the effective date of hazardous waste regulations will be used with caution. These analytical results must be accurate and applicable to the specified waste and should be supplemented with other existing information (e.g., published data). EPA guidance (EPA 1994) suggests that acceptable knowledge may be appropriate for wastes meeting the following descriptions:

- Wastes containing hazardous constituents from specific processes that are well documented, such as RCRA F-listed and/or K-listed waste code descriptions.

- Wastes consisting of discarded unused commercial chemical products, reagents, or chemicals containing known physical and chemical constituents. Several of these fall into the RCRA P-listed and U-listed waste code descriptions.

- Wastes (e.g., radioactive mixed waste) containing levels of radioactivity such that health and safety risks to personnel do not justify sampling and analysis due to quantified and documented radiological concerns.

- Wastes containing heterogeneous materials, where the physical nature of the waste does not lend itself to taking a representative sample (e.g., laboratory trash and construction debris with surface contamination).

At LANL, waste generators will obtain, assemble and prepare the acceptable knowledge documentation available for each waste stream in a separate auditable file or maintain a waste stream reference file that identifies the acceptable knowledge documents and their locations. The acceptable knowledge documentation must be explicitly relevant and traceable to a particular waste type and must not be merely a list of information sources for a particular operation and/or waste.

In an effort to maintain detailed and accurate waste characterization information, LANL's CST Division uses a generator waste profiling program for existing (i.e, currently generated) waste at LANL. The waste profiling effort requires each waste generator to provide a detailed written description of the waste on a standardized Waste Profile Form. A copy of the Waste Profile Form is provided as Attachment 1. The waste description can be based on generator process knowledge, the use of appropriate Material Safety Data Sheets (MSDSs), results of chemical/physical analysis of the specific waste, and/or any additional information for acceptable knowledge. By completing the Waste Profile Form, waste generators supply

information that allows for the proper management of TRU mixed waste. Specific information that is requested on the Waste Profile Form includes:

- Point of generation;
- Method of characterization;
- Waste categories;
- Waste description;
- Waste origination;
- Classification of radioactivity;
- Presence of toxic metals and an estimate of concentration;
- Presence of organic compounds and an estimate of concentration;
- Identification of hazardous constituents;
- Identification of hazardous characteristics; and
- Identification of the radiological characteristics of the waste.

A correctly completed Waste Profile Form contains sufficient information to allow CST to classify the waste type, class, category, source, matrix, and matrix type (see Attachment 1). Ultimately, the waste profile is used by CST Division to determine the proper procedures for managing the waste.

All generators must certify, based on their knowledge of the waste, that the information on the Waste Profile Form is complete and accurate. Knowingly providing false information can result in administrative action by LANL. and/or be subject to potential significant civil or criminal penalties, as stipulated by the waste generator's certification statement.

The Waste Profile Form must be completed prior to any waste treatment, storage, or disposal at LANL. Waste generators must provide new profiles when a process change results in a change in waste composition or when a new waste is generated; otherwise, waste stream profiles are reevaluated annually.

Completed waste profile forms are submitted to LANL's Chemical and Mixed Waste Group (CST-5) by LANL generators. CST-5 personnel review and approve the Waste Profile Form before waste pickup from LANL generators is scheduled. CST-5 review includes evaluating the Waste Profile Form for completeness and assigning a waste classification to the waste stream (e.g., solid waste, hazardous waste, mixed waste, non-hazardous waste, radioactive waste). CST-5 personnel may also collect samples of wastes for laboratory analyses as necessary to complete Waste Profile Forms or verify generator reported information. Once an acceptable Waste Profile Form is on file, the generator submits a Chemical Waste Disposal Request form to CST-5 to schedule pickup of wastes for transport to an appropriate LANL waste storage, treatment, or disposal area.

The following sections provide more specific information on the characteristics of the wastes prior to and following electrochemical treatment.

3.1.1 Waste to be Treated in the RD&D Unit

Wastes designated for treatment will originate from operations at LANL. No wastes will be brought from off-site generators for RD&D electrochemical treatment tests. The types of wastes that will be tested to determine the effectiveness of the experimental treatment technology will have the following waste characteristics:

- Consist of an aqueous mixed waste stream containing inorganic metals, cyanides, nitrates, and sulfides;
- Inorganic mixed wastes selected for treatment may also contain low levels (less than 10 percent by weight) of organic wastes in aqueous waste streams.

Mixed wastes at LANL are segregated into treatability groups for the purposes of storage and treatment. Wastes proposed to be treated in the electrochemical treatment unit will typically (but not necessarily exclusively) belong to one of the following LANL Treatability Groups:

- MWIR Waste ID LA-W929 (also known at LANL as Treatability Group 1 wastes): non-radioactive and radioactive items to be surveyed;
- MWIR Waste ID LA-W913 (also known at LANL as Treatability Group 15 wastes): aqueous waste with heavy metals;
- MWIR Waste ID LA-W914 (also known at LANL as Treatability Group 16 wastes): corrosive solutions; and
- MWIR Waste ID LA-W915 (also known at LANL as Treatability Group 17 wastes): aqueous cyanides, nitrates, chromates, arsenates.

Attachment 2 includes a more detailed description of the types of mixed wastes in Treatability Groups 15, 16, and 17.

Wastes in Treatability Group 1 include a wide variety of wastes that are potentially radioactive and require surveying. Because they are suspected to be radioactive, DOE orders require that the waste be managed as if it were radioactive. Wastes in this Treatability Group will be assessed for their suitability for electrochemical treatment. If the wastes are determined to be suitable for RD&D experiments (e.g., contain metals, cyanides, nitrates, and/or sulfides and low levels [less than 10 percent by weight] organics in an aqueous

solution) they will be accepted for electrochemical treatment. Note that hazardous wastes in Treatability Group 1 may, upon radioactive surveying, be determined not to be radioactive. In this circumstance, the hazardous-only Treatability Group 1 waste will be treated by electrochemical processing, so long as the waste has characteristics that make it suitable for electrochemical treatment. All other wastes accepted for treatment in the unit will be verified mixed waste streams.

As noted above, any other waste type that meets the specifications for suitability for electrochemical treatment may also be selected from other LANL waste stream types. In the event that other waste streams are selected, LANL will notify NMED prior to beginning such activity. For mixed waste streams, such notification will be performed in accordance with the requirements of the LANL FFCA and Site Treatment Plan. Again the characteristics that would make a waste suitable for treatment under this proposed RD&D permit include an aqueous mixed waste stream containing inorganic metals, cyanides, nitrates, and sulfides. Inorganic mixed wastes selected for treatment may also contain low levels (less than 10 percent by weight) of organic wastes in aqueous waste streams.

3.1.2 Wastes Generated by RD&D Treatment

Waste generated by the electrochemical treatment process include a solid fraction and a liquid fraction. The treated wastes must be classified as mixed waste, hazardous-only waste, radioactive-only waste, or solid waste for proper subsequent management at the LANL facility. Mixed waste and hazardous waste will be classified as RCRA characteristic waste in accordance with 20 NMAC 4.1, Subpart II, §261 Subpart C or RCRA listed waste in accordance with 20 NMAC 4.1, Subpart II, §261, Subpart D.

Wastes generated by RD&D treatment will require completion of the Waste Profile Form for review and approval by CST-5. Upon approval, a Chemical Waste Disposal Request form will be submitted to CST-5 for transport of the waste from TA-50 Building 37 Room 117 to a suitable LANL waste management area.

The solid fraction generated as a result of electrochemical treatment will include metals that are electrochemically extracted from the waste solutions and deposited on the cathodes or precipitated and collected at the bottom of the treatment cell. The solid fraction wastes will be managed as follows:

- Recovered metals would be monitored for radioactivity; they are expected to be free of radioactive contamination. Metals that are free of radioactivity may be reused for other laboratory activities (e.g., converted to sulfates, chlorides, nitrates, sulfides, etc. for laboratory uses, or returned to the plating shop for reuse in plating processes). Alternatively, the metals will be subsequently managed in accordance with applicable solid and hazardous waste regulations. If radioactivity is detected, the recovered metals will be sent to low-level radioactive or mixed waste storage areas at TA-54 for subsequent management.

- The small quantity of precipitate collecting at the bottom of the treatment system will be filtered from the liquid waste solution using a vacuum filtration system and paper filters. Waste derived from the treatment of listed hazardous wastes, will be classified as mixed waste and will be sent to TA-54 for subsequent mixed waste management. Waste derived from the treatment of characteristic wastes will be analyzed according to the Toxicity Characteristic Leaching Procedures (TCLP) to see if the characteristic has been removed. The waste will then be properly managed as either hazardous or non-hazardous waste, depending on the results of TCLP testing.

Liquid wastes remaining after electrochemical treatment will either be radioactive waste or mixed waste. Options for managing liquid wastes include the following:

- If the RCRA component of a characteristic mixed waste has not been successfully removed to a low enough level to remove the characteristic, the solution will either be re-run through the electrochemical treatment process to further lower the level of the RCRA regulated components or sent to TA-54 for subsequent management as mixed waste.

- Solutions that have been treated to remove RCRA hazardous characteristics will be containerized for treatment and disposal in the LANL Radioactive Liquid Waste Treatment Facility located at TA-50. In the event that the liquid fraction is not suitable for treatment in the LANL Radioactive Liquid Waste Treatment Facility, it will be containerized and sent to TA-54 for subsequent management as radioactive-only waste.

- Any solutions that remain after electrochemical treatment that were classified as RCRA listed waste will continue to be managed as mixed waste and sent to TA-54 for subsequent management.

- Liquid wastes removed from the gas scrubbing system or resulting from equipment cleanup will be analyzed to determine whether they qualify as mixed or hazardous wastes prior to their proper disposal. This determination will factor in whether listed or characteristic hazardous wastes were treated in the electrochemical treatment unit when the scrubber was operated or when the equipment was cleaned. Depending on the wastewater composition, it will either be handled in the LANL Radioactive Liquid Waste Treatment Facility, sent to TA-54 for subsequent hazardous and/or mixed waste management, or

sent to TA-54 for subsequent hazardous and/or mixed waste management, or disposed as non-radioactive and non-hazardous wastewater in the LANL facility-wide wastewater treatment system or an alternate proper treatment or disposal unit. It is extremely unlikely that the scrubber wastewater will be a radioactive waste.

Procedures for transporting hazardous wastes will conform to standard LANL procedures for internal transportation of low-level waste. Waste transfer will be handled by LANL's Chemical and Mixed Waste Group (CST-5).

3.2 Waste Analysis

Waste analysis will be performed prior to and following treatment in the electrochemical treatment unit. It is necessary to have an accurate assessment of the waste stream components, in order to evaluate the effectiveness of the electrochemical treatment process. The following section describes waste analysis procedures for the electrochemical treatment unit.

3.2.1 Parameters and Rationale

Waste initially selected for treatment in the electrochemical treatment unit will have been characterized based on acceptable knowledge, and this knowledge will be documented on the Waste Profile Form (see Attachment 1). Prior to selecting the waste for electrochemical treatment, RD&D researchers will review documented acceptable knowledge and Waste Profile Form information and any analytical data that will be available from LANL's Chemical and Mixed Waste Group (CST-5). Laboratory analyses will be performed prior to treatment to verify the waste profile information, in order to determine the waste's suitability for electrochemical treatment.

Sampling of each waste stream is initially conducted for all applicable parameters listed in the table below. If similar waste streams are subsequently bulked to create a single batch of waste for electrochemical processing, that bulked batch is also sampled for all applicable parameters listed in the table below.

Following completion of each electrochemical treatment experiment, the treated liquid effluent and any solid-form wastes are also sampled for all applicable parameters listed in the table below. The results of the final analyses are used to assess the overall effectiveness of the treatment process and to determine waste disposal options following treatment.

The following identifies the parameters for which analyses are performed on each waste stream and the rationale for those parameters:

ANALYTICAL PARAMETER	RATIONALE
Radioactivity	Determine whether the waste is radioactive and whether radioactive levels are above levels that would make waste unsafe to handle.
pH	Determine pH of waste stream to determine if D002 corrosive waste, to assess waste compatibility issues (important for waste storage segregation and waste bulking) and to determine if pH requires adjustment for treatment.
Toxicity Characteristic Metals (arsenic D004, barium D005, cadmium D006, chromium D007, lead D008, mercury D009, selenium D010, silver D011)	Determine what RCRA regulated metals are present in the waste and at what levels; determine RCRA regulatory status of waste; also collect information for compliance with Land Disposal Restriction Standards.
Other Non-Regulated Metals* (e.g., copper, cobalt, etc.)	Determine if waste contains other known or suspected metals and at what levels.
Reactivity - Sulfides*	Determine if waste contains reactive sulfides and at what levels.
Reactivity - Cyanides*	Determine if waste contains reactive cyanides and at what levels.
Semi-Volatile Organic Compounds*	Determine what organic constituents are present in the waste and at what levels.
Volatile Organic Compounds*	Determine what organic constituents are present in the waste and at what levels; demonstrate that the total organic concentration of the waste is less than 10 percent by weight so that the requirements of 40 CFR Part 264 Subpart BB are not triggered.

NOTE:

* Analyses for non-regulated metals, sulfides, cyanides, volatile organic compounds, and semi-volatile organic compounds will be performed only if existing data (e.g., waste profile data) or chemical and physical properties suggest presence of these compounds.

Following characterization, wastes of similar type (i.e., those containing similar constituents and pH levels) may be bulked into the waste feed system for simultaneous treatment. Due to the low concentration of organics (less than 10 percent by weight), which will be contained in an aqueous solution, incompatibility of organic-containing wastes will not be of concern.

In addition, wastes of dissimilar pH levels will not be bulked for treatment in order to prevent uncontrolled reactions. Temperature and pH in the waste feed container are monitored continuously during treatment to ensure that uncontrolled reactions are not occurring in the treatment system.

3.2.2 Test Methods

It is a DOE policy that radiation exposure from DOE operations be maintained at "As Low As Reasonable Achievable" (ALARA) levels in order to protect occupational workers. ALARA issues are particularly critical relative to waste sampling and analysis. Before any waste analysis activities are initiated, a thorough review of the radioactive characteristics of the waste stream will be performed. Samples acceptable for analysis must meet the following criteria:

- Alpha-emitting particles must fall below a concentration of 1 microcurie per gram of solid or 1 microcurie per liter of liquid;
- Gross beta activity must not exceed 1 nanocurie per gram of solid or 1 nanocurie per liter of liquid; and
- Gross gamma or tritium activity must not exceed 800 nanocuries per gram of solid or 800 nanocuries per liter of liquid.

An assessment of radioactivity is the first analysis that will be performed on all wastes determined to be potentially suitable for electrochemical treatment. Once radioactivity levels have been determined to be within an acceptable range, the remaining analyses will be performed. All test methods used will be EPA approved methods from EPA's "Test Methods for Evaluating Solid Waste" (SW-846), 3rd Edition (1986) including updates.

PARAMETER	TEST METHOD	SW-846 METHOD
Corrosivity/pH	Electrometric	9040
Toxicity Characteristic Leaching Procedure (for D-coded metal and organic wastes known or suspected to be in waste stream)	Toxicity Characteristic Leaching Procedure (TCLP)	1311
Metals* (following TCLP extraction)	TCLP extraction; Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP)	6010

PARAMETER	TEST METHOD	SW-846 METHOD
Reactivity - Sulfides*	Acid digestion; Spectrometric or Electrometric Analysis	9010
Reactivity - Cyanides*	Acid digestion; Spectrometric or Electrometric Analysis	9010
Total Cyanides*	Acid digestion; Spectrometric or Electrometric Analysis	9010, 9012, 9213
Semi-Volatiles Organic Compounds* (following TCLP extraction)	TCLP Extraction; Gas Chromatography/Mass Spectroscopy (GC/MS)	8270
Volatile Organics Compounds* (following TCLP extraction)	TCLP Extraction; Gas Chromatography/Mass Spectroscopy (GC/MS)	8240

NOTE:

* Analyses for non-regulated metals, sulfides, cyanides, volatile organic compounds, and semi-volatile organic compounds will be performed only if existing data (e.g., waste profile data) or chemical and physical properties suggest presence of these compounds.

Analytical equipment available at LANL for waste stream analysis includes the following items. Note that not all equipment will necessarily be used for each electrochemical treatment experiment. Additionally, some of the equipment noted below will not be used for definitive waste characterization in compliance with 20 NMAC 4.1, Subpart V, §264.13. Rather, certain pieces of equipment may be used during the course of a particular treatment run to monitor specific constituents in order to assess the progress of electrochemical treatment process. Available equipment at LANL includes the following:

- Inductively Coupled Plasma - Atomic Emissions Spectroscopy (ICP) for analyzing metal constituents;
- Gas Chromatograph/Mass Spectrometer (GC/MS) for analyzing volatile and semi-volatile organic constituents;
- Ultraviolet (UV-VIS) for analyzing inorganic and organic constituents;

- Stripping Voltametry for analyzing metals; and
- Ion Sensitive Electrodes for analyzing inorganic cations and ions.

3.2.3 Sampling Methods

Electrochemical treatment system operators will use EPA approved methods for collecting samples of solid and liquid wastes for analysis.

Liquid samples will be collected using a coliwasa type sampling apparatus. Other equivalent EPA SW-846 sampling methods, such as use of tubing or dipper, may be substituted for the coliwasa sampler.

Solid wastes that require sampling include the precipitates that collect at the bottom of the electrochemical treatment cell. These are generated in small quantities and are collected on filter paper using a vacuum filtration system. Samples will be collected using a small stainless steel or plastic scoop.

3.2.4 Sampling Frequency

Sampling of each waste stream is initially conducted for all applicable parameters identified in Section 3.2.1 above. If similar waste streams are subsequently bulked to create a single batch of waste for electrochemical processing, that bulked batch is also sampled for all applicable parameters identified in Section 3.2.1 above.

Following completion of each electrochemical treatment experiment, the treated liquid effluent and any solid-form wastes are sampled and analyzed for all applicable parameters identified in Section 3.2.1 above. The results of the final analyses are used to assess the overall effectiveness of the treatment process and to determine waste disposal options following treatment.

3.2.5 Waste Analysis Requirements for Compliance with Land Disposal Restrictions

It is the intention of the electrochemical treatment process to assist LANL in compliance with the Land Disposal Restriction (LDR) Standards of 20 NMAC 4.1, Subpart VIII, §268. It is the goal of the treatment process to demonstrate that wastes that were originally characteristically hazardous under 20 NMAC 4.1, Subpart II, §261 Subpart C, no longer exhibit a hazardous characteristic. These treated wastes will no longer be required to be managed as hazardous waste. A secondary goal for wastes that are listed hazardous wastes under 20 NMAC 4.1, Subpart II, §261 Subpart D will be to use electrochemical treatment to

meet LDR treatment standards for the listed waste. Listed wastes that are treated by electrochemical treatment will continue to be managed as listed wastes following treatment.

All wastes remaining from or generated by the electrochemical treatment process will be assessed for compliance with LDR standards. LDR standards will not be applicable to those waste streams whose RCRA characteristics (i.e., D002 through D043) are removed as a result of electrochemical treatment. Final waste analysis conducted on all liquid effluents and cleaning solutions and all solid residues destined for further waste treatment or disposal will assess the levels of constituents in wastes or waste extracts in accordance with 20 NMAC 4.1, Subpart VIII, §268. This will allow RD&D researchers to determine whether or not the wastes meet LDR treatment standards. This information, including generator notifications and certifications, will be provided to the CST-5 group for subsequent management of any mixed or hazardous waste at TA-54. No LANL wastes are land disposed that do not meet their applicable LDR treatment standards.

Containers used to store mixed wastes will be clearly marked to identify the contents and the date each was placed into storage. Waste documentation will be retained for both listed and characteristic mixed waste, even when the hazardous characteristic is removed prior to disposal. This information, plus the generator notifications and certifications that accompany each shipment of mixed waste, will be maintained by the generator for a period of five years following off-site treatment or disposal or on-site treatment or disposal.

3.3 Waste Transportation

Wastes will be retrieved from permitted LANL storage areas or generator sites for treatment in the electrochemical treatment unit. Facility-wide hazardous waste handling operations are coordinated by LANL's Chemical and Mixed Waste Group (CST-5). CST-5 responsibilities include: review and approval of Waste Profile Forms; waste sampling and analysis as necessary to complete or verify profiles; pick-up of mixed wastes from LANL generators; proper management of wastes in LANL's RCRA-regulated waste management units; and coordination of off-site shipment of RCRA-regulated wastes to permitted treatment, storage, and disposal facilities.

Wastes retrieved from permitted or interim status storage areas or generator sites will be shipped in either overpacked drums or labpacks. Overpacked drums may range in size up to 55 gallons shipped in an 85 gallon overpack. Labpacks may contain numerous containers ranging in size up to 5 gallons packed in vermiculite or another inert absorbent and placed in larger overpack containers (e.g., 55-gallon drums).

Procedures for transporting hazardous wastes will conform to standard LANL procedures for internal transportation of low-level mixed waste. Wastes transferred to the electrochemical

treatment unit from a storage unit will be accompanied by LANL's transport documentation identifying the waste type and volume and location where waste is transported. Copies of this form will be maintained by the RD&D research group and CST-5.

Records maintained by CST-5 will include the following:

- Copies of all shipping documents;
- The amount of waste shipped to Building 37 Room 117 for treatment under the RD&D experiments;
- The name, address, and EPA identification number of the testing facility conducting the treatment tests;
- The dates shipments were made;
- Whether or not any unused sample or any residue from the RD&D treatment experiments were returned to CST-5.

4.0 PROCESS ENGINEERING

The following section describes the electrochemical treatment system components and their function, equipment to control pollution and prevent uncontrolled releases of constituents to the environment, and waste storage procedures prior to and following electrochemical treatment.

4.1 Description of Treatment Unit

4.1.1 Waste Feed System Components

The waste feed system includes the following components:

- Container to hold the liquid waste feed;
- Portable metering pump to circulate the waste feed through the treatment system; and
- Removable agitator in the feed container to ensure uniform mixing of the waste feed.

The waste feed container may be the original overpacked drum in which the waste was shipped to Building 37, Room 117. In this case the portable pump and agitator will be inserted into the drum. The waste will be pumped to the electrolytic system reservoir where it will undergo treatment and flow back to the feed container and will continue to be circulated via the metering pump until treatment is determined to be complete.

Alternatively, waste from shipping containers will be placed into a polyethylene batch waste feed container. The waste feed container may range in size up to a maximum of 300 gallons, depending on the particular experimental run. In all cases the waste feed container will be placed into another container to provide secondary containment. The secondary containment will be sized to contain the entire contents of the waste feed batch container, in the event that a leak should develop. The quantity of waste that is batch treated depends on the initial quantity of waste available for a particular experiment as well as the nature of the experiment. In some cases, smaller or larger batch sizes of the same waste will be treated to evaluate the impact load size has on treatment effectiveness.

The waste feed pump, tubing/piping, and agitator will all be constructed of polyethylene or another similar inert type of plastic material.

4.1.2 Electrochemical Treatment Unit Components

Electrochemical treatment will be performed under two different configurations. One system uses an undivided electrochemical cell; the other uses a divided electrochemical cell. System components are described in the sections that follow.

4.1.2.1 Undivided Electrochemical Cell System

The first experimental configuration includes an undivided cell where the waste solution circulates freely between the anodes and cathodes in the electrochemical cell. A process flow diagram included as Figure 6 provides a schematic of the undivided cell system.

Flow of liquid waste and main system components include the following:

1. Waste is pumped by a metering pump from the batch feed container (described in Section 4.1.1 above), through piping into the undivided electrochemical treatment cell.

2. The undivided RETEC electrochemical cell is a commercially available bench-top unit that may range in size from 12 liters (unit measuring 16 inches long by 9.8 inches wide by 13.3 inches high) to 150 gallons (unit measuring 32 inches long by 23 inches wide by 21 inches high). The cell will be constructed of polyethylene or another similar inert plastic material and contains inlet and outlet ports, flow distributor, and slots for electrode placement. The cell is furnished with Dimensionally Stable Anodes (DSA), which are titanium grids covered with a mixture of titanium oxide and rare earth oxides. The cathode material used depends on the composition of the waste to be treated. Once waste has been pumped into the cell through the inlet port, the waste passively overflows through the outlet port back through polyethylene (or similar plastic) piping back into the batch waste feed container. The electrochemical cell will be placed in secondary containment sized to hold the entire contents of the cell and equipped with a liquids detector. If liquids are detected in the secondary containment, the waste feed pumps will automatically shut off.

3. Electrical power will be supplied to the unit through a rectifier or pulse rectifier. (A rectifier is a device that converts alternating electrical current into direct electrical current). The unit is equipped with controls to select and change the electrical current and voltage applied to the electrodes in the electrochemical cell. The rectifier is equipped with surge control and automatically shuts off in the event of an electrical surge to the system.

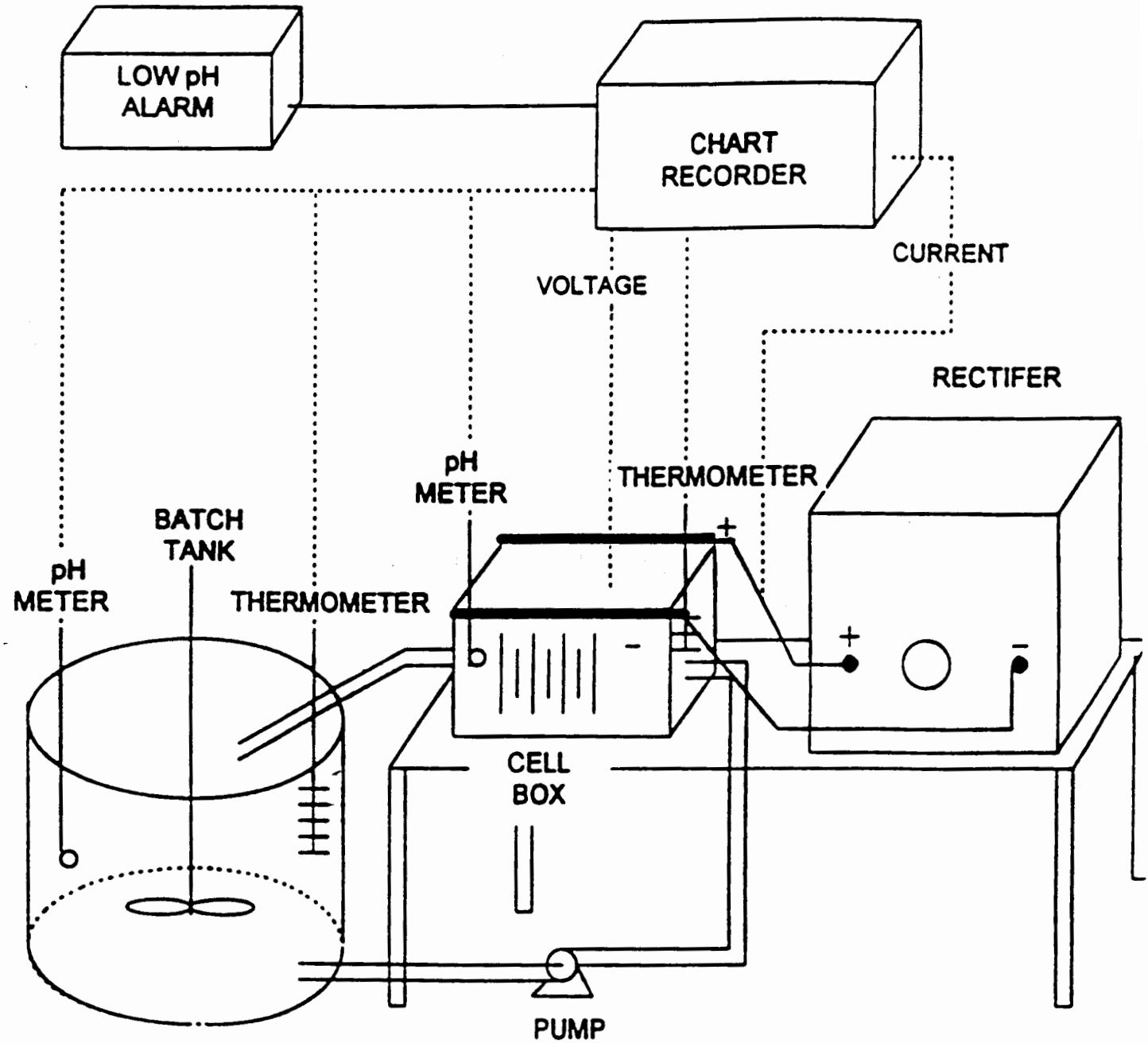


Figure 6
Undivided Electrochemical Treatment System

4. Auxiliary equipment includes: pH meters in both the electrochemical cell and batch waste feed container, thermometers or thermocouples in the electrochemical cell and batch waste feed container, voltmeters, ammeters, a digital coulometer (to measure the amount of electricity used in the electrolytic process), and a multi-channel chart recorder to collect process data.

4.1.2.2 Divided Electrochemical Cell System

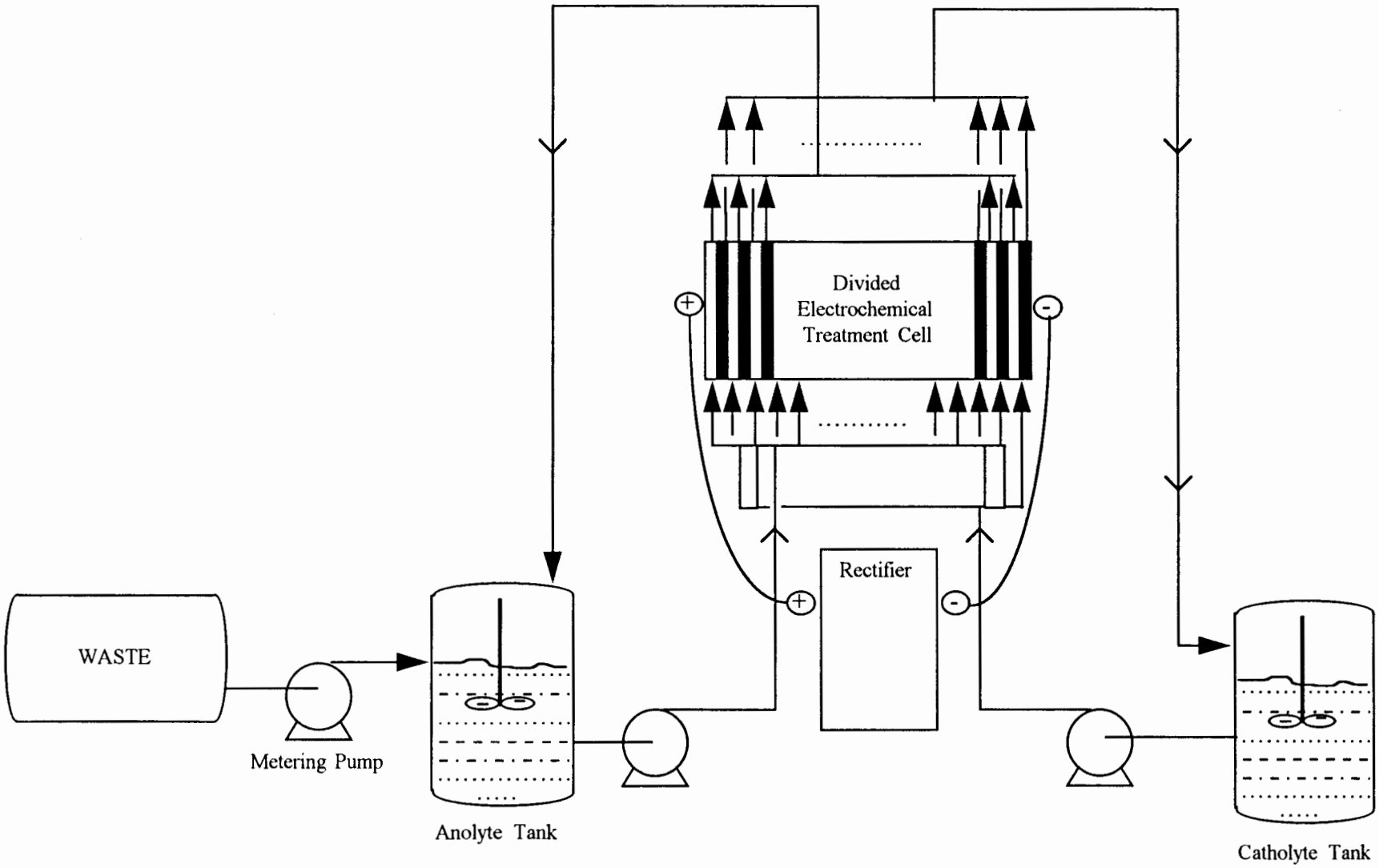
The second experimental configuration includes a divided cell, where a membrane permeable only to hydronium (H^+) ions separates the anodic and cathodic compartments of the electrolytic cell. A process flow diagram included as Figure 7 provides a schematic of the divided cell system. Use of the divided or undivided electrochemical cell depends on the constituent(s) of concern being removed or degraded in a particular waste stream, as well as the concentration of the constituent(s) in the waste. The divided cell is more effective at treating low concentration wastes.

Flow of liquid waste and the main divided cell system components include the following:

1. Waste is pumped by a metering pump from the batch feed container (described in Section 4.1.1 above), through piping into the membrane divided electrochemical treatment cell(s). Depending on the waste constituents, the batch feed container either becomes the anolyte reservoir or the catholyte reservoir. An appropriate electrolyte solution is placed into the opposing catholyte or anolyte container (whichever container is not used for holding waste feed). Both anolyte and catholyte containers are equipped with separate metering pumps and piping systems constructed of polyethylene or a similar inert plastic material.

