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Road Transportable Analytical Laboratory (RTAL) System
Volume I

Final Report

by
Stanley M. Finger
J. Carlos De Avila
Virgil F. Keith

August 1996

Work Performed Under Contract No.: DE-AC21-92MC29109

for

U.S. Department of Energy
Office of Environmental Management
Office of Technology Development
Washington, DC

U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

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Engineering Computer Optecnomics (ECO), Inc.
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Disclaimer

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ABSTRACT

U.S. Department of Energy (DOE) facilities around the country have, over the years, become contaminated with radionuclides and a range of organic and inorganic wastes. Many of the DOE sites encompass large land areas and were originally sited in relatively unpopulated regions of the country to minimize risk to surrounding populations. In addition, wastes were sometimes disposed of underground at the sites in 55-gallon drums, wood boxes or other containers until final disposal methods could be determined. Over the years, these containers have deteriorated, releasing contaminants into the surrounding environment. This contamination has spread, in some cases polluting extensive areas.

Remediation of these sites requires extensive sampling to determine the extent of the contamination, to monitor clean-up and remediation progress, and for post-closure monitoring of facilities. The DOE would benefit greatly if it had reliable, road transportable, fully independent laboratory systems that could perform on-site a full range of analyses meeting high levels of quality assurance and control. Such systems would accelerate and thereby reduce the cost of clean-up and remediation efforts by (1) providing critical analytical data more rapidly, and (2) eliminating the handling, shipping and manpower associated with sample shipments.

The goals of the Road Transportable Analytical Laboratory (RTAL) Project are the development and demonstration of a system to meet the unique needs of the DOE for rapid, accurate analysis of a wide variety of hazardous and radioactive contaminants in soil, groundwater, and surface waters. This laboratory system is designed to provide the field and laboratory analytical equipment necessary to detect and quantify radionuclides, organics, heavy metals and other inorganic compounds. The laboratory system consists of a set of individual laboratory modules deployable independently or as an interconnected group to meet each DOE site's specific needs.

After evaluating the needs of the DOE field activities and investigating alternative system designs, the modules included in the RTAL system are:

- 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

The goal of this integrated laboratory system is a sample throughput of 20 samples per day, providing a full range of analyses on each sample within 16 hours (after sample

preparation) with high accuracy and high quality assurance. This is much shorter than the standard 21-45 day turnaround time typical of fixed laboratories. In addition, shipping samples off-site is a time-consuming, paperwork-intensive process, leading to additional delays in sample analyses. The focused project support provided by the RTAL is designed to significantly accelerate characterization and remediation efforts of critical restoration projects.

A prototype RTAL system was constructed for demonstration at the DOE's Fernald Environmental Management Project (FEMP). It was deployed at FEMP's OU-1 Waste Pits. Its performance was evaluated with samples from these pits and with other environmental samples from the FEMP site. The prototype RTAL system consists of 5 modules - Radioanalytical Laboratory, Organic Chemical Analysis Laboratory, Inorganic Chemical Analysis Laboratory, Aquatic Biomonitoring Laboratory, and Operations Control Center. The U.S. Army Biomedical R&D Laboratory volunteered to provide the Inorganic Chemical Analysis Laboratory and Aquatic Biomonitoring Laboratory as part of its concurrent demonstration of Integrated Aquatic Biomonitoring technology. The demonstration of the prototype RTAL took place during the 1st - 3rd Quarters of FY96 (including the Blizzard of '96). All performance and operational goals were met or exceeded.

The RTAL will provide the DOE with significant time and cost savings, accelerating and improving the efficiency of clean-up and remediation operations throughout the DOE complex. At the same time, the system will provide full protection for operating personnel and sensitive analytical equipment against the environmental extremes and hazards encountered at DOE sites.

ADMINISTRATIVE INFORMATION

The Road Transportable Analytical Laboratory (RTAL) Project was performed by Engineering Computer Optecnomics, Inc. (ECO) for the Morgantown Energy Technology Center (METC) of the U.S. Department of Energy (DOE) under Contract No. DE-AC21-92MC29109. This project is part of the DOE's Subsurface Contaminant Focus Area. The METC Contracting Officer's Representative (COR) is Mr. Jagdish L. Malhotra. The METC Contracting Specialist is Ms. Lisa Kuzniar. FEMP operations were under the auspices of the Office of Technology Demonstration under the leadership of Mr. Donald L. Herman. FEMP personnel responsible for the RTAL demonstration were Ms. Grace Ruesink, Mr. Rick Heath, Mr. Roy Cohen, and Mr. Keith Payne. The ECO Principal Investigator is Dr. Stanley M. Finger, Vice-President and Director of Environmental Programs. The ECO Project Director is Mr. Virgil F. Keith, President.

INTRODUCTION

DOE facilities around the country have, over the years, become contaminated with radionuclides and a range of organic and inorganic wastes. Many of the DOE sites encompass large land areas and were originally sited in relatively unpopulated regions of the country to minimize risk to surrounding populations. In addition, many times wastes were disposed of underground at the sites in 55-gallon drums, wood boxes or other containers until final disposal methods could be determined. Over the years, these containers have deteriorated, releasing contaminants into the surrounding environment. This contamination has spread, in some cases polluting extensive areas.

Remediation of these sites requires extensive sampling to determine the range of the contamination, to monitor clean-up and remediation progress, and for post-closure monitoring of facilities. Transporting these samples to a central laboratory, especially to one off-site, requires wipe tests for surface contamination before shipment and after receipt, specialized transportation containers and procedures (depending on the level of radioactivity present in the sample), and a substantial amount of additional paperwork. It can be very difficult and time-consuming to ship samples off-site from DOE facilities because of requirements established to ensure against inadvertent release of radioactive materials. The occasional improper shipment of radioactive materials from DOE facilities has led to periodic curtailment of all shipments to ensure that proper shipping procedures are followed. Such curtailments can cause havoc to projects where accurate and timely sample analytical data is critical to decision-making and also because environmental samples degrade over time.

The Road Transportable Analytical Laboratory (RTAL) is designed to analyze for all standard contaminants. But, potential contaminants encompass not only standard industrial pollutants. Contaminants at DOE and other government sites include a rather wide range of unique materials and their breakdown products. Allowable concentrations of these unique contaminants in groundwater, soils and other environmental media are often set at exceedingly low levels to ensure the safety of any receiving populations. Standard analytical methods are often strained and are sometimes incapable of achieving the low detection levels required.

To address this problem, the U.S. Army Biomedical Research and Development Laboratory (USABRDL) developed sensitive Aquatic Biomonitoring methods for detecting low levels of hazardous materials in groundwaters. These methods combine (a) exposure of aquatic organisms to test waters under controlled conditions with (b) _in vitro_ mutagenicity assays and (c) analytical chemistry.

Aquatic organisms are sensitive to aqueous contaminants and therefore are rapid indicators of low level hazards. While these methods do not always identify the specific contaminant present, they are very effective in (a) detecting very low levels of contamination, (b) corroborating the lack of any contamination, and (c) monitoring the effectiveness of remediation operations.

The hazard assessment techniques performed in the RTAL's transportable Aquatic Biomonitoring Laboratory address a variety of human health and ecological endpoints. These techniques employ non-mammalian in vivo bioassays, in vitro bacterial mutagenicity assays and analytical chemistry procedures in an integrated biological assessment to address the question "How clean is clean?"

Aquatic Biomonitoring is currently in use in RTAL laboratory modules at the U.S. Army Aberdeen Proving Grounds' O-Field site. Aquatic Biomonitoring data provide direct evidence of the efficacy of the remediation treatments being performed at this site. This supporting data has proven especially valuable at Aberdeen Proving Grounds in assuaging public concern over the discharge of treated groundwater into tributaries of the Chesapeake Bay. The continuous, real-time acute toxicity test using bluegills as test organisms is faster and more comprehensive than standard chemical analyses in monitoring these discharges. These fish act as "mine canaries" to warn of potentially harmful discharges. Thus, while undergoing further development, Aquatic Biomonitoring is helping advance remediation activities at U.S. Army facilities.

