AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

Underground Storage Tank - Integrated Demonstration Technical Task Plan Master Schedule

C. M. Johnson

Date Published
August 1994

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

**Westinghouse
Hanford Company**

P.O. Box 1970
Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

MASTER

Approved for Public Release

yB
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Document Title: Underground Storage Tank - Integrated Demonstration
 Technical Task Plan Master Schedule

Prepared by:

Cynthia M. Johnson
Cynthia M. Johnson
Westinghouse Hanford Company

8-23-94
Date

Approved by:

R. L. Gilchrist for R.A.
Roger L. Gilchrist
Underground Storage Tank - Integrated
Demonstration Coordinator

8/24/94
Date

RELEASE AUTHORIZATION

Document Number: WHC-EP-0431, Revision 1

Document Title: Underground Storage Tank - Integrated Demonstration
Technical Task Plan Master Schedule

Release Date: August 22, 1994

* * * * *

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

M. N. Boston

(Signature)

M. N. Boston

8/22/94

(Date)

TABLE OF CONTENTS

1.0	INTRODUCTION	1-1
2.0	PROGRAM OVERVIEW	2-1
3.0	ACTIVITY DESCRIPTION	3-1
3.1	CHARACTERIZATION SYSTEM	3-1
3.1.1	Spectroscopy	3-3
3.1.2	Physical Properties	3-4
3.1.3	Surveillance and Integrity Monitoring	3-4
3.1.4	Characterization System Implementation	3-5
3.2	LIGHT DUTY UTILITY ARM SYSTEM	3-6
3.2.1	Light Duty Utility Arm	3-7
3.2.2	Light Duty Utility Arm End Effectors	3-9
3.2.3	Light Duty Utility Arm System Design	3-10
3.2.4	Light Duty Utility Arm System Pre-Operational Test	3-10
3.2.5	Light Duty Utility Arm System Operational Testing	3-11
3.3	WASTE DISLODGING AND CONVEYANCE SYSTEM	3-12
3.3.1	High Pressure Scarifier Dislodging and Pneumatic Conveyance Methods	3-12
3.3.2	Medium Pressure Miner Dislodging and Jet Pump Conveyance Methods	3-14
3.3.3	Waste Simulant Development	3-16
3.3.4	Tank Retrieval Support	3-16
3.4	WASTE PROCESSING AND DISPOSAL SYSTEM	3-17
3.4.1	Supernate/Saltcake Processing	3-18
3.4.2	Sludge Processing	3-20
3.4.3	Destruction and Waste Forms	3-21
4.0	MASTER SCHEDULES	4-1
4.1	CHARACTERIZATION SYSTEM	4-1
4.2	LIGHT DUTY UTILITY ARM SYSTEM	4-1
4.3	WASTE DISLODGING AND CONVEYANCE	4-4
4.4	WASTE PROCESSING AND DISPOSAL	4-4
5.0	BIBLIOGRAPHY	5-1

LIST OF FIGURES

Figure 4-1	UST-ID Characterization Level 0 Schedule	4-2
Figure 4-2	UST-ID Characterization Level 1 Schedule	4-3
Figure 4-3	UST-ID Light Duty Utility Arm Level 0 Schedule	4-5
Figure 4-4	UST-ID Light Duty Utility Arm Level 1 Schedule	4-6
Figure 4-5	UST-ID Waste Dislodging & Conveyance Level 0 Schedule	4-7
Figure 4-6	UST-ID Waste Dislodging & Conveyance Level 1 Schedule	4-8
Figure 4-7	UST-ID Waste Processing & Disposal Level 0 Schedule	4-9
Figure 4-8	UST-ID Waste Processing & Disposal Level 1 Schedule	4-10

LIST OF TABLES

Table 3-1	UST-ID Characterization Programmatic Milestones	3-2
Table 3-2	UST-ID LDUA Programmatic Milestones	3-8
Table 3-3	UST-ID Waste Dislodging and Conveyance Programmatic Milestones	3-13
Table 3-4	UST-ID Waste Processing and Disposal Programmatic Milestones	3-19

LIST OF APPENDIXES

Appendix A	Underground Storage Tank-Integrated Demonstration Program Master Site Support Matrix	A-1
Appendix B	Underground Storage Tank-Integrated Demonstration Program Activity and Technical Task Plan Matrix	B-1

LIST OF ACRONYMS

CADAS	Control and Data Acquisition System
CEA	Commissariat L'Energie Atomique
CPU	Compact Processing Unit
CWRP	Characterization and Waste Retrieval Program
DDR	Detailed Design Review
DOE	U.S. Department of Energy
EEES	end effector exchange system
EM	Environmental Restoration and Waste Management
FY	fiscal year
FSU	Florida State University
GTM	Generic TRUEX Model
IR	infrared
LDUA	Light Duty Utility Arm
LRF	laser range finder
NAC	nitrate to ammonia and ceramic
NDE	non-destructive examination
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
OTD	Office of Technology Development
PNC	Power Reactor and Nuclear Fuel Development Corporation of Japan
SCADAS	Supervisory Control and Data Acquisition System
SKID	Skid-mounted Ion-exchange Demonstration
TRIC	Tank Riser Interface Confinement
TRUEX	transuranic extraction
TTP	Technical Task Plan
TWRS	Tank Waste Remediation Services
UST	underground storage tank
UST-ID	Underground Storage Tank-Integrated Demonstration
WD&C	Waste Dislodging and Conveyance
WPDP	Waste Processing and Disposal Program
WP&D	Waste Processing and Disposal

1.0 INTRODUCTION

This document provides an integrated programmatic schedule (i.e., Master Schedule) for the U.S. Department of Energy (DOE) Underground Storage Tank-Integrated Demonstration (UST-ID) Program. It includes top-level schedule and related information for the DOE Office of Technology Development (EM-50) UST-ID activities. The information is based upon the fiscal year (FY) 1994 technical task plans (TTPs) and has been prepared as a baseline information resource for program participants.

The Master Schedule contains Level 0 and Level 1 program schedules for the UST-ID Program. This document is one of a number of programmatic documents developed to support and manage the UST-ID activities. Other related programmatic planning documents are as follows:

- The Strategic Plan defines the values, mission, and vision for the UST-ID Program. It establishes overall multi-year programmatic and technical goals and strategies.
- The Program Plans describe the technical objectives, scope, and interfaces for the Characterization and Waste Retrieval Program (CWRP) and for the Waste Processing and Disposal Program (WPDP).
- The Technical Task Plans are the baseline scoping documents for the technical work to be performed by each of the DOE-Headquarters contractors during the current fiscal year. The TTPs include detailed fiscal year milestones and deliverables.
- The Work Plans are the baseline work management documents and provide integrated system development plans for the technical scope to be performed during the current fiscal year.

The following sections of this document provide the background, Level 0 and Level 1 schedules, and supplemental information described below.

- Section 2.0 Program Overview provides a summary background of the UST-ID Program. This summary addresses the mission, scope, and

organizational structure of the program. It also addresses the applicability of specific technology development to site-specific technology requirements.

- Section 3.0 Activity Description provides a programmatic description of UST-ID technology development activities and lists the key milestones for the UST-ID systems. Separate subsections address the Characterization, Light Duty Utility Arm (LDUA), Waste Dislodging and Conveyance (WD&C), and Waste Processing and Disposal (WP&D) systems.
- Section 4.0 Master Schedules contains the Level 0 and Level 1 programmatic schedules for the UST-ID systems. Separate subsections address the Characterization, LDUA, WD&C, and WP&D systems.
- Section 5.0 References lists the UST-ID programmatic documents used as a basis for preparing the Master Schedule.

The appendixes contain additional details related to site-specific technology applications.

2.0 PROGRAM OVERVIEW

Over the past five decades, contractors for DOE and its predecessor agencies have generated substantial quantities of radioactive, hazardous, and mixed wastes during the production of nuclear materials. Large volumes of the mixed radioactive and hazardous wastes are currently being stored as solids and liquids in underground storage tanks (USTs) at various DOE sites pending the finalization and implementation of treatment and disposal plans.

The Office of Technology Development (OTD) within the DOE Office of Environmental Restoration and Waste Management (EM) established the UST-ID Program to provide demonstration, testing, and evaluation of technologies proposed to support the treatment and final disposal of these tank wastes. UST-ID program support is being provided for tank waste management programs at the Fernald, Idaho Falls, Oak Ridge, Hanford, and Savannah River sites.

