DOE/EM-0381

INNOVATIVE TECHNOLOGY
Summary Report

Road Transportable Analytical Laboratory (RTAL)

Industry Programs

Prepared for
U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

October 1998

INNOVATIVE TECHNOLOGY
Summary Report

Road Transportable Analytical Laboratory (RTAL)

OST Reference # 292

Industry Programs

Demonstrated at
U.S. Department of Energy
Fernald Environmental Management Project
Ohio

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine if a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://em-50.doe.gov under "Publications."

TABLE OF CONTENTS

SECTION I

SUMMARY

Technology Summary

The Road Transportable Analytical Laboratory (RTAL) has been used in support of U.S. Department of Energy (DOE) site and waste characterization and remediation planning at Fernald Environmental Management Project (FEMP) and is being considered for implementation at other DOE sites, including the Paducah Gaseous Diffusion Plant. RTAL was developed by Engineering Computer Optecnomics (ECO) under an Industry Programs (IP) contract managed by the Federal Energy Technology Center (FETC) for the DOE Office of Environmental Management's (EM) Office of Science and Technology (OST).

It is the mission of IP to foster private sector businesses to develop, demonstrate, and deploy cost-effective technologies that will be used to solve problems at multiple DOE sites. To do this, IP contracts directly with the private sector for projects that ensure private sector companies, including small businesses, are able to compete within the DOE market and deploy their innovative, cost effective solutions; develop confidence in the user community at the DOE sites so that the sites are willing to use innovative technology; and establish confidence in the private sector contractor community that will bid innovative technology for future DOE work, thus enhancing competition.

Problem

The objective of the RTAL project has been to develop and demonstrate a system to meet the requirements of DOE for rapid, accurate analysis of a wide variety of hazardous and radioactive contaminants in soil, ground water, and surface waters.

How it Works

The RTAL laboratory system consists of a set of individual laboratory modules deployable independently or as an interconnected group to meet each DOE site's specific analysis needs. The prototype RTAL, deployed at FEMP Operable Unit 1 Waste Pits, has been designed to be synergistic with existing analytical laboratory capabilities, thereby reducing the occurrence of unplanned "rush" samples that are disruptive to efficient laboratory operations. This system is anticipated to accelerate cleanup and reduce costs by:

- providing critical analytical data more rapidly;
- eliminating the handling, shipping, manpower, and other expenses, associated with sample shipments; and
- providing full protection for operating personnel and equipment against environmental extremes encountered at DOE sites.

Advantages over the Baseline

RTAL provides an alternative to taking field samples, packaging them, and shipping them to a fixed laboratory for analysis. In addition to fulfilling the need to develop faster and less expensive methods of obtaining critical environmental analytical data, the RTAL system offers the following advantages:

- provides reliable, road-transportable, fully independent laboratory systems;
- performs the full range of required analyses on site;

- provides field and laboratory analytical equipment necessary to detect and quantify:
— radionuclides,
— organics,
— heavy metals and other inorganics, and
— explosive materials;

- achieves a processing goal of 20 samples per day by means of the integrated laboratory system;

- provides a full range of analyses within 16 hours (after sample preparation) with high accuracy and high quality assurance.

Demonstration Summary

The development of the RTAL system was conducted in two phases. Phase I included the development and optimization of the RTAL system design to most effectively meet the needs of the DOE complex. This phase incorporated the development of detailed performance requirements (based on documented data and identified needs of potential DOE users), development and evaluation of alternative system configurations, and optimization of the final design.

The Phase II effort was divided into two parts to facilitate the synergistic cooperation of the U.S. Army Biomedical Research and Development Laboratory (USABRDL). Phase IIa provided for the development and construction of a 3-module Integrated Aquatic Biomonitoring system. The hazard assessment techniques performed in these modules employ non-mammalian in vivo bioassays, in vitro bacterial mutagenicity assays, and analytical chemistry procedures in an integrated biological assessment. Phase IIb provided for the construction and demonstration of a prototype RTAL system at FEMP and included the USABRDL's Integrated Aquatic Biomonitoring systems as part of the demonstration.