The DOE would benefit greatly from the use of reliable, road transportable, fully independent laboratory systems that could perform the full range of standard and Aquatic Biomonitoring analyses (with high quality assurance and control) required on-site. By focusing on high priority problems, such systems can accelerate clean-up and remediation efforts. They provide critical high quality analytical data more rapidly, and save money by eliminating handling, shipping and manpower costs associated with sample shipments.

The RTAL developed for the DOE is based on the earlier laboratories and operations control centers developed by Engineering Computer Optecnomics (ECO), Inc. for the U.S. Environmental Protection Agency, and the U.S. Departments of Defense and State. These include counter-terrorist systems for use in areas contaminated with chemical or biological warfare agents. The advances achieved in the development of these earlier systems have been incorporated into the development of the RTAL.

OBJECTIVE

The Road Transportable Analytical Laboratory Project covers the development and demonstration of a system to meet unique DOE needs for rapid, accurate analysis of a wide variety of hazardous and radioactive contaminants in soil, groundwater, and surface waters. This laboratory system is designed to provide the analytical equipment necessary to detect and quantify radionuclides, organics, heavy metals and other inorganics. The

RTAL also provides an Aquatic Biomonitoring Laboratory to quantify overall hazard level. The RTAL system consists of a set of individual laboratory modules deployable independently or as an interconnected group to meet each DOE site's specific needs.

The goal of the integrated laboratory system is a minimum sample throughput of 20 samples per day, providing a full range of analyses on each sample within 16 hours (after sample preparation) with high accuracy and high quality assurance. This is much shorter than the standard 21-45 day turnaround time typical of commercial laboratories. In addition, shipping of samples off-site is a time-consuming, paperwork-intensive process, leading to additional delays in sample analyses. This focused attention on high priority needs can accelerate and improve the efficiency of clean-up and remediation operations. The RTAL will be synergistic with existing analytical laboratory capabilities by reducing the occurrence of unplanned "rush" samples which are disruptive to efficient laboratory operations.

APPROACH

The development of the Road Transportable Analytical Laboratory System was conducted in two phases. Phase I, encompassing work at Maturity Level 4, Major Sub-systems, was for the development and optimization of the RTAL system design to most effectively meet the needs of the DOE complex. This phase incorporated development of detailed performance requirements (based on documented data and meetings with potential DOE users of the RTAL system), development and evaluation of alternative system configurations, and optimization of the final design.

Phase II of this project represented a transition to Maturity Level 5, Full-Scale Demonstration. 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. Phase IIb provided for the construction and demonstration of a prototype RTAL system at FEMP. The Phase IIb demonstration included USABRDL's Integrated Aquatic Biomonitoring system as part of the RTAL. This cooperation minimized development costs for the DOE and facilitated cooperation between the DOE and the U.S. Army.

A full-scale, fully operational partial prototype RTAL system was constructed and demonstrated at the Fernald Environmental Management Project (FEMP). 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 prototype system evaluation demonstrated that the analytical quality achieved in the RTAL was equal to the performance in a well-run fixed laboratory but at much shorter turnaround times (1/3 to 1/2 of FEMP's best times) and at significantly (at least 30%) lower cost.

Now that Phase II of the project is complete, ECO is providing the Road Transportable Analytical Laboratory System as a commercial off-the-shelf (COTS) product, providing full warranties and guarantees. The RTAL system has been integrated into ECO's existing family of TERMM™ and Superfund TERMM™ modular transportable analytical laboratory and operational support systems.

RTAL SYSTEM DESCRIPTION

To meet the wide range of environmental analytical requirements at the DOE's facilities while retaining the flexibility for rapid, cost-efficient response, the RTAL was conceived as a series of individual modules that could be deployed individually or as an integrated group. After evaluating the needs of the DOE field activities and investigating alternative system designs, the modules to be included in the full RTAL are:

- 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

Each module provides full protection for operators and equipment against radioactive particulates and conventional environmental contaminants. This is especially important in areas where radioactive particulates from environmental matrices, e.g. soils, are aerosolized by wind or volatile chemicals are present. These contaminants can adversely affect sensitive chemical and radiochemical analyses as well as being potentially harmful to personnel.

ECO's RTAL transportable laboratory system incorporates many unique features giving it the ability to project fixed laboratory analytical capabilities into the field. The RTAL integrates analytical and engineering technologies to meet the multiple competing requirements necessary to perform high quality analyses in a transportable, ergonomically designed, fully independent system. This differs from other suppliers of analytical laboratories in which analytical instruments are placed in standard vehicles. Features included in the RTAL to ensure optimal performance of sensitive state-of-the-art analytical instrumentation and reliable, independent operation, which are not available in other transportable laboratory systems, include:

- 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 analytical 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 temperature and humidity over a wide range of outside conditions
- HEPA filtration of incoming air to remove background contamination which 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 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
- Designed for minimum acquisition and maintenance costs
- Designed for ease of repair and maintenance
- Designed for ease of exterior decontamination
- Innocuous appearance to minimize public apprehension during transport and deployment

The continuous supply of electricity is critical to the reliability of the tests being performed. The loss of power would shut down the analytical equipment and support and control systems, critical for maintaining controlled experimental conditions. For this reason, an automatic switching circuit is provided for use when operating from an external power source. If the external power source fails, this circuit automatically starts the laboratory's electrical generator and switches all systems to this independent source of power, thus ensuring maintenance of experimental conditions.

Each module is housed in a standard 48 foot long by 8½ foot wide trailer to facilitate transport to the test sites. These units have no Department of Transportation restrictions on road transport. Wider trailers are considered "wide loads" which must have vehicular escorts, can not travel all roads, and must pay road use fees in most states. These restrictions limit the adaptability of extra-wide systems to meet the changing requirements across the DOE complex and adds significantly to their operating costs.

The chosen arrangement of RTAL modules closely follows the steps the samples and operating personnel will take, as shown in Figure 1. Figure 2 shows the partial prototype RTAL system, consisting of three modules - Radioanalytical Laboratory, Organic Chemical Analysis Laboratory, and Operations Control Center - deployed at FEMP.

In the full RTAL, the module closest to the contaminated area is the Decontamination/Sample Screening Module, as shown in Figure 1. This module is divided into two halves. The decontamination side is used to decontaminate personnel in protective gear who have been collecting samples or performing other duties in contaminated areas. The other side of the module is for screening of collected samples. Personnel, in appropriate protective gear, bring the samples to the sample pass-through (located on the side of the module closest to the contaminated area). The samples are passed directly into the hot cell inside the Sample Screening side of the module. The samples are screened for radiation level to determine handling requirements during subsequent testing. They are also subdivided for the analyses to follow.

The next modules behind the Decontamination/Sample Screening Module are the Robotics Base Station and the Field Analytical Laboratory. These modules provide robotically operated and hand-carried instrumentation for field determination of radioactive and chemical contamination levels. These modules are needed for initial mapping of large areas. The robotic systems, in particular, would include automated geographic positioning equipment to fix the location of each measurement. All data is transmitted to the computer in the Robotic Base Station for computerized mapping. The data provided by the robotic and field analytical systems would not meet the same high quality assurance and quality control standards as the samples analyzed in the RTAL modules. However, the data are very useful in determining the location of "hot spots," i.e. areas where personnel require protective ensembles.