2. The divided electrochemical cell is a commercially available bench-top unit that is 30 gallons in size. The unit is equipped with numerous aluminum electrode plates that are separated by plastic to prevent their direct contact with the waste and electrolytic solutions. Up to ten 30-gallon units may be operated either in parallel or series for a maximum total waste treatment capacity of 300 gallons per experimental setup. Units set up in parallel will be used to process larger waste batches. Units set up in series will be used to treat progressively lower concentrations of waste constituents. Once waste has been pumped into the cell through the inlet ports, the waste and electrolytic solutions passively overflow from the outlet ports back through polyethylene (or similar plastic) piping back into the appropriate anolyte or catholyte feed containers. The electrochemical

Figure 7
Divided Electrochemical Treatment System



cell will be placed in secondary containment sized to hold the entire contents of the cell and equipped with a liquids detector. If liquids are detected in the secondary containment, the waste feed pumps will automatically shut off.

3. Electrical power will be supplied to the unit through a rectifier or pulse rectifier. The unit is equipped with controls to select and change the electrical current and voltage applied to the electrodes in the electrochemical cell(s). Current and voltage can be set to vary with each of the up to 10 electrochemical cells that can be included in the divided cell system configuration. The rectifier is equipped with surge control, and automatically shuts off in the event of an electrical surge to the system.

4. Auxiliary equipment includes: pH meters in both the electrochemical cells and batch feed containers, thermometers or thermocouples in the electrochemical cells and batch feed containers, voltmeters, ammeters, a digital coulometer, and a multi-channel chart recorder to collect process data.

4.2 Ancillary Waste Storage Area

The ancillary RD&D hazardous waste storage area will only be operated for the duration of the RD&D permit, and will not be used to manage wastes other than those specifically associated with the electrochemical treatment process. The EPA RD&D Guidance Manual specifically allows for the storage of hazardous wastes associated with RD&D activities, without the need to permit the storage area. RD&D guidance allows for storage of up to 15,000 kilograms of hazardous waste intended for experimental purposes.

The ancillary hazardous waste storage area associated with the electrochemical treatment unit will include up to 600 gallons of waste either awaiting or having undergone electrochemical treatment. The storage area will be located in Building 37 Room 117, adjacent to the electrochemical treatment unit. All wastes will be stored in Department of Transportation (DOT) approved containers that are placed on pallets that provide secondary containment. Wastes placed on an individual pallet will all be compatible, and the total volume of waste in all containers on a single pallet will not exceed the total secondary containment capacity of the pallet.

Electrochemical treatment may require the addition of acids and bases in order to maintain treatment system pH at set levels. These reagents will be stored in properly labelled bottles that do not exceed 5 gallons in size. Acids and bases will be stored in separate chemical storage lockers within Room 117.

Room 117 has both concrete walls and floors and was constructed for RCRA permitted storage of hazardous and mixed wastes. All containers and equipment sit on metal grating, elevated above the concrete floor. The floor slopes to a central sump, which is equipped with a pump to remove any spilled liquids. The total RCRA permitted storage capacity of Room 117 is 3,630 gallons. The volume of all wastes managed in connection with the electrochemical treatment process, as well as the volume of all other wastes that may be stored in Room 117 will not exceed the total storage capacity of Room 117.

4.3 Pollution Control

The electrochemical treatment system may also be equipped with a gas scrubber system, depending on the type of waste being treated. A caustic scrubber will be used for waste streams containing acids and chlorides. A potassium iodide scrubber may also be used for chloride-containing waste streams. An acid scrubber will be used for those waste streams that may produce ammonia gases.

The divided electrochemical cell is a closed unit that is equipped with polyethylene gas vent piping. The piping will be plumbed to the scrubber system. The undivided electrochemical cell will be equipped with a portable polyethylene cover that will be plumbed to the scrubber system. The waste feed containers will be kept closed during operations to prevent waste loss. The waste feed containers will be kept closed at all times except when inserting pumps, agitators, and pH/temperature monitors. In the event that it is not possible to completely close the cover during waste treatment operations, a portable polyethylene cover plumbed to a scrubber system will be used.

The scrubbing system will include commercially purchased units that automatically maintain a set pH. In the event that the buffering scrubber solution becomes spent, the scrubber will be equipped with an alarm and will automatically shut off the electrical system supplying power to the unit. Wastewaters from all scrubber units will be containerized and analyzed for waste constituents in order to ensure appropriate waste treatment and disposal.

All electrochemical treatment operations will be conducted under a walk-in fume hood located in Room 117, in order to prevent uncontrolled air emissions from escaping the room and spreading to the rest of Building 37. The portion of Building 37 that includes Room 117 and 118 is designed with a separate exhaust and supply air system and stack. Supply air to this area is filtered using medium grade filters, and is provided for all ventilation and exhaust makeup requirements. A minimum of seven air changes per hour is provided for Room 118, and minimum of eight air changes per hour is provided for Room 117. Exhaust air from the fume hood and ventilation system is filtered both through two high efficiency particulate air (HEPA) filters set in series (to capture particulates including any radioactive particulates) and

through a carbon filter (to collect organic vapors) prior to release to the atmosphere outside Building 37.

4.4 Compliance with Air Emissions Standards

LANL will not be required to comply with the Air Emissions Standards for Process Vents (40 CFR Part 264 Subpart AA) under an RD&D permit. Subpart AA applies to owners and operators of treatment, storage, and disposal facilities that have process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, air stripping, or steam stripping operations that manage hazardous wastes with total organic concentrations of at least 10 parts per million by weight (ppmw). Electrochemical treatment does not incorporate use of any of these particular processes.

Compliance with 40 CFR Part 264 Subpart BB is required for certain equipment (e.g., pumps valves, pressure relief devices, sampling connecting systems, compressors, lines, flanges, and other connectors) that manage hazardous waste with organic concentrations of at least 10 percent by weight. All wastes that will be managed in the electrochemical treatment will have organic concentrations that are less than 10 percent by weight. As described in Section 3.2.1, testing will be performed for organic compounds on waste streams where waste profile data indicates or suggests the presence of organics. Testing for compliance with Subpart BB is covered under 40 CFR §§264.1063(d) through 264.1063(g)

Compliance with 40 CFR Part 264 Subpart CC is required of certain tanks, containers, and surface impoundments managed wastes with an average volatile organic (VO) concentration of at least 100 parts per million by weight (ppmw). EPA has currently deferred application of the Subpart CC regulations for radioactive mixed wastes (see Volume 59 *Federal Register* 62903, December 6, 1994). Therefore, Subpart CC does not apply to the majority of the wastes that are proposed to be treated under this RD&D permit application. A very small amount of the wastes that may be treated under an RD&D permit covering electrochemical processing includes wastes from MWIR Waste ID LA-W929 (Treatability Group 1) that may, upon surveying for radioactivity, turn out to be hazardous-only. Containers of these wastes, if they contain greater than 100 ppmw volatile organics, are equal to or greater in size than 0.1 cubic meters (approximately 26 gallons) will be managed in accordance with the requirements of §264.1086. This includes covering containers that are subject to Subpart CC requirements, while they are in storage so that there are no detectable emissions (this requirement is determined to be met through various processes for the types of containers to be managed in the RD&D ancillary waste storage area). This also includes performing waste treatment where containers may be required to be open in an enclosure equipped with a control device (e.g., the fume hood equipped with a carbon adsorption filter). The effective date for compliance with 40 CFR Part 264 Subpart CC has been postponed until October 6, 1996 (see 60 *Federal Register* 28528).

5.0 RESEARCH PLAN

Electrochemical treatment will involve use of pilot-scale units to demonstrate the technical feasibility and performance capability of an innovative use of a waste treatment technology for the treatment of mixed waste.

This section describes the parameters to be varied and monitored, general methods of sampling and analysis, and inspection procedures to be conducted under the RD&D permit.

5.1 Objective

The research objective of the work to be conducted under a RD&D permit is to experimentally define waste streams that are amenable for electrochemical treatment, to determine the conditions of electrolysis for these waste streams, to identify the influence that other constituents in the waste feed may have on the electrochemical treatment process, and to determine the feasibility of processing larger batch waste quantities than allowed under RCRA treatability studies. The successful completion of this project will be one step in the eventual development of a full-scale treatment system capable of significantly reducing the volume and hazards of several mixed waste streams generated within the DOE production complex.

The objective of the RD&D permit will be to obtain data from the use of the electrochemical treatment unit by treating several different types of mixed wastes under several different operating conditions. Liquid hazardous wastes will be chosen from those wastes in storage at LANL that are described in Section 3.1.

5.2 Operating Parameters and Monitoring Frequency

The hazardous waste streams to be tested under the RD&D permit are discussed in Section 3.1. Under the RD&D permit, optimization of the electrochemical treatment operating parameters will be refined and possible electrochemical treatment limitations for treating the selected wastes will be determined.

Experiments using surrogate chemicals and RCRA treatability studies on selected mixed waste treatment have already been conducted using the electrochemical process. Copies of published research papers describing initial findings using surrogate materials are provided in Attachment 3.

The research planned under the RD&D permit would be conducted using the following operating parameters.

Operating Parameter	Experimental Range
Choice of electrode material	Various materials
Geometry (shape, thickness, mesh size, etc.) of electrode	Various configurations
Cell construction (size and geometry of treatment cell)	Up to 300 gallons, various configurations
Applied electrical current	Up to 1000 amps
Applied electrical voltage	Up to 20 volts
Electrolytic cell pH	Varies
Waste feed container pH	Varies
Addition of polarizers	Various materials, may or may not be added
Liquid flow rate	Up to 100 liters/hour
Treatment time	Up to 24 hours per batch

5.3 Monitoring Plan

Monitoring equipment includes systems for process control and effluent analysis that enable the operator of the electrochemical treatment unit to take those measurements necessary to demonstrate that the unit is operating in a controlled and safe manner, is not presenting a hazard to human health and the environment, and is in compliance with permit conditions.

The electrochemical treatment unit configurations and equipment are described in Section 4 and shown in Figures 6 and 7. The monitoring system involves process monitoring and effluent analysis.

5.3.1 Process Monitors

The electrochemical treatment system is equipped with a multi-channel chart recorder. The following variables are measured and recorded by the chart recorder:

- Anode to cathode voltage;

- Overall cell voltage;
- Rectifier voltage;
- Electrical current supplied to the cell by the rectifier;
- Temperature in waste batch feed container;
- Temperature in the treatment cell;
- Electrolytic cell pH; and
- Waste feed container pH.

In addition, the two pH probes (one in the electrolytic cell, one in the waste feed container) are connected to a pH alarm. When cyanides are present in the waste stream being treated, the pH is maintained above 11.0. A pH value below 8.5 during cyanides treatment may lead to the evolution of toxic hydrogen cyanide gas. At least two staff members are present at all times that cyanide wastes are being treated. Once the pH falls below 11.0 and the alarm sounds, it takes approximately 2 hours for the pH to actually fall below 8.5 where hydrogen cyanide gas might be generated. There will be more than adequate time, therefore, for research personnel to evaluate the problem, add more caustic to raise the pH of the system, and/or shut down electrical power to the treatment system.

5.3.2 Effluent Analysis

As stated in Section 3, wastes and byproducts generated during electrochemical treatment include: metals deposited on cathodes, cyanides decomposed to carbon dioxide, nitrates reduced to nitrogen, sulfides complexed with other heavy metals in the waste stream and precipitated out of solution, and organics oxidized to carbon dioxide and water. The remaining radioactive liquid wastes are appropriately managed as either RCRA regulated mixed waste or non-RCRA regulated low level radioactive wastes. Scrubber wastes are analyzed for subsequent appropriate waste management as either non-hazardous non-radioactive waste, hazardous waste, radioactive waste, or mixed waste.

During electrochemical treatment, sampling of the waste stream undergoing treatment is conducted during intervals ranging from 15 minutes to 4 hours. Typically, analysis is conducted only for one or two indicator constituents to monitor the progress of treatment. This interval sampling may or may not be performed using EPA approved methods, since it is not intended to serve as definitive waste characterization.

The composition of the wastes may be analyzed with several diagnostic instruments including:

- Inductively Coupled Plasma - Atomic Emissions Spectroscopy (ICP) for analyzing metal constituents;

- Gas Chromatograph/Mass Spectrometer (GC/MS) for analyzing volatile and semi-volatile organic constituents;
- Ultraviolet (UV-VIS) for analyzing inorganic and organic constituents;
- Stripping Voltametry for analyzing metals; and
- Ion Sensitive Electrodes for analyzing inorganic cations and ions.

Note that not all equipment will necessarily be used for each electrochemical treatment experiment. Additionally, some of the equipment noted below will not be used for definitive waste characterization in compliance with 20 NMAC 4.1, Subpart V, §264.13. Rather, certain pieces of equipment may be used during the course of a particular treatment run to monitor specific constituents in order to assess the progress of electrochemical treatment process.

5.3.3 Equipment Shut Down

Any upset condition that affects the unit's ability to perform properly or that poses a threat to human health or the environment will be cause for emergency shut down of the unit. Equipment shut down simply involves shutting off electrical power to the unit. There will be no pressure or gas buildup or any threat of system rupture or failure as a result of emergency system shut down.

5.4 Inspection Procedures

Electrochemical treatment will take place in Building 37 Room 117, which already operates under a RCRA permit for the storage of hazardous wastes and RCRA interim status for the storage of mixed wastes. Electrochemical treatment operations will not interfere or prohibit any of these routine inspections from being performed.

Weekly inspections of Room 117 for proper container waste management; structural integrity of the walls, floors, sumps, and grates; presence of spills or leaks; proper operation of security and lighting systems is already performed on an established routine basis when waste is present in Room 117. Attachment 4 provides a copy of the Hazardous and Mixed Waste Facility Inspection Record Form that is used to document the inspection. The Building Manager, or a designated representative performs the weekly inspections and maintains copies of the inspection record.

Inspection of the Room 117 ventilation system, which is equipped with two sets of HEPA filters and a carbon filter, is performed by Industrial Hygiene and Safety Group (ESH-5)

personnel. The system is initially tested upon start up for proper air flow rate and functioning of filters. The filters are checked annually for functioning and replacement, as necessary. Documentation of the inspection is maintained by ESH-5, with a copy sent to the appropriate Facility Manager.

Routine inspections of the electrochemical treatment unit equipment components will be conducted by RD&D research personnel to identify equipment malfunction, deterioration, and operator errors that might lead to a release of hazardous waste to the environment and pose a threat to human health and the environment. Additionally, the ancillary hazardous waste storage area will be inspected to ensure that no releases to the environment have occurred or may potentially occur. Inspections of RD&D equipment components will be conducted every day that the electrochemical treatment system is operated, to identify problems promptly and allow for timely repair and cleanup. Research operators of the unit will be responsible for conducting inspections, and originals of the inspection records will be kept in an inspection logbook or will be documented in the research notebook maintained by the RD&D research group. Information recorded in the notebooks will include name and signature of the inspector, the date and time of the inspection, inspections observations noted, and corrective action needed and taken. Alternatively, the Hazardous and Mixed Waste Facility Inspection Record Form (Attachment 4) may be used to record inspections. Inspection records will be retained for a minimum of three years from the date of inspection. An inspection schedule is provided as Figure 8.

If an inspection indicates that corrective action measures are warranted, any and all actions taken, along with time, date, and other pertinent information, will be recorded on the inspection form or in the research notebook completed each day of operations and during all subsequent inspections until corrective measures are completed. If a condition is found in which a release to the environment is imminent or has already occurred, the condition will be assessed by the RD&D Principal Investigator or a designated representative. If this assessment indicates that human health or the environment may be adversely affected, the Contingency Plan, provided as Attachment 5, will be implemented. Aisle space is maintained around the electrochemical treatment unit to allow unobstructed movement of personnel and any fire protection equipment, spill control equipment, or decontamination equipment that may be needed to respond to an emergency at the treatment unit.

Figure 8

Unit-Specific Inspection Schedule
ELECTROCHEMICAL TREATMENT SYSTEM COMPONENTS

ITEM	TYPES OF PROBLEMS	FREQUENCY
Waste feed containers and electrolytic cell	Improper functioning; signs of leaks or deterioration.	Every operating day.
Waste feed pumps and tubing/piping	Leaks, clogs, deterioration.	Every operating day.
Monitoring equipment (pH and temperature monitors, voltmeters, ammeters, coulometers, chart recorder)	Malfunction, deterioration, lack of routine calibration.	Every operating day.
Rectifiers	Malfunction, deterioration.	Every operating day.
Scrubber	Malfunction, need to add additional buffering solutions, leaks, deterioration.	Every operating day.
Waste storage container	Leaks, spills, inadequate secondary containment, improper segregation of incompatibles, missing waste labels, improperly closed containers, deterioration of containers.	Every operating day.
Aisle space	Less than 2 feet of space maintained between waste container grouping or system components managing wastes	Every operating day.
General housekeeping	Tripping and electrical hazards, acid and basic reagent materials not properly stored in separate cabinets, other reagent solutions not properly stored, signs of hazardous materials spills.	Every operating day.
Spill and Fire Control Equipment	Not present in Room 117, not in good working order.	Every operating day.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The following section described procedures to ensure quality of the data collected to demonstrate the effectiveness of the electrochemical treatment process and to properly characterize waste streams used in treatment process.

6.1 Calibration Procedures

It is essential that equipment used during electrochemical treatment be periodically calibrated to ensure proper operation of the unit and to ensure protection of human health and the environment.

Voltmeters, ammeters, and coulometers will be factory calibrated and will not be adjusted for the duration of the RD&D experiments.

The pH monitors will be calibrated every day that electrochemical treatment is performed, and temperature monitors will be calibrated every third day that electrochemical treatment is performed.

As part of the initial and follow-up (following completion of treatment) waste stream characterization, diagnostic equipment including the ICP, GC/MS, UV-VIS, Stripping volameter, and ion sensitive electrodes will be calibrated using purchased standard solutions before and after each use and after every 5 to 10 samples as part of ongoing quality control checks.

6.2 Equipment Cleaning Procedures

Part of quality assurance/quality control procedures will be the decontamination of electrochemical treatment equipment between processing of waste batches. Because only aqueous solutions are managed in the unit, cleaning of the containers, cells, pumps, and tubing consists merely of rinsing with clean water. Visual inspection is sufficient to determine whether cleaning is adequate. Rinse waters will be containerized, characterized, and properly disposed of in an appropriate LANL waste management unit (see section 3.1.2 on wastes generated by RD&D treatment).

7.0 DATA AND RECORDKEEPING

Data on electrochemical treatment system operating parameters will be collected on a continuous basis by the chart recorder. Other data will be collected manually and recorded in the research notebooks for the project. Specifically, these operational data include:

- Waste characterization information;
- Input waste feed quantity;
- Choice of electrode material;
- Geometry (shape, thickness, etc.) of electrode;
- Cell construction (size and geometry of treatment cell);
- Applied electrical current;
- Electrical voltage from anode to cathode;
- Total applied electrical voltage to the treatment cell;
- Temperature in waste batch feed container;
- Temperature in the treatment cell;
- Treatment system pH;
- Addition of polarizers (amount and type);
- Waste feed circulation (pumping) flow rate;
- Treatment time.

LANL's project monitoring records for analytical data gathering and analysis of the effluent shall include:

- Date and time of sampling;
- Parameters being monitored;

- Sampling location; and
- Name of individual(s) who performed the sampling or measurements.

If waste analyses are performed by staff other than the electrochemical treatment personnel, the on-site analytical laboratory performing the EPA analytical methods will submit summary reports of analytical results to the research Project Director. At a minimum the summary reports shall contain (1) laboratory review/approval date and signature (2) date sample received; (3) sample preparation date; (4) sample analysis date; (5) preparation and analysis method reference; (6) sample identification number; (7) laboratory sample identification number; (8) sample reporting or detection limit; (9) laboratory quality control sample results including calculated percent recoveries, relative percent differences and self-imposed control limits, if applicable; and (10) dilution factors, if required for sample analysis.

Other records maintained by the RD&D research personnel will include the following:

- Name, address, and EPA ID number of the waste generator of the wastes treated;
- The quantity of each waste type accepted at Building 37, Room 117 for RD&D treatment experiments;
- The date each waste shipment was received;
- The date each RD&D treatment experiment was conducted;
- The date any rejected or unused wastes, and any treatment system generated residues were shipped elsewhere at LANL for subsequent storage, treatment, or disposal; and
- Quantities and type of each waste received, treated, shipped, and disposed, in support of preparation of LANL's Biennial Report.

During ongoing RD&D treatment operations, data and project records will be stored in Building 37 Room 117. Permanent storage of data (for durations required by regulations) will occur in Dr. Jacek Dzwienski's office at TA-48 Building 154 Room 101.

Reports summarizing the findings of the RD&D project will be prepared on a semi-annual basis. Copies of the reports will be submitted to the New Mexico Environment Department.

8.0 SAFETY PLAN

The electrochemical treatment unit will be located inside Room 117 of Building 37 at TA-50. Room 117 of Building 37, which is constructed of concrete, sheet metal and metal beams, is structurally sound and secure against unauthorized entry through the walls, roof, or vents. No unauthorized personnel or unescorted visitors are allowed entry into Room 117. Access may only be gained through the main entrance way via Room 118. The door to Rooms 118 and 117 is an automatic overhead-opening metal door, which is opened only with a key inserted into an adjacent key pad. The only personnel with a key are members of the Dual Access Radioactive Hydrological Testing (DARHT) team which operates in Room 118. The central liaison for the electrochemical treatment unit team is also the manager of the DARHT project. The main door is always locked when no personnel are in either room. The other access to Room 117 is via an outside door, which remains locked when no personnel are present. LANL's security force regularly patrols the areas outside of and surrounding Building 37. During off-hours, the doors to Building 37 are locked to prevent unauthorized entry. TA-50 is surrounded by a barbed-wire topped chain-link fence. During the off-hours the gate to TA-50 is closed and locked and LANL's security force regularly patrols the area. The entrance gate to Building 37 is posted with a sign reading "Authorized Personnel Access Only."

The safety plan implemented for the RD&D unit will complement those procedures as approved in LANL's current RCRA Contingency Plan contained in the facility's RCRA mixed waste interim status permit application. A modified Contingency Plan, which addresses general emergency procedures applicable to the RD&D unit, has been included with application as Attachment 5. Potential hazards related to the electrochemical treatment unit are identified below. A building-wide Safety Analysis Report (SAR) is currently in progress for Building 37 and will address all of the activities in the building including the electrochemical treatment work. The SAR is being prepared by LANL's ESH-12 group.

Administrative control measures for electrochemical treatment operations include personnel training and development of Standard Operating Procedures (SOP). A final SOP will be prepared and approved through standard LANL channels prior to operation of the electrochemical treatment system under a RD&D permit. The SOP is reviewed at least annually and updated as necessary. Engineering control measures for electrochemical treatment operations include alarms systems, electrical current breakers (surge protectors), automatic acid/caustic dispensers to maintain pH levels during cyanide waste treatment, a chemical fume hood under which all experiments will be performed, and pollution control equipment.

The electrochemical treatment unit will be configured to minimize hazards, and appropriate measures will be taken to conduct safe operations and to minimize potential emissions. Room

Room 117 in Building 37, where the RD&D unit will be located, is equipped with the following safety systems:

- Fire detection/alarm/annunciator system;
- Fire suppression (sprinkler) system;
- Ventilation system.

The electrochemical treatment unit will have the following safety features:

- Containers of hazardous waste will be indoors and stored in a secondary containment to minimize leakage hazards and eliminate precipitation run-on/run-off problems.
- Acidic and basic waste solutions and treatment reagents will be located at different locations within the room and be stored within separate secondary containment to minimize hazards associated with the mixing of acids and bases.
- All RD&D equipment will be located within the Room 117 walk-in fume hood to collect any and all possible off-gasses. The ventilation system will be connected to the carbon and HEPA filtering system of the building.
- The electrochemical treatment system will be equipped with various scrubbers that may be used, depending on the waste stream type being treated. A caustic scrubber will be in place for acidic and chlorine gases (a potassium iodide scrubber may also be used for chlorines) and acidic scrubber for ammonia gases.
- The systems will have a leakage detection control alarm which will turn off all waste feed pumps if a leak is detected.
- A secondary containment alarm will be intact to detect if liquids are sensed in the secondary containment surrounding the electrochemical treatment cell. If liquids are detected, the waste feed pumps will automatically be shut off.
- A liquid level sensor in the electrochemical treatment cell will be designed to turn off pumps if liquids levels drop below necessary operation levels.

- An automatic dispenser of caustic solution will operate to dispense caustic solution into the treatment system during the treatment of cyanide wastes if the pH alarm detects that the pH is too low.

- The unit is equipped with an emergency shut off control to shut down electrical power to the rectifier.

- All equipment that will come in contact with hazardous waste will be constructed of nonreacting polyethylene or similar inert plastic material (e.g., polyvinyl chloride).

A summary of potential hazards and mitigating measures is provided below.

- **FIRE HAZARDS**

  Hazard Description: Accidental combination of acids and bases used for pH adjustment could cause fire and or explosive hazard.

  Potential Effects: Personnel injury; equipment damage.

  Safety Measures: Acids and bases will be kept in separate area of the room and be stored in secondary containment systems to prevent the accidental mixing of spilled or leaked chemicals.

- **ELECTRICAL HAZARDS**

  Hazard Description: Power supplies, rectifiers, monitoring devices and pumps use 120 volt service. Voltage and current can be altered in the system as part of the experimental setup.

  Potential Effects: Personnel injury from electrical shock; equipment damage.

  Safety Measures: Electrical system contains an emergency shut-off switch and power surge protector. All electrical equipment will be properly grounded. Operating personnel will be properly trained to recognize hazards and respond to emergencies. All operations and work will be conducted by pairs of personnel.

- **CHEMICAL HAZARDS**

Hazard Description: Mixed hazardous liquid organic and inorganic wastes are treated in the unit.

Potential Effects: Personnel injury; equipment damage; fire.

Safety Measures: Hazardous waste containers in the RD&D storage area will be placed in a secondary containment that separates incompatible materials. Reagents and other chemicals necessary for treatment operations (e.g., acids, bases, polymerizers) will be kept in separate storage cabinets that provide secondary containment. Treatment systems are equipped with gas scrubbers and all operations are conducted within the fume hood of Room 117 that vents to a carbon and HEPA filtration system. Spill control kits will be kept in the room. Notebooks with all inspection records and daily equipment checks and calibrations will be kept in the room. MSDSs will be kept on file in the room. Proper dosimeter badges will be worn and monitored and radiation detection equipment will be kept in the room. Chemical residues generated during the RD&D treatment will be managed in approved containers and placed in a secondary containment unit until removed by LANL's Waste Management Group in accordance with procedures outlined in the existing RCRA permit for the facility. All personnel operating the electrochemical treatment system will be fully trained in the handling and uses of mixed hazardous wastes.

- **MECHANICAL HAZARDS**

Hazard Description: Routine mechanical assembly and lifting operations are carried out at the RD&D unit.

Potential Effects: Personnel injury; equipment damage.

Safety Measures: Only approved lifts and/or hoists will be used for the moving of heavy objects. Personnel will wear approved protective clothing and safety goggles. Tripping and slipping hazards will be mitigated by proper storage of equipment and housekeeping.

9.0 PERSONNEL QUALIFICATIONS AND TRAINING

Dr. Jacek Dzwienski will be the principal investigator for the project and will have overall technical and program authority. He will lead the equipment purchase and construction phases and will be responsible for the waste coordination and acceptance. Dr. Stanislaw Marczak will be in charge of day to day operations of the RD&D unit. He will be in charge of overall process control and chemical analysis. A copy of both Dr. Dzwienski's and Dr. Marczak's resumes are provided in Attachment 6. Other qualified and suitable trained personnel may also be authorized to help perform RD&D experiments.

Name	Responsibility
Jacek Dzwienski	Principal Investigator Equipment and Construction Oversight, Waste Coordination and Acceptance
Stanislaw Marczak	Chemical Analysis and Process Control, Calibration and Instrumentation
Kurt Anast	Project Liaison

LANL's personnel training program conforming to RCRA requirements is managed by the Environmental Safety and Health Training Group (ESH-13). Records of formal training for each person who will manage hazardous waste for the RD&D project are maintained in the ESH-13 training office. At a minimum, all personnel involved in electrochemical treatment unit operations will receive the following training. Summaries of the training courses are provided in Attachment 7.

- General Employee Training (GET);
- Waste Generation Overview;
- Hazard Communication;
- Radiological Worker I or II;
- RCRA Personnel Training and Annual Refreshers;
- First Aid: Standard;

- CPR Adult; and
- Waste Documentation Forms.

Division and group leaders and immediate supervisors will be responsible for ensuring that education and training in site-specific emergency response procedures in LANL's emergency response program are also provided. Periodic unannounced emergency drills and exercises will be used to familiarize employees with emergency procedures.

Additionally, authorized personnel will receive unit-specific training in Standard Operating Procedures (SOP). The SOP will be prepared when the RD&D permit application is approved and when equipment purchase is completed. No operations will take place under the RD&D permit until a SOP has been prepared and approved in accordance with standard LANL procedures. The SOP will be reviewed annually and updated when necessary. Review and revision of SOPs will be directed by LANL's CST Environment Safety and Health Group.

All new LANL employees will receive appropriate training within six months of hire date or time of transfer. Personnel, either new hire or transfer, will not work in unsupervised positions until they successfully complete the appropriate levels of training and on-the-job training for their position and responsibilities. All personnel for the RD&D project will work in teams of two.

Training records for all LANL personnel are maintained by ESH-13 at the following location:

ES&H Training Center
35 Rover Boulevard, Mail Stop J596
White Rock, NM 87544
Telephone: 505/665-5605
Registrar: 505/665-7953

10.0 CLOSURE PLAN

10.1 Introduction

Upon completion of the RD&D experiments, the electrochemical treatment unit will be clean closed in a manner protective of human health and the environment. Upon closure all hazardous wastes and hazardous waste residues will be removed from the unit and the area surrounding the unit. A description of the procedures to close the unit are provided below.

10.2 Closure Performance Standard

This closure plan is designed to ensure that the RD&D unit will be closed in a manner that will not require further maintenance and that controls, minimizes, or eliminates, the post-closure escape of hazardous waste and hazardous constituents to the environment. At the time of closure, all waste and decontamination residues will be removed and disposed of at an appropriate storage, treatment, or disposal facility. Decontaminated equipment may be salvaged for continued use of the electrochemical unit at the LANL facility. No post-closure care will be required, as no disposal of hazardous wastes or hazardous constituents will occur.

At closure all hazardous wastes and hazardous constituents of wastes managed in the electrochemical treatment unit will be removed. Verification sampling will be performed to demonstrate that decontamination has been effective. Decontamination will be determined to have been effective when all regulated waste constituents are not detected in rinsewater used to clean the equipment

10.3 Maximum Waste Inventory

The maximum inventory of hazardous wastes that may be stored at in the RD&D ancillary storage area at any one time will be 600 gallons. At closure, the entire inventory of hazardous and mixed waste associated with the unit will be removed. LANL's Chemical and Mixed Waste Group (CST-5) will coordinate the pick-up of wastes from Building 37; characterize the wastes (as necessary); ensure proper management of wastes in LANL's RCRA permitted or interim status units; and coordinate off-site shipment of RCRA wastes to appropriate permitted treatment, storage, and disposal facilities. Other non-RCRA regulated wastes and residues will either be appropriately managed as radioactive waste or non-radioactive waste, depending on the waste characteristics.

10.4 Procedures to Close the Unit

All mixed waste inventory present at the unit at the time of closure will be transported by qualified LANL personnel to one of LANL's RCRA permitted or interim storage units for subsequent storage, treatment, and/or disposal.

Dismantling and decontamination of the experimental unit and waste storage area will be accomplished by either trained CST-5 decontamination personnel, other qualified LANL personnel, or qualified subcontractors. All equipment associated with the electrochemical treatment unit that has come in direct contact with mixed waste will be disposed as mixed waste, decontaminated and reused, or decontaminated and disposed as solid or radioactive-only waste. The treatment unit equipment components and plumbing to be disposed of will be dismantled and placed in appropriate containers. Oversize pieces of equipment will be wrapped in plastic sheeting. The wastes will be characterized in accordance with the general LANL facility-wide Waste Analysis Plan. All wastes will be transported from Building 37 by the CST-5 personnel, other qualified LANL personnel, or qualified subcontractors. Wastes determined to be hazardous-only will be transported to one of LANL's RCRA permitted storage units in TA-50 or TA-54 for subsequent storage, treatment, and/or disposal. Wastes determined to be radioactive-only will either be sent to the LANL Radioactive Liquid Waste Treatment Facility at TA-50 or a suitable mixed waste management unit at TA-54. Wastes determined to be non-hazardous solid wastes will be transported to TA-51 for subsequent storage and disposal.

If feasible and practical, decontamination of equipment and parts may be performed. Decontamination will be performed in Room 117, which is equipped with a containment sump to control runoff. Equipment components and plumbing will be decontaminated by rinsing with water, rinsing with a dilute acid solution to dissolve any precipitated residuals, and final rinsing with water. Decontamination will be performed by the CST-5 personnel, other qualified LANL personnel, or qualified subcontractors wearing appropriate personal protective equipment. Sampling and regulatory support for decontamination activities will be provided by CST-5. Decontaminated equipment may be disposed as non-hazardous scrap in TA-51 or may be returned for reuse at the facility. All solutions produced during decontamination will be characterized and sent to an appropriate storage, treatment, or disposal facility.

Decontamination of equipment components will be demonstrated by analyzing samples of the final rinsate water. Samples will be analyzed for inorganic (metal, cyanide, and sulfide) constituents and organic constituents using EPA Methods 6010, 9010, 8240, and 8270. Successful decontamination will be defined as:

- No detectable hazardous constituents of wastes treated in the electrochemical treatment unit in the final rinsate.