The UST-ID program is organized into two programs which manage the development of the technologies proposed to support the tank waste management programs at the DOE sites listed above. The Characterization and Waste Retrieval Program includes the Characterization systems, the LDUA system, and the WD&C systems. These systems support tank waste characterization, tank waste retrieval, and tank and pipe integrity monitoring. The Waste Processing and Disposal Program consists of the pre-treatment and treatment systems. These systems support hazardous and radioactive waste treatment processes to reduce waste volumes and to produce waste forms suitable for long term disposal.

The UST-ID scope and activities are coordinated with the site EM representatives. Proposed tank waste management technologies have been identified by the site EM representatives and/or the UST-ID program as selected, candidate, or potentially applicable to site issues. The attached Master Site Support Matrix (Appendix A) illustrates the technology demonstrations currently being conducted or supported by UST-ID and the site-specific waste management requirements and issues being addressed by those technologies.

3.0 ACTIVITY DESCRIPTION

The UST-ID program includes the planning, implementation, and evaluation activities that are required to support demonstrations of the technologies being developed. The following sections describe the systems and identify activities and key milestones. The activity descriptions reflect the programmatic logic supporting the UST-ID strategic plan. This programmatic logic is consistent with the scope and milestones contained in the program TTPs and Work Plans, but is not a direct rollup of either the tasks or the work breakdown contained, respectively, in these two documents. The function of the Master Schedule is to provide a programmatic perspective while the functions of the TTPs and Work Plans are to define and manage specific tasks and system development.

The relationship of the Master Schedule programmatic activities to the UST-ID TTPs is shown in Appendix B.

3.1 CHARACTERIZATION SYSTEM

The UST-ID Characterization System activities support the demonstration of technologies being developed to determine the chemical, radiological, and physical properties of the tank wastes and the structural integrity of the underground storage tanks and piping. These technologies include Raman and near-infrared spectroscopy, rheology and physical properties sensors, and pipe and tank leak detection systems.

Characterization activities include study, design, procurement, assembly, testing and evaluation of spectroscopy, physical properties, and surveillance and inspection technologies for hot cell, in situ, and process monitoring systems.

Key milestones for these activities are listed in Table 3-1.

Table 3-1. UST-ID Characterization Programmatic Milestones.

Milestone Number	TTP Number	Title	Date
1	RL-421207 No. 2-1	Raman spectroscopy: Provide report on initial hot cell data collection	11/30/93
2	RL-421207 No. 2-5	Infrared spectroscopy: Demonstrate integrated system in cold test facility	09/30/94
3	SF-211203 No. 3	Cone penetrometer Raman probe: Provide conceptual design	09/30/94
4	OR-132008 No. 9-1	Acoustic emission: Complete report	06/30/94
5	OR-132008 No. 9-2	Acoustic emission: demonstration of prototype configuration	09/30/94
6	RL-421207 No. 4-1	Online chemical monitoring: Prepare Draft needs	09/30/94
6	RL-421207 No. 4-2	Online chemical monitoring: Provide preliminary functions and requirements	09/30/94

3.1.1 Spectroscopy

The scope of Spectroscopy involves the development and testing of spectroscopy-based characterization tools for deployment in hot cells, waste storage tanks, and waste processing and treatment. The workscope includes the development, optimization, and feature testing of Raman and infrared (IR) spectroscopy and deployment technologies. Within Spectroscopy, the activities have been divided into the following:

- LDUA Raman Spectroscopy--procurement and integration of the Raman spectroscopy system for use with the LDUA. Raman spectroscopy will be used to determine chemical speciation for organic and ferritic compounds in the tank wastes. This activity includes the definition of constraints and the design and procurement of a prototype Raman spectroscopy probe for the LDUA.
- Remote Raman--pre-design studies for the development of a Raman fiber optic probe that can be deployed with the cone penetrometer system in waste. This activity includes support by Florida State University.
- Infrared Spectroscopy--procurement and integration of a near-IR spectroscopy system, suitable for moisture measurement in the hot cell or tank. This activity includes definition of constraints affecting hot cell and in situ deployment, development and cold testing of a prototype moisture detection probe, and development of cone penetrometer deployment concepts.
- Cone Penetrometer Raman Probe Concepts--procurement and integration of a cone penetrometer system for in situ deployment of the Raman spectroscopy system. The cone penetrometer will physically penetrate the saltcake and sludge to allow access for in situ characterization sensors. This activity includes the determination of probe design constraints and the design, procurement and cold testing of a prototype probe.

3.1.2 Physical Properties

Physical Properties refers to the development and procurement of prototype physical properties probes. This activity includes development studies and prototype probe procurement for a waste rheology sensor and for a waste material physical properties probe. The scope has been broken down into the following activities:

- Rheology Probe--development and procurement of a prototype rheology probe to measure physical properties of the sludge and saltcake. This activity includes feasibility and implementation studies by Texas Tech University and procurement of a prototype in situ waste rheology sensor.
- Physical Properties/Depth Profiling--development and procurement of a prototype in situ probe capable of determining selected waste material physical properties (e.g., density, shear strength, porosity, etc.) and a probe capable of penetrating waste to allow emplacement of other sensors. The prototype probe will be deployed using the LDUA. This activity includes definition of end effector needs, development of functions and requirements, and procurement of a prototype probe.

3.1.3 Surveillance and Integrity Monitoring

Surveillance and Integrity Monitoring addresses the development of technologies to determine pipe and tank structural integrity. This includes demonstration of a prototype acoustic monitoring system and testing of a prototype tank leak detection system. Surveillance and Integrity Monitoring has been divided into the following activities:

- Acoustic Monitoring--development and demonstration of a prototype pipeline leak detection probe using acoustic monitoring technologies. This activity includes determination of the feasibility of adapting commercial systems and the development and testing of a prototype acoustic emission system.

- Tank Leak Detection Systems--development and testing of a prototype tank leak detection system. This activity includes development and implementation of a tank leak detection test plan and the preparation of a detection system scale-up plan.

3.1.4 Characterization System Implementation

Characterization System Implementation is the development of integrated systems for deployment of demonstrated characterization technologies. This activity includes support for the development of surveillance and inspection systems and for online, in situ, and hot cell monitoring systems. Characterization System Implementation has been separated into the following activities:

- Surveillance and Inspection Systems--development of conceptual integrated surveillance and inspection systems to meet site-specific requirements for in situ physical assessments. This activity includes the definition of site-specific system needs and the development of preliminary system specifications for camera, depth profiling, and physical properties end effectors; structured light and laser range finder (LRF) mapping systems; and pipe and tank integrity monitoring systems.
- Online Monitoring Systems--development of conceptual integrated characterization systems to meet site-specific requirements for online process monitoring. Spectroscopy and rheology technologies are addressed in these integrated systems. This activity includes the definition of site-specific process monitoring needs and the development of preliminary system specifications.
- In Situ Monitoring Systems--development of conceptual integrated characterization systems to meet site-specific requirements for in situ waste characterization. Spectroscopy technologies are addressed in these integrated systems. This activity includes the definition of site-specific in situ chemical and radiological

characterization needs and the development of preliminary system specifications.

- Hot Cell Monitoring Systems--development of conceptual integrated characterization systems to meet site-specific requirements for hot cell process monitoring. Spectroscopy and rheology technologies are addressed in these integrated systems. This activity includes the definition of site-specific hot cell monitoring needs and the development of preliminary system specifications.

3.2 LIGHT DUTY UTILITY ARM SYSTEM

The UST-ID LDUA System will be a versatile, remotely-operated positioning system for deploying relatively light-weight end effectors in the USTs. Characterization tools, surveillance and inspection end effectors, and scaled retrieval end effectors will be deployed by the LDUA.

The LDUA System consists of the LDUA, the Control and Data Acquisition System (CADAS), the Tank Riser Interface Confinement (TRIC), and the Tool Interface Plate.

The LDUA System will be utilized to support the demonstration of surveillance and inspection end effectors. These include camera end effectors, structured light systems, LRF systems, tank waste characterization sensor packages, and non-destructive examination (NDE) systems.

This activity includes development and procurement of the LDUA subsystems and end effectors, integrated LDUA system design and implementation, and pre-operational and operational demonstrations (i.e., cold and hot testing, respectively).

Key milestones for these activities are listed in Table 3-2.