The next set of modules are the four laboratories which are the heart of the RTAL system. These are the Radioanalytical, the

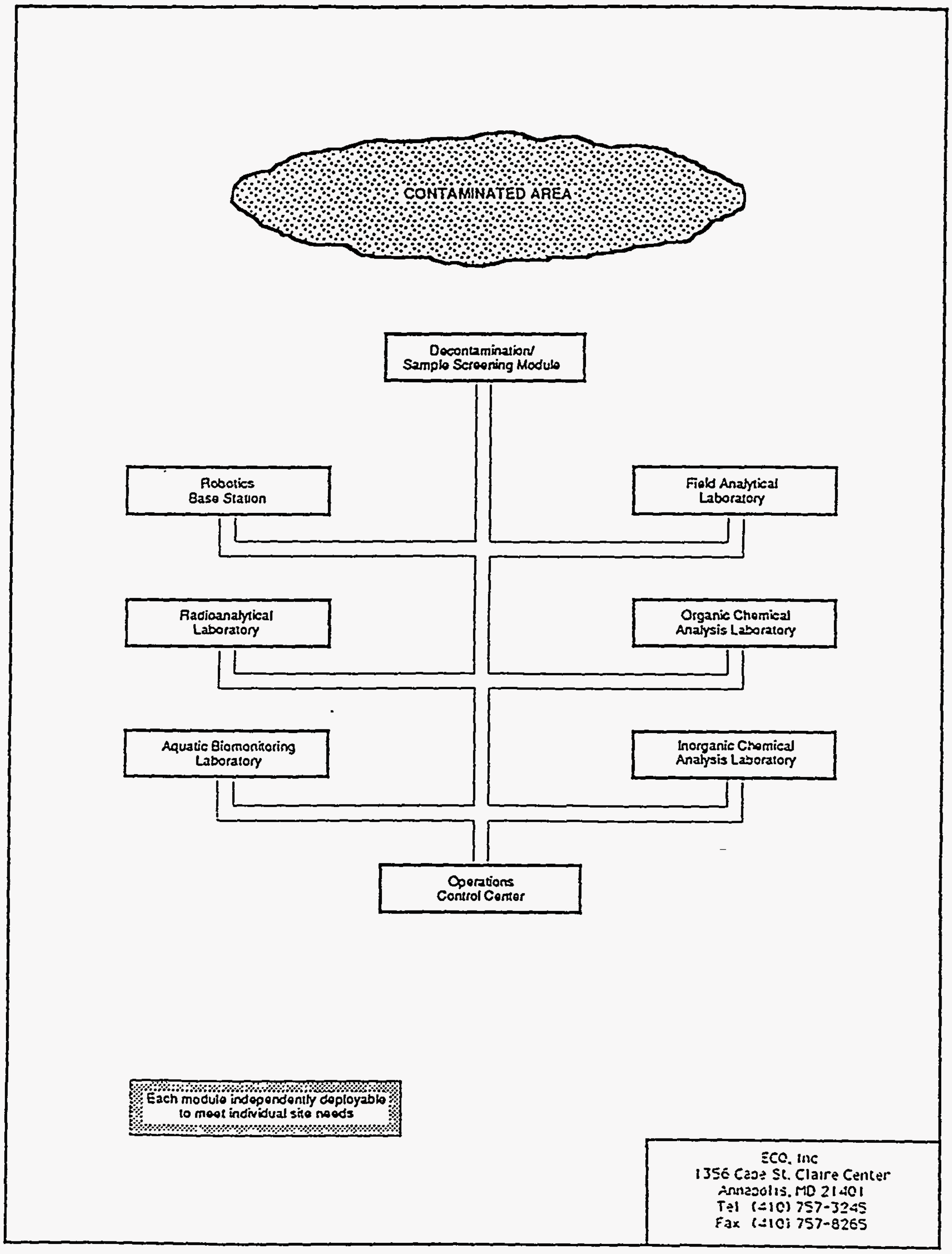

Figure 1. Road Transportable Analytical Laboratory Integrated Complex

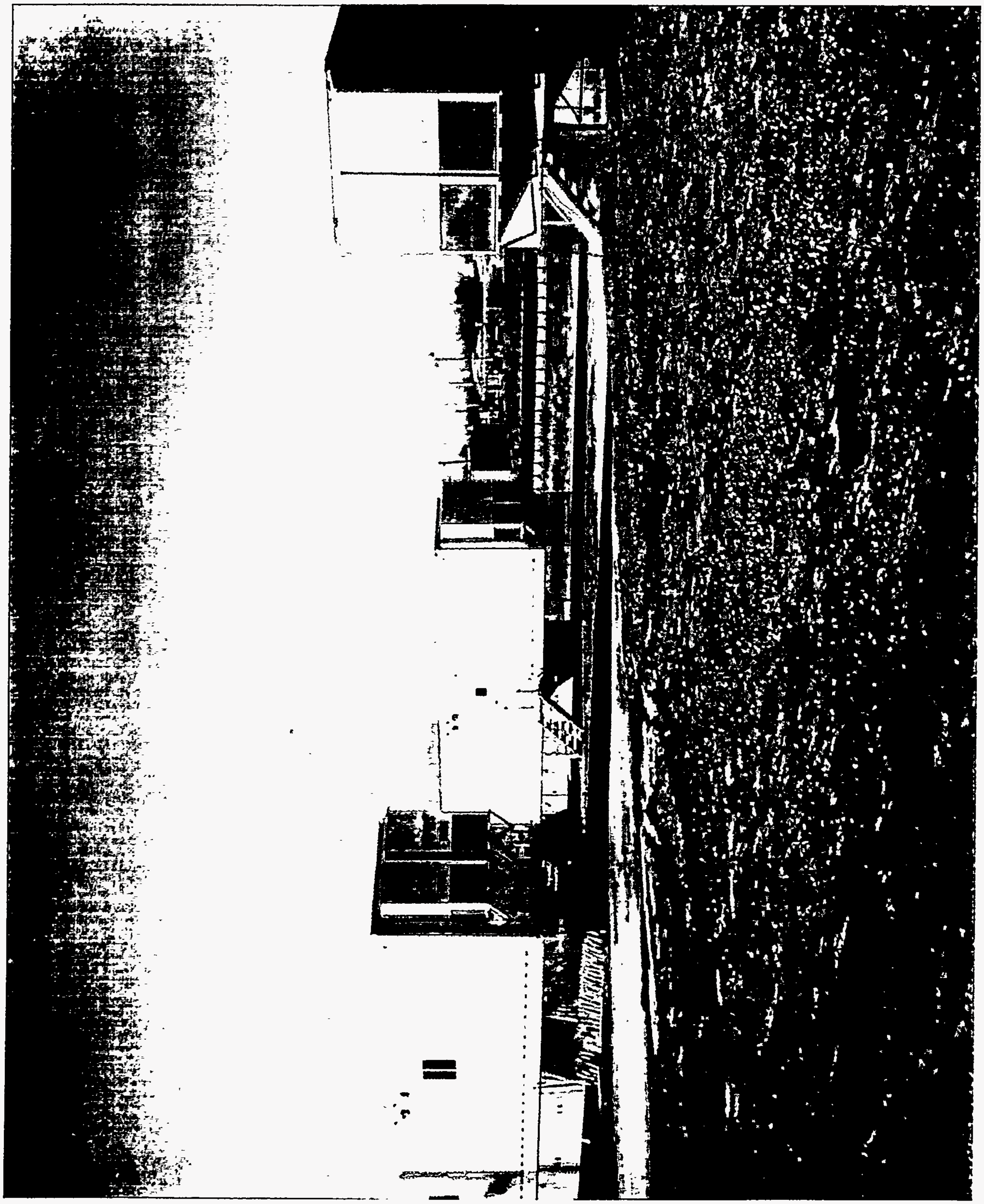

Figure 2: Partial Prototype RTAL at FEMP

Organic Chemical Analysis, the Inorganic Chemical Analysis, and the Aquatic Biomonitoring Laboratories. The subdivided samples from the Decontamination/Sample Screening Module are analyzed for specific analytes in the first three laboratories.

The Radioanalytical Laboratory, Figure 3, is divided into two rooms - a Sample Preparation Room and a Sample Analysis Room. The main entrance into the module leads into the Sample Preparation Room, Figure 4. This room contains three hoods and bench-top work area to facilitate the often time-consuming preparation of samples for subsequent instrumental analysis. The Sample Preparation Room also contains a safety shower and emergency eye wash station.

After preparation, the samples are brought into the Sample Analysis Room, Figure 5, where they are analyzed. The Radioanalytical Laboratory houses two Germanium Detectors (weighing 5,000 lb. each), 24 Alpha Spectrometers, a Liquid Scintillation Counter, and a Gross Alpha/Beta Counter. The analytical equipment makes maximum use of computer control and automatic sample feeding to maximize operator efficiency. This allows the instruments to operate for long periods without direct operator attention, increasing productivity.