If sampling indicates that decontamination has not been successful, then rinsing, steam-cleaning, detergent washing, or other equivalent methods will be repeated until sampling indicates that decontamination is complete.

An alternative demonstration of decontamination may be proposed and justified at the time of closure as circumstances indicate. If the proposed alternative is judged to be acceptable under standards and guidance in effect, then the alternative will be incorporated into the closure plan by permit modification.

10.5 Date and Schedule for Closure

LANL will notify the New Mexico Health and Environment Department in writing 45 days prior to the date of anticipated closure. Within 90 days of accepting the final volume of hazardous wastes for treatment in the RD&D unit or 90 days prior to the expiration of the RD&D permit, the entire inventory of remaining mixed or hazardous waste will be removed from the unit for proper storage and subsequent treatment/disposal at one of LANL's RCRA permitted or interim status mixed waste management units. Within 180 days of accepting the final volume of hazardous wastes for treatment, all closure activities will be completed. The proposed schedule for the unit is as follows:

Activity	Days
Final receipt of waste	0
Removal of waste inventory to RCRA permitted storage unit	0-90
Equipment demolition and removal (as necessary)	30-90
Equipment decontamination	60-90
Appropriate storage, treatment, and/or disposal of decontamination residues	60-120

Activity	Days
Sampling and analysis to verify decontamination	60-120
Closure Certification	180

Upon completion of closure, an independent registered professional engineer and the DOE shall prepare a letter certifying that the RD&D unit was closed in accordance with the approved closure plan.

11.0 DURATION OF PERMIT

LANL requests that the RD&D permit be issued for a one year period. It is anticipated that a one year time frame will be necessary to collect sufficient data to adequately test the technical feasibility and performance capabilities of the electrochemical treatment unit.

Additionally, due to logistics involved in coordinating start-up of the RD&D unit, LANL requests some flexibility in determining when the official start date of the permit will begin. LANL wishes to negotiate with the New Mexico Environmental Department a mechanism to determine a mutually agreeable permit start date. LANL may request a renewal of the permit at a later time, in accordance with limitations specified in 40 CFR 270.65(d), to test other equipment components or other waste streams.

12.0 CERTIFICATION

I certify under penalty of law that this document and all attachments* were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

* This refers to the Electrochemical Treatment Unit RD&D Application, Revision No. 0, Los Alamos National Laboratory, EPA ID No. NM0890010515

Alexander Gancarz
Division Director for Chemical Science and Technology Division
Los Alamos National Laboratory
Operator

8/21/96
Date Signed

for DJE

Dennis J. Erickson
Division Director for Environment, Safety, and Health Division
Los Alamos National Laboratory
Operator

8/20/96
Date Signed

G. Thomas Todd
Area Manager, Los Alamos Area Office
U.S. Department of Energy
Albuquerque Operations
Owner/Operator

9.4.96
Date Signed

ATTACHMENT 1

LANL WASTE PROFILE FORM

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

Los Alamos
National Laboratory

WASTE PROFILE FORM

Account Information

For rapid processing, complete **all sections** in black or blue ink and mail this form to Waste Services Group at MS J579

Reference Number

Waste Generator's Name (Print)	Znumber	Waste Management Coordinator's Name (Print)	Znumber

Generator's Group	Generator's Telephone	Generator's Mail Stop	Waste Stream Technical Area	Building	Room

Waste Accumulation
Check as many as apply.

- ☐ Satellite accumulation area --> site no.: _____
- ☐ Less than 90 day accumulation area --> site no.: _____
- ☐ Radioactive Materials Management Area (RMMA) --> site no.: _____
- ☐ None of the above

Method of Characterization
Check as many as apply.

- ☐ Acceptable Knowledge (AK)
- ☐ Analysis attached --> sample/request no. _____
- ☐ MSDS attached
- ☐ Request for analysis

Section 1- Chemical and Physical Characteristics

For help in completing this section of the form, call 5-WAST or 5-4000.

Waste Type
Check only one.

- ☐ Unused/unspent chemical
  Check *Waste Classes* and *Associated Documentation* Only
- ☐ Process waste/spent chemical
  Complete all of Section 1.

Waste Classes
Check as many as apply.

- ☐ On-going generation
- ☐ One-time generation
- ☐ Radioactive (complete Sec. 2)
- ☐ Non-radioactive
- ☐ Wastewater (complete Sec. 3)
- ☐ Classified/Sensitive

Associated Documentation
Check as many as apply.

- ☐ Process SOP --> no.: _____
- ☐ RMMA OP --> no.: _____
- ☐ WM SOP --> no.: _____
- ☐ Other --> _____
- ☐ None --> describe below

Waste Category
Check as many as apply.

- ☐ Solvent
- ☐ Degreaser
- ☐ Dioxin
- ☐ Electroplating
- ☐ Treated hazardous waste residue
- ☐ Explosive process waste
- ☐ Infectious/biological waste
- ☐ Beryllium
- ☐ Asbestos-friable
- ☐ Asbestos-nonfriable
- ☐ Empty containers
- ☐ PCB (<50 ppm)
  - ☐ PCB (50 - 500 ppm)
  - ☐ PCB (> 500 ppm)
  - → id. no. : _____
- ☐ Not applicable --> describe below

Waste Sources
Check as many as apply.

- ☐ Research and development
- ☐ Maintenance
- ☐ Construction
- ☐ Material processing
- ☐ Decon/decom
- ☐ Investigation derived
- ☐ Remediation
- ☐ UST - petroleum
- ☐ UST - non-petroleum
- ☐ Generator treatment
- ☐ Interim/permitted treatment
- ☐ Industrial sludge
- ☐ Sanitary sludge
- ☐ Abatement

Waste Matrix
Check only one.

Gas

- ☐ ≤ 1.5 Atmospheres
- ☐ > 1.5 Atmospheres

Liquid

- ☐ Aqueous
- ☐ Organic
- ☐ Inorganic

Solid

- ☐ Powder/ash
- ☐ Solid
- ☐ Absorbed liquid

Matrix Type
Check only one.

- ☐ Homogeneous
- ☐ Heterogeneous

Waste/Process Description

_____

_____

_____

_____

_____

_____

_____

Section 1- Chemical and Physical Characteristics (continued)

Ignitability (degrees F.)
Check only one.

- ☐ < 73
- ☐ 73-99
- ☐ 100-139
- ☐ 140-200
- ☐ > 200
- ☐ Ignitable solid
- ☐ DOT oxidizer
- ☐ Not ignitable

Corrosivity (pH)
Check only one.

- ☐ ≤ 2.0
- ☐ 2.1-4.0
- ☐ 4.1-6.0
- ☐ 6.1-9.0
- ☐ 9.1-12.4
- ☐ ≥ 12.5
- ☐ Liquid corrosive to steel
- ☐ Not aqueous

Reactivity
Check as many as apply.

- ☐ Unstable
- ☐ Water reactive
- ☐ Pyrophoric
- ☐ Cyanide bearing
- ☐ Sulfide bearing
- ☐ Shock sensitive
- ☐ Explosive - class _____
- ☐ Non-reactive

Boiling Point (degrees F.)
Check only one.

- ☐ ≤ 95
- ☐ > 95
- ☐ Not applicable

Identify presence of contaminants.			Minimum	Maximum	Unit (ppm or % only)	Analytical method
Toxicity Characteristic Metals						
Arsenic	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Barium	☐ None	☐ < 100.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Cadmium	☐ None	☐ < 1.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Chromium	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Lead	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Mercury	☐ None	☐ < 0.2 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Selenium	☐ None	☐ < 1.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Silver	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Toxicity Characteristic Organic Compounds						
Benzene	☐ None	☐ < 0.5 ppm <	_____	to _____	_____	☐ TCLP ☐ Total
Carbon tetrachloride	☐ None	☐ 0.5 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Chlorobenzene	☐ None	☐ < 100.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Chloroform	☐ None	☐ < 6.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Cresol	☐ None	☐ < 200.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
1,4-dichlorobenzene	☐ None	☐ < 7.5 ppm	_____	to _____	_____	☐ TCLP ☐ Total
1,2-Dichloroethane	☐ None	☐ < 0.5 ppm	_____	to _____	_____	☐ TCLP ☐ Total
1,1-Dichloroethylene	☐ None	☐ < 0.7 ppm	_____	to _____	_____	☐ TCLP ☐ Total
2,4-Dinitrotoluene	☐ None	☐ < 0.13 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Hexachlorobenzene	☐ None	☐ < 0.13 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Hexachlorobutadiene	☐ None	☐ < 0.5 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Hexachloroethane	☐ None	☐ < 3.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Methyl ethyl ketone	☐ None	☐ < 200.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Nitrobenzene	☐ None	☐ < 2.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Pentachlorophenol	☐ None	☐ < 100.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Pyridine	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Perchloroethylene or tetrachloroethylene	☐ None	☐ < 0.7 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Trichloroethylene	☐ None	☐ < 0.5 ppm	_____	to _____	_____	☐ TCLP ☐ Total
2,4,5-Trichlorophenol	☐ None	☐ < 400.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
2,4,6-Trichlorophenol	☐ None	☐ < 2.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Vinyl chloride	☐ None	☐ < 0.2 ppm	_____	to _____	_____	☐ TCLP ☐ Total

Additional Chemical Constituents and Contaminants (for hazardous constituents, see AR 10-3, Appendix A)
List all other constituents (including inerts) not identified above and attach any applicable analyses.

Name of constituent	Cas no.(optional)	Minimum	Maximum	(ppm or % only)
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	
_____	_____	_____	to _____	

Section 2- Radiological Characteristics

For help in completing this section of the form, call 5-WAST or 5-4000.

	Range minimum		Range maximum	Unit (Ci/g or Ci/l)
General				
☐ Alpha	_____	to	_____	_____
☐ Beta	_____	to	_____	_____
☐ Gamma	_____	to	_____	_____
TRU radionuclides				
☐ None present				
☐ Am-241	_____	to	_____	_____
☐ Am-243	_____	to	_____	_____
☐ Cf-249	_____	to	_____	_____
☐ Cf-251	_____	to	_____	_____
☐ Cm-243	_____	to	_____	_____
☐ Cm-245	_____	to	_____	_____
☐ Cm-247	_____	to	_____	_____
☐ Pu-238	_____	to	_____	_____
☐ Pu-239	_____	to	_____	_____
☐ Pu-240	_____	to	_____	_____
☐ Pu-242	_____	to	_____	_____
Fission products				
☐ None present				
☐ Ba-140	_____	to	_____	_____
☐ Ce-144	_____	to	_____	_____
☐ Cs-134	_____	to	_____	_____
☐ Cs-137	_____	to	_____	_____
☐ I-129	_____	to	_____	_____
☐ I-133	_____	to	_____	_____
☐ Kr-85	_____	to	_____	_____
☐ Nb-95	_____	to	_____	_____
☐ Ru-106	_____	to	_____	_____
☐ Sb-125	_____	to	_____	_____
☐ Sr-90	_____	to	_____	_____
☐ Tc-99	_____	to	_____	_____
☐ Zr-93	_____	to	_____	_____
☐ Zr-95	_____	to	_____	_____
Activation products				
☐ None present				
☐ As -74	_____	to	_____	_____
☐ Be-7	_____	to	_____	_____
☐ C-14	_____	to	_____	_____
☐ Co-56	_____	to	_____	_____
☐ Co-57	_____	to	_____	_____
☐ Co-58	_____	to	_____	_____
☐ Co-60	_____	to	_____	_____
☐ Cr-51	_____	to	_____	_____
☐ Eu-152	_____	to	_____	_____
☐ Mn-52	_____	to	_____	_____
☐ Mn-54	_____	to	_____	_____
☐ Nb-94	_____	to	_____	_____
☐ Ni-59	_____	to	_____	_____
☐ Ni-63	_____	to	_____	_____
☐ Rb-83	_____	to	_____	_____
☐ Rb-84	_____	to	_____	_____
☐ Se-75	_____	to	_____	_____
☐ Sr-82	_____	to	_____	_____
☐ Sr-85	_____	to	_____	_____
☐ V-48	_____	to	_____	_____
☐ Y-88	_____	to	_____	_____
☐ Zn-65	_____	to	_____	_____
☐ Zr-88	_____	to	_____	_____

	Range minimum		Range maximum	Unit (Ci/g or Ci/l)
Other				
☐ None present				
☐ Am-242	_____	to	_____	_____
☐ Bi-207	_____	to	_____	_____
☐ Bi-210	_____	to	_____	_____
☐ Cf-250	_____	to	_____	_____
☐ Cf-252	_____	to	_____	_____
☐ Cm-244	_____	to	_____	_____
☐ H-3	_____	to	_____	_____
☐ Pa-231	_____	to	_____	_____
☐ Pb-210	_____	to	_____	_____
☐ Po-210	_____	to	_____	_____
☐ Pu-236	_____	to	_____	_____
☐ Pu-241	_____	to	_____	_____
☐ Ra-226	_____	to	_____	_____
☐ Ra-228	_____	to	_____	_____
☐ Th-230	_____	to	_____	_____
☐ Th-232	_____	to	_____	_____
☐ U-232	_____	to	_____	_____
☐ U-233	_____	to	_____	_____
☐ U-234	_____	to	_____	_____
☐ U-235	_____	to	_____	_____
☐ U-236	_____	to	_____	_____
☐ U-238	_____	to	_____	_____
Add'l radionuclides				
☐ No additional radionuclides present				
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____
_____	_____	to	_____	_____

Contamination Type: *Check as many as apply.*

☐ Volume Contamination

☐ Surface Contamination

Section 3 - Wastewater Characteristics

For help in completing this section of the form, call 7-4301.

Identify presence of contaminants			Minimum	Maximum	Unit (ppm or % only)	Analytical method
Aluminum	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Boron	☐ None	☐ < 5.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Cobalt	☐ None	☐ < 1.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Copper	☐ None	☐ < 1.0 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Vanadium	☐ None	☐ < 0.10 ppm	_____	to _____	_____	☐ TCLP ☐ Total
Zinc	☐ None	☐ < 95.4 ppm	_____	to _____	_____	☐ TCLP ☐ Total

Maximum daily flow when discharge occurs: _____ ☐ Gallons ☐ Liters

Average daily flow when discharge occurs: _____ ☐ Gallons ☐ Liters

Estimated number of days per year that discharge will occur: _____

Estimated total volume per year discharged to the Radioactive Liquid Waste Collection System at TA-50-1: _____ ☐ Gallons ☐ Liters

For TA-55 use only. Wastewater will be discharged through one of the following:

☐ Acid line ☐ Caustic line ☐ Industrial waste line

Section 4 - Additional Information

If additional information is available on the chemical, physical, or radiological character of the waste not covered on this form, provide it below:

WASTE GENERATOR CERTIFICATION: *Based on my knowledge of the waste and/or chemical/physical analysis, I certify that the information on this form is correct. I understand that this information will be made available to regulatory agencies and that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.*

Signature	Date

ATTACHMENT 2

MIXED WASTES IN TREATABILITY GROUPS 15, 16, AND 17

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	87018900	1040171	DILUTE H2SO4 (17%), PB,CR #1145	ORACLE	L	D002 D007 D008	UNKNOWN	UNKNOWN	UNKNOWN	d
15	87061500	1039389	WASTE CHROMIC ACID SOLUTION DRUM #1419	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	87136700	1026905	USED CHROMIC ACID DRUM #1864	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	87136800	1029118	USED CHROMIC ACID DRUM #1865	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	88056800	1039352	AQUEOUS SOLN./PHOS.ACI/CHR.OXI/CU #2468	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	88056900	1032580	WASTE CORROSIVE LIQUID, N.O.S. (PHOSPHOR	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	88057000	1035799	AQUEOUS SOL. OF H3PO4,CHROM OXIDE,CU	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	88077700	1026569	SPENT CHROMIC ACID DRUM #2565	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	88191000	1030301	MIXTURE HN03 CHROMIC ACID DRUM #3486	SFE KOP	LIQUID	D002 D007	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	89183000	1040654	SILVER SOLUTION	SFE KOP	LIQUID	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	89367700	1040510	WASTE CHROMIC ACID	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	89461800	1026786	SPENT CHROMIC ACID (12)	SFE KOP	LIQUID	D002 D007	U238	SUSPECT	N/A	a, d
15	89534000	1038330	IGNITABLES WITH TRICHLOROACETIC ACID	SFE KOP	LIQUID	D001 D002	UNKNOWN	UNKNOWN	UNKNOWN	d
15	898344	1015010	SULFURIC ACID FROM BATTERIES(PB)	SFE KOP	LIQUID	D002 D003 D008	PU239	SUSPECT	N/A	a, d
15	898344	1024572	SULFURIC ACID FROM BATTERIES(PB)	SFE KOP	LIQUID	D002 D003 D008	PU239	SUSPECT	N/A	a, d
15	898344	1024587	SULFURIC ACID FROM BATTERIES(PB)	SFE KOP	LIQUID	D002 D003 D008	PU239	SUSPECT	N/A	a, d
15	898344	1024598	SULFURIC ACID FROM BATTERIES(PB)	SFE KOP	LIQUID	D002 D003 D008	PU239	SUSPECT	N/A	a, d
15	898344	1034309	SULFURIC ACID FROM BATTERIES(PB)	SFE KOP	LIQUID	D002 D003 D008	PU239	SUSPECT	N/A	a, d
15	899349	1017798	CHROMIC ACID IN CONCENTRATED H2SO4	SFE KOP	LIQUID	D002 D007	PU239 PU242 U235 U238 NP237 AM241	1E-7 SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	G N/A N/A N/A N/A N/A	d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER	ITEM	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	899827	1003414	1/2GM SILVER COMPOUND	ORACLE	Unknown	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	899847	1008482	ICP SOLUTION CONTAINING MIXED METALS	SFE KOP	LIQUID	D006	U235 U238	SUSPECT SUSPECT	N/A N/A	a, d
15	900717	1007936	ELECTROLYTE ACID(SULFURIC) (6)	SFE KOP	LIQUID	D002 D008	PU239 AM241	SUSPECT SUSPECT	N/A N/A	a, d
15	900852	1012654	VARIOUS SAMPLES W/RAD	SFE KOP	SOLID	D003 D004	U238 TH232	8.35E-5 1.85E-5	C C	d
15	900853	1002324	VAR SAMPS W/RAD TH, U	SFE KOP	SOLID	D003 D004	TH232 U238	SUSPECT SUSPECT	N/A N/A	a, d
15	901662	1010585	POTASSIUM HYDROXIDE - UNUSED	SFE KOP	LIQUID	D002 D003	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	902421	1018723	POISON LABPACK	ORACLE	Unknown	D004	UNKNOWN	UNKNOWN	UNKNOWN	d
15	903183	1011618	GLACIAL ACETIC ACID (GLASS CONTAINER)	SFE KOP	LIQUID	D001 D002	U238	SUSPECT	N/A	a, d
15	903204	1033516	ENHANCE EXPOSED TO 35S AND/OR 14C	SFE KOP	LIQUID	D001 D002	S35 C14	SUSPECT SUSPECT	N/A N/A	a, d
15	903452	1000172	M PREP NEUTRALIZER 5/H2O BASED ALKALINE	SFE KOP	LIQUID	D001 D002	PU239	SUSPECT	N/A	a, d
15	903452	1000173	M PREP NEUTRALIZER 5/H2O BASED ALKALINE	SFE KOP	LIQUID	D001 D002	PU239	SUSPECT	N/A	a, d
15	904290	1011102	CARBOY GLASS, CHROMIC ACID SOLUTION	SFE KOP	LIQUID	D002 D003 D007	U235 PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
15	904552	1006613	WASTEWATER SAMPLE W/COD ANALYSIS W/SULFURIC ACID & POTASSIUM DICHROMATE	SFE KOP	LIQUID/SUSPENDED SOLIDS	D002 D007 D009 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	905387	1007124	CHROMIC ACID SOLUTION	SFE KOP	LIQUID	D002 D007	PU239	.5E-5	G	d
15	905387	1007402	CHROMIC ACID SOLUTION	SFE KOP	LIQUID	D002 D007	PU239	.5E-5	G	d
15	905633	1011294	CR 10 MG/ML 1 M HCL (UNUSED)	SFE KOP	LIIQUID	D002 D007	PU239	SUSPECT	N/A	a, d
15	905633	1011295	AS .1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D004	PU239	SUSPECT	N/A	a, d
15	905633	1011296	SE .1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D010	PU239	SUSPECT	N/A	a, d
15	905633	1011297	BA .001 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D005	PU239	SUSPECT	N/A	a, d
15	905633	1011298	PB 10 MG/ML 2 M HNO3	SFE KOP	LIQUID	D002 D008	PU239	SUSPECT	N/A	a, d
15	905633	1011299	AG 0.1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D011	PU239	SUSPECT	N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	905633	1011300	CR .005 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D007	PU239	SUSPECT	N/A	a, d
15	905633	1011302	BA 0.1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D005	PU239	SUSPECT	N/A	a, d
15	905633	1011304	CR 0.01 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D007	PU239	SUSPECT	N/A	a, d
15	905633	1023924	BA 0.025 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D005	PU239	SUSPECT	N/A	a, d
15	905633	1025944	CD 0.1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D006	PU239	SUSPECT	N/A	a, d
15	905633	1033582	CR.025 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002 D007	PU239	SUSPECT	N/A	a, d
15	907038	1012515	CHROMIC ACID	SFE KOP	LIQUID	D002 D007	AM241 PU238 PU239	5E-7 5E-7 5E-7	C C C	d
15	907512	1003032	SULFURIC ACID W/U-238 AND TC-99	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907512	1004579	SULFURIC ACID W/U-238 AND TC-99	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907513	1019681	SULFURIC ACID W/U-238 AND TC-99	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907514	1013174	SULFURIC ACID W/U-238 AND TC-99	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907585	1001204	USED CHROMIC ACID W SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907585	1010186	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907585	1010187	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907585	1010188	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907585	1015320	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	907585	1015517	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907586	1010185	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907586	1033591	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907586	1033596	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907586	1033598	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907586	1033604	USED CHROMIC ACID WITH SULFURIC ACID	SFE KOP	LIQUID	D002 D007	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	907894	1025302	MIXED WASTE FROM C.O.D.ANALYSIS/LOWLEVEL	SFE KOP	LIQUID	D002 D007	PU238 PU239 AM241	8E-8 8E-8 8E 8	C C C	d
15	907894	1033507	MIXED WASTE FROM C.O.D.ANALYSIS/LOWLEVEL	SFE KOP	LIQUID	D002 D007	PU238 PU239 AM241	8E-8 8E-8 8E-8	C C C	d
15	909150	1015497	MERCURY/HNO3 WASTE LIQUID USED AS AN ACID BATH	SFE KOP	LIQUID	D002 D009	MFP	SUSPECT	N/A	a, d
15	909491	1014309	NAOH - UNUSED CHEMICAL	SFE KOP	SOLID	D003	H3	1E-7	C	d
15	909491	1016113	NAOH - UNUSED CHEMICAL	SFE KOP	SOLID	D003	H3	1E-7	C	d
15	909491	1016118	NAOH - UNUSED CHEMICAL	SFE KOP	SOLID	D003	H3	1E-7	C	d
15	909491	1016119	NAOH - UNUSED CHEMICAL	SFE KOP	SOLID	D003	H3	1E-7	C	d
15	909537	1023923	SODIUM DICHROMATE IN NITRIC ACID, UNUSED, DISPOSED DURING CLEANOUT	SFE KOP	LIQUID	D002 D007	H3	1E-7	C	d
15	909939	1023622	Jarrell Ash ICP Waste Solution IN 2% HNO3 11 PPM PB	SFE KOP	LIQUID	D002 D008	U235 U238	SUSPECT SUSPECT	N/A N/A	a, d
15	91002073	1025568	SPECTROGRAPH SAMPLES W/17 G/L,LNL-1368	SFE KOP	LIQUID W/SUSPENDED SOLIDS	D007	UNKNOWN	SUSPECT	N/A	a, d
15	91002628	1036036	SPENT COD DIGESTION SOLUTION W/ AG &HG, CR, H2SO4	SFE KOP	LIQUID	D001 D002 D003 D007 D009 D011	PU238 PU239 AM241 BETA	2.5E-9 2.5E-9 2.5E-9	C C C	d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	91002932	1037806	SULFURIC ACID/ 2,4-PENTADION CONT W/ZN65	SFE KOP	LIQUID	D001 D002	ZN65	4.6E-7	C	d
15	91004269	1014074	WATER W/CR F/PU & AM ANALYSIS - WASTEWATER ANALYSIS BYPRODUCT	SFE KOP	LIQUID	D007	PU238 AM241	SUSPECT SUSPECT	N/A N/A	a, d
15	91004819	X 9400010	MIXTURE OF 10% NITRIC ACID, 40% HYDROCHLORIC ACID AND 30% SULFURIC ACID, TRACE BARIUM, CADMIUM AND CHROME	ORACLE	LIQUID	D002 D005 D006 D007	UNKNOWN	UNKNOWN	UNKNOWN	d
15	91005431	1035953	CN WASTE (2) (WASTE FROM CYANIDE ANALYSIS)	SFE KOP	LIQUID	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	91005431	1036014	CN WASTE (WASTE FROM CYANIDE ANALYSIS)	SFE KOP	LIQUID	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	91005431	1036015	CN WASTE (WASTE FROM CYANIDE ANALYSIS)	SFE KOP	LIQUIID	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	91005623	1035604	WASTEWATER BYPRODUCT WITH CHROMIUM	SFE KOP	LIQUID - SINGLE LAYER	D007	AM241 PU238 PU239	8E-10 2E-10 1E-9	C C C	d
15	91007637	1033473	WATER W/HG	ORACLE	Unknown	D009	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C91020924	1092	ULTREY,SULFURIC ACID - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D003	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91020924	1103	HYDROCHLORIC ACID (2) - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D003	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91020924	1106	SULFURIC ACID - UNUSLD CHEMICAL	SFE KOP	LIQUID	D002 D003	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3027	BOTTLE-5% NITRIC ACID W/ TRACE BARIUM - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D005	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	X 3028	BOTTLE-2% NITRIC ACID W/ TRACE CHROMIUM - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D007	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3029	BOTTLE-2% NITRIC ACID W/ NA, K, BA - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D005	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C91022164	3035	BOTTLE-2% HYDROCHLORIC ACID W/ SB, TI, AG - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3037	BOTTLE-5% NITRIC ACID W/ BA, PB, CR, CD - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D005 D006 D007 D008	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3041	2% NITRIC ACID W/TRACE SELENIUM UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D010	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3042	2% NITRIC ACID W/ AG - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D004	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3044	2% NITRIC ACID W/ AG, AS, BA, BE, CD, CR, PB, SC, TI - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D004 D005 D006 D007 D008 D010 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022164	3047	2% NITRIC W/TRACE CHROMIUM - UNUSED CHEMICAL	SFE KOP	LIQUID	D002 D007	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C91022352	3353	DILUTED ACID DICHROMATE W/ 55% H2S04, 5% SODIUM DICHROMATE, 40% H20 (2) - USED TO CLEAN GLASSWARE	SFE KOP	LIQUID	D002 D007	P32 S35 CD109 BA133 C14	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C91022782	4016	ELECTROLYTE W/U238 (GLASS BOTTLE)	SFE KOP	LIQUID	D007	U238	8E-6	C	d
15	C91022990	4275	FIXER W/AG	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C91022990	4276	FIXER W/AG	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C91022990	4277	FIXER W/AG	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C91022990	4278	FIXER W/AG	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C91023024	4321	COD WASTE W/AG,HG,CR,H2S04 (2)	SFE KOP	LIQUID	D001 D002 D003 D007 D009 D011	PU238 PU239 AM241 BETA	SUSPECT SUSPECT SUSPECT 1E-8	N/A N/A N/A C	d
15	C91023408	4800	90% HNO3 W/HG SALTS	SFE KOP	LIQUID	D002 D003 D009	U238	SUSPECT	N/A	a, d
15	C91024924	6869	H2S04,SODIUM DICHROMATE SOL. - UNUSED	SFE KOP	LIQUID	D002 D007	U235 PU239	SUSPECT SUSPECT	N/A N/A	a, d
15	C91025483	7794	USED FIXER	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C92027290	10237	COD MIXED WASTE (AG,HG,CR,H2S04), FROM DIGESTION PROCESS	SFE KOP	LIQUID	D001 D002 D007 D009 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING . .\ THE SITE TREATMENT PLAN

TREAT. GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C92027390	10407	CYANIDE ANALYSIS SOLUTION (4) - WASTE FROM CYANIDE ANALYSIS	SFE KOP	LIQUID	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C92027472	10527	CHROMIC ACID CLEANING SOLUTION	SFE KOP	LIQUID	D002 D007	TC99 TH232 U238	1.34E-7 1.34E-7 1.34E-7	C C C	d
15	C92027525	10632	POTASSIUM DICHROMATE (3) W/ SULFURIC ACID	SFE KOP	LIQUID	D002 D003 D007	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C92027680	11374	SPEX STANDARDS (AS,BA,CD,SE,AG) W/HNO3 USED FOR CALIBRATION	SFE KOP	LIQUID	D002 D004 D005 D006 D007 D008 D009 D010 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C92029281	14237	DILUTE MIXED ACIDIC AQUEOUS SOLUTION W/ SUSPENDED SOLIDS	SFE KOP	LIQUID	D002 D005	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
15	C92029281	14239	MIXED MINERAL ACIDS W/ CI	SFE KOP	LIQUID	D002 D007	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
15	C92029281	14241	DILUTE MIXED MINERAL ACIDS W/ METAL CONTAMINANTS	SFE KOP	LIQUID	D002 D006 D007 D008 D009	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d