3.2.1 Light Duty Utility Arm

This scope addresses the development, procurement, integration, and testing of the LDUA. The LDUA System consists of the LDUA, the CADAS, the TRIC subsystem, the Tool Interface Plate, and the surveillance and inspection end effectors. The scope is broken out into the following activities:

- Light Duty Utility Arm Procurement--procurement of the LDUA. This activity includes placing the contract and vendor fabrication and delivery of the LDUA.
- Control and Data Acquisition System--development and integration of CADAS subsystems. The CADAS provides centralized computer control and data management for the LDUA. CADAS subsystems consist of the trailer, the instrument and controls, and the Supervisory Control and Data Acquisition System (SCADAS).
- Tank Riser Interface and Confinement--development and integration of an interface structure between the tank risers and LDUA subsystem. Components of the structure will include a decontamination and ventilation system, a confinement enclosure and end effector exchange system (EEES), and accessories. Activities will include design, fabrication and assembly of the components.
- Tool Interface Plate--design and fabrication of interface plate between the LDUA and the various end effectors. The Tool Interface Plate at the end of the LDUA provides a standard physical connection for the various end effectors deployed with the LDUA.

3.2.2 Light Duty Utility Arm End Effectors

The development of in situ end effectors related to LDUA deployment is contained within the scope of the LDUA End Effectors. This activity includes design, fabrication, and demonstration of camera, structured light, LRF, characterization sensor package, and NDE end effectors. The scope is

Table 3-2. UST-ID Light Duty Utility Arm Programmatic Milestones.

Milestone Number	TTP Number	Title	Date
1	RL-332011 No. 3-4	Laser Range Finder: Complete Hardware Evaluation Letter	12/31/93
2	RL-332011 No. 3-5	Laser Range Finder: Provide Data Set for Supervisory Data Acquisition System	02/28/94
3	AL-232001 S4M6	UST-ID Computer Interface: Deliver LDUA 80% Design Review Package for Control System	06/30/94
3	AL-232001 S6M7	UST-ID Computer Interface: Deliver 80% Detailed Design Review (DDR) Package for Data Acquisition System and Trailer	06/30/94
3	ID-442001 No. 4	Decontamination System and End Effector: Submit LDUA DDR (80%) Package	06/30/94
3	OR-132008 No. 8-4	LDUA Topographical Mapping: Submit LDUA DDR (80%) Package	06/30/94
	RL-421207 No. 3-4	End Effector and Data Acquisition System: Conduct Demonstration	06/30/94
	RL-421207 No. 1-5	System Design: Initiate 80% Design Review	07/30/94

separated into the following activities:

- Camera End Effectors--development and demonstration of the camera end effectors for the LDUA. This activity includes design, fabrication, cold testing, and cold test evaluation of still and video cameras suited for in situ deployment.
- Structured Light--development and demonstration of a prototype structured light mapping system suited for in situ deployment. With structured light mapping technology, shadows generated by coherent light sources are analyzed by computer programs to define physical objects within a confined space. This technology will be used to identify and locate the interior structures of the tanks. This activity includes design, fabrication, cold testing, and cold test evaluation.
- Laser Range Finder--development and demonstration of a LRF system. The LRF technology will be utilized for mapping the surface of the saltcake and sludge within the tanks. This activity includes the integration and initial testing of laser range finder equipment and the design, fabrication, and cold testing of a prototype LRF system suited for in situ deployment.
- Tank Waste Characterization Sensor Package--development of sensor packages for in situ deployment of tank waste characterization systems using the LDUA. This activity includes design and delivery of sensor packages for radiation fluence measurement, Raman spectroscopy, IR moisture detection, and copper foil neutron/moisture sensing.
- Non-Destructive Examination Systems--development of integrated laser inspection and other tank integrity NDE systems for in situ deployment using the LDUA. This activity will include design of prototype NDE end effectors and preparation of system functions and requirements.

3.2.3 Light Duty Utility Arm System Design

System Design of the LDUA includes the design of the LDUA subsystems and integrated system. The LDUA subsystems include the LDUA, the CADAS, the TRIC, and the Tool Interface Plate. This activity includes development of the LDUA System functions and requirements; conceptual, preliminary, and final design of the LDUA subsystems; and integrated design reviews. Design report preparation and final design are not included. Light Duty Utility Arm System Design is broken down into the following activities:

- Develop Functions and Requirements--development of preliminary and final integrated functions and requirements for the LDUA System.
- Conceptual Design--preparation of the LDUA subsystems' conceptual design packages and the LDUA integrated conceptual design review.
- Preliminary Design--preparation of the LDUA subsystems' 25% design packages and the LDUA integrated preliminary design review.
- Detailed Design--preparation of the LDUA subsystems' 80% design packages and the LDUA integrated Detailed Design Review (DDR).

3.2.4 Light Duty Utility Arm System Pre-Operational Test

This scope addresses the pre-operational testing (i.e., cold testing) of the integrated LDUA system in a cold test facility. This activity includes integration of cold test facility equipment, preparation of the cold test plan and procedures, and cold test implementation and reporting. The LDUA System Pre-Operational Test is separated into the following activities:

- Pre-Operation Test Facility Equipment Integration--preparation of a cold test facility including facility readiness and LDUA System setup.
- Test Plan and Procedure Preparation--preparation of the cold test plan and development of implementing procedures.

- Cold Test--implementation of the cold test procedures, evaluation of the cold test results, and preparation of the cold test report.

3.2.5 Light Duty Utility Arm System Operational Testing

This scope addresses the operational testing (i.e., hot testing) of the LDUA system in tanks A-105 and T-109 (single shell tanks which are not on the Watch List). This activity includes preparation of the hot test plan and procedures, installation and readiness review of the LDUA system, and hot test implementation and reporting. Operational Testing is separated into the following activities:

- Test Plan And Procedure Preparation--preparation of the hot test plan and development of the hot test procedures.
- System Installation and Operational Readiness Review--preparation of the tanks T-109 and A-105 for the hot test. This activity includes required modifications to tank farm facilities, installation of the LDUA system, and an Operational Readiness Review (ORR).
- Hot Test--implementation of the hot test procedures, evaluation of the hot test results, and preparation of the hot test report.

3.3 WASTE DISLODGING AND CONVEYANCE SYSTEM

The UST-ID WD&C System activities support the development and demonstration of technologies to fracture and transport saltcake and sludge wastes from underground storage tanks. Technologies being developed include high pressure scarification coupled with pneumatic conveyance and medium pressure mining coupled with jet pump conveyance. The WD&C System is also developing saltcake and sludge simulants to support development and testing of these retrieval technologies and development and testing of characterization, separations, and treatment technologies.

Development of technologies for the dislodging (fracturing) and conveyance (transport) of tank waste. This activity includes:

- Development and testing of a high pressure scarifier coupled with a pneumatic conveyor.
- Development and testing of a medium pressure miner coupled with a jet pump conveyor.
- Development and validation of saltcake and sludge simulants.
- Tank retrieval support.

Key milestones for these activities are listed in Table 3-3.

3.3.1 High Pressure Scarifier Dislodging and Pneumatic Conveyance Methods

This scope addresses the development of a hydraulic end effector, coupled with a pneumatic conveyance system for tank waste retrieval. The hydraulic end effector is a high pressure jet (i.e., scarifier) used to fracture and dislodge saltcake and sludge. The pneumatic conveyor is an air transport system for retrieval of dislodged materials from the tank. This activity includes separate and integrated effects tests, and preparation of a recommendations report. This scope is broken down into the following activities:

- High Pressure Jet Separate Effects Experiments--laboratory testing of scarifier design variables to determine the end effector design configurations. This activity includes simple bounding tests and parametric testing. It also includes the development of design configurations for two testing units to be constructed for an end effector and conveyance system entrance shroud.
- Pneumatic Conveyance Separate Effects Experiments--investigation of the mechanics of dislodging and retrieval for use in conjunction with the high pressure jet. This activity includes development of a test fixture and test matrix, sequential

Table 3-3. UST-ID Waste Dislodging and Conveyance Programmatic Milestones.

Milestone Number	TTP Number	Title	Date
1	RL-343502 No. 5	Medium Pressure System/Mining Strategy: Document FY 1994 Test Results	09/30/94
2	RL-343503 No. 5	High Pressure Waterjet Scarification: Document FY 1994 Test Results	09/30/94
1 and 2	RL-332011 No. 5-5	Dislodging Systems: Complete Documentation of FY 1994 Test Results	09/30/94
3	RL-332011 No. 5-7	Technology Coordination: Complete Integrated WD&C Work Plan for EM-30 Concurrence	12/30/93
4	RL-332011 No. 5-10	Technology Coordination: Complete RFQ Recommendations to EM-30	07/15/94

investigation of conveyance characteristics for a variety of waste parameters, and preparation of pneumatic transportation system recommendations.