The Organic Chemical Analysis Laboratory is also divided into two rooms - a Sample Preparation Room and a Sample Analysis Room. The main entrance into this module leads into the Sample Preparation Room. This room contains two hoods, automated liquid-liquid and solid-liquid extraction equipment (Figure 6), drying oven, and bench-top work area to facilitate the extensive preparation required for analysis of organic contaminants. The Sample Preparation Room also contains a safety shower and emergency eye wash station.

After preparation, the samples are brought into the Sample Analysis Room, Figure 7. The Organic Chemical Analysis Laboratory houses a Gas Chromatograph (GC)/Mass Spectrometer (MS), Purge and Trap GC/MS, GC with Flame Ionization Detector, automated Liquid/Liquid Extractor, automated Solid/Liquid Extractor, and Size Exclusion Chromatograph. As with the Radioanalytical Laboratory, the analytical equipment makes maximum use of computer control and automatic sample feeding to maximize operator efficiency. This allows for extended operation without direct operator attention, increasing productivity.

The Inorganic Chemical Analysis Laboratory is designed similar to the Organic Chemical Analysis Laboratory but with different analytical instrumentation. The principal instruments in the Inorganic Chemical Analysis Laboratory is an Inductively Coupled Plasma (ICP) Spectrometer for analysis of RCRA metals and other elements, and Toxicity Characteristic Leachate Procedure (TCLP) apparatus, including Zero Headspace Extractor. Since the prototype RTAL did not include an Inorganic Chemical Analysis Laboratory, the TCLP apparatus was included in the Organic Chemical Analysis Laboratory. The ICP for RCRA metals analysis was provided by USABRDL in their Integrated Aquatic Biomonitoring complex Chemical Analysis Laboratory, Figure 8.