TREATABILTY GROUPING . . (THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C92029281	14242	AQUEOUS SOLUTION OF BACL2	SFE KOP	LIQUID	D002 D005	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
15	C92029281	14243	DILUTE MIXED MINERAL ACIDS	SFE KOP	LIQUID	D002 D005	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
15	C92029282	14244	MIXED AQUEOUS ACIDS W/ RESIDUAL ORGANICS	SFE KOP	LIQUID	D001 D002	ZR95 RU103 MO99 CE144 CE141 EU155 AM241	2E-9 2E-9 2E-9 1E-9 1E-9 1E-9 2E-9	C C C C C C C	d
15	C92029286	14258	AQUEOUS SOL W/BA,CD,AG (INC-16)	SFE KOP	LIQUID	D005 D006 D011	ZR95 MO99 RU103	1.82E-6 1.82E-6 1.82E-6	C C C	d
15	C92029313	13911	COD LOW LEVEL MIXED WASTE, FROM DIGESTION PROCESS	SFE KOP	LIQUID	D001 D002 D007 D009 D011	PU239 AM241 PU238	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C92031836	15839	TOTAL NITROGEN WASTE (W/SODIUM HYDROXIDE,HG) (6)	SFE KOP	LIQUID	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C92031840	18970	SODIUM CHLORIDE SOLUTION W/SILVER NITRATE (EM 5)	SFE KOP	LIQUID	D011	PU238 PU239 PU240	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93033451	21300	TOXIC METALS W/HNO3 SOLUTION	ORACLE	L	D002 D004 D005 D006 D007 D008 D009 D010 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93033451	21301	TOXIC METALS W/HNO3 SOLUTION	ORACLE	L	D002 D004 D005 D006 D007 D008 D009 D010 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C93033566	21319	AG,HG,CR & H2SO4	ORACLE	L	D002 D007 D009 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93033838	21951	SODIUM HYDROXIDE SOLUTION W/MERCURY	ORACLE	L	D002 D009	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93033840	21925	ARSENIC SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21952	BARIUM SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21953	BERYLLIUM SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21954	CADMIUM SPECTROMETRIC SOLUTION	ORACLE	L	D002 D006	PU239	SUSPECT	N/A	a, d
15	C93033840	21955	CHROMIUM SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21956	LEAD SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21957	MERCURY SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21959	SILVER SPECTROMETRIC SOLUTION	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93033840	21960	SELENIUM SPECTROMETRIC SOLUTION (2)	ORACLE	L	D002 D004 D005 D007 D008 D009 D010 D011	PU239	SUSPECT	N/A	a, d
15	C93034151	1021789	PLATING SOLUTION W/ ACID, U238	ORACLE	Unknown	D002 D011	UNKNOWN	UNKNOWN	UNKNOWN	d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C93034152	1031913	PLATING SOLUTION W/ ACID, U238	ORACLE	Unknown	D002 D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C93034153	1026009	PLATING SOLUTION W/ ACID, U238	ORACLE	Unknown	D002 D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C93034154	1032778	PLATING SOLUTION W/ ACID, U238	ORACLE	Unknown	D002 D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C93034947	1025804	X-RAY FILM FIXER	ORACLE	L	D011	UNKNOWN	UNKNOWN	UNKNOWN	d
15	C93035068	24207	MERCURY IN HCL	ORACLE	L	D002 D009	AM241 CS137 CO60 U238 U235	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035068	24208	MERCURY IN HNO3 (3)	ORACLE	L	D002 D009	AM241 CS137 CO60 U238 U235	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035068	24209	MERCURY IN HNO3	ORACLE	L	D002 D009	CS137 CO60 U238 U235 AM241	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035068	24219	MERCURY IN HNO3	ORACLE	L	D002 D009	AM241 CS137 CO60 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24210	PRIMARY DRINKING H2O METALS STANDARD (2)	ORACLE	L	D002 D004 D005 D006 D007 D008	AM241 U238 U235 CS137 CO60	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24211	QUALITY CONTROL STANDARD #7 (2)	ORACLE	L	D002 D005 D011	AM241 CS137 CO60 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24212	QUALITY CONTROL STANDARD #19	ORACLE	L	D002 D004 D007 D008 D010	AM241 CS137 U238 U235 CO60	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT. GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C93035069	24213	SELENIUM IN HNO3	ORACLE	L	D002 D010	AM241 CS137 U238 U235 CO60	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24214	SILVER IN HNO3	ORACLE	L	D002 D011	CO60 U238 U235 CS137 AM241	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24215	ARSENIC IN HNO3	ORACLE	L	D002 D004	AM241 CS137 CO60 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24216	CADMIUM IN HNO3	ORACLE	L	D002 D006	AM241 CS137 CO60 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24217	SELENIUM IN HNO3	ORACLE	L	D002 D011	CS137 CO60 U238 AM241 U235	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035069	24218	BARIUM IN HNO3	ORACLE	L	D002 D005	AM241 CS137 CO60 U238 U235	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A	a, d
15	C93035157	23819	TOTAL KJELDAHL NITROGEN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93035157	24423	TOTAL KJELDAHL NITROGEN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93035157	24424	TOTAL KJELDAHL NITROGEN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93035165	23823	WASTE F/CYANIDE ANALYSIS	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C93035165	25083	WASTE F/CYANIDE ANALYSIS	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93036020	25810	SPEX METAL, PH IS L2 IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D009 D010 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93037055	27487	WASTE F/CYANIDE ANALYSIS (3)	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93037439	28053	COD WASTE CONTAINING AG, HG & CR IN STRONGLY ACIDIC SOLUTION	ORACLE	L	D002 D007 D009 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038226	29349	SPEX METAL STANDARDS IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D009 D010 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	27826	SPEX PLASMA STANDARD PLBE2-2Y, BERYLLIUM IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	27827	SPEX PLASMA STANDARD PLPB2-2Y, LEAD IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	27828	SPEX PLASMA STANDARD-PLCO2-2Y, COBALT IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	27829	SPEX PLASMA STANDARD-PLNI2-2Y, NICKEL IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	27830	SPEX PLASMA STANDARD-PLAG2-2Y, SILVER IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93038580	30004	SPEX PLASMA STANDARD-PLPB2-2Y, LEAD IN NITRIC ACID	ORACLE	L	D002 D004 D005 D006 D007 D008 D011	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C93038681	30198	WATER SAMPLES W/ RAD AND HEAVY METALS (DRUM RR#3)	ORACLE	L	D007	CS137 PU238 PU239	0 0 0	C C C	d
15	C93039075	30883	TOTAL KJELDAHL NITROGEN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039075	30884	TOTAL KJELDAHL NITROGEN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039077	30886	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039077	30887	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039077	30888	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039077	30889	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C93039077	30890	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040642	34785	CYANIDE WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040642	34786	CYANIDE WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040642	34787	CYANIDE WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040644	34791	TKN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040644	34792	TKN WASTE	ORACLE	L	D002 D009	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94040908	35747	COD WASTE (LOW-LEVEL MIXED WASTE) CONTAINING AG, HG, CI IN STRONGLY ACIDIC SOL.	ORACLE	L	D002 D007 D009 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94041538	34967	SILVER SOLDER/CU PIPING	ORACLE	S	D011	PU239	0E-9	C	d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C94041840	37232	SODIUM HYDROXIDE, TC-99, CR(+6)	ORACLE	L	D002 D007	TC99	0E-9	C	d
15	C94041842	37242	DIISOPRPYLBENZENE, CR(6+), TC-99	ORACLE	L	D002 D007	TC99	0E-9	C	d
15	C94042472	37253	TC-99, CR VI	ORACLE	L	D002 D007	TC99	0.00000002	C	d
15	C94043644	42300	PERCHLORIC ACID	ORACLE	L	D001 D002	PU239 U235 U238 AM241	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
15	C94043644	42301	PERCHLORIC ACID	ORACLE	L	D001 D002	AM241 PU239 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
15	C94043644	42302	PERCHLORIC ACID	ORACLE	L	D001 D002	PU239 AM241 U235 U238	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
15	C94043686	42431	COD WASTE- LOW LEVEL MIXED WASTE CONTAINING AG, HA, CI, IN H2SO4	ORACLE	L	D002 D007 D009 D011	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044009	44508	TKN WASTE	ORACLE	L	D002 D009	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044009	44509	TKN WASTE	ORACLE	L	D002 D009	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044009	44511	TKN WASTE	ORACLE	L	D002 D009	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	44496	CN WASTE	ORACLE	L	D002 D003	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	44497	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	44498	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	44499	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING F. THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
15	C94044010	44500	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	44501	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044010	45899	CN WASTE	ORACLE	L	D002 D003	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
15	C94044055	44735	HYDROFLUORIC ACID 48% HF ANALYTICAL REAGENT	ORACLE	L	D002 D003	U238 U235 PU238 PU239	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
15	C94044108	40604	KODAK EMULSION TYPE NTB-2	ORACLE	S	D011	H3	0.00000009	C	d
15	C94044108	40605	KODAK EMULSION TYPE NTB-2	ORACLE	S	D011	H3	0.00000005	C	d
15	C94044108	40606	KODAK EMULSION TYPE NTB-2	ORACLE	S	D011	H3	0.00000005	C	d
15	C94044108	40607	TREATED GLASS SLIDES	ORACLE	S	D011	H3	0.000485	C	d
15	C94044119	40608	KODAK DEVELOPER, D-19	ORACLE	L	D011	H3	0.0000005	C	d
15	C94044119	40609	KODAK FIXER	ORACLE	L	D011	H3	0.0000005	C	d

TREATABILTY GROUPING F. THE SITE TREATMENT PLAN

[illegible]	CONTAINER	ITEM	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RADIONUCLIDE	RADIAMOUNT	RADUNIT	POTENTIAL [illegible]
16	88028600	1029007	ALPHA METAL(HCL)-(COPPER CONTAM.)#2246	ORACLE	LIQUID	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	88162900	1037216	HNO3, UX, OX DRUM #3240	SFE KOP	LIQUID	D002	U238	2.72E-5	C	d
16	88163000	1036701	HNO3, UX, OX DRUM #3239	SFE KOP	LIQUID	D002	U238	2.72E-5	C	d
16	88163100	1038569	HNO3, UX, OX DRUM #3238	SFE KOP	LIQUID	D002	U238	2.72 E-5	C	d
16	88163300	1029244	HNO3,UX, OX DRUM #3237	SFE KOP	LIQUID	D002	U238	2.72E-5	C	d
16	88274800	1029568	PHOTO RESIST STRIP.DRUM#4036 RET.101889	ORACLE	S	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	89164100	1032546	CORROSIVE, MIXED WASTE	ORACLE	S	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	89360800	1036666	WASTE ACID, LIQUID, N.O.S.	ORACLE	L	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	89460200	1039288	OXIDIZER DRUM #1945 - HNO3/ URANIUM / SE03	SFE KOP	LIQUID	D002	U238	UNKNOWN	UNKNOWN	d
16	89460600	1027087	WASTE ACID, LIQUID, N.O.S. - UF5	SFE KOP	LIQUID	D002	U238	UNKNOWN	UNKNOWN	d
16	89657200	1024024	CLEANUP FROM BROMINE SPILL	ORACLE	S	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	89726400	1030061	1D - UNKNOWN AQUEOUS	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	89726500	1028565	HYDROGEN PEROXIDE (30%)	SFE KOP	LIQUID	D001	U235	SUSPECT	N/A	a, d
16	89827500	1040073	MIXED WASTE-ACID - MIX: FE, CO, NI, N, HNO3	SFE KOP	LIQUID	D002	PU238	SUSPECT	N/A	a, d
16	900359	1003963	METAL PREP (CONTAINS PHOSPHORIC ACID) (3)	SFE KOP	LIQUID	D002	PU239	SUSPECT	N/A	a, d
16	900717	1007945	PHOSPORIC ACID	ORACLE	Unknown	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	902419	1011600	MIXED WASTE, CORROSIVE LIQUID	ORACLE	Unknown	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	902420	1021667	CORROSIVE LIQUID W/RAD	ORACLE	Unknown	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	902605	1011481	AMMONIUM HYDROXIDE - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	902605	1023467	3 EA/AMMONIUM HYDROXIDE - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	902606	1019682	10% HC1 - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	902606	1019684	2 EA/H2SO4 - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	902606	1019685	LIME SCALE REMOVER	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	902606	1019686	HCL	SFE KOP	LIQUID	D002	U235	SUSPECT	N/A	a, d
16	903529	1008393	27 NCI AM-241 100 ML HNO3	SFE KOP	LIQUID	D002	AM241	2.7E-9	C	d
16	905633	1011301	AU .1 MG/ML 8 M HNO3 (UNUSED)	SFE KOP	LIQUID	D002	PU239	SUSPECT	N/A	a, d
16	905633	1035765	BE 10 MG/ML 1 M HCL (UNUSED)	SFE KOP	LIQUID	D002	PU239	SUSPECT	N/A	a, d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	907513	1024579	SULFURIC ACID W/U-238 AND TC-99	SFE KOP	LIQUID	D002	U238 TH232 TC99	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	907989	1008074	3 MOLAR HN03 WITH 2.5G DEPLETED U AND 0.0025G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008075	3 MOLAR HN03 WITH 2.5G DEPLETED U AND .0025G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008076	3 MOLAR HN03 WITH 2.5G DEPLETED U AND .005G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008077	3 MOLAR HN03 WITH 2.5G DEPLETED U AND .0025G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008078	3 MOLAR HN03 WITH 1.5G DEPLETED U AND .0015G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008079	3 MOLAR HN03 WITH 2.5G DEPLETED U AND .0015G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008080	3 MOLAR HN03 WITH 1G DEPLETED U AND .001G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008081	3 MOLAR HN03 WITH 1G DEPLETED U AND .001G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008082	3 MOLAR HN03 WITH .5G DEPLETED U AND .005G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1008083	3 MOLAR HN03 WITH .5G DEPLETED U AND .005G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1010698	3 MOLAR HN03 WITH .2G DEPLETED U AND .002G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	907989	1017230	3 MOLAR HN03 WITH 0.2G DEPLETED U AND .002G THORIUM	SFE KOP	LIQUID	D002	U238 TH232	SUSPECT SUSPECT	N/A N/A	a, d
16	908848	1019592	BASE WASTE W/RAD CONTAM.(KOH/H2O)	SFE KOP	LIQUID	D002	PU239 U238 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	909491	1016117	NAOH - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	H3	1E-7	C	d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	909532	1033512	TRICHLOROACETIC ACID - UNUSED, DISPOSED DURING CLEANOUT	SFE KOP	LIQUID	D002	H3	1E-7	C	d
16	909548	1004578	BROMINE, UNUSED, DISPOSED DURING STORAGE ROOM CLEANOUT	SFE KOP	LIQUID	D002	H3	1E-7	C	d
16	91001275	1012052	D38 URANYL NITRATE SOLUTION, 40 G U/L	SFE KOP	LIQUID	D002	U238	20	G	d
16	91001275	1021417	D38 OR NATURAL URANIUM SOLN., 0 G U/L	SFE KOP	LIQUID	D002	U238 U235	SUSPECT SUSPECT	N/A N/A	a, d
16	91001275	1021567	8 EA/D38 URANYL NITRATE SOLN., 40 G U/L	SFE KOP	LIQUID	D002	U238	20	G	d
16	91001275	1021850	D38 OR NATURAL URANIUM SOLN., 1 G U/L	SFE KOP	LIQUID	D002	U238 U235	0.05 SUSPECT	G N/A	a, d
16	91001275	1021859	D38 OR NATURAL SOLUTION, 2.5 G U/L	SFE KOP	LIQUID	D002	U238 U235	0.125 SUSPECT	G N/A	d
16	91001275	1021863	D38 URANIUM SOLUTION, 20 G U/L	SFE KOP	LIQUID	D002	U238 U235	15 SUSPECT	G N/A	d
16	91001275	1022241	D38 URANYL NITRATE SOLUTION, 300 G U/L	SFE KOP	LIQUID	D002	U238	6	G	d
16	91001275	1025305	NATURAL U URANYL NITRATE SOLN., 20 G U/L	SFE KOP	LIQUID	D002	U238 U235	15 SUSPECT	G N/A	d
16	91001275	1025306	D38 URANIUM, 60 G U/L	SFE KOP	LIQUID	D002	U238	60	G	d
16	91001275	1025307	D38 OR NATURAL SOLUTION, 10 G U/L	SFE KOP	LIQUID	D002	U238 U235	0.04 SUSPECT	G N/A	d
16	91001275	1025309	D38 OR NATURAL URANIUM SOLN., 7.5 G U/L	SFE KOP	LIQUID	D002	U238 U235	0.375 SUSPECT	G N/A	d
16	91001275	1025310	D38 OR NATURAL URANIUM SOLN., 5 G U/L	SFE KOP	LIQUID	D002	U235 U238	SUSPECT 0.25	N/A G	d
16	91001275	1025311	D38 OR NATURAL URANIUM SOLN., 5 G U/L	SFE KOP	LIQUID	D002	U238 U235	0.25 SUSPECT	G N/A	d
16	91003471	1035183	HYDROCHLORIC ACID 35% (2) (UNUSED)	SFE KOP	LIQUID	D002	H3	SUSPECT	N/A	a, d
16	91004385	1035803	AMMONIUM HYDROXIDE (2)	SFE KOP	LIQUID	D002	U235 PU239	SUSPECT SUSPECT	N/A N/A	a, d
16	91004387	1025570	AMMONIUM HYDROXIDE (4)	SFE KOP	LIQUID	D002	U235 PU239	SUSPECT SUSPECT	N/A N/A	a, d
16	91004720	9400025	POTASSIUM HYDROXIDE SOLUTION, pH 12	SFE EST	LIQUID	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	91006111	1003059	6 EA/NO3-NO2 ANALYSIS WASTE	SFE KOP	LIQUID	D002	PU238 PU239 AM241	UNKNOWN UNKNOWN UNKNOWN	N/A N/A	d

TREAT GROUP	CONTAINER	ITEM	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	91005278	1008073	NITRIC ACID H20 F/CLEANING OF S.S. PIPES	SFE KOP	LIQUID	D002	BE7 MN54 CO60 SC46	1.02E-3 6.89E-3 1.51E-2 1.11E-2	C C C C	d
16	91005413	1035978	MIXED AQUEOUS ORGANIC LIQUID (4-PICOLINE, H20, NAOH)	SFE KOP	LIQUID W/ SUSPENDED SOLIDS	D002	TC97 TC98 TC99	2E-6 2E-6 2E-6	C C C	b
16	91005423	1035989	1 G/L THORIUM IN 10% HNO3 (UNUSED)	SFE KOP	LIQUID	D002	TH232	5E-14	C	d
16	91005423	1035992	1 G/L URANIUM IN 2% HNO3 (UNUSED)	SFE KOP	LIQUID	D002	U238	5E-14	C	d
16	91006000	1024372	PHOSPHORIC ACID - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	P32 H3	SUSPECT SUSPECT	N/A N/A	a, d
16	91006160	1034992	FAB FOAM COMPONENT R (PH > 12.5) - POLYOL/AMINE BLEND	SFE KOP	LIQUID	D002	PU239	SUSPECT	N/A	a, d
16	91006539	1034734	WASTE F/N03 ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	91006540	1034578	WASTE F/NH3 ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	5.09E-6 5.09E-6 5.09E-6	C C C	d
16	91006540	1034823	WASTE F/NH3 ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	5.09E-6 5.09E-6 5.09E-6	C C C	d
16	91006540	1035541	WASTE F/NH3 ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	5.09E-6 5.09E-6 5.09E-6	C C C	d
16	91006542	1000976	SI02 W/H2S04,NAHS03,AMMONIUM MOLYBDATE	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	91006542	1034576	SI02 W/H2S04,NAHS03,AMMONIUM MOLYBDATE	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	91006542	1034795	SI02 W/H2S04,NAHS03,AMMONIUM MOLYBDATE	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91020339	1033521	DENOR RESIDUE, 5% POTASSIUM HYDROXIDE	ORACLE	UNK	D002	UNKNOWN	UNKNOWN	UNKNOWN	d
16	C91020923	1100	AMMONIUM HYDROXIDE (CONC) (UNUSED CHEMICAL)	SFE KOP	LIQUID	D002	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91020925	1110	SODIUM DEUTEROXIDE (UNUSED)	SFE KOP	LIQUID	D002	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	C91020930	1139	NITRIC ACID (UNUSED CHEMICAL)	SFE KOP	LIQUID	D002	PU238 PU239 H3	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3026	BOTTLE-5% NITRIC ACID W/ FE, BE, CU, ZN - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3030	BOTTLE-5% HYDROCHLORIC ACID W/ MN - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3032	BOTTLE-2% NITRIC ACID W/ AL, MN, CU, FE, SB - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3033	BOTTLE-2% NITRIC ACID W/ NA, CA, MN, K - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3034	BOTTLE-2% NITRIC ACID W/ B, MO, TI - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3036	2 EA/BOTTLE-5% HYDROCHLORIC ACID W/ MN - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3039	2% NITRIC W/TRACE METALS (BE, CO, CU, FE, MN) - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3040	2% NITRIC W/ AL, FE, V, CO, CU, MN - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022164	3043	2% HCL SOLUTION W/ AL, CA, FE, NA - UNUSED CHEMICAL	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91022165	3052	LAL-STEVE-91/CORROSIVE MATERIAL (LIQUID), UNUSED STANDARDS W/ HF, METALS, H20	SFE KOP	LIQUID	D002	PU239 PU238 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C91023021	4320	WASTE F/NO3-NO2 DETERMINATION (3)	SFE KOP	LIQUID	D002	PU238 PU239	SUSPECT SUSPECT	N/A N/A	a, d
16	C91024550	6195	WASTE F/AMMONIA ANALYSIS (9)	SFE KOP	LIQUID	D002	PU238 PU239	1.26E-8 1.26E-8	C C	d
16	C91025672	7364	AQUEOUS NITRIC ACID W/TH, U238	SFE KOP	LIQUID	D002	U238 TH232	1.6E-6 4E-7	C C	d
16	C92027019	9920	5% SOLUTION OF TBAOH	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING FOR THE SITE TREATMENT PLAN

TREAT. GROUP	CONTAINER	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RATIONALE	POSSIBLE TREATMENT
16	C92027388	10405	SODIUM HYDROXIDE F/NH3-N ANALYSIS (2)	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92027389	10406	H2SO4 F/NO3-NO2 ANALYSIS (3)	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92029281	14238	DILUTE HCL	SFE KOP	LIQUID	D002	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
16	C92029281	14240	DILUTE HCL	SFE KOP	LIQUID	D002	SE75 AS73 BA133 BI207 RU106 ZR95 RU103 TL204	SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A N/A N/A N/A N/A	a, d
16	C92030423	14873	NH3-N ANALYSIS WASTE	SFE KOP	LIQUID	D002	PU238 PU239	7E-9 7E-9	C C	d
16	C92030423	16453	NH3-N ANALYSIS WASTE	SFE KOP	LIQUID	D002	PU238 PU239	7E-9 7E-9	C C	d
16	C92030426	14876	NO3-N,NO2-N ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92030426	16456	NO3-N,NO2-N ANALYSIS	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92031026	17254	ION EXCHANGE RESINS F/IRIDIUM ANALYSIS W/2M HCL (3)	SFE KOP	SOLID AND LIQUID	D002	SC46 FE59 SR89	1E-10 1E-10 1E-10	C C C	d
16	C92031836	18964	AMMONIA ANALYSIS WASTE	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92031837	18965	AMMONIA ANALYSIS WASTE (8) (EM-2) CONTAINING PHENOL	SFE KOP	LIQUID	D002	AM241 PU238 PU239	SUSPECT 4.24E-8 SUSPECT	N/A C N/A	d
16	C92031837	18966	TETRABUTYL AMMONIUM HYDROXIDE (2)	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREAT GROUP	CONTAINER	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	C92031842	18972	SULFURIC ACID MIXTURE W/NON-PCB ELECTRICAL INSULATING OIL (EM-7)	SFE KOP	LIQUID	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C92032261	19721	THORIUM STANDARD SOLUTION, UNUSED, EXPIRED DATE, .1000 PPM THORIUM	SFE KOP	LIQUID	D002	TH232 RA228	SUSPECT SUSPECT	N/A N/A	a, d
16	C93033408	20446	WEAPONS GRADE PU IN NITRIC ACID (11)	ORACLE	L	D002	PU239	0E-9	C	d
16	C93033830	21336	AMMONIA SOLUTION (3)	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93033833	21338	NITRIC ACID SOLUTION (6)	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93033835	21147	NITRIC ACID SOLUTION	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93033836	21148	AMMONIA SOLUTION (2)	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035157	23822	WASTE F/AMMONIA ANALYSIS	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035157	24425	WASTE F/AMMONIA ANALYSIS	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035157	24426	WASTE F/AMMONIA ANALYSIS	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035157	24427	WASTE F/AMMONIA ANALYSIS	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035164	23821	WASTE F/NO3-NO2 ANALYSIS (5)	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93035167	24422	TETRABUTYL AMMONIUM HYDROXIDE	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93036500	27486	WASTE F/NO3-N ANALYSIS (4)	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREAT. GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS. STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	ROUTE TREATMENT
16	C93036501	27488	WASTE HNO3 NO2 ANALYSIS (6)	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93037029	27313	ALLEN ALL SOL MURIATIC ACID	ORACLE	L	D002	H3	0	C	d
16	C93037029	27314	ALLEN ALL SOL MURIATIC ACID	ORACLE	L	D002	H3	0	C	d
16	C93038580	27831	SPEX PLASMA STANDARD-PLTA2-2Y, TANTALUM IN HCL	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30885	MIXTURE OF PHENOL AND NAOH SPENT REAGENT	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30891	NH3-N	ORACLE	L	D002	PU238 AM241 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30892	NH3 N	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30893	NH3 N	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30894	NH3 N	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	30895	NH3-N	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C93039076	31339	NH3-N	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34774	NO3-N, NO2-N WASTE	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34775	NO3-N, NO2 N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34776	NO3-N, NO2 N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34777	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREAT. GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	C94040641	34778	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34779	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34780	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34781	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34782	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34783	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040641	34784	NO3-N, NO2-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040643	34789	NH3-N WASTE	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94040643	34790	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44502	NH3-N WASTE	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44503	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44504	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44505	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44506	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPING F HE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER #	ITEM #	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
16	C94044011	44507	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	44520	SPENT PHENOL-NAOH	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044011	45895	NH3-N WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44512	NO3-NO2 WASTE	ORACLE	L	D002	PU238 PU239 AM241	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44513	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44514	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44515	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44516	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44517	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44518	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	44519	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	45896	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	45897	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
16	C94044012	45898	NO3-NO2 WASTE	ORACLE	L	D002	AM241 PU238 PU239	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

TREATABILTY GROUPIN THE SITE TREATMENT PLAN

TREAT GROUP	CONTAINER	ITEM	ITEM DESCRIPTION	DATA SOURCE	ITEM PHYS STATE	RCRA CODE	RAD CODE	RAD AMOUNT	RAD UNIT	POTENTIAL TREATMENT
17	89614300	1026591	LP3A-R	SFE EST	Liquid	D007	UNKNOWN	UNKNOWN	UNKNOWN	d
17	89726100	1039115	1B - CUPROUS CYANIDE (2)	SFE KOP	SOLID	D003 P029	U235	SUSPECT	N/A	a, d
17	89726300	1039225	MIXED WASTE, CORROSIVE - SILVER CYANIDE PLATING SOLUTION (3)	SFE KOP	LIQUID	D011 F007	U235	SUSPECT	N/A	a, d
17	909493	1011091	IMMERSION GOLD SOLUTION	SFE KOP	LIQUID	D003	H3	1E-7	C	d
17	91006235	1034881	CONDENSED ALKALI SALT SLUDGE WITH TC99	SFE KOP	SLUDGE	D001	TC99	8E-2	C	o
17	C91020339	1033522	POLYGLYCOL DIAMINE EPOXY CATALYST	ORACLE	UNK	D002	UNKNOWN	UNKNOWN	UNKNOWN	o
17	C91020339	1033531	EPOXY CURER W/DIETHYLENE TRIAMINE	ORACLE	Unknown	D002	UNKNOWN	UNKNOWN	UNKNOWN	c
17	C91023505	5065	GLASS & METAL GETTER W/AGGASORB	SFE KOP	SOLID DEVICE	D003	H3	4.54E-5	C	c
17	C91024929	6960	POTASSIUM CYANIDE - UNUSED CHEMICAL	SFE KOP	SOLID	P098	U235 PU239	SUSPECT SUSPECT	N/A N/A	a, d
17	C92029271	14199	SODIUM CYANIDE/ETHANOL SOL (INC-7)	SFE KOP	LIQUID	D001 D003	AG110 AG111 AU198	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
17	C92029271	14200	SODIUM CYANIDE/ETHANOL SOL (INC-7)	SFE KOP	LIQUID	D001 D003	AG111 AU198	SUSPECT SUSPECT	N/A N/A	a, d
17	C92032262	19724	URANYL NITRATE W/NON-AROMATIC HYDROCARBON, PROBABLY A STANDARD USED FOR METALS ANALYSIS BY ICP	SFE KOP	LIQUID	D002	U238	2 X 10-7	C	d
17	C93033622	17187	SODIUM ARSENATE SOLUTION	ORACLE	L	D004	S35 H3 I125 P32	SUSPECT SUSPECT SUSPECT SUSPECT	N/A N/A N/A N/A	a, d
17	C93034972	23396	AQUEOUS SOLUTION W/RAD INGREDIENTS (Lead Nitrate)	SFE EST	L	D004 D005 D006 D007 D008 D009 D010 D011	BA133 CO60 RH101	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d
17	C93034972	23397	AQUEOUS SOLUTION W/RAD INGREDIENTS (Lead Nitrate)	SFE EST	L	D004 D005 D006 D007 D008 D009 D010 D011	BA133 CO60 RH101	SUSPECT SUSPECT SUSPECT	N/A N/A N/A	a, d

ATTACHMENT 3

RESEARCH PAPERS ON ELECTROCHEMICAL TREATMENT

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

CHEMTECH

Electrochemical destruction of mixed wastes

Jacek Dziewinski, Stanislaw Marczak, Wayne Smith

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Electrochemical destruction of mixed wastes

At Los Alamos National Labs, the problem being considered involves treating waste that contains organics, cyanides, metals, and radioactivity.

Jacek Dziewinski
Stanislaw Marczak
Wayne Smith

Electrochemical technologies seem to offer ideal tools for addressing environmental problems. Unlike chemical treatments, electrochemical systems do not increase the volume of the waste. Electrochemical treatments are quiet, operate at room or slightly elevated temperatures, and allow for selective separation and recovery. Greater control can be exercised over the reactions via the application of applied potential or current, so there is little chance of runaway reaction or explosion; in many cases the reaction can be instantaneously terminated by simply turning off the power supply. For these reasons, electrochemical technology is likely to gain better public acceptance than the alternative methods for environmental cleanup.

Mixed waste is defined as a waste containing both hazardous and radioactive components. Substantial quantities of such wastes have accumulated at Los Alamos and throughout the nuclear complex as a result of weapons development and other research activities. Having resulted from nonroutine research, these wastes are characterized by a great chemical diversity—but they are in low volumes. For such a situation, the economical solution for waste treatment is a versatile process that can treat several kinds of waste using the same equipment. This approach limits the capital equipment costs and downtime. The electrochemical process that we are developing can treat a great variety of waste using one type of equipment built at moderate expense. Such a process can extract and recycle heavy metals, destroy cyanides, remove surface contamination, oxidize toxic organic compounds to carbon dioxide, separate salts into acids and bases, and reduce the nitrates to nitrogen.

We conducted our experiments with surrogate waste compositions for the wastes we would need to treat. We experimented with toxic metals, cyanides, and some organic compounds. During these tests our waste compositions were well defined; we dealt with pure solutions and had the comfort of knowing there was no radioactivity in our systems. In these experiments, conditions were found for electrochemical treatment of waste containing cadmium, mercury, chromium, copper, cyanides, and some organic compounds (*1, 2*). The generic experimental setup consists of an electrolytic cell (we used different cells depending on the nature of an experiment), a batch tank with mixer, a pump, and a rectifier or potentiostat/galvanostat (Figure 1). A control set includes pH meters, thermometers or thermocouples, voltmeters and ammeters, a multichannel chart recorder, and a digital coulometer. A low-pH alarm was used during experiments with cyanides.

The authors are with Los Alamos National Laboratory.

Cyanides

In the electrochemical treatment of solutions containing cyanides, there are several possible reactions that can occur at the anode and at the cathode under alkaline conditions:

Anode:

$$CN^- + 2OH^- = CNO^- + H_2O + 2e^- \quad E_f^0 = -0.97\ V \quad (1)$$

$$4OH^- = O_2 + 2H_2O + 4e^- \quad E_f^0 = 0.40\ V \quad (2)$$

$$CNO^- + 4OH^- = CO_3^{-2} + \tfrac{1}{2}N_2 + 2H_2O + 3e^- \quad E_f^0 = -0.98\ V \quad (3)$$

Cathode:

$$2H_2O + 2e^- = H_2 + 2OH^- \quad E_f^0 = -0.83\ V \quad (4)$$

where E_f^0 is a formal reaction potential. When a heavy metal (e.g., copper, silver, cadmium) is present, it will be released from the complex bond and reduced according to

Anode:

$$Cu(CN)_3^{2-} + 6OH^- = Cu^+ + 3CNO^- + 3H_2O + 6e^- \quad E_f^0 = -0.69\ V \quad (5)$$

Cathode:

$$Cu(CN)_3^{2} + e^- = Cu + 3CN^- \quad E_f^0 = -1.09\ V \quad (6)$$

$$Cu(CN)_2^{-} + e^- = Cu + 2CN^- \quad E_f^0 = -0.43\ V \quad (7)$$

The situation is additionally complicated by the hydrolysis of cyanate and cyanide's ability to combine with hydronium ions to form a polymeric form called azulmine.

$$CNO^- + 2H_2O = NH_4^+ + CO_3^{2-} \quad (8)$$

$$xH^+ + xCN^- = (HCN)_x \quad (9)$$

The electrochemical destruction of cyanide was carried out in a 12-L open cell with dimensionally stable anodes

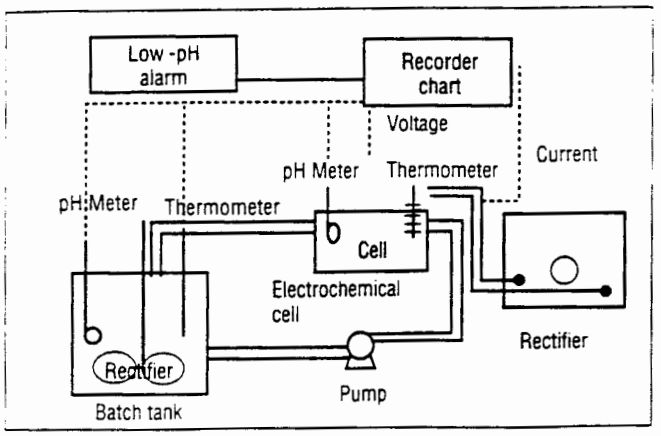

Figure 1. **The experimental setup for our electrochemical experiments.**

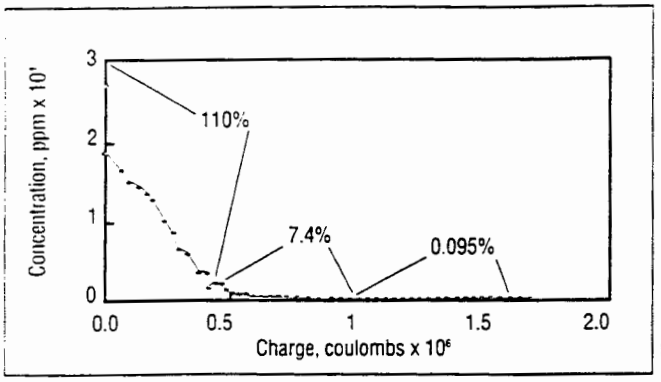

Figure 2. **Reducing cyanide by electrolysis of NaCN solution in a RETEC cell.** Initial conditions were 3.0 L , 27 g/L of CN^-, 0.1 M NaOH; dimensionally stable anodes, copper mesh cathodes, constant current 18 A. Total time of electrolysis was 23 h 15 min. Final total CN^- concentration was 0.2 ppm. Percentages indicate current efficiency (CE) at the various stages; overall CE was 35%.

(titanium grids coated with a mixture of rare earth oxides) and several different cathodes. The results are presented in Figure 2. In the initial stage of electrolysis, current efficiencies usually exceeded 100% (based on Equation 1), indicating that a chemical reaction was taking place in addition to the electrochemical process. A literature study revealed that, at high CN^- concentrations, CN· formed at the anode tended to polymerize with hydronium ions to form azulmine, a polymer of HCN (*3, 4*). Formation of azulmine depends on the ratio of CN^- to OH^-. When the initial ratio of CN^-/OH^- was higher than 5, the solution became light yellow a few minutes into the electrolysis, indicating polymer formation. The solution gradually darkened with time. However, after 2 h, when the CN^-/OH^- dropped, the solution began to clear. When the electrolysis was complete, only carbonate and ammonia were identified in the solution. The cyanate ions formed during the electrolysis probably hydrolyzed according to Equation 8.

The same experimental setup was used to electrolyze cuprous cyanide. The electrolysis started at a cyanide concentration of 200 ppm and was discontinued when the cyanide concentration dropped to 0.08 ppm. Copper was simultaneously removed to <0.03 ppm (Figure 3, p. 32). During electrolysis, some tiny brownish-black solids were deposited on the bottom and walls of the cell. These solids contained copper and were partially soluble in 1 M HCl. All solid could be dissolved in concentrated HNO_3 with evolution of NO_x. Cu^{2+} was found in both acidic solutions. The mechanism of $Cu(CN)_n^{1-n}$ oxidation is not clear. Some authors postulate oxidation of Cu^+ to Cu^{2+} with liberation of cyanide ions and precipitation of $Cu(OH)_2$ (*5*). Others suggest that the main product of anodic oxidation of $Cu(CN)_n^{1-n}$ is CuO (*6*). Hwang and colleagues (*7*) analyzed the reddish-brown precipitate that formed at a platinum anode during destruction of complex cuprous and found a mixture of Cu_2O and CuO. This observation agrees with chemical properties of our precipitate.