- Integrated Effects Testing--integrated testing of the scarifier and pneumatic transportation system. This activity will include integration of the scarifier and conveyance line, testing with saltcake and sludge simulants, and evaluation of the integrated performance of the dislodging and conveyance system.
- Additional Parametric Tests of Integrated WD&C System--development of recommendations for scarifier/pneumatic conveyance system specifications for the hydraulic test bed and first generation retrieval system. This activity includes review and analysis of separate and integrated effects testing and other commercial and developmental methods.

3.3.2 Medium Pressure Miner Dislodging and Jet Pump Conveyance Methods

This scope addresses the development of a medium pressure miner, coupled with a jet pump transport system for tank waste retrieval. The medium pressure miner is a high-volume sluicing end effector to fracture and slurry the saltcake and sludge. The jet pump utilizes a venturi effect to transport the resulting slurry from the tank. This activity includes development of a mining strategy, separate and integrated effects tests, and preparation of a recommendations report. Involved in the Medium Pressure Miner Dislodging and Jet Pump Conveyance Methods are the following activities:

- Mining Strategy Development--develop a conceptual strategy for conducting the mining operations. This activity includes experiments to determine a mining strategy based on tank, tank waste, and long-reach arm parameters; development of an excavation sequence; definition of the conveyance system features; and identification of a cutting path and fragmentation sequence to produce particles in the size range required.

- Separate Effects Testing--conduct laboratory tests of the medium pressure miner and the jet pump transport system. This activity includes testing and analysis of the mining head performance jet design, jet entrant conditions, and the pumping of simulated waste streams.
- Integrated Effects Testing--integrated testing of the medium pressure miner and jet-pump transport system. This activity will include integrated cutting and moving tests, multiple pass surface quality evaluation, and variable condition tests with saltcake and sludge simulants.
- Additional Parametric Testing of WD&C System--develop recommendations for miner/jet pump conveyance system specifications for the first-generation integrated test bed arm and system. This activity includes review and analysis of separate and integrated effects testing and other commercial and developmental methods.

3.3.3 Waste Simulant Development

Waste Simulant Development involves the activities that develop saltcake and sludge simulants to support design and testing of UST-ID retrieval technologies. The simulants will be designed to have physical properties similar to the tank waste saltcakes and sludges. The simulant characteristics will be verified through testing and analysis. These activities include the following:

- Saltcake Simulant Testing--develop composition and preparation instructions for saltcake simulant to support the development and demonstration of the high pressure and medium pressure water-jet projects and the mechanics project. This activity includes identification of applicable tank waste properties; development of simulant specifications, verification methods, and acceptance criteria; development of preparation methods; verification of simulant performance; and development of a validation strategy.

- Sludge Simulant Testing--develop composition and preparation instructions for sludge simulant to support the development and demonstration of the high pressure and medium pressure water-jet projects and the mechanics project. This activity includes identification of applicable tank waste properties; development of simulant specifications, verification methods, and acceptance criteria; development of preparation methods; verification of simulant performance; and development of a validation strategy.

3.3.4 Tank Retrieval Support

Tank Retrieval Support involves providing support to EM-30 Hanford tank waste retrieval. This activity includes procurement and installation of the integrated test bed, development of a multi-year testing strategy, and coordination of EM-50 testing and technology transfer with EM-30 at Hanford. This support is broken down into the following activities:

- Integrated Test Bed Acquisition and Preparation--procurement and installation of the integrated test bed. The integrated test bed consists of the platform, equipment, and instrumentation needed to setup and test the WD&C systems at test sites selected by EM-30. This activity includes specification, design, and procurement for the integrated test bed, the data acquisition/controls computer and instruments, and other required equipment; facility preparation; equipment assembly, installation, integration and checkout; and performance testing of the integrated test bed.
- Waste Dislodging and Conveyance Integrated Testing--conduct the WD&C system testing scope that has been assigned to EM-30. This activity includes definition of the testing and initial and advanced integrated testing and validation. These activities will be integrated with the other joint testing activities which will be conducted by EM-30.
- Technology Coordination--coordination of testing and technology transfer between EM-30 and EM-50 at the Hanford Site. This

activity includes Richland EM-30/EM-50 joint testing and data transfer to Richland EM-30.

3.4 WASTE PROCESSING AND DISPOSAL SYSTEM

The UST-ID WP&D System activities support the demonstration of technologies for tank waste pre-treatment and treatment processes. Pre-treatment technologies supported include cesium separations, waste volume reduction, and sludge processing. Treatment technologies supported by WP&D include the nitrate to ammonia and ceramic (NAC) process and biological treatment processes.

Development of waste pre-treatment and treatment processes for supernate, saltcake, and sludge. This activity includes technology studies, development, testing, and demonstration of physical, chemical, and biological separations and treatment processes.

Key milestones for these activities are listed in Table 3-4.

Table 3-4. UST-ID Waste Processing and Disposal Programmatic Milestones.

Milestone Number	TTP Number	Title	Date
1	RL-332011 No. 2-1	Compact Processing Unit: Complete Project Work Plan	10/31/93
2	RL-332011 No. 2-4	Compact Processing Unit: Complete Conceptual Design Enclosure and TFI	12/21/93
3	CH-243501 No. 2	Mobile Evaporator/Concentrator: Issue Design Criteria Document	1/31/94
4	OR-132008 No. 2-3	Comprehensive Sludge and Supernate: Evaluation of Sorbents	3/31/94
5	OR-132008 No. 2-4	Comprehensive Sludge and Supernate: Characterize Acid Dissolution of Sludge	4/30/94
6	OR-132008 No. 5-2	Clean Option: Provide Operability Studies for the Clean Option	9/30/94
6	CH-243501 No. 7	Mobile Evaporator/Concentrator: Report on Proof of Principal	9/30/94
6	SR-132002 No. 4	Cesium Ion Exchange: Issue Final Report on the Resorcinol Degradation Study	9/30/94
7	CH-243501 No. 5	Mobile Evaporator/Concentrator: Issue Test Plan	6/15/94
8	OR-132008 No. 5-1	Clean Option: Provide Design Review Comments to the Hanford CPU Processing Module	2/22/94
9	OR-132008 No. 4-1	TRUEX Validation: Issue Report on TRUEX Demonstration and GTM Evaluation	3/31/94
10	OR-132008 No. 3-1	CEA Technical Interchange: Complete technical interchange	5/30/95
11	ID-121204 No. 9	Biodenitrification: Letter Report on the Capabilities of Spent Biomass	01/31/94
12	OR-132008 No. 1-2	NAC Process: Submit manuscript for publication on the NAC Process Kinetics	6/30/94
13	ID-121204 No. 11	Biodenitrification: Letter Report on the Capabilities of Spent Biomass	6/30/94

3.4.1 Supernate/Saltcake Processing

These activities involve the development of a pretreatment separations processes for supernate and saltcake. This includes development and demonstration of cesium separations technologies, development of separations process flowsheets, and development and testing of a waste stream evaporator/concentrator. Supernate/Saltcake Processing activities are separated into the following:

- Cesium Removal Compact Processing Unit--develop and demonstrate a compact processing unit (CPU) for the separation of cesium from waste streams using ion exchange technology. This activity includes design, fabrication, installation and demonstration of the cesium removal CPU. Nonradioactive demonstration and radioactive demonstrations (i.e., cold test and hot test, respectively) will be conducted.
- Cesium Extraction Testing and Skid-mounted Ion-exchange Demonstration Testing--develop and demonstrate the resorcinol-formaldehyde resin ion-exchange process for the separation of cesium from waste streams. This activity includes resorcinol-formaldehyde resin chemical studies and laboratory-scale testing, pilot scale testing with the Skid-mounted Ion-exchange Demonstration (SKID) unit, and technical support to the cesium removal CPU development and demonstration.
- Comprehensive Sludge/Supernate Demonstration, Testing and Evaluation--develop a comprehensive flowsheet for the optimum pretreatment/ separations processing of tank waste. This activity includes hot cell testing and demonstrations of the best processes for sludge/supernate separations; cesium, strontium, and technetium separations from the supernate; and sludge acid dissolution.
- CLEAN Option Support--assist the Tank Waste Remediation System (TWRS) team working on flowsheet development, study, and the operability of the CPU concept, and interface with the CLEAN

Option committees of TWRS and with the Waste Processing and Disposal Steering Committee. This activity includes technical and engineering support to Hanford EM-30 feasibility studies, flowsheet development, and equipment recommendations.