Contacts

Technical

Stanley M. Finger and Virgil F. Keith, Principal Investigators, Engineering Computer Optecnomics, 1356 Cape St. Claire Road., Annapolis, MD 21401, (410) 757-3245), e-mail: eco@annap.infi.net

Management

Project Manager: Jagdish (Jeet) L. Malhotra, Federal Energy Technology Center, P.O. Box 880, Morgantown, WV 26507-0880, (304) 285-4053, e-mail: jmalho@metc.doe.gov

FETC/IP Program Manager: Robert C. Bedick, Federal Energy Technology Center, P.O. Box 880, Morgantown, WV 26507-0880, (304) 285-4505, e-mail: rbedic@fetc.doe.gov

HQ Program Manager: Kurt Gerdes, U.S. Department of Energy Headquarters, (301) 903-7289, e-mail: kurt.gerdes@em.doe.gov

Other

All published Innovative Technology Summary Reports are available on the OST Web site at http://em-50.em.doe.gov under “Publications.” The Technology Management System, also available through the OST Web site, provides information about OST programs, technologies, and problems. The OST Reference # for RTAL is 292.

SECTION 2

TECHNOLOGY DESCRIPTION

Process Schematic

The RTAL system consists of a set of individual laboratory modules deployable independently or as an interconnected group to meet the specific needs of each DOE site. Each module is housed in a standard 48-ft long by 8½-ft wide trailer to facilitate transport to the site and provides full protection for operations and sensitive analytical equipment against radioactive particulates and conventional environmental contaminants. Each module is shock and vibration protected to prevent damage during transport and operation and has its own electrical generation and HVAC systems. When interconnected, the modules provide back-up utilities for each other to ensure a high degree of performance reliability. The RTAL computers are interconnected via a wireless Local Area Network, including software that enables remote monitoring and control from the Operations Control Center or any other module. Cellular communications capabilities have been incorporated, and satellite communications capabilities are available. STU-III encryption devices can be added to provide secure communications. Available RTAL modules include the following:

- Radioanalytical Laboratory,
- Organic Chemical Analysis Laboratory,
- Inorganic Chemical Analysis Laboratory,
- Aquatic Biomonitoring Laboratory,
- Field Analytical Laboratory,
- Robotics Base Station,
- Decontamination/Sample Screening Module,
- Operations Control Center, and
- Protected Living Quarters Module.

The Radioanalytical Laboratory provides the shielded analytical and laboratory support equipment necessary for analysis of alpha (α), beta (β), and gamma (γ) emitting radionuclides. The analytical instruments make full use of laboratory automation equipment to maximize throughput.

The Organic and Inorganic Chemical Analysis Laboratories have full complements of analytical and laboratory support equipment for a wide range of analyses. The modules are designed to accommodate the linear robotic analysis systems that are being developed commercially and at the Los Alamos National Laboratory (LANL).

The Aquatic Biomonitoring Laboratory monitors for environmental hazards and is capable of verifying ground-water cleanliness at levels below the sensitivity of current chemical analyses.

The Field Analytical Laboratory contains equipment for rapid field detection of contaminants. The laboratory is designed for automatic transmission of data, including measurement position, directly to the RTAL computers.

The Robotics Base Station provides housing and operations control for the robotic field sampling and robotic monitoring systems that are currently available and under development. A position locator will be integrated into the robotic systems and data will be transmitted directly to the RTAL computers.

The Decontamination/Sample Screening Module provides a decontamination shower (in protective ensembles) for personnel working in contaminated areas and also provides a hot cell, glove box, and hood for initial screening of samples prior to full analysis in the Radioanalytical, Organic, and Inorganic Chemical Analysis Laboratories.

The Operations Control Center integrates laboratory and field activities and data analysis to ensure efficient performance of all phases of RTAL work functions. This module provides additional computer capacity and work space for system operators as well as laboratory oversight via the Local Area Network integrating all RTAL computers and control systems.

The Protected Living Quarters Module provides full facilities for up to five operators and is deployed only for operations in remote areas where it would be inefficient to bring in new personnel every 8–12 hours.