The low concentration problem

Part of the reason for the underuse of electrochemical methods for waste treatment is the challenge of dealing with low concentrations. Whereas industrial processes operate at high concentrations—typically tens or even hundreds of grams per liter—waste processing operations require treatment of concentrations down to part-per-million or even part-per-billion levels. Working at such low concentrations is difficult because of thermodynamic and kinetic factors. The potential at which an electrochemical reaction occurs depends on two factors: the type of reaction and the concentrations of the reacting species.

The thermodynamics of electrochemical reactions are governed by the Nernst equation:

$$E = E_f^0 \pm 0.06 \log C$$

where E is the anode or cathode potential, E_f^0 is a formal reaction potential, and C is the concentration of a reacting compound; the sign is positive for the reduction and negative for the oxidation reaction. Each reaction has a potential threshold at which it can thermodynamically commence at a given concentration. The potential threshold for water decomposition in neutral solution is

$$2H_2O \rightarrow 4H^+ + O_2 + 4e \quad E_f^0 = 0.87\ V$$

$$2H_2O + 2e \rightarrow H_2 + 2OH^- \quad E_f^0 = -0.83\ V$$

Usually the experimental potential of oxidation or reduction is different from its thermodynamic value because some kinetic factor is present. Thus the real reaction potential is equal to the sum of the thermodynamic potential and kinetic overpotential. When the reaction potential goes beyond that for water decomposition, hydrogen and oxygen are produced instead of the desired reaction. Conditions must be found that inhibit water decomposition while the waste destruction reaction proceeds; it can be done by changing the overpotential of water decomposition. Proper selection of several factors can accomplish this change. These factors include electrode material and geometry, cell construction, applied current and voltage, temperature, pH, addition of polarizers, and flow control. Finding the right combination of these factors to run electrochemical treatment of a given waste composition constitutes the crux of our development.

Other metals

Chromium. Commercial chromium plating baths typically contain chromium (as Cr^{6+}) in concentrations in the range of 200 g/L. Even at these high concentration levels, chromium deposition is characterized by low current efficiency (*8*), usually around 10%. For a more dilute solution, such as might exist in a waste, electrochemical deposition of the chromium would operate at too low an efficiency to be useful. An alternative approach to chromium removal is to reduce the chromium to the +3 oxidation state followed

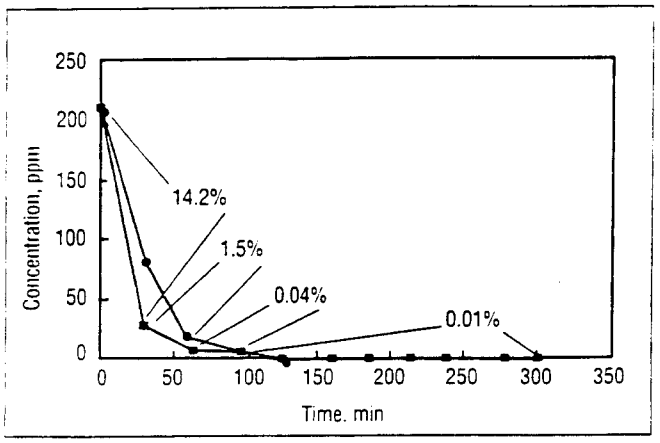

Figure 3. **Removal of copper (●) and cyanide (■) is possible.** The electrolysis of CuCN + NaCN solution in a RETEC cell is shown. Initial conditions: 5.0 L; 200 ppm Cu^+ (as CuCN), 200 ppm CN^- (as CuCN and NaCN), 0.03 M NaCN; copper mesh cathodes, DSA anodes. Final total concentration of copper was <0.03 ppm and CN^- was 0.08 ppm. Percentages indicate current efficiency (CE) at the various stages; overall CE was 1.5%.

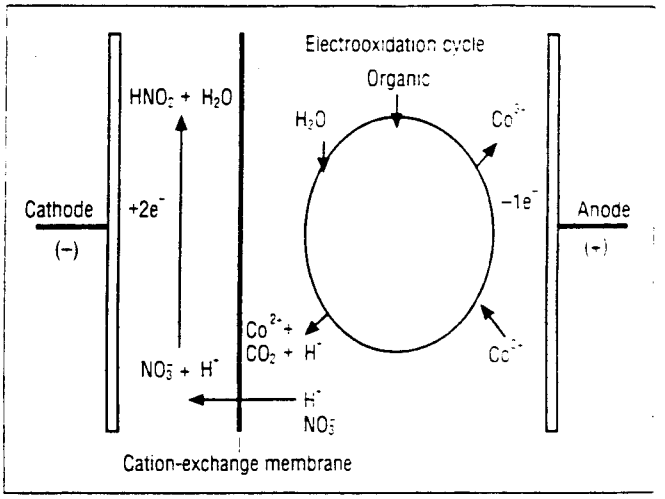

Figure 4. **Mediated electrooxidation.**

by precipitation as the insoluble hydroxide. To facilitate this reaction, an iron plate was used as the anode. The Fe^{2+} formed as the anode dissolved reacted with Cr^{6+} in solution to produce Fe^{3+} and Cr^{3+}. The Cr^{6+} concentration was lowered from 570 to 5 ppm at a current efficiency of 72%. After alkaline precipitation, the residual chromium level was reduced to 0.07 ppm.

Cadmium. The electroreductive stripping of cadmium from aqueous solution was carried out in an open bath cell. Typically, 12 L of solution containing 13 g/L of Cd^{2+} was electrolyzed for 5–8 h. The solutions were prepared using $CdSO_4$, $Cd(NO_3)_2$, or $CdCl_2$. The initial pH was adjusted to approximately 2 with the appropriate mineral acid. During the electrolysis the pH tended to decrease and was held at pH 2 by adding 5.0 M NaOH. Several combinations of cathode materials (nickel and aluminum sheets) and polarizers (polyacrylamide, bone glue, and gelatin) were used. The polarizers were necessary to inhibit the reduction of water to hydrogen gas, thereby increasing the overall current efficiency of the process. The best results were obtained with aluminum cathodes and 60 mg/L of polyacrylamide. The average current efficiency was 88% in the 2–13 g/L range and 46% in the 0.2–2 g/L range. The cadmium concentration in the solutions was decreased to 0.05 ppm. The cadmium deposit on the cathode was soft and easily removable from the aluminum surface. Current efficiencies and final Cd^{2+} concentrations were independent of the counterion.

Mercury. A small-scale experiment was conducted to test the effectiveness of mercury removal from waste solutions using electrochemical methods. A sheet of copper metal served as the cathode and solid graphite as the anode. The surrogate waste solution, originally 27 ppm mercury ($HgCl_2$, pH 2, HNO_3), was reduced to 0.122 ppm mercury after electrolysis. The average current efficiency was predictably low (7%) because of the low starting concentration.

A larger scale experiment was conducted using the open cell fitted with DSA anodes and graphite cathodes. Mercury was deposited on graphite; it coalesced and fell down to the bottom of the cell. Precautions had to be taken to avoid shorts between anodes and cathodes as a mercury pool collected at the bottom of the cell. The initial mercury concentration of 85.4 g/L in 10 L of the solution [$Hg_2(NO_3)_2$, pH 2, HNO_3] was reduced to <1.3 ppm during 8 h of electrolysis. The overall current efficiency was 47%. The surface of the mercury collected from the cell was slightly contaminated with graphite dust.

Organic compounds

We have also investigated the electrochemical oxidation of selected organics that are known components of mixed wastes. The goal of the process is to oxidize the organic component to carbon dioxide by direct or mediated electron transfer and then recover the heavy metal component for recycle before disposal. Mediated oxidation was carried out using Co^{3+} generated by oxidation of Co^{2+} at the anode. As shown in Figure 4, the unstable Co^{3+} is contacted with the organic to oxidize it to carbon dioxide and water. A membrane permeable to hydronium ions separates the anodic and cathodic compartments and prevents the cobalt from being cathodically reduced. A solution of nitric acid is often the electrolyte of choice.

As anticipated, there is a unique set of reaction conditions for each organic compound or class of organic compounds studied. For example, in the oxidation of isopropanol at room temperature, with or without a mediator present, the reaction proceeds rapidly with the generation of acetone, the two-electron oxidation product. A second two-electron oxidation of the acetone produces acetic acid at a rate approximately two orders of magnitude slower. The generation of acetic acid is essentially quantitative, and the reaction ceases at that point. Subsequent oxidation to carbon dioxide can only be accomplished by continuing the electrolysis at elevated temperature. For a given organic, as the degree of oxidation increases, the difficulty of further oxidation also increases. Thus, one can predict the order of ease of oxidation to be alcohols < aldehydes, ketones < carboxylic acids. Because the oxidation of organics is carried out in aqueous media, where there is an unlimited source of oxygen, large organic molecules can be expected to form carboxylic acid intermediates. Therefore, one can also expect to achieve complete conversion to carbon dioxide only at elevated temperatures.

In acidic aqueous media, the oxidation of Co^{2+} to Co^{3+} occurs at a more positive potential than the solvent. Thus it can never be generated at 100% current efficiency, because water will be simultaneously oxidized at any

Table 1. Organic compounds destroyed by mediated electrooxidation

Compound	Reaction temp.: °C	Current efficiency, %
iso-Propanol	80	>90
Acetone	80	>90
Acetic acid	80	>90
Chloroform	20	>90
Carbon tetrachloride	20	>90
Cheesecloth	50	~20
Ion-exchange resins	80	NA

NA, not measured.

applied potential or current density. After it is generated, the Co^{3+} is reasonably stable at room temperature, slowly reacting with water to reduce back to Co^{2+}. However, as the temperature is raised, this reaction experiences a rather dramatic rate increase, leaving Co^{3+} quite unstable. Thus the electron transfer mediator must be continually generated at a fairly high current density so that there is a sufficient steady-state concentration available to effect oxidation of the organic compounds present. Under these conditions, the overall current efficiency can be expected to be very low. An exception to this behavior is seen primarily in small, one-carbon molecules. We have found that methanol, chloroform, and carbon tetrachloride, for example, are converted to carbon dioxide at room temperature at ~100% current efficiency. Examples of some organic compounds treated with mediated electrochemical oxidation are given in Table 1.

Problems with mixed-waste treatment

Enormous resources are necessary to handle and treat mixed waste: capability to measure radiation and perform extensive chemical analyses, access to abundant chemical literature, and great knowledge and expertise in various aspects of chemistry as well as environmental regulatory and legal counsel. Only a large scientific organization—such as a national research laboratory, a large industrial organization, or a university—can provide all of these resources.

Major effort must be dedicated to analyzing the waste. In many cases, the contents of the waste drums are either not known or ill defined. Even if the description is reasonable, some doubt remains. For these reasons, opening a waste drum is a hazardous operation and must be handled with tremendous safety and care. After the composition is determined, it is much more difficult to treat real waste than it was to treat surrogate solutions. Some of the materials have aged over time, hardened, gone through changes in crystalline phases, cross-crystallized, grown to the container wall, and so on. Some of the containers are broken, and the hazardous and radioactive compounds have leaked to the drum packing material (usually sawdust, plastic, or vermiculite). These materials must be cleaned from the waste components before treatment and often involve long leaching procedures. Appropriate leaching solvents must be found and used. Sometimes it is also necessary to analyze the packing material. Other complications arise from the existence of minute quantities of impurities that may have catalytic activity, thereby accelerating reactions.

Another problem is the final waste minimization. Unlike handling surrogate solutions, radioactive waste should be handled with minimum use of solvents, rinse water, paper, rubber gloves, et cetera. In the end they all constitute radioactive waste and must be treated before disposal.

Clearly feasible

Bench-scale tests clearly demonstrated the feasibility of electrochemical systems for treatment of hazardous mixed wastes. For all investigated elements and compounds, the concentration of the hazardous component was decreased below disposal limits. Process conditions for treatment of wastes containing toxic metals, cyanides, and organic compounds have been determined. Having gained experience and confidence, and having defined the parameters of operation for various waste components, this work is now proceeding with the treatment of actual mixed wastes. We are expanding the spectrum of electrochemically treatable waste and scaling up our equipment.

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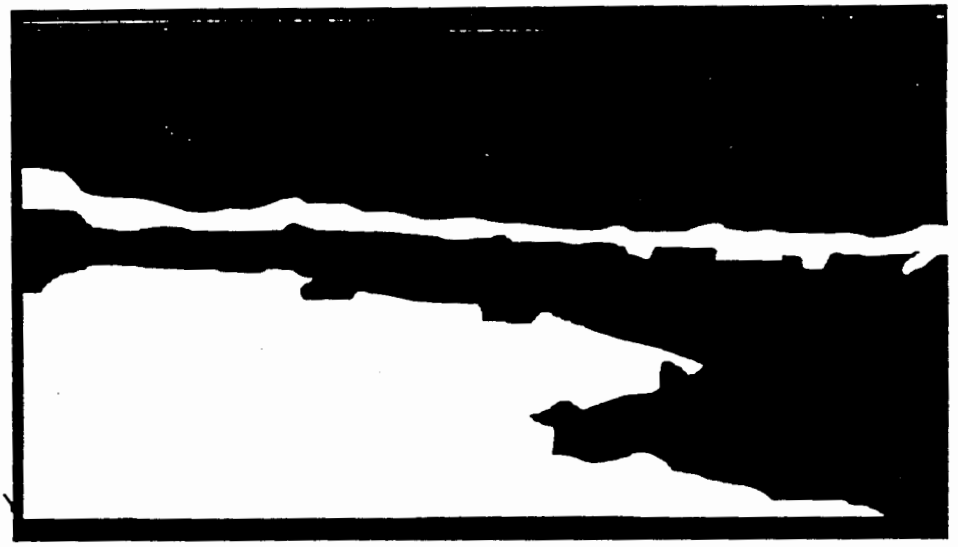

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EXPERIENCES WITH TREATMENT OF MIXED WASTE

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ABSTRACT

Results of a treatability study of chosen mixed wastes from Los Alamos Mixed Waste Inventory are presented. Using electrochemical methods cyanide and heavy metals bearing wastes were treated to below disposal limits.

INTRODUCTION

During its many years of research activities involving toxic chemicals and radioactive materials, Los Alamos National Laboratory (LANL) has generated considerable amounts of waste. Much of this waste includes chemically hazardous components and radioisotopes. The nature of this waste is very diversified; the mixed-waste storage at Los Alamos contains small volumes of a great variety of discarded hazardous and radioactive materials. Knowledge of the contents of waste containers is limited and sometimes unreliable. Continuing to store this waste represents a hazard and is not in compliance with the law. The waste needs to be treated and disposed of. Such treatment must convert the hazardous components of various waste items into non-hazardous forms. Then the waste may be disposed of according to appropriate regulations.

Capital equipment costs are an overwhelming factor when designing a treatment process for a small volume of waste. The amount of capital expense is divided by a low-waste volume. The result is a very high dollar number per unit of treated waste. Because of the diversity but rather small volumes of the wastes at Los Alamos and other research and development institutions, it is economically advantageous to develop one versatile process that can treat different kinds of waste.

ELECTROLYTIC APPROACH TO WASTE TREATMENT

We chose to use an electrochemical process for the treatment of many mixed waste components. The electrochemical process, which we are developing, can treat a great variety of waste using one type of equipment built at a moderate expense. Such a process can extract heavy metals, destroy cyanides, dissolve contamination from surfaces, oxidize toxic organic compounds, separate salts into acids and bases, and reduce the nitrates. All this can be accomplished using the equipment and one crew of trained operating personnel.

Such equipment consists of several electrochemical cells. Each cell is designed to electrolyze a separate group of waste. The cells are assisted by a common current rectifier, a gas-handling system, tanks and piping, and a control system.

Electrochemical processing has other advantages in addition to its ability to treat diversified waste. It has the ability to recover and recycle waste components rather than immobilize and dispose of them. For example metals can be plated on cathodes and recovered or salts can be split into acids and bases and reused.

In most instances the electrochemical processing does not require the addition of chemical reagents—the reactions are driven by the electric current. If there is a secondary waste product it would be another form of the initial hazardous waste component converted to a benign form (without gaining the weight of an added chemical reagent). In many cases the hazardous components are converted to benign gases, such as carbon dioxide or nitrogen, and can be released to the atmosphere without additional disposal costs.

Among the many challenges facing the designers and operators of waste treatment technologies is confronting public opinion. Processes that suffer from adverse public perception have little chance of success. Electrochemical treatments operate at low temperature and ambient pressure. Great control can be exercised over the reactions via the application of applied potential or current so there is little chance for a runaway reaction or explosion. In many cases the reaction can be instantaneously terminated by simply turning off the power supply. For these reasons electrochemical waste processing is remarkably prone for positive public perception.

The electrochemical apparatus is easily scaleable. Single-cell modules are simply combined much like building bricks to deliver any desired output. Each of them operates independently. The risk of scale-up problems and possible failures, quite often experienced by the chemical industry, are thus alleviated. Finally, the cost of setting up and operating an electrochemical treatment is relatively inexpensive.

SURROGATE WASTE TESTS

We have developed experimental methods and conditions for treatment of toxic metals, cyanides, and some organic compounds using surrogate waste compositions. During these tests our waste compositions were well defined, we dealt with pure solutions, and we had the comfort of not having radioactivity in our systems. Some of this experimental work[1] has been presented at The Seventh Special Symposium - Emerging Technologies in Hazardous Waste Management held in Atlanta, Georgia in 1995. In these experiments the conditions were found for electrochemical treatment of waste containing cadmium, mercury, chromium, copper, cyanides, and some organic compounds. Results included the following:

- We found that cadmium can be effectively removed from solutions using the RETEC cell with aluminum cathodes, DSA anodes, and polyacrylamide as depolarizer. A chlorine scrubber should be considered when treating cadmium chloride solution.
- Copper stripping can be performed in a cell with graphite bead packed-bed cathodes and DSA anodes separated by ion exchange membranes. No depolarizer is required.
- Mercury may be easily removed from its inorganic soluble compounds by electrolysis using graphite cathodes and DSA anodes in the RETEC cell.
- Free and complex cyanide can be electrolytically destroyed below disposal limits using graphite cathodes and DSA anodes in an undivided cell.
- The best procedure for electrochemical removal of chromium(VI) is electrolysis in an undivided cell with copper cathodes and carbon steel anodes. Part of the chromium is electrochemically reduced to metal and part remains in the solution as chromium(III). The electrolysis must be followed by alkaline precipitation of chromium hydroxide. Chemical reduction of chromium(VI) by ferrous iron contributes to the electrochemical reactions. The ferrous ions are present in the solution due to anodic dissolution of carbon steel.
- We have also investigated the electrochemical oxidation of selected organics that are known components of mixed wastes. The goal was to oxidize the organic component to carbon dioxide by direct or mediated electron transfer, then recover the heavy metal component for recycling prior to disposal. Mediated oxidation was carried out using cobalt(III) that was generated by oxidation of cobalt(II) at the anode. As anticipated there was a unique set of reaction conditions for each organic compound or class of organic compounds studied. For example in the oxidation of isopropanol at room temperature, with or without a mediator present, the reaction proceeds rapidly with the generation of acetone, the two electron oxidation product. A second two electron oxidation of the acetone produces acetic acid at a rate approximately one order of magnitude slower. The generation of acetic acid is essentially quantitative and the reaction ceases at that point. Further oxidation to carbon dioxide can only be accomplished by continuing the electrolysis at an elevated temperature. For a given organic, as the degree of oxidation increases, the difficulty of further oxidation also increases. Thus one can predict the order of ease of oxidation to be alcohols < aldehydes, ketones < carboxylic acids. Therefore, selected organics can be effectively destroyed by conversion to carbon dioxide using mediated electron transfer oxidizing agents. Each compound or class of compounds will have a unique set of operation parameters that will result in optimum current/destruction efficiency.

Bench-scale tests clearly demonstrated the feasibility of electrochemical systems for treatment of hazardous mixed wastes. For all investigated elements and compounds, the concentration of the hazardous component was decreased below disposal limits. Process conditions for

treatment of wastes containing toxic metals, cyanides, and organic compounds have been determined.

Having gained experience and confidence, and having defined the parameters of operation for various waste components, we decided to continue with the optimization in a real life environment. We began the treatability study of mixed waste from Los Alamos Mixed Waste Inventory. We have learned valuable lessons while treating the mixed waste. Some of them are briefly discussed below.

MIXED WASTES TREATABILITY STUDY

A. Equipment and Analytical Set-up.

The generic experimental set-up consisted of the electrolytic cell (RETEC 07), batch tank with mixing, a pump (Cole-Palmer Masterflex 7591-50), and a rectifier (Darrah Electric Comp. R35) or a pulse rectifier (Dynatronix DPR20-100-400). A control set included pH-meters (Orion 250A and Corning pH-meter 340), thermometers or thermocouples, volt- and am- meters, a multichannel chart recorder (Yokogawa LR4110), and a digital coulometer (Electro-synthesis Inc. ESC640). A low pH alarm was used during experiments with cyanides. Concentration of species was measured with an AtomScan-16 ICP spectrometer (Thermo Jarell Ash Corp.).

RETEC 07 is a commercially available cell[2]. It consists of a 12 L rectangular vessel with inlet and outlet ports, flow distributor, and slots for electrode placement. The cell is furnished with 8 Dimensionally Stable Anodes (DSA, titanium grids covered with mixture of titanium oxide and rare earth oxides) and 7 cathodes. The cathode material depended on the composition of waste to be treated. Electrodes are 22.3 x 11.8 cm large.

The composition of electrolyzed solution was determined using anodic stripping voltammetry (Hg), inductively coupled plasma - atomic emission spectroscopy (ICP-AES; Ag, Cu, Hg, total Cr), UV-VIS spectroscopy, and potentiometry (cyanide).

Each determination was repeated 3 times for the voltammetric, UV-VIS, and potentiometric measurements. For each element the ICP-AES measurements were performed at two or three various wavelengths and the intensity of light emission was measured 3 or 4 times for each wavelength. Usually the relative standard deviation was less than 2% for the voltammetric and spectroscopic measurements and less than 5% for potentiometric measurements. When the standard deviation was greater than 5% - the value was rejected and the whole experiment repeated.

Free cyanide concentration measurements were done with a cyanide ion specific electrode (Orion, model 9606 Combination Cyanide Electrode). The electrode was calibrated immediately before and after each 10-15 determinations. The mean slope of the calibration curve was equal to the theoretical Nernstian value (at 25°C 59 mV for 10-fold change of cyanide concentration). The maximum deviations which occurred during several weeks of measurements were less than ±2 mV.

Total cyanide analysis was performed according standard method SW846-9010[3,4]. In this method a cyanide bearing sample is acidified with 50% H_2SO_4 and heated. The liberated gaseous HCN is next absorbed in a NaOH solution. Because of the absence of complexing cations in the NaOH solution, the free cyanide concentration is equal to total CN^- concentration. The concentration of absorbed CN^- was measured using the Cyanide Combination Electrode or an Automated Cyanide Analyzer (AP1214, Leeman Labs, Inc.). In the AP1214 a sample is mixed with chloramine T, pyridine, barbituric acid, and phosphate buffer, and a resulting colored compound is determined spectrophotometrically at 575 nm. The differences between potentiometric and spectrophotometric measurements were less than 3% (7% for CN^- concentrations less than 1 ppm).

For Cr(VI) determination, the sample pH was adjusted to about 12 and an absorption peak for CrO_4^{2-} anion was measured at 366 nm using a HP 8452 diode array spectrometer[5]. Total chromium concentration was measured either by ICP-AES or by UV-VIS spectrometry after oxidation of Cr(III) to Cr(VI) by H_2O_2 in alkaline media. Cr(III) concentration was calculated as a difference between total chromium and Cr(VI) concentrations.

Gas chromatography (Hewlett-Packard 5890 GC) and gas chromatography /mass spectrometry (Hewlett-Packard 970 MS) were used to analyze the organics.

All solutions were made using deionized water and reagent grade chemicals.

Electrolyses were conducted with constant or pulsating current. All direct current experiments were performed in current control mode. If continuous monitoring of concentration changes was impossible, small samples of solution were taken every 15 to 30 minutes depending on the predicted total electrolysis time. During electrolysis of inorganics, solutions were neither heated nor cooled (except heating by the current flow through the solution). Except for some chromium electrolyses the temperature did not exceed 42°C. Several chromium electrolyses employed very large currents. In these cases the solution temperature rose to about 70°C due to the ohmic heating.

Post-treatment solutions (except solutions resulted from cyanide destruction) were disposed to the drain connected with a Radioactive Liquid Waste Treatment Plant. All of them met disposal criteria (below 5 ppm of Ag and Cr). Cyanides are a listed waste. Every waste resulted from treatment of cyanide bearing wastes is considered by definition as a hazardous waste and have to be properly disposed in the landfill.

B. Mixed Wastes Selected For The Study.

Several mixed waste items were selected from LANL mixed waste inventory. Description and amounts of wastes are presented in Table 1. Except for "Ag plating bath" and KCN all waste containers were found in a good condition. Wet, solid "Ag plating bath" was placed in a broken beaker with a slightly corroded lead frame. The beaker was wrapped in a plastic bag. Part of the waste leaked out and contaminated sawdust packing material. KCN was placed in a glass bottle with a perforated cap similar to a salt shaker. The bottle was wrapped with paper towels and placed in a metal can. Other packing materials, sawdust and paper towels, were found wet and the can was very corroded. Cyanides were found present only in the inner packing material. Contaminated packing materials were leached 3 times with dilute NaCN solution and finally with water. The rinsing waters were analyzed for the presence of cyanide. When the concentration of cyanide was less than 1 ppm the rinsing was terminated. Solutions resulting from leaching procedures were employed to dissolve the main volume of this waste.

Table 1. Mixed Wastes Used in the Treatability Study

Description	Quantity
CuCN unused chemical	0.45 kg
Ag plating bath (with cyanide)	0.9 kg
Cu plating bath (with cyanide)	10g
potassium cyanide	1.0 kg
mercurous nitrate	0.5 kg
mercuric nitrate	0.5 kg
chromium(VI) in solution	2.0 L
used chromic acid	17.5 L

Although most solids were found in a good condition, their appearance and properties had changed. KCN and mercury compound were slightly colored (fresh salts are colorless). Small samples of CuCN dissolved in NaCN solution resulted in a dark mixture. Removing the items from bottles and dissolution of solids was always somewhat problematic.

C. Treatment Methods.

1. Cuprous cyanide. Solid CuCN was dissolved in a basic solution of NaCN. The bottles containing both wastes: "unused chemical" and "Cu plating bath" were rinsed with a small amount of NaCN solution and deionized water. The rinses were added to the treated solution. This solution contained 0.29 M (18.4 g/L) total Cu, 0.07 M free CN^-, 1.17 M (30.4 g/L) total CN, a pH equal to 13 and 10.0 L total volume. The solution was electrolyzed in a RETEC 07 cell with copper mesh cathodes and DSA anodes. A 30 A constant current was used. Voltage varied within a range of 2.8 V to 4.2 V. The pH was decreased during the electrolysis. To avoid HCN gas evolution, 50% NaOH was added in 3 portions. The total NaOH used was 135 ml. After 23 hours of the electrolysis the total concentrations were reduced to $2.3 \cdot 10^{-5}$ M (0.60 ppm) for CN^- and $7.9 \cdot 10^{-7}$ M Cu (50 ppb). Overall current efficiencies were equal to 88.2% for the anodic reaction ($CN^- + 2OH^- - 2e \rightarrow CNO^- + H_2O$) and 11.0% for the cathodic reaction ($Cu(CN)_4^{3-} + e \rightarrow Cu + 4\ CN^-$). The course of electrolysis is illustrated in Figure 1.

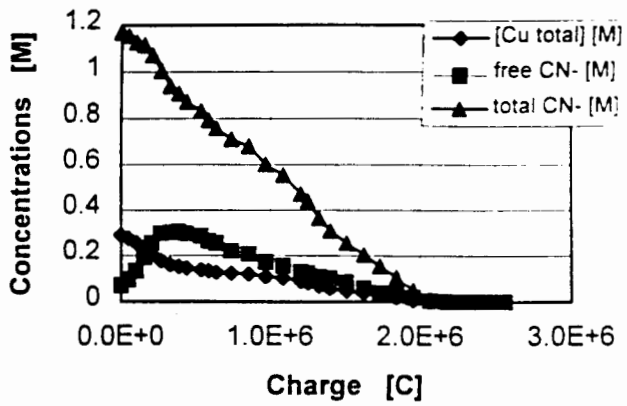

Fig. 1 The course of CuCN waste electrolysis. Values of total CN^- concentrations were calculated based on concentrations of free CN^-, total Cu and literature stability constants for $Cu^+ + CN^-$ complexes[6].

The post-electrolysis solution was neutralized with conc. H_2SO_4 and evaporated. 1070 g of Na_2SO_4 was obtained as a final product (1072 g theoretical).

2. Ag plating bath. This solid waste was non-homogeneous with some green tinted crystals mixed in with colorless crystals. Silver content ranged from 8.6 to 36.0% in random sampling sites. The average Ag content was 26.4% (w/w). The other main components averaged: 32.4% in K, 4.2% in Na and 13.9% in CN^-. In addition to Ag, small amounts of other metals were found: Cd 0.007%, Cr 0.011%, and Cu 0.03%. Ba, Pb, and Hg were absent. Chloride and carbonate anions were present in this waste but only qualitative analyses were performed.

The entire solid waste was dissolved in water, resulting in 11.0 L of solution containing 0.20 M (21.6 g/L) total Ag and 0.44 M (11.4 g/L) total CN^-. The concentration of free CN^- was equal to 0.016 M and the pH was equal to 11.0. After several minutes of electrolysis the solution became yellow and kept darkening to a light brown color. This trend was reversed after six hours of the electrolysis when the color began to lighten, finally becoming light yellow. The presence of ammonia was detected over the

solution. A literature study revealed that at high CN^- concentration CN^- radicals formed at the anode tend to polymerize with hydronium ion to form azulmine, a yellow to brown colored polymer of HCN[7,8]. Formation of azulmine depends on the CN^-/OH^- ratio[9]. During our experiments when the initial CN^-/OH^- ratio was high, the solution became light yellow a few minutes into the electrolysis indicating polymer formation. The solution gradually darkened with time. However, after a couple of hours when the CN^-/OH^- ratio dropped, the solution began to clear. At the completion of the electrolysis, only carbonate, chloride, and ammonia were identified in the solution. Most likely the cyanate ions formed during the electrolysis hydrolyzed according to the reaction[10]:

$$CNO^- + 2\,H_2O \rightarrow NH_4^+ + CO_3^{2-}$$

The pH of the solution decreased continually during the electrolysis requiring the addition of a total of 135 ml of 50% NaOH to maintain alkaline conditions. After 15 h 50 min. of electrolysis, the volume of the solution dropped to 9.8 L and the concentrations decreased to: total Ag $9.3\cdot10^{-6}$ M (1.0 ppm); total CN^- $3.4\cdot10^{-5}$ M (0.90 ppm), free CN^- $1.5\cdot10^{-5}$ M (0.39 ppm). The course of the electrolysis is shown in Figure 2.

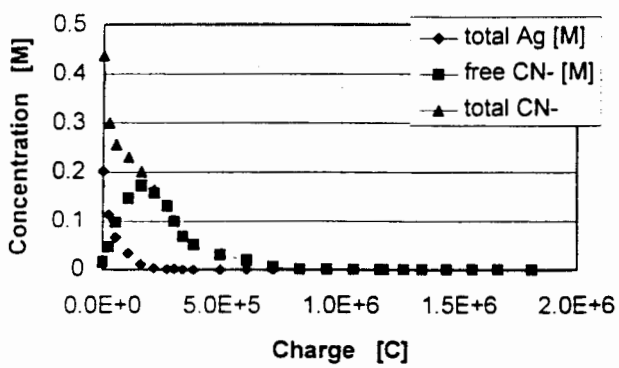

Fig. 2 The course of "Ag plating bath" waste electrolysis. Values of total CN^- concentrations were calculated based on concentrations of free CN^-, total Ag and literature stability constants for $Ag^+ + CN^-$ complexes[6].

After electrolysis the solution was acidified to pH~5 and evaporated to 5.0 L. The total Cr content in solution was found to be 24.5 ppm. In order to lower the chromium down to the discard limit, <5ppm, the solution was further acidified to pH=2 and 5 g of $FeCl_3$ was added. After neutralization to pH=7 the solution was left overnight for $Fe(OH)_3$ and $Cr(OH)_3$ sedimentation. Next day a clear solution was decanted. A total of 3.5 g of $Fe(OH)_3$ and $Cr(OH)_3$ containing precipitate was collected and added to another chromium containing waste resulting from this treatability study. The decanted solution contained 1.1 ppm of Cr and 0.13 ppm of CN^-. Finally the solution was evaporated and the obtained solid dried at 140°C. 1100 g of $K_2SO_4 + Na_2SO_4$ mixture remained. A total of 240.5 g of essentially pure metallic silver was scraped from the graphite cathodes. From material balances, 472 g of Na_2SO_4 and 632 g of K_2SO_4 (total 1104 g), and 238 g of Ag should have been obtained.