- Mobile Evaporator/Concentrator--develop a mobile evaporator/concentrator unit to concentrate the supernate waste stream. This activity includes development of design criteria, design, fabrication, and installation of laboratory-scale equipment, and testing and evaluation. Design, fabrication and testing support will be contracted to two commercial companies (LICON Inc. and Artisan Industries).

3.4.2 Sludge Processing

Sludge Processing is the development of pretreatment separations technologies for sludge. This activity includes the transuranic extraction (TRUEX) process development and validation and the technical interchange with the French Commissariat L'Energie Atomique (CEA). Sludge Processing is broken down into the following activities:

- TRUEX Validation and Data Collection--conduct TRUEX pilot tests to generate process data for the TRUEX validation activities. TRUEX is a solvent extraction process for removing transuranic (TRU) elements from acidic waste solutions. This activity includes pilot-scale TRUEX processing using acid waste from the Oak Ridge National Laboratory (ORNL) Mark 42 americium recovery program; sample collection and analysis; and test data analysis and reporting.
- TRUEX Model Development--conduct research and development work to broaden TRUEX processing of high-level and TRU-containing waste streams. This activity includes batch testing using ORNL Melton Valley sludge; validation of the General TRUEX Model (GTM) using ORNL Mark 42 pilot test results; and development of TRUEX

flowsheets for the Power Reactor and Nuclear Fuel Development Corporation of Japan (PNC).

- Technical Interchange with CEA--assign a technical staff member to the French CEA to develop a broad understanding of the French waste management program and the diamide process which is an alternative solvent extraction process to TRUEX.

3.4.3 Destruction and Waste Forms

This scope addresses the development of tank waste treatment technologies. This includes development and pilot-scale demonstration of the NAC process; development and laboratory-scale demonstration of biological treatment technologies; and investigation of alternative technologies for organic and ferrocyanide treatment. Destruction and Waste Forms activities involve the following:

- Nitrate to Ammonia and Ceramic Process--develop and demonstrate the NAC process for converting nitrate-based waste solutions to ammonia gas and a ceramic and glass byproduct suitable for pressing and sintering into a final waste. This activity includes bench-scale reactor and kinetic validation tests; production, testing, evaluation, and characterization of the ceramic waste form; preparation and evaluation of an ORNL Melton Valley waste form; design and construction of a pilot plant; and NAC process pilot plant tests and waste form demonstration studies.
- Biological Destruction of Tank Wastes--development and lab-scale demonstration of biological pretreatment processes for tank wastes. This activity includes laboratory scale testing of the biodenitrification process, studies of metals and radionuclides biosorption processes, and construction and demonstration of a laboratory-scale biotechnology processing unit.

4.0 MASTER SCHEDULES

The UST-ID maintains a three-tiered schedule hierarchy defined as Levels 0, 1, and 2. The Level 0 and Level 1 schedules included in this Master Schedule document provide a programmatic perspective of the demonstrations. Typically, the Master Schedule is updated annually to reflect planned work.

The Level 2 schedules are developed and utilized to manage the demonstration technical work as defined in the TTPs. The Level 2 schedules are maintained in the TTPs, work plans, and project management plans for each technical program. Level 2 schedules have their status checked and are updated as necessary for these to be effective work management tools.

All DOE and key milestones are reflected in the Level 0, 1, and 2 schedules. The Level 0 and Level 1 schedules include milestones representing programmatic events. DOE and key milestones selected to be tracked at the TTP level are included in the Level 2 schedules.

4.1 CHARACTERIZATION SYSTEM

The various characterization technologies under development are generally not interrelated (there are few or no development interdependencies) and are, therefore, being developed concurrently and independently. The development schedules for the systems are based on the availability of the technology and site-specific EM requirements.

Figures 4-1 and 4-2 provide the Level 0 and Level 1 schedules for Characterization.

4.2 LIGHT DUTY UTILITY ARM SYSTEM

The design and acquisition of the LDUA subsystems are being performed concurrently. Following completion and integration of the subsystems, the LDUA System will be demonstrated in a series of pre-operational and

WBS	Name	93			
		Q3	Q4	Q1	Q2
1.1	Spectroscopy				Develop
1.2	Physical Properties				
1.3	Surveillance and Integrity Monitoring				
1.4	Characterization System Implementation				

Project:
Date: 6/24/94

Milestone

Level 0 Level 1

ion Level 0 Schedule

1994			1995				1996				1997	
2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Design, Fabricate, and Test Spectroscopy Systems & Probes												
Design and Fabricate Physical Properties Probes												
Design and Test Surveillance and Integrity Monitoring Equipment												
Design and Assemble Characterization Systems												

Level 2

Figure 4-1. UST-ID Characterization Level 0 Schedule.

WBS	Name	93			
		Q3	Q4	Q1	Q2
1.1	Spectroscopy				
1.1.1	LDUA Raman Spectroscopy				
1.1.2	Remote Raman				
1.1.3	Infrared Spectroscopy				
1.1.4	Cone Penetrometer Raman Probe Concepts				
1.2	Physical Properties				
1.2.1	Rheology Probe				
1.2.2	Physical Properties/Depth Profiling				
1.2.3	Test Rheology/Physical/Depth Probes				
1.3	Surveillance and Integrity Monitoring				
1.3.1	Acoustic Monitoring				
1.3.2	Tank Leak Detection Systems				
1.4	Characterization System Implementation				
1.4.1	Hot Cell Monitoring Systems				
1.4.2	On-line Monitoring Systems				
1.4.3	Surveillance & Inspection Systems				
1.4.4	In-Situ Monitoring Systems				

Project:
Date: 6/24/94

Milestone

Level 0

Level 1

on Level 1 Schedule

Figure 4-2. UST-ID Characterization Level 1 Schedule.

operational tests. Surveillance and inspection end effectors are being developed and tested concurrently.

Figures 4-3 and 4-4 provide the Level 0 and Level 1 schedules for LDUA.

4.3 WASTE DISLODGING AND CONVEYANCE

The systems for the two alternative methods being considered for retrieval of the tank wastes are being developed concurrently. Subsystems will be tested separately, and then jointly, prior to testing and demonstration on an integrated test bed.

Figures 4-5 and 4-6 provide the Level 0 and Level 1 schedules for WD&C.

4.4 WASTE PROCESSING AND DISPOSAL

The various pretreatment and treatment technologies under development are generally not interrelated and are, therefore, being developed concurrently. Exceptions to this are the Compact Processing Unit (Activity 4.1.1), that will utilize the resorcinol-formaldehyde resin (activity 4.1.2), and the TRUEX model development (Activity 4.2.2), that will utilize information from TRUEX validation data collection (Activity 4.2.1).

Figures 4-7 and 4-8 provide the Level 0 and Level 1 schedules for WP&D.