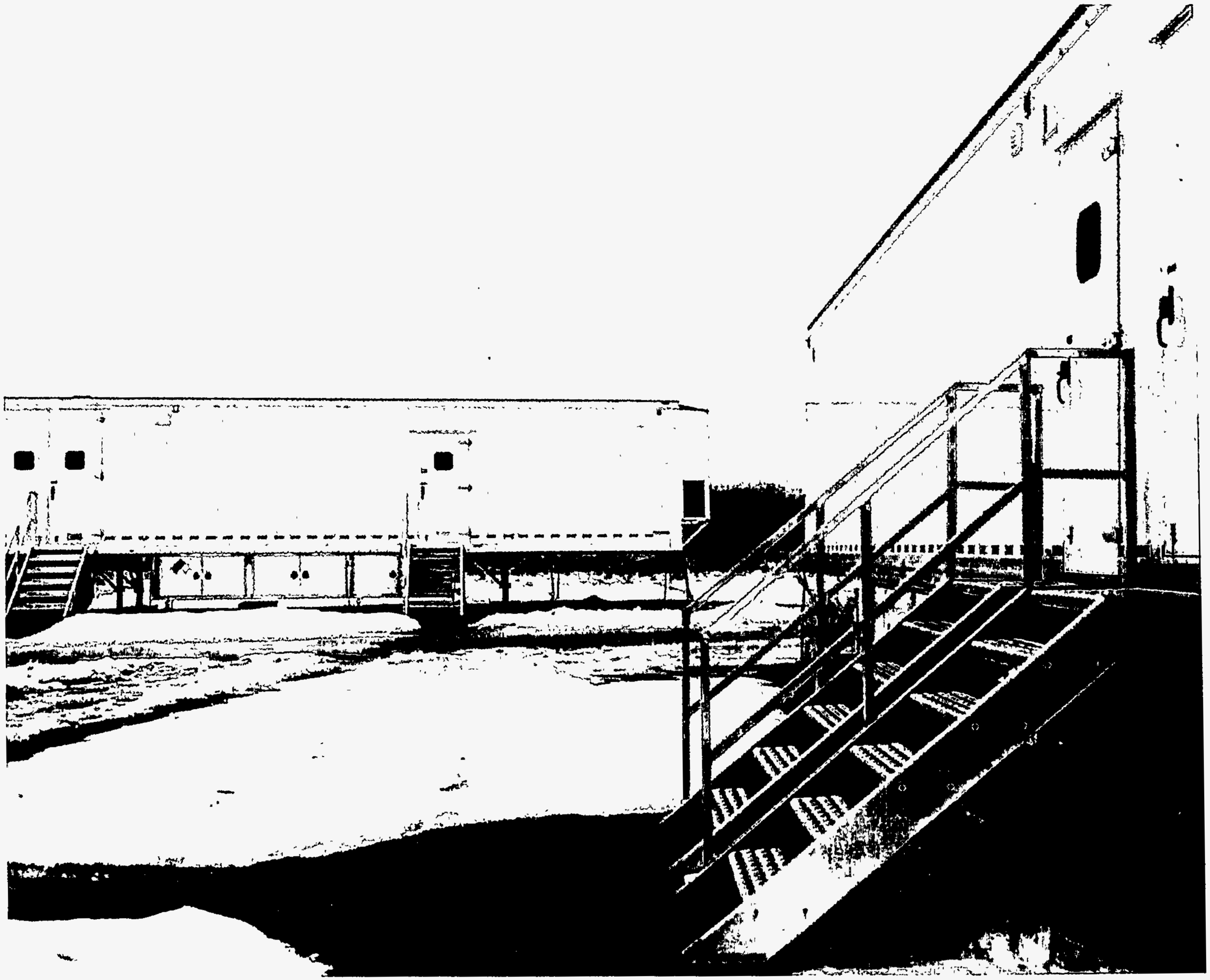

Figure 3: Radioanalytical Laboratory and Operations Control Center at FEMP

Figure 4: Radioanalytical Laboratory Sample Preparation Room

Figure 5: Radioanalytical Laboratory Sample Analysis Room

Figure 6: Automated Liquid-Liquid Extractor

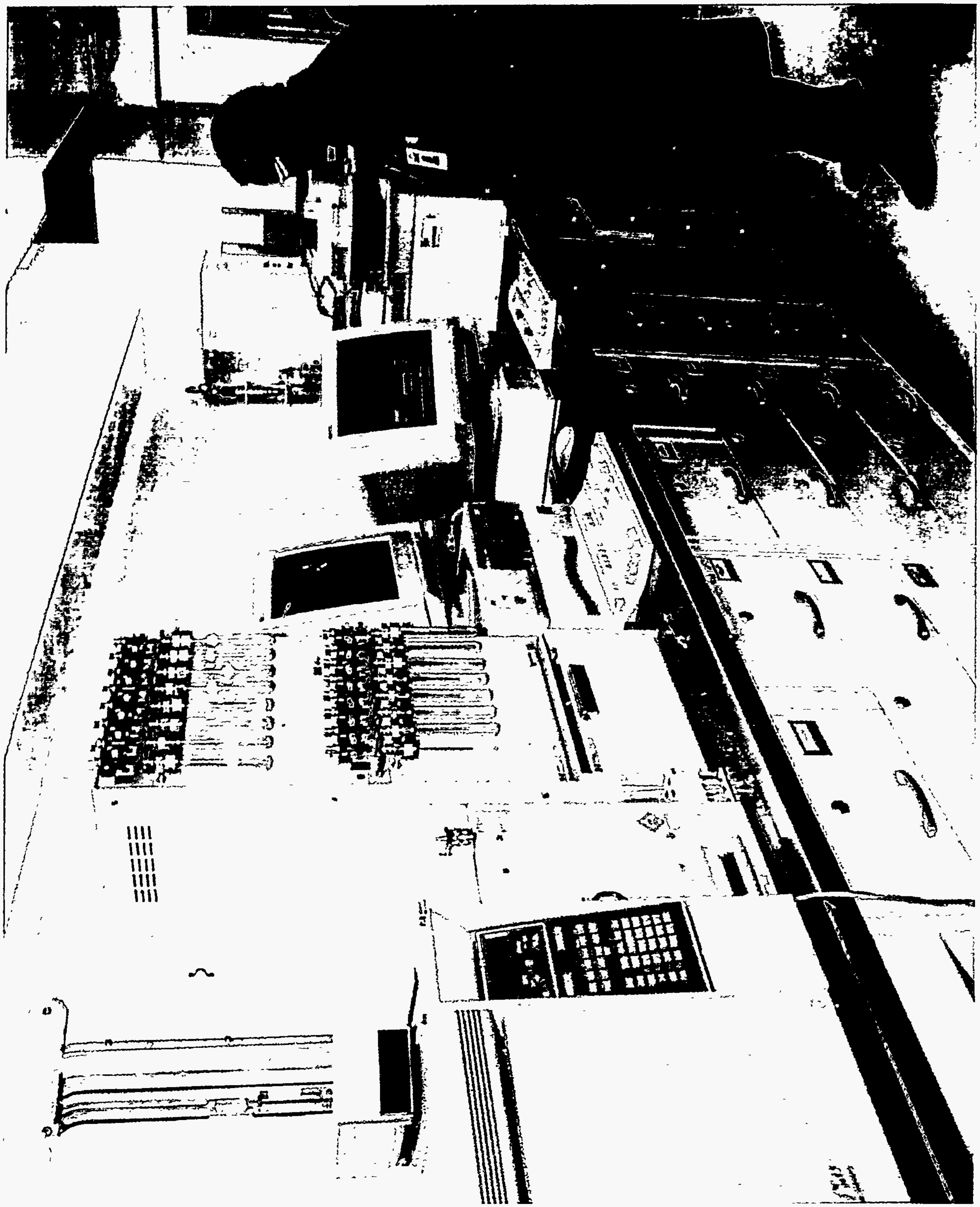

Figure 7: Organic Chemical Analysis Laboratory Sample Analysis Room

Figure 8: ICP Spectrometer in Aquatic Biomonitoring Chemical Analysis Laboratory

The Aquatic Biomonitoring Laboratory is used for broad screening of hazardous contamination (radiological or chemical) using fish and amphibians as test organisms. Aquatic biomonitoring tests can be used to detect the presence of exceedingly low levels of contamination, i.e. below standard detection levels for specific analytes, and analytes for which there is no test. It can also be used to determine the absence of contaminants, providing a means for determining whether an environmental matrix is "clean."

Aquatic Biomonitoring simultaneously assesses several potential health hazards in groundwater, surface water, discharge water, soil, and other environmental media. To assess the potential cancer risk, a carcinogenicity bioassay using two species of small fish has been developed. These vertebrate animals share many anatomical, biochemical and genetic characteristics with mammalian animals. Basic and applied research projects continue to explore the similarities and dissimilarities these species have with the more classical rodent models. The opportunity to perform an on-site, several thousand animal, chronic bioassay on the complex mixture of interest remains a compelling advantage of this new bioassay. In addition, maintenance of aquatic test species is significantly less expensive than maintaining comparable numbers of test rodents.

Developmental toxicity of test waters is assessed using an amphibian embryo assay. The Frog Embryo Teratogenicity Assay Xenopus (FETAX), refined by USABRDL, allows one to determine the developmental hazard of test waters by exposing frog embryos to varying concentrations of the material of concern. The FETAX assay is performed using an approved protocol and published atlas of abnormalities. The FETAX assay allows both human hazard assessment and ecological impact conclusions to be drawn from the same data set.

Near real-time biomonitoring of treated waters for rapidly developing acutely toxic conditions is accomplished using a computerized fish ventilatory monitor. Ventilatory and movement parameters from a series of small bluegills contained in individual chambers, Figure 9, through which pass the water of interest are examined for deviations from normal values. Abnormal responses of these animals to water flowing through the exposure chambers indicates the possible presence of toxins in the water. This system can be programmed to alert a treatment plant operator or begin sampling of the water for later chemical analysis.

Salmonella mutagenicity assays, acute aquatic organism toxicity tests and routine chemical analysis are also simultaneously conducted on the water of interest, affording a powerful integrated biological assessment measure of hazard. This measure can be used to prioritize sites for remediation, compare pre-treatment water with post-treatment water yielding insights into remediation efficacy, and provide long-term monitoring data for tracking trends in the potential hazards

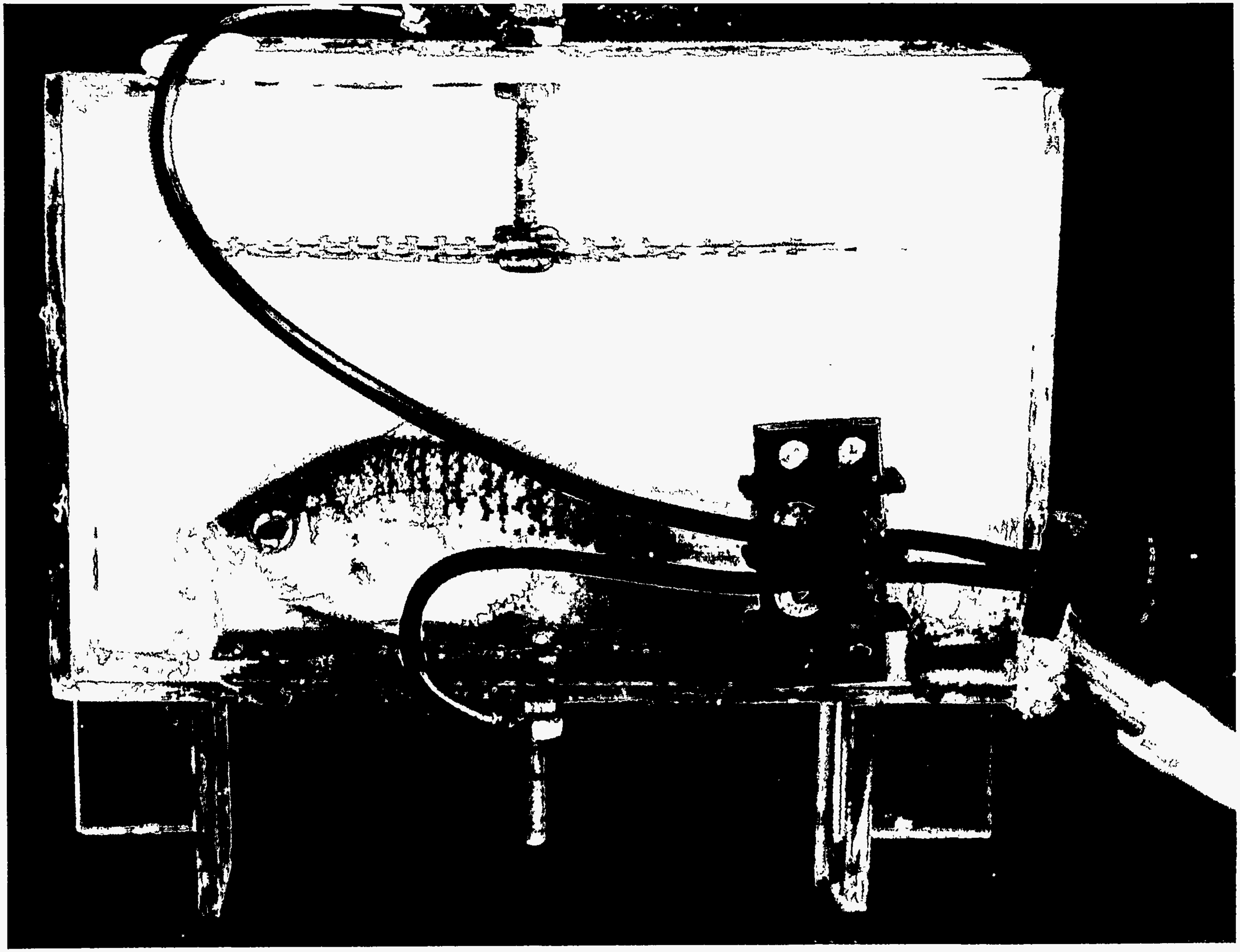

Figure 9: Ventilatory Monitoring for Real-Time Acute Toxicity Measurement

associated with contaminated environmental sites.

The Aquatic Biomonitoring Laboratory is divided into three work rooms. The entry doors lead into the Analytical/Operational Control Room, Figure 10. This space contains analytical equipment necessary to support the experiments, computers to record all data, and operational controls for all laboratory systems.