The RTAL includes features that ensure optimal performance of sensitive state-of-the-art analytical instrumentation and reliable, independent operation. Among these features, which are not available in other transportable laboratory systems, are:

- sufficient onboard power (100 kW) to run the mechanical systems as well as the analytical equipment;
- filtered power to ensure constant voltage and frequency, necessary to obtain optimum performance from sensitive equipment;
- uninterruptible power supply (10 kVA for 30 minutes) to protect data and sensitive instruments from power loss;
- sufficient heating and cooling capacity to ensure uniform temperatures and humidity over a wide range of outside conditions;
- HEPA filtration of incoming air to remove background contamination that could affect instrument accuracy;
- controlled air flow from “clean” to “dirty” areas;
- extremely low vibration as a result of four levels of vibration isolation (also provides shock protection for road transport) necessary to maintain performance levels of sensitive instruments;
- shock and vibration protection for road transport;
- hydraulic leveling legs for operations on uneven terrain;
- no U.S. Department of Transportation restrictions;
- sufficient structural support for heavy analytical equipment (e.g., the two germanium detectors in the radioanalytical laboratory each weigh 5,000 lb);
- sufficient space to integrate and ergonomically place all the hoods, benches, and equipment necessary to run a high-performance, state-of-the-art laboratory;
- integrated human engineering (windows, lighting, lab layout, wall and flooring materials, etc.) to ensure long-term operator efficiency;
- integration of laboratory operations via a Local Area Network;
- use of state-of-the-art automated equipment to minimize operator requirements;
- onboard water, wastewater, and fuel tanks providing for a minimum of several days’ operation between replenishment;
- redundant, rugged design for maximum availability;
- minimum acquisition and maintenance costs;
- ease of repair and maintenance;
- ease of exterior decontamination; and
- innocuous appearance to minimize public apprehension during transport and deployment.

The complete RTAL system is depicted schematically in Figure 1.