WBS	Name	1993			
		Q2	Q3	Q4	
2.1	Light Duty Utility Arm				
2.2	LDUA End Effectors				
2.3	LDUA System Design				Inte
2.4	LDUA System Pre-Operational Testing				
2.5	LDUA System Operational Test				

Project:
Date: 6/24/94

Milestone

Level 0

Level 1

Light Duty Utility Arm Level 0 Schedule

1994				1995				1996				
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Develop Light Duty Utility Arm & Subsystems												
Design, Fabricate, and Test LDUA End Effectors												
Integrated LDUA System Design												
Pre-Operational (Cold) Test of Integrated LDUA System												
				Operational (Hot) Test of Integrated LDUA System								

Level 2

Figure 4-3. UST-ID Light Duty Utility Arm Level 0 Schedule

WBS	Name	1993			
		Q2	Q3	Q4	Q1
2.1	Light Duty Utility Arm				
2.1.1	Light Duty Utility Arm Procurement				
2.1.2	Control & Data Acquisition Systems (CADAS)				
2.1.3	Tank Riser Interface & Confinement (TRIC)				
2.1.4	Tool Interface Plate				
2.2	LDUA End Effectors				
2.2.1	Camera End Effectors				
2.2.2	Structured Light				
2.2.3	Tank Waste Characterization Sensor Package				
2.2.4	Non-Destructive Examination (NDE) Systems				
2.3	LDUA System Design				
2.3.1	Functions & Requirements				
2.3.2	Conceptual Design				
2.3.3	Preliminary Design				
2.3.4	Detailed Design				
2.4	LDUA System Pre-Operational Testing				
2.4.1	Pre-Operational Integration				
2.4.2	Test Plan and Procedure				
2.4.3	Cold Test				
2.5	LDUA System Operational Test				
2.5.1	Test Plan and Procedure				
2.5.2	Operational Readiness Review (ORR)				
2.5.3	Hot Test				

Project:
Date: 6/24/94

Milestone

Level 0

Level 1

n Level 1 Schedule

Level 2

Figure 4-4. UST-ID Light Duty Utility Arm Level 1 Schedule

UST-ID Waste Dislodging and

WBS	Name	1993				1994	
		Q1	Q2	Q3	Q4	Q1	Q2
3.1	High Pressure Scarifier Dislodging & Pneumatic Conveyance	Develop and Test High Pressure					
3.2	Medium Pressure Miner Dislodging and Jet Pump Conveyance	Develop and Test Medium Pres					
3.3	Waste Simulant	Develop and Test					
3.4	Tank Retrieval						

Project: WD&C
Date: 8/5/94

Milestone

Level 0 Level 1

Conveyance Level 0 Schedule

		1995				1996				1997				1998			
Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
		Scarifier Dislodging & Pneumatic Conveyance Methods															
		ure Miner Dislodging & Jet Pump Conveyance Methods															
		aste Simulants															
		Provide Support for Tank Waste Retrieval Activities															

Level 2

Figure 4-5. UST-ID Waste Dislodging & Conveyance Level 0 Schedule

WBS	Name	1993				1994	
		Q1	Q2	Q3	Q4	Q1	Q2
3.1	High Pressure Scarifier Dislodging & Pneumatic Conveyance	Develop and Test High Pressu					
3.1.1	High Pressure Jet	Conduct High Pressure Jet Separa					
3.1.2	Pneumatic Conveyance	Conduct Pneumatic Conveyanc					
3.1.3	Scarifier/Pneumatic Conveyance	Conduct Scarifier/Pneum					
3.1.4	Integrated WD&C System						Conc
3.2	Medium Pressure Miner Dislodging and Jet Pump Conveyance	Develop and Test Medium Pre					
3.2.1	Mining Strategy	Develop Mining Strater					
3.2.2	Separate Effects	Conduct Separate Eff					
3.2.3	Integrated Effects						Conduct In
3.2.4	Integrated WD&C System						Cond
3.3	Waste Simulant	Develop and Tes					
3.3.1	Saltcake Simulant	Test and Analyze Sal					
3.3.2	Sludge Simulant	Test and Anal					
3.4	Tank Retrieval						
3.4.1	WD&C Integrated Test Bed	Design, Procure, and Assem					
3.4.2	WD&C Integrated Testing						
3.4.3	Technology Coordination						

nd Conveyance Level 1 Schedule

Level 2

Figure 4-6. UST-ID Waste Dislodging & Conveyance Level 1 Schedule.

UST-ID Waste Processing

WBS	Name	1991			1992				
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	
4.1	Supernate/Saltcake Processing								■
4.2	Sludge Processing								■
4.3	Destruction and Waste Forms								■

Project: UST-ID MASTER
Date: 6/29/94

Milestone

Level 0

Level 1 ■

nd Disposal Level 0 Schedule

1993			1994				1995				1996				1997				1998				1999				2000		
Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Develop and Demonstrate Supernate/Saltcake Processing Technologies -																													
Develop Sludge Processing Technologies																													
Develop and Demonstrate Destruction and Waste Form Technologies																													

Level 2

Figure 4-7. UST-ID Waste Processing & Disposal Level 0 Schedule

WBS	Name	1991			1992				
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	
4.1	Supernate/Saltcake Processing								
4.1.1	Cesium Compact Processing Unit (CPU)								
4.1.2	Cesium Extraction								
4.1.3	Comprehensive Sludge/Supernate Demonstration								Demonstr
4.1.4	Clean Option								Supp
4.1.5	Mobile Evaporator/Concentrator								
4.2	Sludge Processing								
4.2.1	TRUEX Data								Collect Data
4.2.2	TRUEX Model								
4.2.3	Technical Interchange with French CEA (Level of Effort Activity)								Co
4.2.4	Future Hot Demonstrations (TBD)								
4.3	Destruction and Waste Forms								
4.3.1	Nitrate to Ammonia and Ceramic (NAC) Process								Test, Eva
4.3.2	Biological Destruction of Tank Wastes								Develop and Demonstrate Bi
4.3.3	Future Hot Demonstrations (TBD)								

Project: UST-ID MASTER
Date: 6/29/94

Milestone

Level 0

Level 1

d Disposal Level 1 Schedule

Level 2

Figure 4-8. Waste Processing & Disposal Level 1 Schedule

5.0 BIBLIOGRAPHY

1. Office of Technology Development Technical Task Plan No. AL2-3-20-01, "USTID Computer Interface", Revision 00 dated 10/14/93.
2. Office of Technology Development Technical Task Plan No. CH2-3-20-01, "Generic TRUEX Model", Revision 00 dated 09/28/93.
3. Office of Technology Development Technical Task Plan No. CH2-4-35-01, "UST-ID: Mobile Evaporator/Concentrator Development", Revision 00 dated 09/28/93.
4. Office of Technology Development Technical Task Plan No. ID1-2-12-04, "Biodenitrification", Revision 00 dated 09/23/93.
5. Office of Technology Development Technical Task Plan No. ID4-4-20-01, "LDUA Decontamination System and End Effector," Revision 01 dated 01/06/94.
6. Office of Technology Development Technical Task Plan No. OR1-3-20-08, "USTID: Demonstration, Testing, and Evaluation", Revision 01 dated 12/20/93.
7. Office of Technology Development Technical Task Plan No. RL3-3-20-11, "UST-ID: Demonstration, Testing & Evaluation, Revision 00 dated 10/05/93.
8. Office of Technology Development Technical Task Plan No. RL3-4-35-02, "UST: Medium Pressure System/Mining Strategy", Revision 00 dated 09/29/93.
9. Office of Technology Development Technical Task Plan No. RL3-4-35-03, "UST: High Pressure Waterjet Scarification", Revision 00 dated 09/29/93.
10. Office of Technology Development Technical Task Plan No. RL4-2-12-07, "UST-ID: Demonstration, Testing & Evaluation", Revision 01 dated 01/13/94.

11. Office of Technology Development Technical Task Plan No. SF2-1-12-03,
"Advanced Fiber-Optic Spectroscopy for Inorganic Contaminants", Revision
01 dated 09/28/93
12. Office of Technology Development Technical Task Plan No. SR1-3-20-1,
"LDUA: Surveillance and Inspection End Effectors," Revision 03
dated 09/10/93.
13. Office of Technology Development Technical Task Plan No. SR1-3-20-02,
"Cesium Extraction Testing", Revision 00 dated 09/21/93.
14. Office of Technology Development Technical Task Plan No. SR1-3-20-03,
"Spectrometer System for Hanford In situ Deployment", Revision 02 dated
09/23/93.
15. UST-ID CWRP Program Plan
16. UST-ID Strategic Plan
17. UST-ID WPDP Program Plan
18. (work plans)

APPENDIX A

UNDERGROUND STORAGE TANK - INTEGRATED DEMONSTRATION
MASTER SITE SUPPORT MATRIX

A.0 UST-ID MASTER SITE SUPPORT MATRIX

The UST-ID Master Site Support Matrix (Figure A-1) summarizes the relationship of ongoing UST-ID technology development to the functional issues that are associated with characterization, retrieval, processing, and disposal of mixed radioactive and hazardous wastes stored in underground storage tanks at the DOE sites.

Shaded areas indicate relationships between technology systems and specific site issues. As described in the matrix legend, the heavier shading indicate proposed technology applications and lighter shading indicates potential applications.

Letter designators, described in the matrix legend, indicate the degree to which a technology, is or may be applicable to an issue, and also indicate the affected site EM organization. In several cases, available information is not sufficient to determine technology applicability.