A doorway from the Analytical/Operational Control Room leads to the Main Diluter Room, Figure 11. This room contains two banks of test animal tanks arranged along the walls. These banks are fed from two wall-hung diluters, one for each set of tanks, to evaluate response to a range of test water concentrations. This room also contains the diluter used to feed the set of tanks in the Ventilatory Monitor Room.

The Ventilatory Monitor Room is entered through a doorway from the Main Diluter Room. In addition to another set of test tanks, this room also contains equipment to aerate, filter and control the temperature of the entering test waters. It also contains an autosampler connected to the test water feed lines.

Air is fed into the laboratory in the Analytical/Operational Control Room. It then flows through the Main Diluter Room and, finally, into the Ventilatory Monitor Room. The air from the Ventilatory Monitor Room is either discharged or it can be recycled through carbon filters to remove any volatile contaminants. The sensitive tests conducted in this laboratory module require exquisite temperature control in the module's test rooms. The Aquatic Biomonitoring Research Laboratory maintains a uniform temperature of 70±2°F in the test rooms.

This laboratory has external connections to accept three water sources as feeds to the diluters. Two of these sources are normally test waters, e.g. groundwater before treatment and groundwater which has been treated to remove contamination. This allows for parallel experiments to determine the effectiveness of alternative remediation treatments. The third water source would normally be "clean" water used for diluting the test waters.

The final RTAL module is the Operations Control Center, which serves as the coordinating "brain" for all RTAL operations. The entrance to the Operations Control Center provides a portal monitor for all personnel leaving the laboratory area. Even though great care will be taken to ensure that all personnel handling samples remain uncontaminated, a final check is important to ensure that there is no inadvertent contamination as a result of operations conducted within the RTAL area. If contamination is detected, a decontamination shower is located in this module adjacent to the frisking station.

The Operations Control Center also contains three work stations for the system operators, Figure 12, and a meeting room with a conference table, as shown in Figure 13. Since many of the analyses are automated and the RTAL's computers are connected via the wireless Local Area Network, the operators can work in the Operations Control Center and still maintain oversight and control over the laboratory operations. The Operations Control