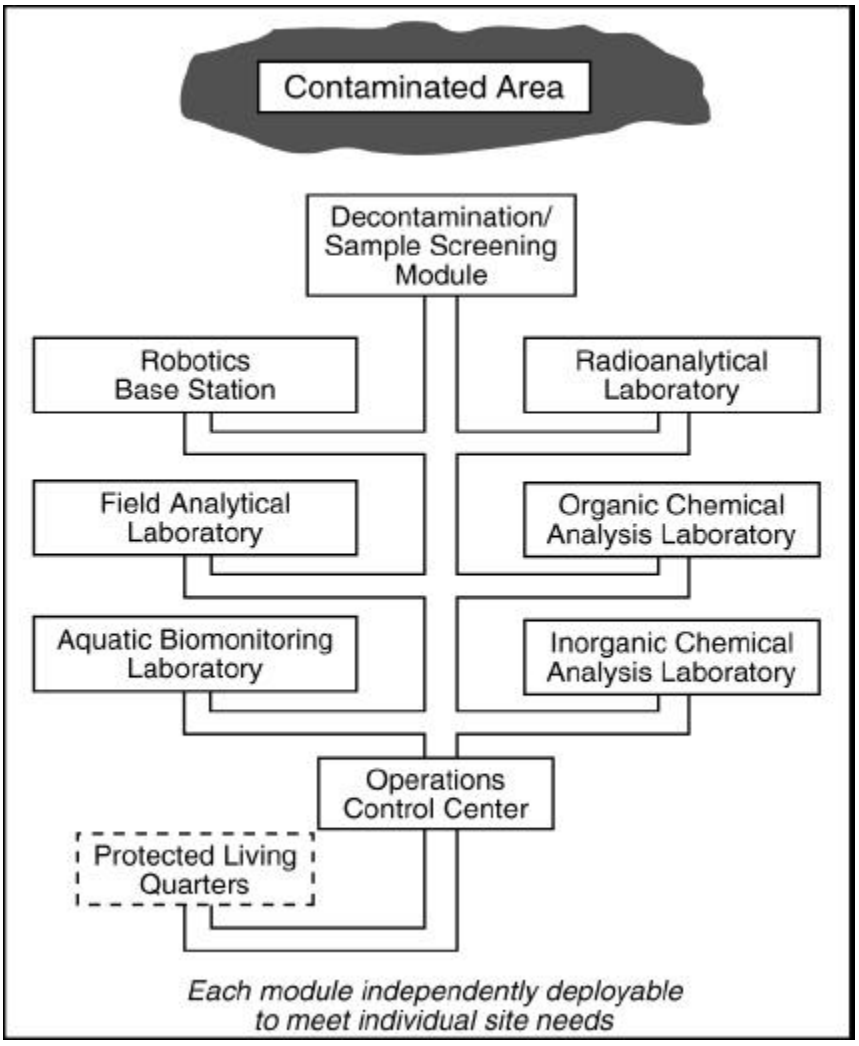

Figure 1. Schematic representation of the RTAL system.

SECTION 3

PERFORMANCE

Demonstration Overview

A prototype RTAL system was constructed and delivered to FEMP for demonstration during 1st–3rd quarters of FY96. The partial prototype system consisted of a Radioanalytical Laboratory, an Organic Chemical Analysis Laboratory, and an Operations Control Center. It was augmented by three Integrated Aquatic Biomonitoring modules provided by the U.S. Army. These modules were an Aquatic Biomonitoring Laboratory, a Chemical Analysis Laboratory (simulating the RTAL Inorganic Chemical Analysis Laboratory), and an Operations Control Center.

The RTAL system was deployed near FEMP's Operable Unit 1 Waste Pits. Its performance was evaluated based on samples from these pits and with other environmental samples from the FEMP parking lot near the FEMP Advanced Wastewater Treatment (AWWT) Plant, but outside the Process Area. Discharge water from AWWT was used for the demonstration of Aquatic Biomonitoring technology. All the laboratories were operated without external connections, using their onboard electrical generators, water supply and wastewater tanks, fuel tanks, and cellular telephones. The RTAL's computers were integrated via the system's wireless Local Area Network.

Results

The results of the analyses performed in RTAL were in excellent agreement with the results obtained by FEMP using conventional laboratories. All contaminants of concern were identified at the correct concentrations. Turnaround times ranged from 1 day for the volatile organic analysis (VOA) samples to 3.5 days for the Toxicity Characteristic Leachate Procedure (TCLP) semi-volatile samples (including sample preparation, report preparation, and record keeping). Sample throughput of seven samples per 8-hour shift (equating to 21 samples per day) was achieved. In all cases, the goal of completing all analyses within 16 hours after sample preparation was achieved. Excellent quality control was maintained throughout the evaluation tests. The following analytical procedures were evaluated during the demonstration:

- VOA in accordance with U.S. Environmental Protection Agency (EPA) method SW-846 Method 8260,
- semi-volatile organic analysis (SVOA) in accordance with EPA method SW-846 Method 8270,
- TCLP in accordance with EPA method SW-846 Method 1311,
- heavy metals analysis, performed by Inductively Coupled Plasma,
- total uranium concentration using the procedure currently in use at FEMP,
- isotopic uranium concentration, using the procedure currently in use at FEMP,
- automated liquid-liquid extraction, and
- automated sample concentration.

Turnaround Times

One of the main advantages of the RTAL system is the ability to perform high-quality analyses with fast turnaround times. Turnaround times were defined as the time from sample delivery to the RTAL laboratories to report delivery to the FEMP staff. A comparison of RTAL turnaround times to turnaround times of commercial laboratories used by FEMP are presented in Table 1.

Table 1. Sample turnaround time in days

Procedure	RTAL	FEMP best recorded	FEMP typical
VOA	1	7	7–14
TCLP-VOA	1.75	7	7–14
SVOA	2	7	7–14
TCLP-SVOA	3.5	7	7–14
Isotopic + Total Uranium	3[a]	5[b]	5–10
Resource Conservation and Recovery Act (RCRA) Metals	<1	7	7–14

[a]Without soil muffling step, which is not performed by FEMP.

[b]Performed by FEMP central lab; FEMP uses outside lab for organic and RCRA metals analyses.