US DOE UNDER
INTEGRATED DEMO

MASTER SI

FUNCTION		CH									
ISSUE/NEED		C1: Tank Waste Safety Status (Chemical Stability)			C2: Tank & Piping Structural Integrity					C3: Tank Properties, Process	
SYS.	SUBSYSTEM	HAN	SR	OR	HAN	ID	SR	OR	FR	HAN	P
LDUA	Light Duty Utility Arm Development of mobile, remotely operated, multi-axis positioning arm to deploy light-duty, in-tank sensors and end-effectors.	S 3	U		S 3	S 3	U	I 3		S 3	P
	Ancillary Subsystems Development of the control, containment and other subsystems to support deployment of the Light Duty Utility Arm.	S 3	U		S 3	I 3	U	I 3		S 3	P
	Structured Light Development of in-tank mapping system to support deployment of the Light Duty Utility Arm				S 3	I 3	U	P 3			
WD&C	Dislodging Subsystems Development of high-pressure and medium-pressure scarifier technology to loosen sludge and saltcake deposits in the tanks.										
	Conveyance Subsystems Development of technology to transport scarified saltcake and sludge from the tanks.										
	Sludge & Saltcake Simulant Development of simulants to support development and testing of characterization, retrieval, processing, and disposal subsystems.										

FUNCTION

ISSUE/NEED

		R1: Pilot-Scale Removal of Tank Wastes					R2: Bulk Removal of Sludge and Saltcake From Tanks					R3: In-Tank Support and I
SYS.	SUBSYSTEM	HAN	ID	SR	OR	FR	HAN	ID	SR	OR	FR	HAN
CHAR	Acoustic Emission Method Development of acoustic monitoring technology to detect and localize leaks in pipelines.											
	Raman Spectroscopy Develop and test spectroscopy systems and probes for hot cell operational use and in-tank deployment											
	Near-IR Spectroscopy Develop and test near-IR spectroscopy for sensing moisture content in tank waste.											
	Fiber Optic Probe Develop and test fiber optic probes to support hot cell and in-tank deployment of sensors.											
	Physical Properties Probe Development of sensors for determining in-situ physical properties of saltcake and sludge.											
	Depth Profiling Probe Develop probe to access waste to a depth from the LDUA.											
	Surv. & Insp. End Eff. Development and testing of photography and video technology for in-tank surveillance and inspection activities.											P 3

DOE UNDERGROUND STORAGE TANK
ATED DEMONSTRATION (UST-ID) PROGRAM
MASTER SITE SUPPORT MATRIX

RETRIEVAL					
R5: Detection, Identification and Retrieval of Anomalous Artifacts					
R5: On-Line Retrieval Process Monitoring					
R6: In-Tank Maintenance Support					

ST P = POTENTIAL NO U = UNKNOWN
= ADDRESSED N = NOT ADDRESSED

[illegible]

Figure A-1. UST-IN Master Site Support Matrix. (Sheet 2 of 6)

FUNCTION		ISSUE/NEED										
		R1: Pilot-Scale Removal of Tank Wastes					R2: Bulk Removal of Sludge and Saltcake From Tanks					R3: If Support
SYS.	SUBSYSTEM	HAN	ID	SR	OR	FR	HAN	ID	SR	OR	FR	HAN
LDUA	Light Duty Utility Arm	I 3	P 3	P 3	P 3	P 3						P 3
	Development of mobile, remotely operated, multi-axis positioning arm to deploy light-duty, in-tank sensors and end-effectors.											
	Ancillary Subsystems	I 3	P 3	P 3	P 3	P 3						P 3
	Development of the control, containment and other subsystems to support deployment of the Light Duty Utility Arm.											
	Structured Light											
	Development of in-tank mapping system to support deployment of the Light Duty Utility Arm											
WD&C	Dislodging Subsystems						C 3	U	P 3	P 3	P 3	
	Development of high-pressure and medium-pressure scarifier technology to loosen sludge and saltcake deposits in the tanks.											
	Conveyance Subsystems						C 3	U	P 3	P 3	P 3	
	Development of technology to transport scarified saltcake and sludge from the tanks.											
	Sludge & Saltcake Simulant						S 3	U	P 3	U	P 3	
	Development of simulants to support development and testing of characterization, retrieval, processing, and disposal subsystems.											

12/20/93 DRAFT
FOR COMMENT

S = SELECTED C = CANDIDATE I =
3 = EM-30 4 = EM-40 6 = EM-60

[illegible]

ebas;crd;ustssmd.xls
6/27/94

A-4

US DOE UNDER
INTEGRATED DEMON

MASTER SIT

		FUNCTION										CHA
ISSUE/NEED		C1: Tank Waste Safety Status (Chemical Stability)			C2: Tank & Piping Structural Integrity					C3: Tank W. Properties for Process		
SYS.	SUBSYSTEM	HAN	SR	OR	HAN	ID	SR	OR	FR	HAN	ID	
CHAR	Acoustic Emission Method Development of acoustic monitoring technology to detect and localize leaks in pipelines.				1 3	U	U	C 3				
	Raman Spectroscopy Develop and test spectroscopy systems and probes for hot cell operational use and in-tank deployment	S 3	P 3	P 3						S 3		
	Near-IR Spectroscopy Develop and test near-IR spectroscopy for sensing moisture content in tank waste.	S 3	P 3	U						1 3	P	
	Fiber Optic Probe Develop and test fiber optic probes to support hot cell and in-tank deployment of sensors.	S 3	P 3	P 3						S 3		
	Physical Properties Probe Development of sensors for determining in-situ physical properties of saltcake and sludge.											
	Depth Profiling Probe Develop probe to access waste to a depth from the LDUA.	1 3	U							1 3		
	Surv. & Insp. End Eff. Development and testing of photography and video technology for in-tank surveillance and inspection activities.				S 3	S 3	1 3	P 3	1 3		1	

ROUND STORAGE TANK STRATION (UST-ID) PROGRAM

SUPPORT MATRIX

ACTERIZATION

te Chemical Retrieval & Planning		C4: Tank Waste Physical Properties for Retrieval & Process Planning				C5: Leak Detection and Management				
SR	OR	HAN	ID	SR	OR	HAN	ID	SR	OR	FR
								P 3		
I 3	U									
P 3	U	S 3	P 3	P 3	U					
P 3	U	C 3		P 3	U					
		I 3		U	U					
U	U	I 3		U	U					
						I 3		I 3		I 3

I = INTEREST P = POTENTIAL NO U = UNKNOWN

M-60 A = ADDRESSED N = NOT ADDRESSED

Figure A-1. UST-ID Master Site Support Matrix. (Sheet 4 of 6)

FUNCTION ISSUE/NEED		PROCESSING									
		P1: Treatment of Acidic Tank Waste			P2: Onsite Volume Reduction of Liquid Wastes				P3: Removal of Cesium Basic Liquid Waste		
SYS.	SUBSYSTEM	HAN	ID	OR	HAN	ID	SR	OR	HAN	ID	S
CHAR	Acoustic Emission Method Development of acoustic monitoring technology to detect and localize leaks in pipelines.										
	Raman Spectroscopy Develop and test spectroscopy systems and probes for hot cell operational use and in-tank deployment										
	Near-IR Spectroscopy Develop and test near-IR spectroscopy for sensing moisture content in tank waste.										
	Fiber Optic Probe Develop and test fiber optic probes to support hot cell and in-tank deployment of sensors										
	Physical Properties Probe Development of sensors for determining in-situ physical properties of saltcake and sludge.										
	Depth Profiling Probe Develop probe to access waste to a depth from the LDUA.										
	Surv. & Insp. End Eff. Development and testing of photography and video technology for in-tank surveillance and inspection activities.										