3. Potassium Cyanide. The blackish solid was dissolved in a NaOH solution and electrolyzed using copper mesh cathodes and DSA anodes. The initial solution was 5.0 L total volume, pH=13.3, and contained 1.43 M (37.2 g/L) of CN^-. Its color was dark brown. A constant 20 A current was applied. The voltage varied from 2.8 to 3.6 V. During the electrolysis, the initial dark color of the solution slowly disappeared. After electrolyzing for 23 h 30 min. the total CN^- concentration dropped to $5.4\cdot10^{-6}$ M (0.14 ppm) and the current source was disconnected.

Following electrolysis the solution was acidified to pH~6 with concentrated H_2SO_4, resulting in the evolution of a large quantity of CO_2. A sample of the final solution was analyzed by AES-ICP for presence of RCRA metals (Ba, Ag, Cd, Cr, Hg, Pb) - none were detected. Only a small amount of copper was found, ~1.5 ppm, probably due to dissolution of the copper cathodes. Evaporation of the final solution resulted in 635 g of solid residue consisting of K_2SO_4 and Na_2SO_4. From Na^+ and K^+ balances 94 g of Na_2SO_4 and 542 g of K_2SO_4 (634 g total) should have been obtained.

4. Mercury nitrates. Mercurous nitrate is a colorless crystalline solid, while the compound found in the waste bottle was slightly yellow, indicating the compound had oxidized to mercuric nitrate. The entire solid sample was placed in a large Erlenmeyer flask and ~8 L of water was added. The pH was adjusted to 2 with concentrated HNO_3. This mixture was stirred overnight. A small amount of solid remained undissolved. The cloudy solution was filtered under vacuum. Tiny specs of yellow and red residue were collected on a filter paper. Both solids easily dissolved in concentrated HNO_3 (without any fumes of NO_x); the solution was combined with the main solution in the large flask. The yellow and red solids were most likely two polymorfic forms of HgO. Had any Hg(0) or Hg(I) been present in the precipitate brown fumes of NO_2 would have been visible during dissolution in HNO_3. Water was next added to the solution to yield a total volume of 10.0 L. This solution was placed in a RETEC cell and electrolyzed. The course of electrolysis is illustrated in Figure 3.

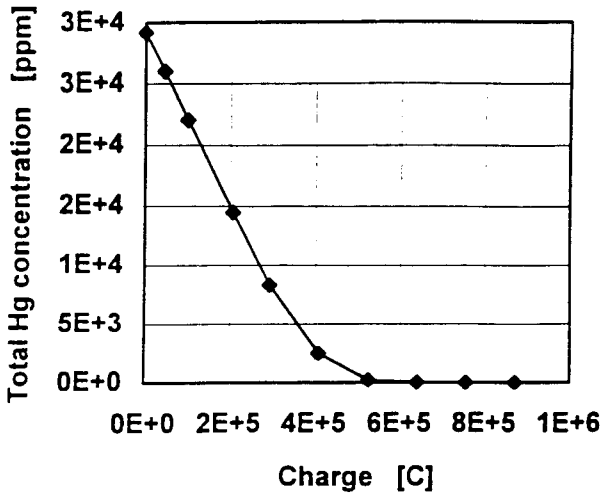

Fig. 3. The course of $Hg_2(NO_3)_2$ waste electrolysis. Conditions: 7 graphite cathodes; 8 DSA anodes; current 30 A, voltage 2.0 - 3.6 (voltage was increasing during electrolysis). Initial volume 10.0 L; total Hg conc. 29.2 g/L; initial pH 1.20. Total time of electrolysis 17 h 10 min. Final conditions: volume 9.3 L, total Hg concentration 1.0 ppm. Overall current efficiency: 16.2%

After the electrolysis, 293.5 g of liquid mercury was collected on the bottom of the cell in a form of small drops contaminated by graphite dust. The solution was decanted from the cell to an Erlenmeyer flask. Liquid mercury was placed in a large beaker and rinsed by decantation several times with DI water. All rinse water was added to the post-electrolysis solution. This solution was then used to dissolve the next batch of mercuric nitrate waste.

Mercuric nitrate is a white or yellow-white solid depending on the degree of hydration. The compound in the bottle was yellow-white in appearance. The entire solid was placed in a large Erlenmeyer flask and 9.8 L of post-electrolysis solution from $Hg_2(NO_3)_2$ treatment was added. This mixture was stirred overnight. A small amount of solid remained undissolved. The cloudy solution was filtered under vacuum and the filtrate was collected. A small amount of black residue was collected on the filter paper. This residue did not dissolve in concentrated HNO_3.

The filtrate was diluted to 10.0 L, placed in a RETEC cell and electrolyzed. Conditions and the course of the process were similar to those for $Hg_2(NO_3)_2$. The concentration of Hg was decreased from 33.1 g/L to 1.3 ppm during 13 h of electrolysis. A total of 329 g of liquid mercury was recovered. Overall current efficiency was 7.5%.

The post-electrolysis solution was decanted from the cell to the Erlenmeyer flask and few drops of 30% H_2O_2 were added to oxidize any residual mercurous ions to Hg(II). The following day a small amount of saturated Na_2S solution was added. Due to precipitation of HgS, the concentration of Hg in solution dropped below the ICP-AES detection limit. This solution was then disposed of as a non-hazardous waste.

5. Chromium wastes. The actual chromium waste composition was unlike any surrogate waste that had been treated previously, so different treatment methods were tested.

Direct current electrolysis was the first among the electrochemical methods to be tested. Ten 10 L of the waste solution was electrolyzed in a RETEC cell fitted with 8 graphite anodes and stainless steel cathodes (sizes and number of cathodes varied). The cathodic current density was varied over a range of from 2.2 A/cm^2 to 0.04 A/cm^2. At none of these current densities was chromium electrodeposited.

Pulsed current electrolysis was also tested. After 4 hours of electrolysis a bright mirror-like coating of chromium was deposited on the stainless steel cathode. Solution analysis showed that the concentration of Cr dropped from 0.67M to about 0.66M. During the last 3 hours of electrolysis, the total Cr concentration remained constants.

Direct current electrolysis using an amalgamated cathode was also tested. During the first hour of electrolysis the total chromium concentration dropped very slightly from 0.67M to about 0.66M and remained constants during the next 4 hours of current flow.

These experiments showed that the electrochemical route is not an effective method for treating this kind of waste. Chemical treatment methods were pursued next.

Due to the presence of concentrated H_2SO_4 these wastes were very corrosive and had to be neutralized before disposal. This forced a hydroxide precipitation as a chemical method for chromium removal. First, 50% NaOH was added very slowly to neutralize 85% of the acid. As expected, the mixture became very hot. After cooling it down to 40-50°C some white-greenish precipitate (Na_2SO_4 contaminated by Cr(III)) was filtered out. The precipitate was rinsed several times with water. The rinsing water was added to the filtrate and neutralized to pH~7 (±1). The mixture was left overnight allowing the precipitated $Cr(OH)_3$ to settle. Next morning a clear solution was pumped out and green slurry of $Cr(OH)_3$ was moved to a cylinder and left to settle again. The clear solution was analyzed for the presence of chromium. In 3 batches the total concentration of chromium, after removing $Cr(OH)_3$, was equal to approximately 20 ppm due to presence of Cr(VI). approximately 2 g of sodium dithionite ($Na_2S_2O_4$) was added to each batch to reduce the residual chromium to Cr(III). The pH was adjusted again to ~7 and the solution was allowed to settle. The following day, the total concentration of chromium in the solution was below 5 ppm. This value met the disposal limit to the radioactive liquid effluent plant.

A slight greenish color in the Na_2SO_4 precipitate indicated the presence of chromium. Analysis of eight, 1 g samples dissolved in 100.0 ml of water gave chromium concentrations of from 0.17 ppm to 25 ppm. So we decided to treat this precipitate to remove chromium prior to disposal.

The Na_2SO_4 precipitate obtained during the 85 % acid neutralization was dissolved in water and the pH of the solution was adjusted to 7. Next morning the solution was still cloudy. About 1g/L of $FeCl_3$ was added to coagulate the $Cr(OH)_3$. The pH had to be adjusted to 7 again. The precipitate was allowed to settle overnight and the clear solution was decanted. Analysis of this showed a chromium content <2.0 ppm.

The dense slurries of $Cr(OH)_3$ + $Fe(OH)_3$ were mixed together, placed in stainless steel trays and dried at 140°C. A total of 4.63 kg of salt consisting of a $Cr(OH)_3$, $Fe(OH)_3$, and Na_2SO_4 mixture was obtained from all batches processed.

Small samples of the dry slurry were cemented: n g of dry slurry was mixed carefully with (100-n) g of dry cement (Low Alkaline Portland Cement 5). After adding water the wet cemented waste was placed as a thin layer in a small aluminum tray and left for 3 days to dry. The dry cement forms were then crushed and powdered in a mortar. Small samples of the powder were taken for TCLP tests. The results are presented in Table 2. Similar tests were performed with samples of the dry slurry prepared by different procedures: roasted over a small flame, roasted and sintered over a large flame, and dried at 140°C. The resulting solids were non-homogeneous and ranged in color from white to blue-green. Analytical results varied depending on the sampling location. The total concentration of chromium varied from 3.1 to 28.3 ppm. The TCLP limit for Cr land disposal is 5 ppm. Only the cemented waste samples passed this criterion. This indicated a necessity of waste cementation.

Table 2. Results of the TCLP Tests for the Chromium Waste Residues.

Description	TCLP result (total Cr concentration)
dry slurry sample 1 (no cement)	33.6 ppm
dry slurry sample 2 (no cement)	29.4 ppm
dry slurry sample 3 (no cement)	33.9 ppm
5% of dry slurry + 95% cement	0.94 ppm
10% of dry slurry + 90% cement	1.06 ppm
20% of dry slurry + 80% cement	1.63 ppm
50% of dry slurry + 50% cement	2.58 ppm

Based on cementation results in Table 2, the approximate composition of 20% slurry and 80% cement was chosen. Every chromium waste residue was cemented. Appropriate amounts of waste and cement were placed into polyethylene bags with interlocking seals and mixed together. Next, water was added and mixed with the solids. Open bags were left for a week to dry and harden. The contents of two plastic bags, selected at random, were crushed and small pieces were removed for analysis. Approximately 50 g of sample was collected this way and subjected to the TCLP tests. The results from three analyses gave Cr concentrations of 0.97 ppm, 0.90 ppm and 0.95 ppm, with an average value of 0.94 ppm.

CONCLUSIONS

Valuable lessons were learned during these small scale treatability studies with mixed wastes.

It takes considerable resources to handle and treat the mixed waste. These resources must include: radiation measurement capability, abundant chemical analysis capability, access to plentiful literature, and great knowledge and expertise in various aspects of chemistry as well environmental regulatory and legal counsel. Only a large scientific organization such as a national research laboratory, or a university, can provide these capabilities. We have drawn from these resources across Los Alamos National Laboratory very extensively.

Major effort must be dedicated to analyzing the waste. In many cases the content of the waste drums is not known or is ill defined. Even if the description is reasonable, some doubt remains. For these reasons opening a drum with waste is a hazardous operation and must be handled with tremendous safety and care.

Once the composition is determined, it is much more difficult to perform the treatment on real waste than on surrogates. Problems occur with the dissolution of some compounds. These wastes have aged over a long time, hardened, gone through changes in crystalline phases, cross-crystallized, grew to the container walls, et cetera. Some of the containers had broken and the hazardous and radioactive compounds leaked into drum packing materials, sawdust, plastic, or vermiculite. These materials had to be cleaned from waste components, often involving long leaching procedures. Analysis of the packing material was often necessary. The experience from this treatibility study showed that the initial waste preparation steps could consume up to 50% of the total treatment time.

Other complications arise from the existence of minute quantities of impurities which may have catalytic activities thereby accelerating or inhibiting reactions. Small amounts of impurities may also force additional steps in treatment as it happened with chromium impurity in the "Ag plating bath".

Another problem exists in the final waste minimization. Radioactive waste should be treated with minimal use of solvents, rinse water, paper, rubber, etc. In the end they

all constitute radioactive waste and must be disposed of accordingly.

The small amounts of wastes used in this treatability study did not allow optimal treatment conditions to be determined. Current efficiencies for metals' deposition were quite low, but more emphasis was given to developing methods to process the waste than to maximizing process efficiency. It is certainly desirable to perform a series of experiments to determine the best conditions for treatment of a specific kind of waste. The experiments performed with "synthetic waste" are always easier, but do not reproduce the composition and complexity of real waste treatment. Hence treatability studies with mixed waste are a very meaningful and important step for defining the methods and optimizing the conditions of the treatment. Also the quantities of waste that are processed and disposed of as a result of such studies represents an added benefit.

Current efficiencies of electrochemical processes may be much improved by using more sophisticated cell geometry. The simple rectangular tank cell does not allow the deposition of metals efficiencies from dilute solutions with high efficiency. Usually cells with 3-dimensional or moving electrodes, such as packed bed or fluidized bed, have much larger rates of metal removal than batch cell with 2-dimensional electrodes[11]. However, a RETEC cell has its advantages. It can be used to recover metals at high to moderate concentrations, is easy to clean, can be readily adapted to treat a variety of wastes, and allow for easy removal of solid products.

In future work, a combination of electrochemical treatments with a RETEC-type cell for high concentrations and a more sophisticated and efficient one for use in a polishing step for very low concentrations will be considered. This should shorten the time required for treatment of the waste and increase the overall process efficiency.

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ATTACHMENT 4

HAZARDOUS AND MIXED WASTE FACILITY INSPECTION RECORD FORM

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

HAZARDOUS AND MIXED WASTE FACILITY INSPECTION RECORD FORM

1 FACILITY	2 ☐ <90 DAY, GENERATOR STORAGE ☐ TREATMENT,STORAGE,DISPOSAL	3 START DATE	4 END DATE

5 ☐ Containers ☐ Landfill ☐ Surface Impoundment ☐ Waste Pile ☐ Thermal Treatment ☐ Chem/Phys/Bio. Treat.

☐ Incinerator ☐ Misc. Unit ☐ Tank ☐ UST ☐ Land Treatment ☐ Underground Inj.

PART I - Enter condition of item inspected (OK or AR*) in column for day inspected.

ITEM	INSPECTED FOR	SUN	MON	TUE	WED	THU	FRI	SAT
6 NO USE	CHECK IF NO WASTE IS PRESENT							
7 (UN)LOADING AREA TANKS/CONTAINERS	SPILLS AND DETERIORATION							
8 COMMUNICATION EQUIPMENT (PHONE/RADIO/ALARMS)	PROPERLY FUNCTIONING							
9 TANKS (ALL ABOVE GROUND PORTIONS) MONITORING DATA	DISCHARGE CONTROLS, CONDITION, LEAKS, LEVEL (6" FREEBOARD), CORROSION							
10 SURFACE IMPOUNDMENTS AND CONTAINMENT	FREEBOARD (2 FT.) SUDDEN DROPS IN LEVEL							
11 PORTA BERM	LEAKS, CONDITION							
12 EYE WASH SAFETY SHOWERS	LEAKS, FUNCTIONING							
13 STRUCTURAL INTEGRITY OF CONTAINERS/TANKS, VALVES, PIPES, AND FLANGES	DETERIORATION AND LEAKS, CORROSION, DAMAGE							
14 COVER/LID OF CONTAINERS	CLOSED AND SECURED							
15 WARNING SIGNS	POSTED & READABLE (BILINGUAL)							
16 LABELS	"HAZARDOUS WASTE" PRESENT ON ALL CONTAINERS/TANKS							
17 ACCUMULATION START DATE	PRESENT ON ALL CONTAINERS, TANKS, NONE EXCEED TIME RESTRICTIONS							
18 RUN ON/OFF CONTROL (AREA L, G,H, P) LANDFILLS, DETONATION PADS	INTEGRITY, EROSION, PONDING							
19 COVER INTEGRITY (AREA L, G, H,P), LANDFILLS	EROSION, SUBSIDENCE WATER INTRUSION							
20 SECURITY	CONDITION , FENCE, GATES, AND LOCKS							
21 SITE LIGHTING	FUNCTIONS PROPERLY							

Attachment 6-1
Hazardous and Mixed Waste Facility Inspection Record Form

HAZARDOUS AND MIXED WASTE FACILITY INSPECTION RECORD FORM

ITEM	INSPECTED FOR	SUN	MON	TUE	WED	THU	FRI	SAT
22 CONTAINMENT STRUCTURES	INTEGRITY, STANDING WATER, VEGETATION, EROSION							
23 AISLE SPACE, STACKING	ADEQUACY, APPROPRIATENESS							
24 MANAGEMENT OF CONTAINERS	SEGREGATED ACCORDING TO COMPATABILITY							
25 HOSE BIBS, WATER SUPPLY	LEAKS, FUNCTIONING							
26 STORAGE SHEDS	FLOOR DAMAGE, LIQUID							
27 ROAD/WORK SURFACES	CRACKS/ POTHOLES							
28 WIND SOCK	DAMAGE, FUNCTIONING							
29 SHAFT COVER AND RAIL	PRESENT, DAMAGE							
30 PALLETS	INTEGRITY, DAMAGE							
31 TREATMENT TANKS	PROPER OPERATION, LEAKS							
32 REFRIGERATOR	DAMAGE CONTAINERS, PROPER OPERATION							
33 SPILL CONTROL, FIRE, AND EMERGENCY EQUIPMENT	PRESENT AND IN GOOD WORKING ORDER							
34 INCINERATOR EMERGENCY WASTE FEED CUTOFF/ALARMS	PROPER OPERATING CONDITION OF ALL SHUTDOWN CONTROLS							
35 INCINERATOR PUMPS, VALVES, PIPES, MONITORING CONTROLS	LEAKS/SPILLS/TAMPERING OPERATING WITHIN SPECS.							
36 PRESSURE VESSELS (S-SITE)	DETERIORATION AND SAND CONDITION							
37 OIL BURN PANS (S-SITE)	DETERIORATION & LEAKS							
38 H.E. BURN PADS (S-SITE)	DETERIORATION, VEGETATION, SAND CONDITION, EROSION							
39 RADIATION SAFETY	SIGNS, MONITORING, (A, B, G, H)							
40 DATE	DATE OF INSPECTION							
41 TIME	TIME OF INSPECTION							
42 INSPECTOR	INITIALS OF INSPECTOR							

Attachment 6-1 (Continued)
Hazardous and Mixed Waste Facility Inspection Record Form

HAZARDOUS AND MIXED WASTE FACILITY INSPECTION RECORD FORM

PART II - For any AR (Action Required) in PART I above, describe below: action required, action taken, date of action. Attach additional sheets if necessary

(Note: Items 43-48 must be completed for all inspections.)

43 INSPECTOR (Printed Name)	45 Z NUMBER	46 GROUP	47 DATE	

44 INSPECTOR (Signature)

Attachment 6 -1 (Continued)
Hazardous and Mixed Waste Facility Inspection Record Form

Capacity of ETU

4.1.2.2 Divided Electrochemical Cell System

2. The divided electrochemical cell is a commercially available bench-top unit that is 30 gallons in size. The unit is equipped with numerous aluminum electrode plates that are separated by plastic to prevent their direct contact with the waste and electrolytic solutions. Up to ten 30-gallon units may be operated either in parallel or series for a maximum total waste treatment **capacity of 300 gallons per experimental setup**. Units set up in parallel will be used to process larger waste batches. Units set up in series will be used to treat progressively lower concentrations of waste constituents. Once waste has been pumped into the cell through the inlet ports, the waste and electrolytic solutions passively overflow from the outlet ports back through polyethylene (or similar plastic) piping back into the appropriate anolyte or catholyte feed containers. The electrochemical cell will be placed in secondary containment sized to hold the entire contents of the cell and equipped with a liquids detector. If liquids are detected in the secondary containment, the waste feed pumps will automatically shut off.

10.3 Maximum Waste Inventory

The **maximum inventory** of hazardous wastes that may be **stored** at in the RD&D ancillary storage area **at any one time will be 600 gallons.**

ATTACHMENT 5

LANL MIXED WASTE CONTINGENCY PLAN

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

ATTACHMENT 5
LANL MIXED WASTE CONTINGENCY PLAN

1.0 INTRODUCTION

This section presents general contingency measures for hazardous and mixed waste treatment and storage units at Los Alamos National Laboratory (LANL). The contingency plan is intended to meet the requirements specified in Title 20, New Mexico Administrative Code, Chapter 4, Part 1, (20 NMAC 4.1), Subpart (Subpt.) V, Subpart D, "Contingency Plan and Emergency Procedures," and Part B permit application requirements in 20 NMAC 4.1, Subpt. IX, 270.14(b)(7), for Resource Conservation and Recovery Act (RCRA) treatment, storage, or disposal (TSD) facilities. In addition, this document is consistent with the LANL *Emergency Management Plan* (EMP) (LANL 1993b) prepared by the LANL Emergency Management and Response (EM&R) Office. The provisions of this contingency plan will be carried out immediately whenever there is a fire, explosion, or release of hazardous or mixed waste or hazardous or mixed waste constituents that could threaten human health or the environment [20 NMAC 4.1, Subpt. V, 264.51(b)].

1.1 LANL HAZARDOUS AND MIXED WASTE EMERGENCY RESPONSE RESOURCES [20 NMAC 4.1, Subpt. V, 264.52(c) and 264.53]

The primary resources for management of emergency incidents at LANL reside within the EM&R Office, which is part of the Facilities, Security and Safeguards (FSS) Division. During an emergency situation, line management (i.e., the Group Leader of the affected area) works with the duty Emergency Manager from the EM&R Office. The Emergency Manager has primary responsibility for managing emergency response operations, making appropriate notifications, activating the emergency response organizations, and proceeding to the scene. The Emergency Manager has the authority to assume the role of Incident Commander (IC) during an emergency and assumes full responsibility for management of the emergency response operations at the scene. Additional resources include personnel from the environmental protection group(s) in the Environment, Safety, and Health (ESH) Division and the Chemical Science and Technology (CST) waste management groups at LANL.

Contracted services and other agencies are also available for assistance during emergencies. These include the contracted services of Protection Technology Los Alamos (PTLA) for security, Johnson Controls World Services, Inc. (JCI) for facility maintenance, and the Los Alamos County Fire Department (LACFD). The Los Alamos County Police Department (LACPD) provides assistance under a Memorandum of Understanding (MOU). The Los Alamos Medical Center (LAMC) provides assistance under a Planning Agreement with the U.S. Department of Energy (DOE) Los Alamos Area Office.

The IC coordinates all groups and agencies responding to the emergency and personnel operating at the scene. The emergency notification procedure is illustrated in Figure 3-1. The responsibilities and/or assistance available from the response groups and agencies are listed in Table 3-1 and discussed briefly in Sections 1.1.1 through 1.1.7. Each of the emergency response groups or agencies and the facility operators will retain a current copy of this contingency plan. The Hazardous and Solid Waste Group (ESH-19) is responsible for the controlled distribution of the contingency plan.

1.1.1 Emergency Management and Response Office [20 NMAC 4.1, Subpt. V, 264.52(d) and 264.55]

The Director of LANL has delegated the authority and responsibility for administering and implementing LANL's emergency management program to the FSS Division, which includes the EM&R Office. The EM&R Office coordinates and issues LANL's EMP and coordinates the response for emergencies. The EM&R Office also provides a 24-hour duty Emergency Manager to respond to emergencies, including hazardous and mixed waste releases. The LANL Emergency Manager is the functional equivalent of the RCRA Emergency Coordinator (20 NMAC 4.1, Subpt. V, 264.55). The EM&R Office maintains an Emergency Operations Center (EOC) in a ready condition should the center be required. The primary EOC is located at Technical Area (TA) 59, Building 1 (TA-59-1). An alternative EOC is located at TA-49-113. The duty Emergency Manager can be reached by contacting the EM&R Office (667-6211) during working hours, 667-7080 after working hours) or the emergency Central Alarm Station (CAS) operator (911).

The duty Emergency Manager will respond to emergency incidents involving the release of hazardous or mixed waste to the environment, including spills, fires, or explosions. With input from the appropriate ESH, CST, and site groups, the duty Emergency Manager will initially assess the possible hazards to human health or the environment and will use whatever response group(s) and emergency equipment are necessary to control and contain the waste. In the event of an emergency, the Emergency Manager becomes the IC will full responsibility for field activities (including logistics, planning, and operations or establishing these positions within the Incident Control Group [ICG]). At the scene of the emergency, the IC will assemble an ICG consistent of the senior person from each responding organization, functional specialists, and the duty Emergency Manager. Additional technical or management representation may be integrated into the emergency response, as needed. The ICG will receive direction from the IC. The members of the ICG will work together to mitigate emergency situations.

The duty Emergency Manager responding to an emergency will have access to a copy of the appropriate building emergency plan(s) (BEP) relating to the area in which the incident is occurring. These plans are located at the EM&R Office at TA-59. From the BEP and other site-specific information, the ICG will then supply the various response groups with specific

information relating to the facilities involved (including the layout of all affected buildings; the location of evacuation routes, equipment, and personnel; properties of the materials and wastes managed at the facility; and the hazards associated with these materials and wastes).

1.1.2 Hazardous Materials Response Group

The Hazardous Materials (HAZMAT) Team is comprised of personnel from the Hazardous Materials Response Group (ESH-10). The HAZMAT Team is responsible for the aggressive mitigation of chemical, radiological, hazardous waste, and mixed waste emergencies, including field decontamination of responders and response equipment. The HAZMAT Team may provide the LACFD with limited field decontamination support for victims. The HAZMAT Team can provide a contamination-control station at the scene of a hazardous material incident to process people working in a contaminated area and to decontaminate personnel. LANL standards require that the HAZMAT Team meet the training criteria for emergency response personnel specified in the Code of Federal Regulations (CFR), Title 29 (29 CFR), Subparts 1910.120(q)(6)(iii), (iv), and (v). The HAZMAT Team is part of the ICG reporting through the HAZMAT Group Supervisor (HMGS). The LANL HMGS coordinates or arranges for any additional ESH or CST personnel and resources that may be required for LANL or LANL-related emergencies and coordinates the HAZMAT Team and radiological field monitoring activities.

During an emergency, ESH-10 also provides site field monitoring to determine the nature and extent of contamination, provides information on correct handling of chemicals, makes recommendations on protective clothing and equipment, and provides exposure and treatment information to responders. To operate effectively, ESH-10 may obtain resources from other ESH groups, such as the Health Physics Operations Group (ESH-1) and the Industrial Hygiene and Safety Group (ESH-5).

1.1.3 The Waste Management and the Environmental Protection Response Groups

At the scene, the IC coordinates representatives and technical advisors from the Chemical and Mixed Waste Sciences (CST-5) and Hazardous and Solid Waste (ESH-19) groups and designates an Environmental Management Advisor (EMA). In addition to their post-emergency duties, these groups are responsible for on-scene emergency operations such as planning. The EMA will provide technical support and ensure LANL compliance with federal, state, and local regulations.

1.1.3.1 Waste Management Group

CST-5 is responsible for initial response actions at the hazardous and mixed waste treatment and storage units. This group also provides guidance on proper treatment, storage, and transportation of hazardous and mixed waste.

1.1.3.2 Environmental Protection and Air Quality Groups

ESH-19 provides guidance to other groups on regulatory compliance. After an emergency, ESH-19 provides field surveys of soil, water, air, and biota to determine environmental effects of exposure. ESH-19 and the Air Quality Group (ESH-17) provide expertise in hydrogeology and meteorology, respectively, to establish short- and long-term environmental effects of emergency conditions.

1.1.4 Other LANL Response Resources

Personnel from the Nuclear Materials Processing - Nitrate Systems Group (NMT-2) have been trained in emergency procedures.

1.1.5 Contracted Response Groups

Contracted response groups report to the Crisis Manager in the ICG if personnel from the EOC are activated (in a smaller emergency, the EOC is not activated). They report directly to the IC in the event of a smaller emergency. If the IC deems it necessary, the IC may designate an Operations Officer to aid in the coordination and direction of these groups.

1.1.5.1 Protection Technology Los Alamos

PTLA is responsible for LANL security, which is provided by PTLA under contract to LANL. During an emergency, PTLA activities include maintaining security, directing traffic within LANL, and controlling access to the emergency scene. PTLA maintains the necessary equipment (such as crowd-control equipment and patrol vehicles) to perform these functions. In addition, PTLA personnel staff the CAS at TA-64-1 24 hours a day.

1.1.5.2 Johnson Controls World Services, Inc.

JCI provides a maintenance support force under contract to LANL. This support force is under LANL's direction in an emergency. JCI conducts inspections of LANL equipment, maintains equipment, and participates in post-emergency cleanup under the direction of a Recovery Manager designated by the IC. The Utilities Control Center (UCC) at TA-3-223 is maintained by JCI personnel 24 hours a day.

1.1.5.3 Los Alamos County Fire Department

The LACFC provides fire protection and ambulance coverage for the residential communities of Los Alamos and White Rock and for LANL. For an emergency within LANL, the LACFD coordinates fire suppression and Emergency Medical Technician efforts, while the IC retains overall responsibility for the emergency response effort. DOE requires that

LACFD personnel meet the training criteria for emergency response personnel specified in 29 CFR Subparts 1910.120(q)(6)(i) and (ii).

1.1.6 LANL Support Groups

1.1.6.1 Health Physics Operations Group

ESH-1 provides field personnel to perform routine site evaluation and monitoring to determine the nature and extent of radiological contamination. ESH-1 also provides routine guidance on radiological decontamination. Field personnel conduct these activities under the supervision of certified health physicists. In addition, this group augments the assessment and monitoring functions of the HAZMAT Team.

1.1.6.2 Occupational Medicine Group

LANL maintains its own medical facility operated by the Occupational Medicine Group (ESH-2). ESH-2 provides appropriate medical treatment for occupation-related illnesses and injuries and monitors employees to assess the effectiveness of health protection programs. In addition to promoting early identification and prevention of illnesses or injuries that may arise from exposures to hazardous or radioactive materials, ESH-2 maintains records of the health status of employees and related occupational medicine activities.

Although ESH-2 is not routinely involved with on-scene emergency response, the group maintains a central medical facility and decontamination facilities at TA-3, Building 409 (SM-409). Additionally, this group staffs three satellite first-aid stations at TA-53, TA-16 (S-Site), and TA-55. The locations of these emergency facilities are shown on Figure 3-2. Medical staff includes physicians, physician's assistants, registered nurses, x-ray technicians, and clinical laboratory technicians. All full-time physicians and nurses receive radiation accident training.

ESH-2 maintains access to a software program called the TOMES system at the central medical facility in SM-409. This extensive database provides the clinical staff with timely exposure and treatment information. ESH-2 is supported by ESH-5, as described in Section 1.1.6.3.

1.1.6.3 Industrial Hygiene and Safety Group

ESH-5 supports ESH-2 with its ability to obtain additional exposure and treatment information via telephone access to the National Library of Medicine's TOXLINE and CHEMLINE, the Toxicity Databank files POISONDEX and TOMESPLUS (Micromedics), and the CC/INFO database files on material safety data sheets. In addition, ESH-5 maintains access to the National Institute of Occupational Safety and Health Technical Information

Center and the Registry of Toxic Effects of Chemical Substances. During routine operations, ESH-5 performs site evaluations and field testing to determine the nature and extent of chemical contamination and specifies protective clothing and equipment to be worn by LANL personnel.

1.1.6.4 Occurrence Investigations Group

The Occurrence Investigations Group (ESH-7) is responsible for the Occurrences Reporting and Processing System at LANL and has the lead in reporting the occurrence of an on-site emergency. ESH-7 is in part responsible for tracking corrective actions. ESH-7 personnel assist the facility manager in investigating the occurrence, determining casual factors, identifying appropriate corrective actions, and assisting in the preparation and submittal to DOE of reports documenting the occurrence. This group tracks the target and actual completion dates for all corrective actions associated with an emergency and maintains the information in an on-site database.

1.1.7 Outside Response Agencies

During an emergency, outside response agencies report directly to the IC. The IC may designate an Operations Officer to help coordinate and direct the groups responding to an emergency.

1.1.7.1 Los Alamos County Policy Department

The LACPD has only minimal interaction with LANL in an on-site emergency. The interaction is limited to traffic control on DOE roads with public access and to criminal investigations.

1.1.7.2 Los Alamos Medical Center

LANL maintains a fully-equipped decontamination room adjacent to the emergency room at LAMC. If a case is sent to LAMC, the emergency room staff is supported by ESH-2 medical personnel. ESH-1, ESH-5, and ESH-10 personnel also assist the emergency room staff. This assistance is coordinated through the EM&R Office.

1.2 EMERGENCY EQUIPMENT AND COMMUNICATIONS [20 NMAC 4.1, Subpt. V, 264.52(e)]

The equipment and communications system described in this section are specifically available to LANL. They represent coordinated aspects of the contingency plan.

1.2.1 Emergency Equipment

20 NMAC 4.1, Subpt. V, Subpart D requires a list of all emergency response equipment that can be used in the event of an emergency. Exhibit 3-1 lists all available emergency equipment located at the hazardous and mixed waste subunits addressed in this permit application and in the HAZMAT vehicle and trailers. The list in Exhibit 3-1 also includes supplemental emergency equipment maintained by JCI, the LACFD, and ESH-2. The locations of emergency facilities are shown on Figure 3-2.

1.2.2 Emergency Communications [20 NMAC 4.1, Subpt. V, 264.56(a)]

Effective emergency response at LANL requires an efficient communication system that will integrate required personnel into the emergency response. The initial phase of an emergency will involve a small number of individuals at the affected area and notification of the duty Emergency Manager. When responding to hazardous or mixed waste emergencies, the EM&R Office provides communications between response units and emergency organizations.