Analytical Performance

Analytical performance is typically measured by two criteria: (1) accuracy and (2) precision. Analytical accuracy is determined by calculating the percent recovery of the analytes in the samples. Precision estimates are determined by relative percent differences between replicate samples. It is important to note that SW-846 methodology provides only “recommended” guidelines but does not provide validation requirements. Rather, SW-846 requires that each laboratory establish its own criteria for recovery and differences between samples. A laboratory may elect to validate samples against other criteria, such as the Contract Laboratory Protocol, but this is not a requirement.

For the 22 aqueous VOA samples in the demonstration phase, RTAL showed recoveries ranging from 75–105 percent, which is comparable to recoveries for most performance evaluation samples. Precision ranged from 0.5–7.0 percent relative standard deviation, again comparable with established laboratories.

For the 16 aqueous SVOA samples in the demonstration phase, RTAL showed recoveries ranging from 15–92 percent, which is comparable to normally expected recoveries for acids of 5–114 percent and for polyaromatic hydrocarbons of 30–114 percent. Precision was 10 percent or less relative standard deviation, again comparable with established laboratories.

For the seven aqueous RCRA metal samples in the demonstration phase, RTAL showed recoveries ranging from 80–100 percent, which is comparable to recoveries for most performance evaluation samples where recovery ranges from 80–120 percent.

SECTION 4

TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Technology Applicability

The RTAL system has been designed to incorporate the flexibility needed to be of use at many of DOE's sites. Those sites most likely to be in need of the RTAL system include the Hanford Site, the Savannah River Site, FEMP, the Oak Ridge Reservation, the Idaho National Engineering and Environmental Laboratory, the Rocky Flats Environmental Technology Site, LANL, and the Nevada Test Site. Of these potential users, the Savannah River Site has specifically indicated an interest in using the RTAL system to handle some of its analytical work.

DOE's Office of Environmental Management conducted a preliminary study of projected analytical needs across the DOE complex. The study defines four levels of handling requirements based on sample radioactivity:

- R1 - bench top (<10 mR/h and <10 nCi/g alpha);
- R2 - hood (10-200 mR/h or <10 nCi/g alpha);
- R3 - hot cell (>200 mR/h); and
- R4 - glove box (<200 mR/h and >10 nCi/g alpha).

Preliminary results show that 84 percent of the samples projected will fall into category R1, and an additional 14 percent will fall into category R2. Categories R3 and R4 represent a combined total of only 2 percent. The RTAL system, equipped to handle category R1 and R2 samples, would be expected to be able to handle up to 98 percent of all anticipated sample types. The sample screening area can safely handle all four categories, and those samples encountered in categories R3 and R4 would be processed by central laboratories.

Alternative Technologies

The baseline technology is to take field samples, package them, and ship them to a fixed laboratory for analysis. This technology meets regulatory requirements (Resource Conservation and Recovery Act [RCRA], Comprehensive Environmental Restoration, Compensation, and Liability Act [CERCLA], etc.) for sample collection, preparation, and analyses. Unfortunately, a higher per-sample cost is usually associated with the amount of labor involved when using a fixed laboratory. Additionally, sample turnaround time is often a function of the laboratory's capacity and may be longer than more innovative techniques, such as the RTAL system.

Field laboratories represent the baseline technology and field screening techniques have been in use for some time. However, recent literature reviews have been unable to identify any field laboratory that compares to the RTAL system's ability to supply individual, independent, or networked modules as necessary, including the capability to determine radionuclides. Based on the literature review, there is no indication that other competitive technologies are under development for DOE or the U.S. Department of Defense.

Patents, Commercialization, and Sponsorship

The RTAL system is available through ECO as a commercial, off-the-shelf product, providing full warranties and guarantees on a sale or lease basis. Maintenance and/or fully trained operating personnel are available to support RTAL operations. The RTAL system has been integrated into ECO's existing line of TERMM™ and Superfund TERMM™ modular transportable and analytical laboratory and operational support systems.

SECTION 5

COST

Introduction

The RTAL system technology can provide DOE with significant savings in terms of time and cost. Samples can be analyzed on site, and results obtained within days, compared to the typical 21–45 day turnaround time for commercial laboratories. Additionally, off-site sample shipments are minimized, saving additional time and labor.