5 DOE UNDERGROUND STORAGE TANK
6 RATED DEMONSTRATION (UST-ID) PROGRAM

MASTER SITE SUPPORT MATRIX

[illegible]

I = INTEREST P = POTENTIAL NO U = UNKNOWN
EM-60 A = ADDRESSED N = NOT ADDRESSED

Figure A-1. UST-ID Master Site Support Matrix. (Sheet 5 of 6)

FUNCTION ISSUE/NEED		PROCESSING										
		P1: Treatment of Acidic Tank Waste			P2: Onsite Volume Reduction of Liquid Wastes				P3: Removal of Cesium Basic Liquid Wastes			
SYS.	SUBSYSTEM	HAN	ID	OR	HAN	ID	SR	OR	HAN	ID	S	
WP&D	TRUEX Process TRUEX model development , validation and data collection	C 3	C 3	P 3								
	Diamide Process Technology exchange with CEA	I 3	I 3	P 3								
	Comp. Sludge & Supernate Process flow sheet for comprehensive processing of tank waste sludge and supernate	S 3	P 3	P 3					C 3	P 3		
	Mobile Evap./Concentrator Mobile processing unit to remove excess processing water from retrieved tank waste				S 3	C 3	I 3	C 3 P 4				
	Compact Processing Unit Compact Processing Unit for cesium removal by ion exchange								S 3	I 3	C	
	Cs Extraction Resorcinal/formaldehyde ion exchange process to remove cesium from tank wastes								S 3		P	
	NAC Process Process to convert tank waste nitrate into ammonia while co- producing a final waste form ceramic											

S DOE UNDERGROUND STORAGE TANK RATED DEMONSTRATION (UST-ID) PROGRAM

MASTER SITE SUPPORT MATRIX

							DISPOSAL									
P4: On-Line Process Monitoring							D1: Denitrification of Liquid Wastes				D2: Development of the Final Waste Form		D3: On-Line Process Monitoring			
OR	HAN	ID	SR	OR	FR		HAN	SR	ID	OR	HAN	OR	HAN	SR	ID	OR
P 3																
3	C 3 P 4															
3	C 3 P 4															
							P 3	P 3	P 3	P 3	I 3	C 3				

I = INTEREST P = POTENTIAL NO U = UNKNOWN
EM-60 A = ADDRESSED N = NOT ADDRESSED

Figure A-1. UST-ID Master Site Support Matrix. (Sheet 6 of 6)

APPENDIX B

UNDERGROUND STORAGE TANK - INTEGRATED DEMONSTRATION
PROGRAM ACTIVITY AND TECHNICAL TASK PLAN MATRIX

B.0 UST-ID ACTIVITY AND TTP MATRIX

The UST-ID Activity and TTP Matrix (Figure B-1) relates the UST-ID programmatic activities of the Master Schedule to the TTPs. While representing the same scope of work, the Master Schedule activities provide a programmatic perspective on planned work while the TTPs define the baseline tasks including deliverables and milestones. Since TTPs define the scope of work for organizations, each programmatic activity may be supported by several TTPs. Conversely, an individual TTP may support several programmatic activities.

As indicated in the matrix legend, both current fiscal year and projected outyear activities are included in the matrix. In several cases, current fiscal year activities will also extend into outyears.

UST-ID PROGRAM PROGRAM ACTIVITIES AND TTP'S

ACTIVITY ID (1)

TTP NO. AND TITLE (2)

UST-ID PROGRAM PROGRAM ACTIVITIES AND TTP'S		CHARACTERIZATION AND WASTE RETR																							
		10 CHARACTERIZATION														20 LIGHT DUTY UTILITY									
		1.1		1.2		1.3		1.4		2.1		2.2		2.3											
		SPECTROSCOPY	PHYSICAL PROPERTIES	SURV. & INTEG. MONITORING	SYSTEM IMPLEMENTATION	LIGHT DUTY UTILITY ARM	END EFFECTORS	INTEGRATED LDUA SYSTEM																	
ACTIVITY ID (1)		TECH. PLANNING AND COORD.	1.1.1 LDUA RAMAN SPECTR.	1.1.2 REMOTE RAMAN	1.1.3 INFRARED SPECTROMETER	1.2.1 RHEOLOGY PHORE	1.2.2 PH. PROP/DEPTH PROF.	1.3.1 ACOUSTIC MONITORING	1.3.2 TANK LEAK DETECTION	1.4.1 SURV. & INSP. SYSTEM	1.4.2 ON-LINE MONIT. SYSTEM	1.4.3 IN SITU MONIT. SYSTEM	1.4.4 HOT CELL MONIT. SYSTEM	2.1.1 LDUA PROCUREMENT	2.1.2 CADAS SUBSYSTEM	2.1.3 TRIC SUBSYSTEM	2.1.4 TOOL INTER. PLATE	2.2.1 CAMERA END EFFECTORS	2.2.2 STRUCTURED LIGHT	2.2.3 LASER RANGE FINDER	2.2.4 CHAR. SENSOR PACKAGE	2.2.5 NDE SYSTEMS	2.3.1 FUNCTIONS & REQ'S	2.3.2 CONCEPTUAL DESIGN	
TTP NO. AND TITLE (2)																									
AL-232001 USTID: COMPUTER INTERFACE																									
DR-232001 GENERIC TRUEX MODEL																									
DR-243501 UST-ID: MOBILE EVAP./CONC. DEVELOPMENT																									
DR-121204 BIOREMEDIATION																									
DR-412001 LDUA DECON. SYSTEM AND END EFFECTORS																									
DR-132008 UST-ID: DEMONSTRATION, TESTING AND EVALUATION	SUBTASK 1 NAC PROCESS																								
	SUBTASK 2 COMPREHENSIVE S&S																								
	SUBTASK 3 CEA TECH. INTERCHANGE																								
	SUBTASK 4 TRUEX VALIDATION																								
	SUBTASK 5 CLEAN OPTION SUPPORT																								
	SUBTASK 6 WPCF PROGRAM																								
	SUBTASK 7 ORGANICS DESTRUCTION																								
	SUBTASK 8 LDUA TOPO MAPPING																								
	SUBTASK 9 ACOUSTIC EMISSIONS																								
RL-332011 UST-ID: DEMONSTRATION, TESTING AND EVALUATION	SUBTASK 00 PLANNING & COORD.																								
	SUBTASK 01 SIMULANT DEVELOPMENT																								
	SUBTASK 02 COMPACT PROC. UNIT																								
	SUBTASK 03 ARM & END EFFECTOR																								
	SUBTASK 04 MECHANICS																								
	SUBTASK 05 TEST REQ'S & EVAL. (3)																								
SUBTASK 06 INTEGRATED TESTING																									
RL-353503 USTID: MEDIUM PRESS. SYS./MINING STRATEGY																									
RL-353503 UST: HIGH PRESS. WATERJET SCARIFICATION																									
RL-421207 UST-ID: DEMONSTRATION, TESTING AND EVALUATION	SUBTASK 0 COORD. & TECH. REVIEW																								
	SUBTASK 1 LDUA SYSTEM (3)																								
	SUBTASK 2 LASER RAMAN SPECTRO.																								
	SUBTASK 3 CHAR SYSTEM INTEG. (3)																								
	SUBTASK 4 ON-LINE PROCESS MONIT.																								
SUBTASK 5 WD&C SYSTEM																									
SP-211203 ADV. FIBER OPTICS SPECTRO FOR INORG. CONT.																									
SP-132001 LDUA: SURVEILLANCE & INSPECTION EE'S																									
SP-132002 CESIUM EXTRACTION TESTING																									
SP-132003 SPECTRO. SYSTEM FOR HANFORD IN SITU DEPL.																									

DRAFT FOR COMMENT

3/8/94

LEGEND

- FY'94 PROGRAM ACTIVITIES
- PROJECTED OUTYEAR ACTIVITIES

NOTES (1) UST-ID MASTER SCHEDULE ACTIVITY IDENTIFICATION NUMBERS
(2) FY'94 DRAFT TTP'S SUBMITTED 10/93
(3) SYSTEM LEAD TTP'S

Figure B-1. UST-ID Activity and TTP Matrix.

DISTRIBUTION

Number of copies

OFFSITE

2	<u>U.S. Department of Energy- Headquarters</u> Sherry Gibson EM-552 Pawel Szerszen EM-552
1	<u>Oak Ridge National Laboratory Martin Marietta Energy Systems</u> Bethel Valley Road Oak Ridge, TN 37830 C. P. McGinnis #6273

ONSITE

1	<u>U.S. Department of Energy- Richland Operations Office</u> Public Reading Room A1-65
1	<u>Pacific Northwest Laboratory</u> Technical Files K1-11
19	<u>Westinghouse Hanford Company</u> D. A. Brown (2) K8-50 B. A. Carteret N1-21 J. M. Cruse L5-63 R. C. Eschenbaum N1-21 R. L. Gilchrist (5) L5-63 C. M. Johnson (3) G3-08 A. F. Noonan B1-40 M. J. Quadrel (2) K8-07 M. W. Rinker K5-26 Central Files L8-04 Information Release Administration (3) L8-07

DATE

FILMED

10 / 13 / 94

END