1.2.2.1 Emergency Central Alarm Station

The emergency CAS is located at TA-64-1. This station is staffed by PTLA personnel 24 hours a day and is equipped with telephones (including direct line telephones), medium- and short-range radios, a National Warning System (NAWAS) station, and an emergency power system. The fire alarm board at the control room gives the location of automatic and pull fire alarm equipment. The CASe receives alarms from several sources and, in turn, notifies the duty Emergency Manager of a hazardous or mixed waste emergency. Sources include:

- Telephone communication (911)
- Automatic fire alarms
- Manual pull alarms
- Computer interface (to warn of critical events at selected facilities)
- Security alarms
- Radio communications

Upon receipt of an alarm, the CAS operator then notifies the LACFD and the duty Emergency Manager. The Emergency Manager, the HMGS, the EOC communicator, or the CAS operator may request emergency response groups to respond. Should the LANL 911 system fail, the Los Alamos County System, located at the LACPD Station, will be used to activate emergency response groups.

1.2.2.2 Utilities Control Center

JCI personnel maintain the UCC at TA-3-223 24 hours a day. Alarms at this facility are connected to LANL experiments, equipment, and buildings to record outages and hazardous conditions. Any conditions that activate these alarms will be reported immediately to building management or to the CAS operator for notification and response.

1.2.2.3 Additional Communication Systems

Internal communication systems at LANL include the following:

- The Centrex telephone system
- A telephone paging system
- A variety of frequency modulation (FM) very high frequency (VHF) simplex repeater and trunked radio systems, including:
  - Multiple base stations
  - Mobile and hand-held units
  - Links to northern New Mexico public safety agencies
- An ultra-high frequency (UHF) radio system, including:
  - Multiple antenna sites
  - Mobile and hand-held units
  - Links with the LACPD, LACFD, and the State Medical System
- A 400 megahertz trunked radio system that includes a link with the LACFD
- Transmission and reception (through EOC) for:
  - Secure telephone
  - Secure tax
  - Secure still video
- Access to all radio systems outlined above (through EOC)

Off-site communications with federal, state, tribal, county, and other agencies are available through the following:

- A Centrex telephone system
- Private telephone lines (if Centrex fails)
- Two NAWAS
- A link to KRSN radio (local radio station)

- The local cable television
- A Community Alert Network

The LANL EOC, maintained by the EM&R Office, operates radio systems on key LANL and off-site channels. Emergency personnel responding to on-site incidents have the benefit of wide-area radio coverage using EOC facilities. After hours, the duty Emergency Manager is responsible for activating whatever support personnel, services, or equipment are needed.

1.3 CONTINGENCY PLAN IMPLEMENTATION [20 NMAC 4.1, Subpt. V, 264.56]

Section 1.3.1 defines the guidelines used to initiate this contingency plan and the resulting actions taken.

1.3.1 Guidelines for Implementation [20 NMAC 4.1, Subpt. V, 264.51(b) and 264.56]

The decision to implement this contingency plan at TA-63 depends upon whether an imminent or actual incident involving a release of hazardous or mixed waste to the environment could threaten human health or the environment. The duty Emergency Manager will use the guidelines listed below to decide whether to implement this plan.

This contingency plan will be implemented immediately in the following situations involving releases or potential releases of hazardous or mixed waste:

- Spills
  - If a hazardous or mixed waste spill cannot be contained with secondary containment or application or sorbents
  - If precipitation threatens to move spilled materials off site
  - If a hazardous or mixed waste spill causes the release of flammable material, creating a fire or explosion hazard
  - If a hazardous or mixed waste spill results in toxic fumes that threaten human health
  - If an earthquake or other natural disaster threatens containment integrity

- Explosions
  - If an unplanned explosion involving hazardous or mixed waste occurs
  - If an imminent danger of an explosion involving hazardous or mixed waste exists
- Fires
  - If a fire involving hazardous or mixed waste occurs
  - If any building, grass, forest, or nonhazardous waste fire exists that threatens to volatilize or ignite hazardous or mixed waste

1.3.2 Emergency Notification [20 NMAC 4.1, Subpt. V, 264.56(a) and (b)]

During working hours, immediately upon discovery of an imminent or actual incident involving hazardous or mixed waste, personnel will notify line management and the EM&R Office. During nonworking hours, personnel will report all incidents involving hazardous or mixed waste to the duty Emergency Manager or the CAS operator. In the case of fire involving hazardous or mixed waste, automatic alarms will be activated, personnel will activate a pull fire alarm, or personnel will dial 911 (from telephone exchanges 667 and 665) or 667-7080 (from all exchanges). All fire alarms alert the CAS operator, the LACFD, and PTLA. The CAS operator will contact the duty Emergency Manager.

Upon recognition of a hazardous or mixed waste emergency, the first arriving emergency-trained person will become the temporary IC. Once the EM&R Office is notified of the emergency, the duty Emergency Manager will proceed to the scene and be briefed by the temporary IC, personnel in the building or area, or other emergency units. The Emergency Manager will then assume the position of IC. If necessary, the IC may recommend that the EOC be activated and that the necessary members of the emergency management team be determined. The IC will form an ICG and contact the HMGS. The HMGS will notify the appropriate emergency response groups. The IC may determine from the list of response groups described in Table 3-1 which groups to contact in an emergency. Each response group maintains an on-call person or a call-down procedure to respond to emergencies.

The EM&R Office will be notified of any potential hazardous or mixed waste emergency (e.g., spills, fires, explosions). The IC and the HMGS will use whatever means are available (including the assistance of other response groups, computer data searches, and sampling) to determine if a hazardous or mixed waste is being generated, has been generated, or is being released. CST-5, ESH-10, and ESH-19 personnel have the expertise to determine

the nature and extent of contamination and the characteristics of the hazardous or mixed waste involved.

1.3.3 Emergency Manager Actions [20 NMAC 4.1, Subpt. V, 264.56(b-h)]

Upon notification of an incident, the duty Emergency Manager will:

1. Proceed directly to the scene.

2. Call the HMGS.

3. Assess the nature of the incident (e.g., through communication with the temporary IC).

4. Assume incident command.

5. Make an initial assessment of the incident and, in conjunction with the ICG, obtain resources to determine the source, quantities, and types of hazardous or mixed waste involved, and the areal extent of any released materials.

6. Based on the guidelines in Section 1.3.1 of this plan, determine if implementation of this contingency plan is warranted.

7. Recommend activation of the EOC, if necessary.

Upon deciding to implement this contingency plan, the IC will, when appropriate:

1. Assess the hazards to human health and the environment, including both direct and indirect effects (such as generation of toxic, irritating, or asphyxiating gases or hazards of runoff of water or chemicals used for fire suppression). An individual designated by the IC will use the guidelines in Section 1.3.1 to assess the hazards to human health and the environment. If any of the criteria under Section 1.3.1 are met and if the Group Leader has not already completed an evaluation of the area, the IC will initiate evacuation of the immediate area.

2. Determine if evacuation of the local area is advisable and, if so, immediately notify appropriate response groups and the LACPD, if appropriate. The IC may activate one or more of the following community alert mechanisms; the Community Alert (telephone) Network, the KRSN radio remote input system, or the cable television capture system.

3. Notify required response personnel and the LAAO Duty Officer. In the case of fire, the IC will confirm that the LACFD Senior Officer at the scene is aware of the special hazards associated with hazardous or mixed waste.

4. Warn the remaining on-scene and response personnel of imminent or actual hazards using internal radio communication systems or the public address system. A radio or public address system at key facilities throughout LANL may be used for emergency notification.

5. In emergency situations, the activated ESH representative will notify the New Mexico Environment Department (NMED) at (505) 827-9329 and the National Response Center at (800) 424-08802, reporting the following information:

   - The name and telephone number of the ESH representative
   - The name and address of the facility
   - The time and type of incident
   - The name and quantity of material involved, to the extent known
   - The extent of injuries, if any
   - The possible hazards to human health or the environment outside the facility

6. Advise the response groups of hazards in order to minimize personnel exposure and expedite mitigation.

7. When the emergency interrupts operations at the CPW skid, ensure that CST-5 personnel or, in the case of TA-55, the NMT-2 emergency response personnel monitor for leaks, pressure building, gas generation, or equipment ruptures.

Once control of the emergency is established, the IC will take all reasonable measures to minimize the occurrence, recurrence, or spread or fires, explosions, or releases. In addition, the IC will delegate cleanup and decontamination responsibilities to include the following:

1. Arranging for site cleanup.

2. Providing for proper handling of recovered waste, contaminated soil, or contaminated surface or groundwater.

3. Providing for decontamination of equipment, as needed.

4. Arranging for replacement or repair of equipment, as needed.

5. Ensuring that testing is conducted to verify successful cleanup.

Within 15 days of the incident, DOE/LAAO will submit a report to the Secretary of the NMED. The contents of this report are generated by several LANL groups responding to the emergency, as detailed in Section 1.12.

1.4 SPILLS [20 NMAC 4.1, Subpt. V, 264.56(e) and 264.196(a-e)]

Sudden releases include spills of hazardous or mixed waste that pose a significant threat to human health or the environment. Spills resulting in a sudden release of hazardous or mixed waste that presents a potential threat to human health or the environment, as listed in Section 1.3.1, require implementation of this contingency plan.

Hazardous and mixed wastes are stored on site in a variety of containers including, but not limited to, 55-gallon drums, lab packs, tanks, and small laboratory bottles. At the TA-63 Hazardous and Mixed Waste Treatment Building (HMWTB), chemical and plating waste will be treated in a tank treatment system. Volumes of hazardous or mixed waste stored or treated will vary from subunit to subunit. The general steps in handling hazardous and mixed waste spills are as follows:

1. Isolate the immediate area and deny entry to all unauthorized personnel.

2. If safe, contain the spill by spreading sorbents or forming temporary dikes to prevent further migration (performed by properly trained personnel).

3. Monitor the spill area and sample the spilled waste and contaminated media.

4. Package the waste and contaminated media in sound containers.

5. Decontaminate the area and all involved equipment and personnel (followed by monitoring to ensure adequate cleanup.

6. Remove the waste and contaminated media (performed by CST-5).

The IC will determine the steps to be taken for spill mitigation. If initial mitigation of the spill is necessary and can be accomplished safely before the Emergency Manager arrives, a qualified member of the affected area's operating group will serve as the temporary IC.

The emergency preparedness procedures related to flammable organic solve spills require stabilization of the spilled material with an organic solvent spill kit. Other chemical spills are to be stabilized using acid and caustic spill kits or by adding sorbents. During spill control and cleanup, all personnel will wear personal protective equipment (PPE). ESH-5 will conduct monitoring to ensure that chemical exposure is minimized. ESH-1 will conduct health physics monitoring whenever mixed waste is involved to ensure that radiation

exposure is also minimized. The stabilized material may be treated as hazardous or mixed waste, depending on the components present. Runoff from spills of listed hazardous or mixed wastes that have migrated outside waste storage or treatment areas must be contained and managed as hazardous or mixed waste, as appropriate. If the spill was from a characteristic hazardous or mixed waste and if analysis shows that the runoff does not exhibit the characteristic (i.e., ignitability, corrosivity, reactivity, or toxicity), then the runoff need not be managed as characteristic waste. Temporary dikes may be constructed to contain runoff.

1.4.1 Spill Control Procedures

When a flammable organic solvent spill, a highly acidic spill, or a highly caustic spill has been stabilized with the contents of an organic solvent spill kit, an acid spill kit, or a caustic spill kit, respectively, the resulting material may be sorbed using a nonbiodegradable sorbent. The nonbiodegradable sorbent must be compatible with the spilled material. Approved drums or packaging will be used to collect all spilled material and contaminated sorbent. For cossorives, the drums will be lined with polyethylene drum liners. Exhibit 3-1 lists emergency equipment available. CST-5 will determine the ultimate disposition of any contaminated sorbent or waste material according to RCRA regulatory requirements.

1.4.1.1 Tank System Spill Control and Reporting

Treatment tank or storage tanks will be removed from service immediately using approved shutdown procedures if a leak or spill occurs from the tank system or its secondary containment system or if either system is determined to be unfit for use. Further addition of waste to the tank or containment system will cease and the system will be inspected to determine the cause of the leak or spill. If a leak occurs from a tank system, as much of the waste as is necessary to prevent further release of waste will be removed within 24 hours after detection or as early as practicable, and the system will be inspected and repaired. All released waste will be removed within 24 hours or as soon as possible if a leak occurs to a tank's containment system.

If a spill from a tank is not immediately contained and cleaned up and exceeds a quantity of 1 pound, the release will be reported to the NMED within 24 hours of its detection as required at 20 NMAC 4.1, Subpt. V, 264.196(d)(1). In addition, a written report will be submitted to the NMED within 30 days describing the likely migration route of the release; soil characteristics at the site; monitoring and sampling data relevant to the releases; proximity to downgradient drinking water, surface water, and populated areas; and response actions taken or planned.

1.4.1.2 Tank System Secondary Containment, Repair, and Closure

If the integrity of a tank system, including its secondary containment, has not been damaged by a spill, the system may be returned to service. Service may not resume until after all released waste is removed and any necessary repairs are made. Any tank system that cannot satisfy the criteria described above will be closed in accordance with the requirements of 20 NMAC 4.1, Subpt. V, 264.197.

1.4.1.3 Certification of Major Repairs

If a tank system has been repaired and the repair has been extensive (e.g., an internal liner installed, or a ruptured primary or secondary containment vessel repaired), the tank system will not be returned to service unit until it is certified by an independent, qualified, registered professional engineer who verifies that the repaired system is capable of handling wastes without releases for the intended life of the system. This certification will be submitted to NMED within 7 days after returning the tank system to use.

1.4.2 Decontamination Verification

Decontamination will be accomplished at the spill site. After the spilled material has been sorbed, the material will be containerized. If the spill occurs on a cemented or asphalt area, water or an appropriate solvent will be used to clean the area. Liquids (i.e., spilled material and the cleaning water or solvents used to clean a spill) will be sorbed with a compatible, nonbiodegradable sorbent and will be containerized. If a spill is known source, the spilled material will be analyzed for the hazardous waste constituents known to be components of the waste managed at that subunit. The appropriate analytical method(s) given in Table 3-2 will be used. If the spill is from an unknown source, the spilled material will be analyzed for all of the parameters listed in Table 3-2. All personnel who verify decontamination will wear PPE. ESH-5 will conduct monitoring to ensure that chemical exposure is minimized. ESH-1 will conduct health physics monitoring whenever mixed waste is involved to ensure that radiation exposure is minimized. Any hazardous or mixed waste collected from decontamination activities will be handled appropriately.

In order to establish baseline data, a sample of decontamination water or solvent and nonbiodegradable sorbent material will be taken prior to the start of the decontamination effort. A sample of the material used to sorb the final wash water will then be taken. No hazardous waste constituents should be present in this sample at levels above those found in the baseline data. If the sample exhibits any of the characteristics of a hazardous waste as defined in 20 NMAC 4.1, Pt. II, Subpart C, or if a hazardous constituent listed in 20 NMAC 4.1, Pt. II, Appendix VIII (and not detected in the baseline data) is present above established health-based levels, the decontamination procedure will be repeated. An alternative demonstration of decontamination may be proposed and justified to NMED, who will

evaluate the proposed alternative in accordance with the standards and guidance then in effect. If the proposed alternative is accepted, decontamination levels will meet the levels approved by NMED. Each sample will be collected with an appropriate sampling device (e.g., thief or trier) as specified in EPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition Updates I and II (SW-846) (EPA 1992), and subsequent updates, as applicable.

If the spill occurs on soil around the tank perimeter, any free liquid present will be sorbed with a compatible nonbiodegradable sorbent, and the resulting material will be containerized. For such a spill, all contaminated soil will be excavated and containerized. ESH-5 will conduct industrial hygiene monitoring. If mixed waste is involved, ESH-1 will conduct health physics monitoring to minimize exposure during soil removal operations. To establish comparative background data, one or more samples will be collected from an unaffected area near the spill site. The samples will be analyzed and the data will be compared with the background data to ensure that all contaminated material has been removed.

If a spill occurs in an area with sealed floors, verification sampling will be performed after decontamination. Swipe samples or other types of sampling appropriate for the contaminant will be collected at random in the area and analyzed. For a spill that occurs in an area that does not have sealed floors, random samples of the floor material, such as concrete chips, will be collected and analyzed for decontamination verification. Contaminated floor material will be removed if the level of contamination remains above that detected in the background data after repeated decontamination attempts. If a spill occurs on asphalt, the asphalt will be decontaminated, and a sample of the material used to sorb the final wash water will be collected and analyzed for decontamination verification.

1.5 EXPLOSION

Explosions and resultant releases may result in a significant threat to human health or the environment. The potential exists for hazardous or mixed waste to be released during an explosion. Implementation of this contingency plan is required whenever a sudden release that cannot be contained or that presents a threat to human health or the environment occurs as a result of an explosion.

In the case of an explosion, all personnel will immediately evacuate the area. On-site personnel will call 911 immediately. The CAS will ensure that all necessary emergency response personnel are alerted, including the EM&R. The LACFD is notified automatically by CAS. Any injured personnel will be decontaminated at the site, if required and time allows. An LACFD ambulance will transport these personnel to an ESH-2 facility or to LAMC for treatment. If an injury is severe and requires immediate medical evacuation, the injured person will be wrapped to contain contamination, if necessary. The Emergency

Manager assumes incident command and will remain near, but at a safe distance, from the site in order to inform personnel responding to the explosion of the known hazards.

If a fire results from an explosion, the LACFD Senior Officer will, upon arrival at the scene, evaluate all available information and determine the appropriate fire fighting methods and tactics. The LACFD Senior Officer will direct firefighting operations under the generation direction of the IC.

1.6 FIRE

Fires and resultant releases of hazardous or mixed waste may result in a significant threat to human health or the environment. Implementation of this contingency plan is required whenever a fire results in a sudden release of hazardous or mixed waste that cannot be contained or that presents a threat to human health or the environment.

Depending on the size of the fire and the fuel source, portable fire extinguishers may be used. However, LANL policy does not encourage the use of portable fire extinguishers by personnel. Instead, LANL policy encourages immediate evacuation of the area and notification of the LACFD. For any fire, including a fire that involves hazardous or mixed waste, the responsible Group Leader and the EM&R Office must be contacted immediately. The Emergency Manager will alert all other necessary emergency response personnel. If the fire spreads or increases intensity, all personnel must evacuate to an assembly/muster area or other area designated by the Group Leader or Emergency Manager. The Emergency Manager assumes incident command and will remain near the scene to advise personnel responding to the fire of the known hazards.

Upon arrival at the scene, the LACFD Senior Officer will evaluate all available information and determine the appropriate firefighting methods and tactics. The LACFD Senior Officer will direct firefighting operations under the generation direction of the IC.

1.7 EXPOSURE TO HAZARDOUS OR MIXED WASTE

If a person is exposed to hazardous or mixed waste, the affected person, a coworker, or line management will notify the EM&R Office. Appropriate first aid should be administered immediately. An EM&R Office representative will contact ESH-10 as soon as possible so that exposure levels and decontamination requires can be established. The injured person will then be quickly transported to the ESH-2 medical facility or to the LAMC for evaluation. If possible, the material causing the injury will be ascertained and the information given to the medical staff.

The following effects may indicate exposure to hazardous or mixed waste that will necessitate evacuation of the area:

- Irritation of the eyes, breathing passages, or skin
- Difficulty in breathing
- Nausea, light-headedness, vertigo, or blurred vision

The affected person will be transferred to the ESH-2 medical facility or LAMC. An ESH-1, ESH-5, or ESH-10 representative will attempt to ascertain what, if any, exposure occurred and what corrective measure is appropriate.

1.8 EVACUATION [20 NMAC 4.1, Subpt. V, 264.52(f)]

A facility will be evacuated upon the voice command to evacuate the area or upon the surrounding of the evacuation or fire alarm.

1.8.1 Emergency Process Shutdown Prior to Evacuation

Personnel will be instructed to shut down equipment before evacuating a building unless an immediate building evacuation is announced or signaled. To ensure efficient shutdown, training and exercises in process shutdown will be performed. In the case of an immediate evacuation, a selected team may shut down designated equipment in an evacuated area. The team will be equipped with the proper equipment, clothing, and breathing apparatus. If present, ESH-1, ESH-5, and ESH-10 personnel will provide advice and assistance. Process shutdown procedures apply mainly to hazardous or mixed waste treatment units.

1.8.2 Evacuation Plan

Emergency situations may warrant the shutdown and evacuation of areas or buildings in order to protect personnel and property, to anticipate an emergency condition, or to enhance an appropriate response. Table 3-3 shows the criteria for evacuation, personnel responsible for initiating evacuations, and reentry conditions.

To initiate the evacuation of a building or area, the evacuation or fire alarm will be sounded, the public address system may be used, or both. Evacuation alarms cannot be silenced and reset by site personnel. On the Fire Alarm Maintenance Section at 667-4027 and the LACFD Platoon Chief at 667-7026 can silence and reset the alarms.

To evacuate a portion of a building or area, the public address system may be more appropriate. The public address system will be used to notify the occupants of the area to be evacuated and will advise personnel throughout the building of the existence of a problem in a specific area.

In the evacuation of only a portion of the building, an outbuilding, or an outlying work area, the Group Leader will designate a control point at the closest safe location (considering wind direction). The designated area will be outside the affected area and will serve as an assembly/muster area where the Group Leader, or designee, can oversee evacuation operations and work to prevent further spread of the hazards.

The evacuation procedure follows:

1. The personnel discovering the accident or emergency will call 911 and ensure that line management and the EM&R Office are notified.

2. TA-50 building emergency plan(s) or emergency action procedures will be followed concerning evacuation, sweep, personnel accountability, and equipment shutdown procedures.

As personnel exit an affected building or area, a primary sweep of the building or area will be performed to ensure that all personnel have evacuated. If the building or area is evacuated, a group leader designee will take attendance at the assembly/muster area and report personnel accountability to the IC.

For a small-scale evacuation, a responsible on-site person may direct the evacuation. For a large-scale evacuation, the CAS may be activated. The EM&R Office will be notified immediately and will dispatch the duty Emergency Manager. A responsible on-site person may begin the evacuation process until the duty Emergency Manager arrives at the scene to assume that responsibility.

1.9 SALVAGE AND CLEANUP [20 NMAC 4.1, Subpt. V, 264.56(g) and (h)]

Appropriate representatives from the ESH groups will survey the affected area before salvage and cleanup begin. They will visually inspect and sample the affected area to determine whether cleanup is complete. If gases or fumes, electrical or radiological problems, or other conditions present a hazardous situation, personnel or selected teams equipped with proper breathing apparatus and protective clothing will reenter the area to perform designated decontamination tasks, repairs, and salvage to allow the return to normal operations. After an emergency, the IC will turn the operation over to the Recovery Manager. The Recovery Manager is the functional equivalent of the RCRA Emergency Coordinator for post-emergency, who will:

- Provide for proper handling of recovered waste, contaminated soil or surface water, or any other material that results from a spill, fire, or explosion. Contaminated material will be managed appropriately and temporarily stored at one of the hazardous or mixed waste storage areas

at LANL. CST-5 will be responsible for determining the final disposition of the waste. This determination will be made in compliance with RCRA treatment, storage, and disposal standards.

- Arrange to inspect for damage or improper operation of the unit and associated equipment.

- Arrange for site cleanup and ensure that no waste that may be incompatible with the released material is treated or stored in the same area.

- Ensure that emergency equipment is cleaned, decontaminated, and fit for its intended use before operations are resumed. Equipment will be inspected visually and then sampled, if necessary, to determine the type and degree of contamination and to determine appropriate cleanup measures.

Prior to resuming operations, facility management will verify that the previously mentioned tasks have been performed. The owner/operator (LAAO) will notify appropriate state and local authorities that cleanup procedures are completed and emergency equipment is clean and fit for its intended use.

The IC assumes coordination of post-emergency actions (particularly during the time immediately following the emergency) until a Recovery Manager is appointed. The post-emergency actions include cleanup operations, repairing vital equipment, or interim hazard-removal operations (such as arranging for the demolition of unstable walls). The services of the affected operational organizations, ESH groups, JCI, and other on-site resources will also be used to estimate cleanup costs and operational impact.

1.10 POST-EMERGENCY ASSESSMENT

When the emergency is over, the cause of the emergency and the effectiveness of the response will be investigated in an effort to prevent future emergencies and to facilitate more effective responses to them. Following each emergency requiring the implementation of this contingency plan, EM&R will schedule and conduct a critique with representatives from all response groups, representatives from the building or area in which the emergency occurred, and representatives from LANL management to determine the adequacy of the response.

1.11 EMERGENCY RESPONSE RECORDS AND REPORTS [20 NMAC 4.1, Subpt. V, 264.56(j)]

Any emergency that requires implementation of the contingency plan will be documented by the Group Leader responsible for the hazardous or mixed waste unit. The Group Leader will submit the incident report to ESH-19. The incident report, submitted to LAAO to the NMED within 15 days, will include the following information:

- Name, address, and phone number of owner or operator
- Name, address, and phone number of the facility
- Date, time, and type of incident (e.g., fire, explosion, spill)
- Name of material(s) involved
- Quantity of material(s) involved
- Extent of injuries (if any)
- Assessment of actual or potential hazards to human health or the environment
- Estimated quantity and disposition of material recovered from the incident

LANL personnel responding to the emergency will record the details of any incident requiring implementation of this plan. The CAS operator, the EOC communicator, the Emergency Manager, or the Group Leader responsible for the hazardous or mixed waste management area or unit in which the emergency occurred will record the date, time, location of the incident, wastes and materials involved, injuries (if any), property damage (if any), and a detailed description of the incident. This information will be maintained in the facility operating record. CST-5 will supply information to ESH-19 concerning any follow-up actions. Appropriate LANL personnel will provide to ESH-19 details regarding the removal and disposition of hazardous and mixed wastes associated with the emergency.

1.12 CONTINGENCY PLAN AMENDMENT [20 NMAC 4.1, Subpt. V, 264.54]

This contingency plan will be reviewed by the EM&R Office, CST-5, ESH-19, and if necessary, by ESH-10. The plan will be amended immediately if determined to be inadequate to handle releases (spills, explosions, or fires), and whenever

- The facility permit is reviewed and revised

- There is change in the design or operation of the facility (e.g., quantities of waste handled and handling techniques) that increases the likelihood of an emergency and requires changes in emergency response

- The list of Emergency Managers changes
- The list of emergency equipment changes significantly

This plan is a controlled document distributed by ESH-19. Amendments to this contingency plan will be distinguished by the revision number and date of revision noted in the upper right-hand corner of each page. Amendments will be issued to all contingency plan holders and will include a cover letter that describes the plan changes and the rationale for those changes.

TABLE 3-1

Response Groups and Agencies Available to the Emergency Management and Response Office for Guidance and/or Emergency Assistance

LANL[a]-Controlled Response Group	Telephone	Responsibilities
ESH-1, Health Physics Operations	667-7171	Provides routine guidance on radiological decontamination. Provides routine site evaluation and monitoring to determine the nature and extent of radiological contamination.
ESH-2, Occupational Medicine	667-7251	Provides emergency medical treatment.
ESH-5, Industrial Hygiene and Safety	667-5231	Provides guidance on industrial hygiene equipment and on operational safety. Provides routine site evaluation/support and field testing to determine the nature and extent of chemical contamination.
ESH-7, Occurrence Investigation	667-0598	Reports occurrences and tracks follow-up actions.
ESH-10, Hazardous Materials Response	665-5237	Provides emergency site evaluation and field monitoring (chemical and radiological). Specifies protective clothing and equipment. Dispatches the Hazardous Materials Response Team. Provides support for chemical, radiological, hazardous, and mixed waste incidents and decontamination of responders and response equipment.
CST-27, Waste Management Facilities	667-7391	Provides guidance on proper treatment, storage, and off-site shipment of hazardous and mixed waste.
ESH-19, Hazardous and Solid Waste	667-0666	Provides guidance on regulatory requirements. Conducts field surveys to determine spread of contamination and adequacy of cleanup.
ESH-17, Air Quality	665-8855	Provides information on meteorological conditions.
NMT-2, Nuclear Materials Processing - Nitrate Systems Group	665-1448	Monitors for leaks, pressure building, gas generation, or equipment ruptures in the event of interruption of operations at TA-55 caused by an emergency.
PTLA, Protection Technology Los Alamos	667-4437	Provides traffic control and security.
JCI, Johnson Controls World Services, Inc.	667-6191	Dispatches maintenance personnel and equipment. Assists in waste cleanup under direction of the Recovery Manager.

Refer to footnotes at end of table.

TABLE 3-1 (Continued)

Response Groups and Agencies Available to the Emergency Management and Response Office for Guidance and/or Emergency Assistance

Non-LANL[a]-Controlled Response Group	Telephone	Responsibilities
Los Alamos County Fire Department	667-4055	Dispatches firefighting personnel, equipment, and Emergency Medical Technicians.
Los Alamos County Policy Department	662-8222	Provides traffic control on public access roads.
Los Alamos Medical Center[b]	662-4201 662-2455	Provides medical services. Provides and maintains the Emergency Room.

[a] Los Alamos National Laboratory
[b] Medical services related to hazardous and mixed waste injuries are provided under the direction of ESH-2.

Table 3-2

Waste Analysis Parameters and Test Methods[a]

Parameter	Test Method	Reference[b]
Ignitability	Pensky-Martens Closed-cup method	(L) SW1010 (L) ASTM D93-80
Reactivity	Test method to determine hydrogen cyanide released from waste Test method to determine hydrogen sulfide released from waste	(L,S) SW Section 7.3
Corrosivity	Electrometric (pH of aqueous solution)	(L) SW9040
Toxicity Characteristic:	Toxicity characteristic leaching procedure (TCLP) Extraction and graphite furnace atomic absorption (AA) spectroscopy	(L,S) Method SW1311
Arsenic		(L) SW7060, SW7061A
Barium		(L) SW7081, SW7080
Cadmium		(L) SW7131, SW7130
Lead		(L) SW7191, SW7190
Selenium		(L) SW7421, SW7420
Silver		(L) SW7740
Mercury	TCLP extraction and manual cold vapor technique	(L) SW7761, SW7760A (L) SW7470
Volatile organics	TCLP extraction and gas chromatography/mass spectrometry (GC/MS) GC/MS capillary column technique	(L) SW8240
Semivolatile organics	TCLP and GC/MS Packed column technique GC/MS capillary column technique	 (L) SW8250 (L) SW8270A
Organochlorine pesticides	TCLP extraction and GC	(L) SW8080
Chlorinated herbicides	TCLP extraction and GC	(L) SW8150
Chemical composition	95% organic composition by GC/flame ionization detector (FID)	(L) SW8100
Trace organic analysis	Any of the following:	
	Volatile organic compounds (GC/MS) Semivolatile organic compounds (GC/MS) - packed column - capillary column	(L) SW8240 (L) SW8250 (L) SW8270

Refer to footnotes at end of table.

Table 3-2 (Continued)

Waste Analysis Parameters and Test Methods[a]

Parameter	Test Method	Reference[b]
Heat value	Bomb calorimeter	(L) A006, ASTM D240
Organic chloride	Halide titration of combustion residue	(L,S) A004, ASTM D2361
Ash content	Residue after combustion in muffle furnace	(L) A001, ASTM D482 (S) A001, ASTM D3174
Cyanide, free and total	Distillation and colorimetric ultraviolet	(L) SW9012, SW9010
Total chromium	Colorimetric method for hexavalent chromium	(L) SW7196
Sulfide	Colorimetric titration	(L) SW9030
Total metals[c]	Acid digestion Inductively coupled plasma-atomic emission spectroscopy	(L,S) SW3020A (L) SW6010A
Arsenic		(L) SW6010A
Barium		(L) SW6010A
Beryllium		(L) SW6010A
Cadmium		(L) SW6010A
Chromium		(L) SW6010A
Lead		(L) SW6010A
Nickel		(L) SW6010A
Selenium		(L) SW6010A
Silver		(L) SW6010A
Thallium		(L) SW6010A
Zinc		(L) SW6010A
Mercury	Manual cold vapor technique	(L) SW7471A (L) SW7470
Free liquids	Paint Filter Liquids Test	(S) SW9095

[a] At Los Alamos National Laboratory, current analytical capabilities include the analysis of mixed waste samples. This analysis include gross alpha, beta, and gamma screening.

[b] "A" refers to "Sampling and Analysis Methods for Hazardous Waste Combustion," EPA-600/8-84-001 (EPA 1984).
"ASTM" refers to American Society for Testing Materials Standards.
"SW" refers to U.S. Environmental Protection Agency, 1992, "Test Methods for Evaluating Solid Waste," SW-846, Physical/Chemical Methods.
(L) refers to liquid waste.
(S) refers to solid waste.
See 55 FR 11863.

[c] See also Atomic Absorption Methods listed under TCLP.

Table 3-3

Evacuation Determination and Reentry Conditions

Reason for Evacuation	Evacuation Determination Made by	Reentry Conditions[a]
Fire	Fire or evacuation alarm, Group Leader or alternate, lead engineer, senior staff member present, senior technician, or emergency manager	Following survey by the chief fire officer, ESH-1[b], ESH-5[c], and/or ESH-10[d], and R&D[e] supervision
Explosion	Same as above	Same as above
Loss of ventilation	Group Leader or alternate, senior staff member, lead engineer, or senior technician	Following survey by ESH-1 and/or ESH-5, and R&D supervision
Loss of electric power	Same as for loss of ventilation	Following survey by ESH-1 and/or ESH-5, and R&D supervision
Extensive contamination	ESH-1 representative or same as for loss of ventilation	Following survey by ESH-1 and ESH-10, or following survey by ESH-1 and/or ESH-5, and R&D supervision
Airborne contamination	Same as for loss of ventilation or radiation monitor	Following survey by ESH-1 and ESH-10, or following survey by ESH-1 and/or ESH-5, and R&D supervision
Escape or release of toxic of hazardous gas or fumes	Group Leader or alternate, senior staff member, lead engineer, senior technician, or emergency manager	Following survey by ESH-1 and/or ESH-5, and R&D supervision plus ESH-5 or ESH-10
Bomb or bomb threat	EM&R[f] or PTLA[g] representative, trained R&D section leader or alternate, senior staff member, or lead engineer	Following determination by the emergency manager or HDT[h] leader

[a] All reentries are authorized by the incident commander.
[b] "ESH-1" refers to the Health Physics Operations Group.
[c] "ESH-5" refers to the Industrial Hygiene and Safety Group.
[d] "ESH-10" refers to the Hazardous Materials Response Group.
[e] "R&D" refers to the Research and Development Section.
[f] "EM&R" refers to the Emergency Management and Response Office.
[g] "PTLA" refers to the Protection Technology Los Alamos.
[h] "HDT" refers to the Hazardous Devices Team.