Cost Comparison

Fixed Laboratory Cost Information

FEMP personnel provided current laboratory costs for the environmental analyses performed in RTAL during its evaluation at that facility. These costs, as presented in Table 2, are based on actual sample analysis costs required for FEMP's National Pollutant Discharge Elimination System permit using an off-site laboratory. FEMP analyzes a large number of these samples annually and receives a discounted rate in consideration of the sample volume. The following comparison is based on RTAL's *demonstrated* throughput rate of 50 samples per day for RCRA metals, and 21 samples per day for each of the other categories listed in Table 2. At this rate, FEMP estimates an average 240-day operational year (5 days per week for 48 weeks), which allows for holidays, downtime, equipment repair/maintenance, and other non-collection days. A 300-day operational year estimate has also been prepared as a maximum anticipated work year. Prices reflect a standard 21-day turnaround time.

The costs presented in Table 2 do not include health and safety, oversight, radiological control, surveying, sample collection, preparation, shipment, or reporting costs. It is assumed that technician time to collect samples will be comparable across the DOE complex; however, labor rates vary (including overhead and the manner in which they are applied) from site to site. Shipping costs may vary slightly depending on the carrier used and the total weight of the container but should be comparable. The laboratory provides a printout of the sample results, but each site must decide how the results will be used and whether the site will prepare additional reports based on the results. Again, these costs will vary across the DOE complex and are not included in Table 2. However, these costs would be incurred by the site regardless of the analytical laboratory used (i.e., fixed-location laboratory or RTAL). Therefore, it is appropriate to compare actual laboratory costs only.

RTAL Cost Information

Using the demonstrated throughput rates given above, a cost estimate has been prepared for using RTAL at FEMP. The RTAL estimate is based on the use of the Radioanalytical Laboratory, the Organic Chemical Analysis Laboratory, the Inorganic Chemical Analysis Laboratory, and the Operations Control Center to accomplish the analyses presented in Table 2. An annual capital cost was calculated from the total capital cost using straight-line depreciation. A 15-year life was used for the laboratory structures, and a 10-year life was used for the analytical equipment within the laboratories. Annual personnel costs have been estimated based on a staffing level (per laboratory) of three analysts for two shifts, one analyst for third shift, and one manager for operations oversight. Maintenance, chemical, fuel, and other consumable costs have been estimated. A 20 percent contingency factor was added as a conservative projection. Mobilization costs account for less than 1 percent of the total costs. Estimated RTAL costs are presented in Table 3.

Table 2. FEMP's fixed laboratory analytical costs

Analysis	Per sample cost ($)	Estimated samples per day	Estimated annual cost (240 days per year) ($)	Estimated annual cost (300 days per year) ($)
RCRA metals	143	50	1,716,000	2,145,000
VOA	97	21	488,880	611,100
SVOA	145	21	730,800	913,500
TCLP-VOA	380	21	1,915,200	2,394,000
TCLP-SVOA	675	21	3,402,000	4,252,500
TCLP-RCRA metals	340	21	1,713,600	2,142,000
Uranium (total and Isotopic)	150	21	756,000	945,000
Total estimated cost			10,722,480	13,403,100

Table 3. Summary of RTAL annual estimated costs

Itemization	Cost, 240 operating days ($)	Cost, 300 operating days ($)
Depreciation	340,260	340,260
Personnel	3,300,000	3,300,000
Maintenance	38,000	38,000
Fuel	58,400	58,400
Chemicals	2,649,360	3,311,700
Miscellaneous consumables	36,000	45,000
Contingency	1,284,400	1,418,670
Total	7,706,420	8,512,030

The total cost for performing the analyses listed above, 240 days per year in RTAL ($7.7M), represents a cost savings of roughly 30 percent over the cost of using a fixed laboratory. Assuming 300 operating days per year, a savings of roughly 38 percent can be realized by using RTAL.