Figure 10: Aquatic Biomonitoring Laboratory Analytical/Operational Control Room

Figure 11: Aquatic Biomonitoring Laboratory Main Diluter Room

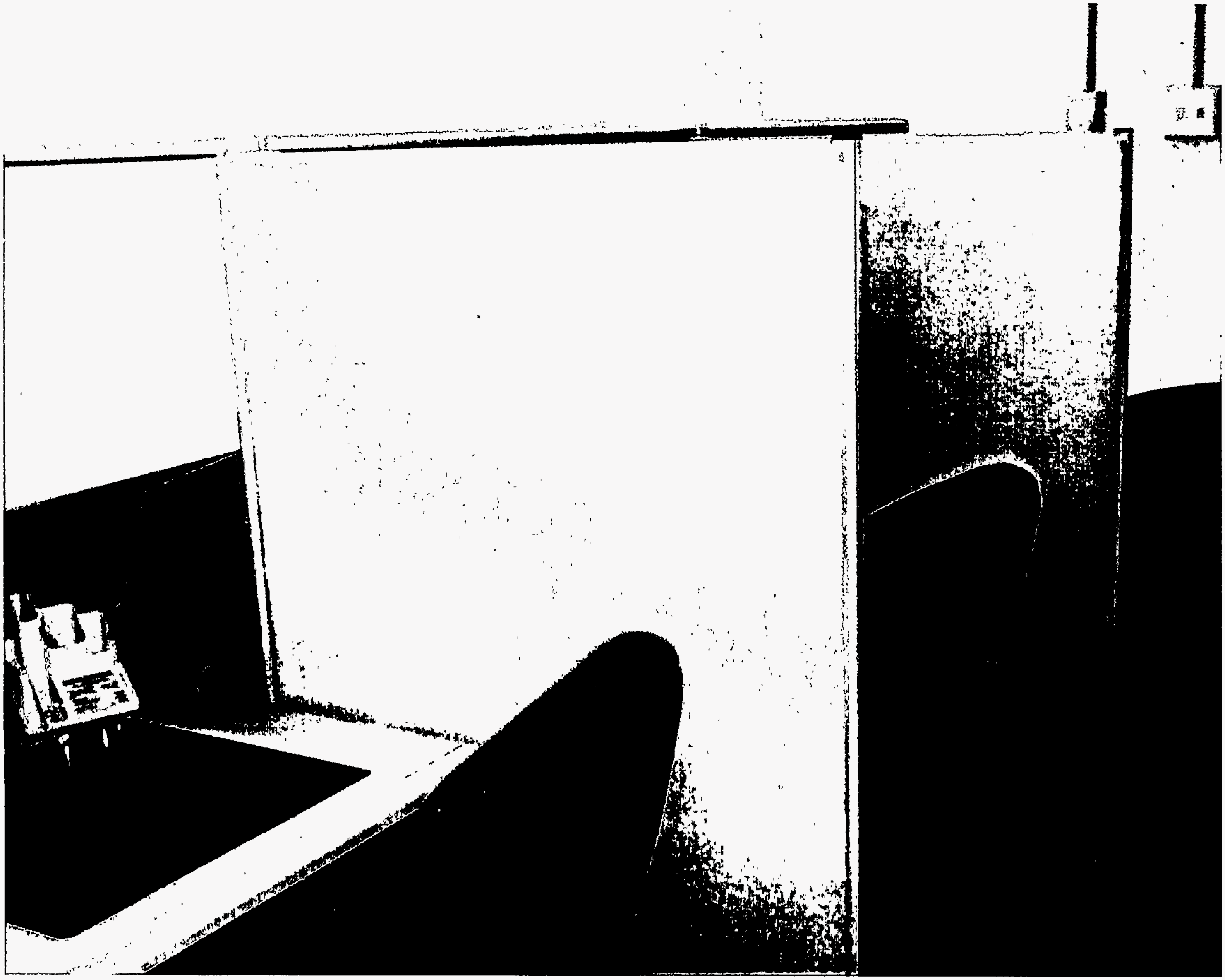

Figure 12: Operations Control Center Work Stations

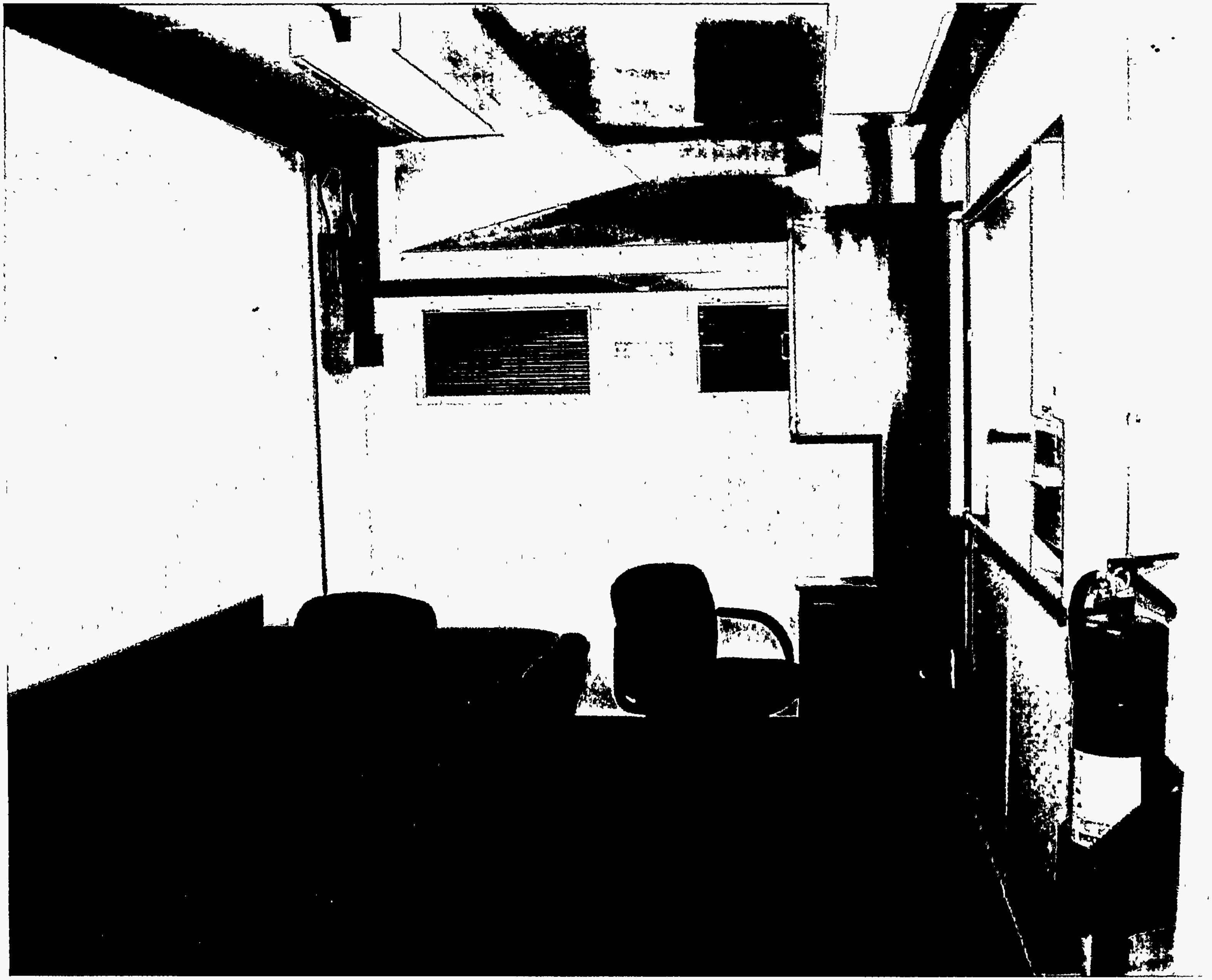

Figure 13: Operations Control Center Meeting Room

Center also has a restroom for the convenience of the operators, an important consideration when the RTAL is stationed far from support buildings.

The RTAL system configuration divides the overall area into three contamination zones. The first zone is the contaminated area where radioactive and chemical contaminants are expected. The second zone is the laboratory modules where contaminated samples are handled in hoods, on bench tops, and in the analytical equipment. Although these areas are designed to contain contaminants, there is always a small risk of inadvertent release. The third zone is the contaminant-free zone beyond the portal monitor in the Operations Control Center.

Personnel and samples exiting the contaminated zone must go through the Decontamination/Sample Screening Module. This ensures that the only contamination entering the second zone is contained within the samples. All personnel exiting the second zone must go through the Operations Control Center frisking station to ensure they are contaminant-free. This arrangement minimizes contaminant risks for all personnel, both within and outside the RTAL area.

The DOE's Office of Environmental Restoration and Waste Management conducted a 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
R4 - glove box	<200 mR/h and >10 nCi/g alpha

Preliminary results show that the vast majority (84%) of the samples projected to be collected fall in the R1 category, suitable for bench-top handling. Samples falling in the R2 category (handling in a hood) represent 14% of the total. Samples in the R3 and R4 categories (handling in a glove box or hot cell) represent a combined total of only 2% of the samples to be collected. These results clearly indicate that the RTAL system design should emphasize handling of samples on benches and in hoods. Providing the hot cells, glove boxes, and associated handling equipment necessary to perform the complete range of analyses on the 2% of the samples in the R3 and R4 categories greatly increases the cost of the RTAL modules. The RTAL's mission is to provide rapid response with high quality assurance and control for a limited number of samples. The remaining samples, not requiring rapid analysis, would be processed through central laboratories. For this reason, it was determined that the sample screening area of the Decontamination/Sample Screening Module would be designed to safely screen for all sample categories, R1 through R4, but the other laboratory modules would be designed for R1 and R2 samples only.

An additional module that can be included in the RTAL is the Protected Living Quarters. This module would be located beyond the Operations Control Center and used when personnel are needed on-site for around-the-clock operations. The need for such demanding efforts are expected to occur infrequently. However, in critical situations, the Protected Living Quarters would be very effective in supporting needed personnel in a safe environment very near the area of operations.

The RTAL incorporates cellular communications and, if desired, satellite communications. STU-III encryption devices for secure communications can also be added, if needed.

The RTAL computers are interconnected in a wireless Local Area Network (LAN), Figure 14. Appropriate software is included so that the computer systems within the RTAL complex can be monitored and controlled from the Operations Control Center or any of the other modules. This greatly enhances the efficiency of the operation and minimizes personnel requirements for operating the complex and performing the analyses.

The RTAL provides the DOE with significant savings in terms of time and cost. Samples are analyzed within days as opposed to the 21-45 day turnaround typical of commercial laboratories. In addition, off-site sample shipments are minimized, saving additional time and manpower. Estimates based on the performance of the prototype RTAL during its demonstration at FEMP indicate that the focused, integrated approach provided by the RTAL generates significant savings of 30% or more compared to central, fixed laboratories. More importantly, the RTAL's responsiveness in rapidly providing high quality data will accelerate and improve the efficiency of clean-up and remediation operations throughout the DOE complex, resulting in major reductions in overall program costs.

PROTOTYPE RTAL SYSTEM

A prototype RTAL system was constructed and delivered to the DOE's Fernald Environmental Management Project for demonstration. The prototype RTAL system consists of 5 modules - Radioanalytical Laboratory, Organic Chemical Analysis Laboratory, Inorganic Chemical Analysis Laboratory, Aquatic Biomonitoring Laboratory, and Operations Control Center. The Radioanalytical Laboratory houses two Germanium Detectors (weighing 5,000 lb. each), 24 Alpha Spectrometers, a Liquid Scintillation Counter, and a Gross Alpha/Beta Counter. The Organic Chemical Analysis Laboratory houses a Gas Chromatograph (GC)/Mass Spectrometer (MS), Purge and Trap GC/MS, GC with Flame Ionization Detector, automated Liquid/Liquid Extractor, automated Solid/Liquid Extractor, Size Exclusion Chromatograph, and Toxicity Characteristic Leachate Procedure (TCLP) Apparatus. Each laboratory also houses a sample preparation area (with hoods) in a separate room.