EXHIBIT 3-1

Emergency Equipment

Hazardous Materials (HAZMAT) Vehicles and Associated Emergency Equipment:

Hazardous Materials (HAZMAT) vehicles and trailers are available to ESH-10 for emergency response to all of the Technical Areas (TAs) at LANL. They are located at TA-52. ESH-10 is responsible for maintaining the supplies of appropriate emergency equipment in each vehicle and trailer.

The HAZMAT vehicles and trailers are equipped with safety and emergency equipment, personal protective clothing, and other supplies, which may include, but are not limited to assorted coveralls, T-shirts, and gloves; safety goggles and glasses; boots and booties; face shields; totally encapsulating suits and boots; Level A and B suits; flash suits; self-contained breathing apparatus (SCBA) and SCBA bottles; hazardous chemical reference books and other reference materials; shovels; siphon pumps; assorted spill kits and sorbents; chemical burn and neutralizing solutions; communication radios; bottles of leak detector; leak repair kits; emergency repair packs; HAZMAT bags; gas detectors; respirators and cartridges; sponges and cleaners; warning signs; traffic control barriers; flashlights; timers; cameras and film; knives; warning and signal horns; harnesses and belts; portable emergency oxygen; and assorted tools, tape, and other supplies.

Supplemental Emergency Equipment Available from the Los Alamos County Fire Department

Equipment	Number
Engine companies (1,250 gallons per minute) Engines 1, 3, 4, 5, 6, 10, and 40	7
Engine 50 (reserve - 1,000 gallons per minute)	1
Minipumpers MT-1, MT-3, MT-4, and MT-5	4
Modular ambulances 3 first line - M1, M3, M4 1 reserve unit - M10	4
Rescue vehicles 1 first line 1 stored at Station 5, out of service 1 newly purchased	3
Crash-Fire-Rescue units CFR 6	2
SCBA units	44
SCBA air tanks	130
105-foot tower ladder with pump (1,500 gallons per minute)	1
Personnel with 120 hours Emergency Medical Technician Training	90
Personnel with Advance Life Support Training	14
Water tankers T-1 (1,500 gallons) T-3 (2,500 gallons) T-4 (3,000 gallons) T-5 (2,500 gallons) T-50 (1,500 gallons)	5

Supplementary Emergency Equipment and Personnel Available from Johnson Controls World Services, Inc.

Equipment/Personnel	Number
Transportation	
Pickups (1/2 to 3/4 ton)	183
Trucks (1 to 3 ton)	25
Buses (11 passenger)	2
Vans (panels and carryalls)	24
Special Equipment	
Road grader, Caterpillar, self-propelled blade, with radio	1
Grader, John Deere, self-propelled, with radio	2
Loaders, bucket, Melroe, Bobcat, 1/3 cubic yards	3
Loader, bucket, Caterpillar, 2-3/4 cubic yards with radio	1
Loader, Fiat-Allis, 3 cubic yards	1
Loader, bucket, Caterpillar, 2-1/2 cubic yards	1
Loader, bucket, Caterpillar, 3-1/4 cubic yards	1
Loader, bucket, Yale, 3 cubic yards, with radio	1
Loader, bucket, backhoe, Case, 1-1/2 cubic yards	1
Loaders, bucket, backhoe, Case, 7/8 cubic yards	2
Loader, backhoe, Ford, 1 cubic yard	1
Snowplows, Bombardier, with blade	2
Bulldozer, D-8 Crawler	1
Bulldozers, TD-25, International	2
Scraper, Terex, self-propelled	1
Scraper, Fiat-Allis, self-propelled	1
Bulldozer, 280, rubber-tired, with radio	1
Semitrailers	6
Chain saws	(approx) 6
Flusher, street, 3,000-gallon truck, 500-gallon tanker, FMC	1
Mobile transceivers (2-way, KOB-753)	144
Generators	6
Handsets (2-way)	113
Pageboys (1-way)	398
Welders, mounted on trailers and trucks	32
Personnel	
Heavy-equipment operators	14
Clerks	10
Dispatchers	1
Mechanics	17
Power-saw operators	8
Radio and telephone operators	1
Truck drivers	13

Emergency Equipment and Personnel at the Central Medical Facility and Satellite First-Aid Stations, ESH-2

TA-3 (SM-409) Central Clinic

Equipment/Personnel	Number*
Personnel	
Physicians (2 casual)	7
Physician's Assistants (2 casual)	4
Nurses (3 casual and 1 at 75%)	10
X-ray Technicians	1
Clinical Laboratory Technicians (4 part-time)	5
Special Equipment - Portable	
Multichannel emergency receiver	1
Two-way radios on the State Medical Net, the LANL Emergency Management channel	5
Cardiac monitors and defibrillators (1 backup)	2
Crash cart emergency equipment with E-tank oxygen (O_2)	1
Portable physicians' bag with medications	1
Portable suction unit	1
Portable stretchers, 1 ambulance, 2 gurney, 1 folding	4
Wheelchairs	3
O_2 tanks	3
Manual resuscitators	2
Intravenous (IV) stands	2
IV solutions	*
Otoscope/ophthalmoscopes	4
Portable sphygmomanometers	6
Stethoscopes	20
Anticontamination apparel	*
Eye irritation solution	*
Full set air splints	1
Industrial first-aid kits	3
Extrication and cervical collars, crutches, canes	*
Suture sets	4
Protective apparel	4

* Inventory varies as needed.

Emergency Equipment and Personnel at the Central Medical Facility and Satellite First-Aid Stations, ESH-2 (Continued)

TA-3 (SM-409) Central Clinic (Continued)

Equipment/Personnel	Number*
Supplies - General	
Bedding/pillows	
Rescue blankets	
Burn blankets	
Thermal/icing pouches	
Multitrauma dressings, surgical and first aid supplies	
Disposable ice bags	
Special Facilities - Nonportable	
Completely-equipped emergency room with ambulance entrance	
Emergency lighting system	
Complete X-ray suite	
Protective clothing, and wound counters	
12-lead electrocardiograph (2)	
Fully-equipped crash cart with Life Pak, intubation equipment, emergency medications, etc.	
Fully-equipped decontamination room at Los Alamos Medical Center (LAMC) adjacent to the LAMC emergency room	
Transportation	
1983 Dodge Van (full ambulance service is available within minutes to the central facility and all satellite clinics	
Communication	
Base station on State Medical Net	

* Inventory varies as needed.

Emergency Equipment and Personnel at the Central Medical Facility and Satellite First-Aid Stations, ESH-2 (Continued)

TA-16 (S-Site) Satellite First-Aid Station

Equipment/Personnel	Number*
Personnel	
Nurse (half-time)	
Special Equipment - Portable	
Ambulance bag	1
Stretcher	1
Wheelchair	1
O_2 Tank	1
IV solutions	*
Otoscope/ophthalmoscopes	1
Sphygmomanometer	2
Industrial first-aid kit	1
Crutches	1
Cane	1
Disposable suture set	1
Full face shields, vinyl apron	1
Endotracheal tube laryngoscope	1
Digital thermometer	1
Supplies	
Ample first-aid supplies	

* Inventory varies as needed.

Emergency Equipment and Personnel at the Central Medical Facility and Satellite First-Aid Stations, ESH-2 (Continued)

TA-53 Satellite First-Aid Station

Equipment/Personnel	Number*
Personnel	
Physician's Assistant (part-time)	1
Nurse (half-time)	10
Special Equipment - Portable	
Beeper	1
Stretcher	1
Wheelchair	1
O_2 Tank	1
IV solutions	*
Otoscope/ophthalmoscopes	2
Sphygmomanometer	1
Stethoscope	2
Anticontamination apparel	*
Eye irritation solution	*
Industrial first-aid kit	1
Extrication and cervical collars	1
Crutches	1
Suture set	1
Supplies	
Ample first-aid supplies	

* Inventory varies as needed.

Emergency Equipment and Personnel at the Central Medical Facility and Satellite First-Aid Stations, ESH-2 (Continued)

TA-55 Satellite First-Aid Station

Equipment/Personnel	Number*
Personnel	
Nurse (half-time)	
Special Equipment - Portable	
Beeper	1
Stretcher	1
Wheelchair	1
O_2 Tank	1
Otoscope/ophthalmoscopes	1
Sphygmomanometer	1
Stethoscope	1
Contamination apparel	*
Eye irritation solution	1
Inflatable limb traction splints (set)	1
Industrial first-aid kit	1
Cervical collar	1
Crutches (pair)	1
Ambulance bag	2
Supplies	
Ample first-aid supplies	

* Inventory varies as needed.

Spill Kit Inventory* for TA-63

Description of Item	Number**
Surgical gloves	
Rubber mallet	
83-gallon overpack drum	
Drum up-ender	
Face shield	
Goggles (pair)	
Utility knife	
Safety glasses	
Drum sling	
Pair leather gloves	
Channel locks	
25-lb bag of clay absorbent	
Small plastic shovel	
Large plastic shovel	
HazMat substance and waste compliance book	
Bung wrench	
Neoprene gloves	
1/2 in. drive ratchet	
15/16 in. deepwall socket(s)	
7/16 in. socket	
50 lbs. of caustic neutralizer	
100 lbs. of acid neutralizer	
Coveralls	
Crescent wrench	
Duct tape (roll)	
Small broom	
Scoop	

* Typical inventory.
** Inventory varies as needed.

ATTACHMENT 6

RESUMES OF KEY PROJECT STAFF

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

Stanislaw Marczak
802 9th Street Apt. #22
Los Alamos NM 87544
ph. 661-6521(home); 6674487 (work)
e-mail stas@lanl.gov

SUMMARY OF EXPERIENCE

Extensive experience in basic, applied and analytical electrochemistry. Experience in various electroanalytical technics, DC technics (polarography, linear and staircase voltammetry, chronopotentiometry, chronocoulometry and chronoamperometry, pulse technics) and AC technics. Appreciable skills in bench scale experimenting and chemical analysis (different spectral and electrocanalytical methods, classic methods). Teaching experience in analytical and inorganic chemistry.

EDUCATION

Ph.D. in Chemistry with Honors. 1994, Warsaw University, Department of Chemistry, Poland. Thesis: "Chemical and electrochemical properties of Cr(III)/Cr(II) and Cr(II)/Cr(0) redox couples in aqueous, weakly complexing solutions".
M.S. in Chemistry with Honors. 1985 Warsaw University, Department of Chemistry, Poland.

AWARDS

In 1983 - 1986 participant in International Competitions in Analytical Chemistry (ICAC, about 10-15 countries from Europe), places: 4 (11th ICAC, 1983), 2 (12th), 2 (13th; 1986). In 1985, during 12th ICAC Obtained the highest score in the theoretical part of ICAC in the history of these competitions.

EMPLOYMENT

LANL. March 1995 - Present; Postdoctoral Research Associate.
University of Warsaw, Chemistry Department. 1985 - 1995; Assistant Professor.

Research

- Applications of electrochemical systems for treatment of diversified mixed wastes;
- Investigations of electrode kinetics, mass transport phenomena and thermodynamic properties for electrode reactions of transition metal complexes;
- Investigations of chemical, electrochemical and spectroscopic properties of complexes, mainly Cr(III), Co(III) and Cr(II);
- Development and testing of a new electrochemical digital equipment (potentiostats, phase analyzers for AC measurements);
- Development of a process for recovery of vanadium from toxic wastes resulting from oil distillation in a refinery;
- Investigations of production of hydroxylamine by electrolytic reduction of nitrate or nitrite.

Teaching

- Teaching courses in analytical and inorganic chemistry, electroanalysis, properties and methods of preparations of complexes, at the Department of Chemistry and the Department of Biology of Warsaw University;

- Since 1991 a member of the Main Committee of the Polish Chemistry Olympiad (for high school students), since 1988 - referee of problems for this Olympiad;
- Mentor of the Polish team for the International Chemistry Olympiad in 1992 in USA, and 1994 in Norway.

PUBLICATIONS and PRESENTATIONS

1. Dziewinski J., Marczak S., Smith W.; "Electrochemical treatment of mixed and hazardous waste"; Proceedings of the 1995 MRS Fall Meeting, Boston, MA, Nov. 27 - Dec. 1, 1995

2. Marczak S., Wrona P. K., Galus Z; "Kinetics and Mechanism of the Electrode Reactions of the Cr^{2+}"; *Journal of Electroanalytical Chemistry*; **396**(#1-2) (1995) 419-429

3. Dziewinski J., Marczak S., Purdy G., Smith W., Taylor J., Zhou C.; "Electrochemical Treatment of Waste"; Proceedings of "Emerging Technologies in Hazardous Waste Management VII"; ACS Special Symposium, Atlanta, GA, September 17-20, 1995

4. Marczak S.; "The Structure of Water and Aqueous Solutions"; *Chemia w Szkole*; **40** (1994) 25-32

5. Marczak S.; "The Amalgams"; *Kurier Chemiczny*; **6** (1992) 1-7

6. Marczak S., Wrona P. K., Scholz F.; "Stability of $Cr(H_2O)_5Br^{2+}$ and $Cr(H_2O)_5I^{2+}$ Complexes Formed by Cr^{2+} Oxidation at Mercury Electrodes"; *Journal of Electroanalytical Chemistry;* **280**(#2) (1990) 359-370

7. Marczak S., Wrona P. K.; "Electrooxidative Formation and Characteristics of Cr(III) Thio Complexes at Mercury Electrodes"; *Journal of Electroanalytical Chemistry*; **247**(#1-2) (1988) 215-227

8. Dziewinski J., Marczak S., Smith W. "Electrochemical System for Mixed Waste Treatment"; *Chemtech*, accepted for printing

9. Dziewinski J., Marczak S., Nuttall E., Smith W., "Experiences with Treatment of Mixed Waste"; presentation accepted for "Spectrum 96, Nuclear and Hazardous Waste Management International Topical Meeting"; Seattle, WA, August 18-23, 1996

10. Dziewinski J., Marczak S., Nuttall E., Purdy G., Smith W., Taylor J., Zhou C.; "Electrochemical treatment of waste"; *Journal of Environmental Science and Health*, in print

11. Marczak S. (co-author); "Encyclopedia of Chemistry for High Schools and Colleges"; in print

12. Marczak S. (co-author); "Applications of the Elements"; in print

13. Marczak S., Wrona P. K.; "Frequency Dispersion of the Double Layer Lapacity. Experimental Verification of the Damaskin and Grafov Theory"; sent to *Journal of Electroanalytical Chemistry*

14. Marczak S., Wrona P. K.; "Diffusion Coefficient of Chromium in Mercury"; in preparation

15. Marczak S., Wrona P. K.; "Temperature Dependence of the Transfer Coefficients for Cr^{3+}/Cr^{2+} and Cr^{2+}/Cr^{0}(Hg) Couples in Concentrated Sodium Perchlorate Solution"; in preparation

16. Marczak S., Wrona P. K.; "Determination of Kinetics Parameters of Electrode Reaction by the Fast Pulse Method and Semiintegration"; in preparation

17. Marczak S., Wrona P. K.; "Numerical Simulation of Chronocoulometric Wave for the EC Mechanism"; in preparation

Jacek J. Dziewinski

79 Mesa Verde, Los Alamos, NM 87544

Telephones: work 505/667-9792; home 505/672-0409

e-mail: jacek@lanl.gov

SUMMARY OF EXPERIENCE

- In-depth and hands-on knowledge of industrial electrochemical processes.
- Experience in plant operations of a nonferrous metal smelter.
- Experience with Ni-Cd and Zn-alkaline batteries.
- A history of experience with bench/pilot/implementation stages of process and product development.
- Managerial experience in development of waste treatment processes.
- Expertise in dealing with environmental regulations.

EMPLOYMENT

Los Alamos National Laboratory. 1993 - Present.

Technical Staff Member

Major Projects.

Leads the development of an innovative electrochemical process for treatment of mixed (hazardous and radioactive) wastes. The project involves an alliance of a multidivision LANL team, with the University of New Mexico, and a private company, under a Cooperative Research And Development Agreement (CRADA). The process has been successfully employed to treat drums of waste containing heavy metals and cyanides. Currently it is undergoing a scale-up.

Managed the development of several skid mounted mixed waste treatment processes: Water-Reactive Waste Treatment Skid, Chemical Plating Treatment Skid, and Uranium Chips Treatment Skid. The responsibilities included conceptual design and modeling, development of PFDs and P&IDs, fabrication supervision, and start-up.

Big River Zinc Corporation. St. Louis, MO. 1989-1993.

Senior Process Engineer.

Major Projects.

Led a project to modify the process for production of cadmium oxide. The successful modification allowed to control the size of CdO crystals. This ability gave the company a competitive edge in the nickel-cadmium rechargeable battery market.

Led a group of engineers and technicians which developed a new cadmium product from bench to pilot plant operation. The new crystalline form of Cd enhanced the performance of rechargeable batteries.

Directed the design of an off-gas train for a new smelting operation. This $30 million project included gas cooling, dedusting, and desulfurization.

Optimized the process for production of high purity zinc powder for no gassing alkaline batteries.

Engaged in support of plant operations, such as production logistics, trouble-shooting, quality control, evaluation and purchasing of the equipment.

Prototech Company - subsidiary of Metallgesellschaft. Newton, MA. 1987-1989.

Process Engineer.

Major projects:

Lead a team of engineers and technicians that developed a process for electrochemical production of hydrogen peroxide for paper pulp bleaching.

Provided engineering support in the development, design, and startup of a new process for electrowinning of metals based on the concept of a hydrogen depolarized anode. The process, which was implemented by Ruhr Zink GmbH, lowers the zinc electrowinning voltage from approximately 3.6 to 1.5 Volts

University of Mining and Metallurgy. Cracow, Poland. 1982-1986.

Assistant Professor.

Worked on mathematical models of solid-fluid reactions. Developed a method for determination of reaction rate constant for such reactions. The method was later successfully applied to determine the rate constant for coal gasification.

Delivered lectures to graduate students on heat and mass transfer.

EDUCATION

M.Sc. in Chemical Process Engineering. Polytechnic University of Cracow, Poland. 1976-1982.

The University of New Mexico. Pursuing a Ph.D. degree at the Department of Chemical and Nuclear Engineering.

Other non-credit courses:

Colorado School of Mines, Golden, CO - Economic Evaluation and Investment Decision Methods;
University of Edwardsville, Edwardswille, IL - Concepts and Practices of Management;
Executive Enterprises - Environmental Regulations;
Government Institutes, Inc. - Advanced RCRA Course;
American Management Association - Project Management, Planning, Scheduling and Control;
Foxboro Training Institute - I/A Series System - Computerized Process Control.

PUBLICATIONS:

Author of fifteen technical papers.

ADDITIONAL INFORMATION:

Active Q-Clearance.
Married, two children.
Ability to communicate in German, Russian and Polish languages.
Knowledge of political, social, and economical culture of Eastern Europe, including former Soviet Union.

Stanislaw Marczak
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SUMMARY OF EXPERIENCE

Extensive experience in basic, applied and analytical electrochemistry. Experience in various electroanalytical technics, DC technics (polarography, linear and staircase voltammetry, chronopotentiometry, chronocoulometry and chronoamperometry, pulse technics) and AC technics. Appreciable skills in bench scale experimenting and chemical analysis (different spectral and electrocanalytical methods, classic methods). Teaching experience in analytical and inorganic chemistry.

EDUCATION

Ph.D. in Chemistry with Honors. 1994, Warsaw University, Department of Chemistry, Poland. Thesis: "Chemical and electrochemical properties of Cr(III)/Cr(II) and Cr(II)/Cr(0) redox couples in aqueous, weakly complexing solutions".
M.S. in Chemistry with Honors. 1985 Warsaw University, Department of Chemistry, Poland.

AWARDS

In 1983 - 1986 participant in International Competitions in Analytical Chemistry (ICAC, about 10-15 countries from Europe), places: 4 (11th ICAC, 1983), 2 (12th), 2 (13th; 1986). In 1985, during 12th ICAC Obtained the highest score in the theoretical part of ICAC in the history of these competitions.

EMPLOYMENT

LANL. March 1995 - Present; Postdoctoral Research Associate.
University of Warsaw, Chemistry Department. 1985 - 1995; Assistant Professor.

Research

- Applications of electrochemical systems for treatment of diversified mixed wastes;
- Investigations of electrode kinetics, mass transport phenomena and thermodynamic properties for electrode reactions of transition metal complexes;
- Investigations of chemical, electrochemical and spectroscopic properties of complexes, mainly Cr(III), Co(III) and Cr(II);
- Development and testing of a new electrochemical digital equipment (potentiostats, phase analyzers for AC measurements);
- Development of a process for recovery of vanadium from toxic wastes resulting from oil distillation in a refinery;
- Investigations of production of hydroxylamine by electrolytic reduction of nitrate or nitrite.

Teaching

- Teaching courses in analytical and inorganic chemistry, electroanalysis, properties and methods of preparations of complexes, at the Department of Chemistry and the Department of Biology of Warsaw University;

14. Marczak S., Wrona P. K.; "Diffusion Coefficient of Chromium in Mercury"; in preparation

15. Marczak S., Wrona P. K.; "Temperature Dependence of the Transfer Coefficients for Cr^{3+}/Cr^{2+} and Cr^{2+}/Cr^{0}(Hg) Couples in Concentrated Sodium Perchlorate Solution"; in preparation

16. Marczak S., Wrona P. K.; "Determination of Kinetics Parameters of Electrode Reaction by the Fast Pulse Method and Semiintegration"; in preparation

17. Marczak S., Wrona P. K.; "Numerical Simulation of Chronocoulometric Wave for the EC Mechanism"; in preparation

Prototech Company - subsidiary of Metallgesellschaft. Newton, MA. 1987-1989.

Process Engineer.

Major projects:

Lead a team of engineers and technicians that developed a process for electrochemical production of hydrogen peroxide for paper pulp bleaching.

Provided engineering support in the development, design, and startup of a new process for electrowinning of metals based on the concept of a hydrogen depolarized anode. The process, which was implemented by Ruhr Zink GmbH, lowers the zinc electrowinning voltage from approximately 3.6 to 1.5 Volts

University of Mining and Metallurgy. Cracow, Poland. 1982-1986.

Assistant Professor.

Worked on mathematical models of solid-fluid reactions. Developed a method for determination of reaction rate constant for such reactions. The method was later successfully applied to determine the rate constant for coal gasification.

Delivered lectures to graduate students on heat and mass transfer.

EDUCATION

M.Sc. in Chemical Process Engineering. Polytechnic University of Cracow, Poland. 1976-1982.

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ATTACHMENT 7

SUMMARIES OF TRAINING COURSES

Los Alamos National Laboratory

ELECTROCHEMICAL TREATMENT UNIT RD&D PERMIT APPLICATION

Subject: General Employee Training

Compliance Requirements:	DOE Order 5480.20A, 10 CFR, 29 CFR, 40 CFR, and DOE and LANL Radiological Control Manuals
Description:	Consists of the following 16 training modules: Classified and Sensitive Information (6936) Emergency Management (5544) Environment (5548) Facilities (5974) Fire Protection (7710) Industrial Hygiene (5545) Industrial Safety (5540) Introduction to the Laboratory (8881) Lockout/Tagout (5541) OSHA Rights and Responsibilities (5543) Occupational Medicine (5546) Policies and Procedures (5975) Quality Program (5976) General Employee Radiological Training (5547) Materials Control and Accountability (5711) Security (5977)
Audience:	Required for *new* workers who will be on site for more than 10 consecutive workdays and for *all* workers whose job assignments require unescorted access to nuclear facilities and/or radiological controlled areas.
Prerequisite:	None
Examination:	Successful completion of the written GET examination is required for unescorted access to nuclear facilities and/or to radiological controlled areas.
Retraining/ Reexamination:	Every 2 years: Retraining and reexamination on only the General Employee Radiological Training (5547) module is required for unescorted access to radiological controlled areas.
Length:	8 hours
Frequency:	Every week
Self-Study/ CBT Options:	This training may be completed through self-study or computer-based training, followed by the written GET examination.
Information:	Contact Ken Johnson, ESH-13, 5-8249, MS J596.
Registration:	Contact ESH-13, 5-7948 or 7-0059, MS J596, for classroom training, self-study materials, or computer-based training.

Subject: **Environment—Waste Management**
Course: **Waste Generation Overview**

Course Number: **8477**

Compliance Requirements:	AR 10-3 and 40 CFR 262–265
Description:	Presents an overview of federal and state regulations and LANL policies and procedures pertaining to hazardous waste management; waste identification; and the waste management process, including waste minimization, temporary storage requirements, and waste disposal.
Audience:	Required for RCRA waste generators, less-than-90-day storage area workers, satellite accumulation area workers, TSD facility workers, and waste management coordinators. Suggested for line managers of hazardous waste workers. Note: This course replaces both Hazardous Waste Generator (4419) and Waste Generator for Temporary Storage (3597).
Prerequisite:	None
Retraining:	Every 2 years is suggested
Length:	4 hours
Frequency:	Every 2 weeks
Self-Study Option:	This training may be completed through the following 5 self-study courses, preferably in the order listed: Environmental Regulations Overview (11492) Waste Management Overview (11494) Waste Minimization/Pollution Prevention Overview (11489) Waste Characterization Overview (11490) Temporary Waste Storage Overview (11493)
Information:	Contact Wilbur Bergquist, ESH-13, 5-7932, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596, for classroom training or self-study materials.

Subject: **Health—Chemical** Course Number: **2388**

Course: **Hazard Communication Introduction**

Compliance Requirements:	ARs 1-4, 1-9, 6-1, 6-2, 6-4, 6-9, and 8-1; and 29 CFR 1910.1200 and 1910.1450
Description:	Provides information about requirements of the OSHA Hazard Communication Standard and its application at LANL. Includes detailed discussion of the worker's right-to-know, labeling requirements, and MSDSs, and the general principles of hazard recognition, evaluation, and control. Also covers the LANL Chemical Hygiene Plan and spill and leak response.
Audience:	Required for those who work directly with chemicals or who may be routinely exposed to chemicals during the course of their normal work activities.
Prerequisite:	None
Retraining:	None
Length:	3.5 hours
Frequency:	Every week
Information:	Contact Joan March, ESH-13, 5-7965, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596.

Subject: **Radiation—Radiological Worker** Course Number: **7453**

Course: Radiological Worker I Training

Compliance Requirements:	LANL and DOE Radiological Control Manuals, Articles 611–634, and 10 CFR 835.902
Description:	Provides information on worksite radiation hazards, basic radiation concepts, the biological effects of radiation, the risks associated with exposure to ionizing radiation, and general radiological control requirements that will allow the radiological worker I to make informed decisions on personal safety and to take actions that can reduce radiation exposure. Consists of classroom training, a written examination, and a practical evaluation.
Audience:	Required for radiological workers whose job assignments require unescorted access to radiological buffer areas or radiation areas and/or who operate radiation-generating devices.
Prerequisite:	None
Retraining:	Every 2 years
Length:	12 hours
Frequency:	Every week
Self-Study/ CBT Options:	This training may be completed through self-study or computer-based training, followed by the written examination and the practical evaluation.
Information:	Contact Angela Coop, ESH-13, 5-7966, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596, for classroom training, self-study materials, or computer-based training.

Subject: Radiation—Radiological Worker
Course: Radiological Worker II Training

Course Number: **7454**

Compliance Requirements:	LANL and DOE Radiological Control Manuals, Articles 611–634, and 10 CFR 835.902
Description:	Provides information on worksite radiation and contamination hazards, basic radiation concepts, the biological effects of radiation, the risks associated with exposure to ionizing radiation, and radiological control requirements that will allow the radiological worker II to make informed decisions on personal safety and to take actions that can control contamination and reduce radiation exposure. Consists of classroom training, a written examination, and a practical evaluation.
Audience:	Required for radiological workers whose job assignments involve unescorted access to high radiation areas, very high radiation areas, contamination areas, high contamination areas, or airborne radioactivity areas and/or who have potential contact with hot particles, or who perform operations on bench tops, in fume hoods, at sample stations, in open-front boxes, or in glove boxes.
Prerequisite:	None
Retraining:	Every 2 years
Length:	16 hours
Frequency:	Every week
Self-Study/ CBT Options:	This training may be completed through self-study or computer-based training, followed by the written examination and the practical evaluation.
Information:	Contact Angela Coop, ESH-13, 5-7966, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596, for classroom training, self-study materials, or computer-based training.

Subject: **Environment—RCRA**
Course: **RCRA Personnel Training**

Course Number: **7488**

Compliance Requirements:	40 CFR 264.16 and 265.16
Description:	Covers RCRA provisions, applicable state and federal regulatory requirements, the permitting process, internal and external inspection requirements, and an overview of LANL's Contingency Plan. Partially fulfills RCRA training requirements.
Audience:	Required for less-than-90-day storage area workers, TSD facility workers, RCRA-permitted RD&D workers, spill coordinators and waste management coordinators working in RCRA-regulated areas, and HAZMAT team members who may respond to incidents at RCRA facilities. May be required for environmental restoration workers, depending on the site. Suggested for satellite accumulation area workers and line managers of hazardous waste workers.
Prerequisite:	Waste Generation Overview (8477) or Hazardous Waste Generator (4419)
Retraining:	Every year: RCRA Refresher Training (9581)
Length:	5 hours
Frequency:	6 times a year
Information:	Contact Wilbur Bergquist, ESH-13, 5-7932, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596.

Subject: **Health—First Aid/CPR** Course Number: **3583**
Course: **CPR: Adult**

Compliance Requirements:	ARs 1-8, 6-1, 6-9, 7-1, 8-1, 8-4, 8-5, and 15-1
Description:	Includes artificial ventilation, 1-person adult CPR, and choking-prevention procedures for adults. Participants who successfully complete this course are issued an American Red Cross certification card, valid for 1 year.
Audience:	Suggested for all workers. Required for field workers, confined space rescue workers, emergency responders, and those working hands-on with energized electrical systems. CPR requirement may also be fulfilled through successful completion of First Aid: Standard (3574) or CPR: Community (3582).
Prerequisite:	None
Retraining:	Every year
Length:	4–6 hours, depending on class size
Frequency:	As needed
Information:	Contact Joan March, ESH-13, 5-7965, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596; for classes at your work site, contact Safety Services at 471-2628.

Subject: **Health—First Aid/CPR** Course Number: **3582**
Course: **CPR: Community**

Compliance Requirements:	ARs 1-8, 6-1, 6-9, 7-1, 8-1, 8-4, 8-5, and 15-1
Description:	Includes 1-person CPR; artificial ventilation; and choking-prevention procedures for adults, children, and infants. Participants who successfully complete this course are issued an American Red Cross certification card, valid for 1 year.
Audience:	Suggested for all workers.
Prerequisite:	None
Retraining:	Every year
Length:	8 hours
Frequency:	As needed
Information:	Contact Joan March, ESH-13, 5-7965, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596; for classes at your work site, contact Safety Services at 471-2628.

Subject: **Health—First Aid/CPR** Course Number: **3574**

Course: **First Aid: Standard**

Compliance Requirements:	ARs 1-8, 6-1, 6-9, 7-1, 8-1, 8-4, 8-5, and 15-1
Description:	Includes adult 1-person artificial ventilation; CPR; choking-prevention procedures; control of bleeding; initial treatment of burns, fractures, sprains, poisoning, diabetes, shock, strokes, seizures, and hypothermia; and movement of injured persons. Participants who successfully complete the entire course are issued an American Red Cross certification card for (1) adult CPR, valid for 1 year, and (2) standard first aid, valid for 3 years.
Audience:	Suggested for all workers, especially those working in remote field locations, in areas involving spark- or flame-producing operations, in limited egress/confined spaces, and/or with chemicals, flammables, combustibles, explosives, cryogens, hazardous gases, energized electrical systems, and machine shop equipment.
Prerequisite:	None
Retraining:	Every 3 years to maintain certification in first aid; CPR: Adult (3583) is required every year during intervening years to maintain CPR certification
Length:	8 hours
Frequency:	As needed
Information:	Contact Joan March, ESH-13, 5-7965, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596; for classes at your work site, contact Safety Services at 471-2628.

Subject: **Environment—Waste Management** Course Number: **8504**
Course: **Waste Documentation Forms**

Compliance Requirements:	ARs 10-2, 10-3, and 10-9
Description:	Provides step-by-step instructions on how to fill out the appropriate forms for characterizing and disposing of hazardous and mixed wastes using a case study approach with relevant LANL examples.
Audience:	Required for generators of hazardous, mixed, and/or radioactive waste who complete the Waste Profile Form and the Chemical Waste Disposal Request and for waste management coordinators who have oversight of the forms.
Prerequisites:	Waste Generation Overview (8477) and for mixed or radioactive waste generators, Radiological Worker I Training (7453) or Radiological Worker II Training (7454)
Retraining:	None
Length:	4 hours
Frequency:	Once a month
Information:	Contact Wilbur Bergquist, ESH-13, 5-7932, MS J596.
Registration:	Contact ESH-13, 7-0059, MS J596.