SECTION 6

REGULATORY AND POLICY ISSUES

Regulatory Considerations

Environmental sample collection, preparation, and analyses for regulated sites must be performed in accordance with strict protocol(s) under federal and/or individual state requirements. Different protocols may be required based on determinations for RCRA, CERCLA, Drinking Water standards, etc., and based on the particular state or region where the site is located. Failure to adhere to the protocol may jeopardize sample integrity and may not withstand legal scrutiny should the site be summoned to court.

Additionally, laboratories performing the analyses may be required to demonstrate proof of appropriate certification (including quarterly analyses of blind samples) to participate in the analyses of regulated samples. Therefore, in preliminary decisions to use the RTAL system, a factor to be considered should be whether the technology is certified under the required authorities, state and/or federal, based on the site's needs and location. If the RTAL system is not certified by appropriate federal and/or individual state requirements, there may be a waiting period while the RTAL system becomes certified. (Note: local variances and/or exceptions can be granted.)

The RTAL system will need to gain and maintain appropriate certification for the location(s) in which it will operate. Federal and state agencies have authority to independently grant or deny exceptions, exemptions, and/or certification within their jurisdiction. Certification within any given jurisdiction does not necessarily guarantee certification within any other jurisdiction, although certification in a particular state sometimes extends to surrounding states. Therefore, the RTAL system may need to receive certification from multiple regional jurisdiction(s) if it is to be used across the DOE complex.

Safety, Risks, Benefits, and Community Reaction

Worker Safety

Health and safety issues for the RTAL system operation are essentially equivalent to those for conventional technologies. The system manufacturer can supply trained personnel upon request.

Community Safety and Reaction

- No unusual or significant community safety concerns are associated with the transport or use of the RTAL system.
- Overall, the local communities have little familiarity with the RTAL system but are generally supportive of all efforts to identify and remove environmental contaminants.
- There are no significant socioeconomic impacts anticipated with the use of the RTAL system.

SECTION 7

LESSONS LEARNED

Implementation Considerations

RTAL has been fully developed and demonstrated. Implementation of the system is currently available by contacting the vendor. No additional considerations have been identified.

Site Requirements

Site requirements are minimal. The RTAL utility system is self-contained, so there are no requirements imposed on the DOE site for utility usage. As demonstrated at FEMP, local weather conditions do not affect operation of RTAL. The site will need to provide a level area large enough to park the truck trailers (the size of the area required will depend on the number of independent laboratory modules required), including appropriate access to the location. In general, this should not be an issue at most DOE sites.

Technology Limitations/Needs for Future Development

The RTAL system is an innovative, mobile design of existing technology. Future development of the technology is not considered necessary at this time. Application of the technology is limited to currently available laboratory modules (available modules are listed in Section 2).

APPENDIX A

REFERENCES

Finger, S. M., and J. L. Molhotra. 1997. *Road Transportable Analytical Laboratory (RTAL)*, *Technology development through industrial partnerships: A compilation of technology development data sheets related to the field of environmental restoration and waste management.* U.S. Department of Energy, Office of Environmental Management, Office of Science and Technology, Federal Energy Technology Center.

Engineering Computer Optechnomics, Inc. 1997. *Road-Transportable Analytical Laboratory (RTAL)*. Draft date June 16. Federal Energy Technology Center, Project Progress Review and Analysis, Industry Programs.

APPENDIX B

ACRONYMS

AWWT	Advanced Wastewater Treatment
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act
DOE	U.S. Department of Energy
ECO	Engineering Computer Optecnomics
EM	DOE Office of Environmental Management
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FETC	Federal Energy Technology Center
HEPA	High-Efficiency Particulate Air (filter)
HVAC	Heating, Ventilation, and Air Conditioning (system)
IP	Industry Programs
kVA	Kilovolts/Amper
kW	Kilowatt
LANL	Los Alamos National Laboratory
mR/h	Millirem/hour
nCi/g	Nano-Curie/gram
OST	DOE Office of Science and Technology
RCRA	Resource Conservation and Recovery Act
RTAL	Road Transportable Analytical Laboratory
SVOA	Semi-Volatile Organic Analysis
TCLP	Toxicity Characteristic Leachate Procedure
USABRDL	U.S. Army Biomedical Research and Development Laboratory
VOA	Volatile Organic Analysis