The U.S. Army Biomedical R&D Laboratory provided their

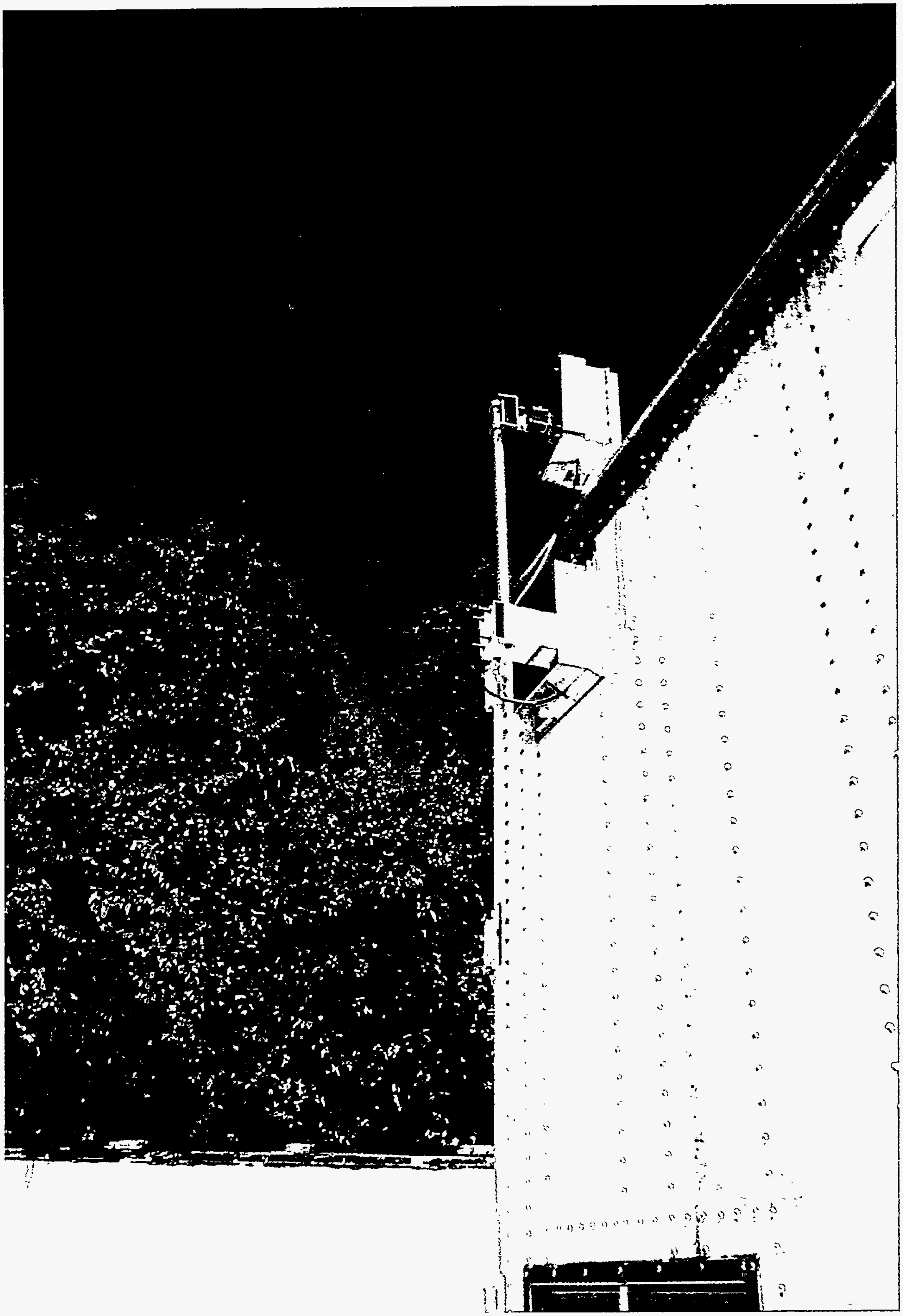

Figure 14: Wireless Local Area Network Antenna

Aquatic Biomonitoring Laboratory and Chemical Analysis Laboratory to demonstrate Aquatic Biomonitoring technology. The RCRA Metal analyses were conducted in this Chemical Analysis Laboratory, simulating some of the capabilities of the RTAL's Inorganic Chemical Analysis Laboratory.

The 3-module prototype RTAL system was deployed near FEMP's OU-1 Waste Pits. Its performance was evaluated with samples from these pits and with other environmental samples from the FEMP site. The Aquatic Biomonitoring laboratories were deployed in a parking lot near the FEMP Advanced Wastewater Treatment (AWWT) plant but outside the Process Area. Discharge water from the 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.

PROTOTYPE RTAL DEMONSTRATION

The demonstration of the prototype RTAL was conducted during 1st - 3rd Quarters of FY96. The units operated independently, using their onboard generators to provide electricity, and onboard water supply and wastewater tanks. The prototype RTAL operated without any umbilicals during the entire period of the demonstration, including through the "Blizzard of '96." The cold temperatures and intense snow, Figure 15 (this was one of the milder snowfalls encountered), did not degrade the performance of the laboratories or their analytical equipment. Thus, it was a most challenging demonstration of the system's ability to operate independently for extended periods.

The following analytical procedures were evaluated during the demonstration of the prototype RTAL:

- Volatile organic analysis (VOA)
- Semi-volatile organic analysis (SVOA)
- Toxicity Characteristic Leachate Procedure (TCLP)
- Heavy metals analysis
- Total uranium concentration
- Isotopic uranium concentration
- Automated liquid-liquid extraction
- Automated sample concentration

The VOA analyses were performed in accordance EPA with SW-846 Method 8260 (modified only to allow for safe handling of radioactive samples). The SVOA analyses were performed in accordance with EPA SW-846 Method 8270 (also modified only to handle radioactive samples). These are the methods used by FEMP for their VOA and SVOA analyses. TCLP extractions were performed in accordance with EPA SW-846 Method 1311 (the same procedure used by FEMP). Heavy metals analyses were performed by

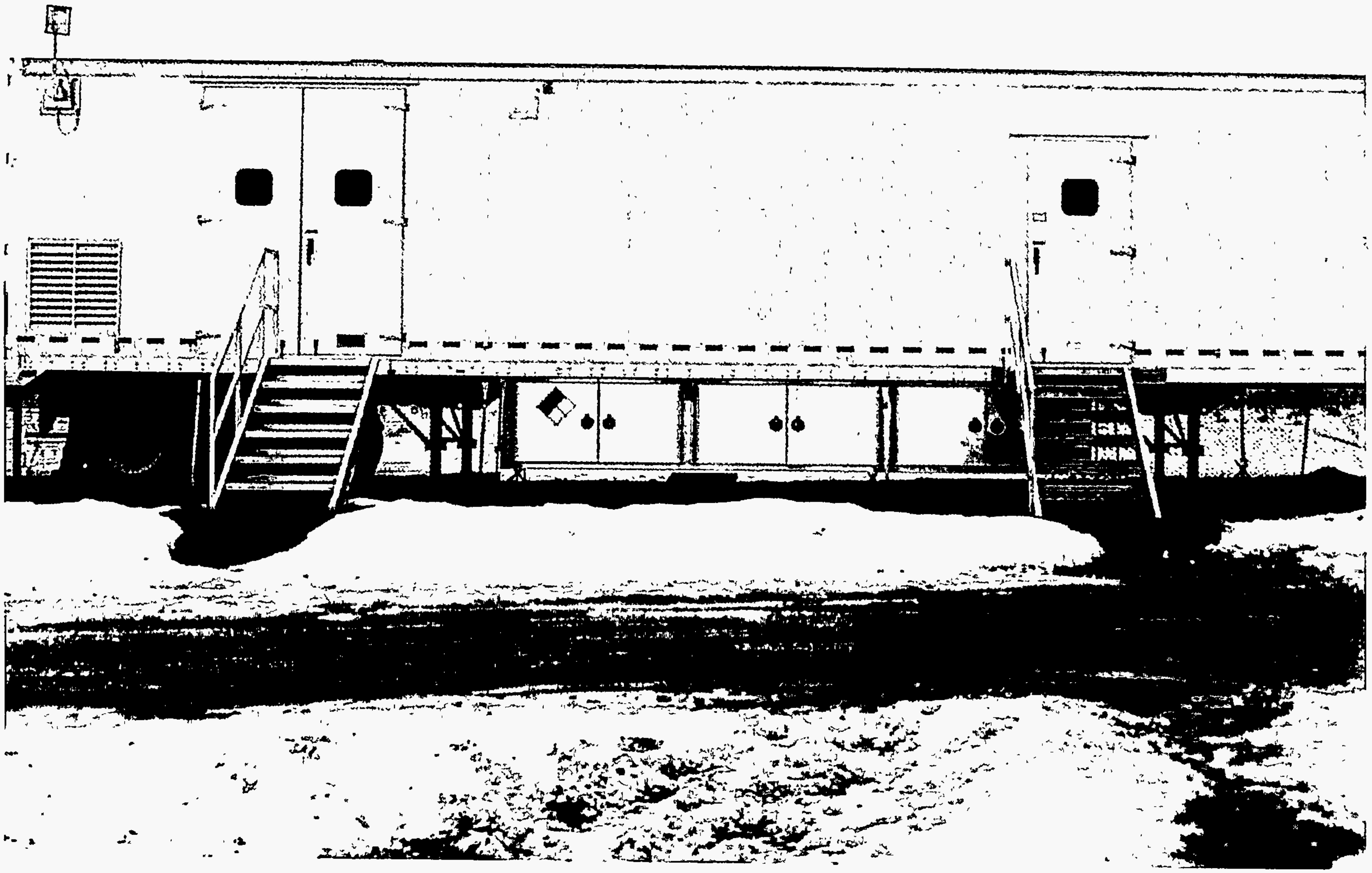

Figure 15: Organic Chemical Analysis Laboratory During Demonstration at FEMP

Inductively Coupled Plasma (ICP) spectroscopy. The uranium isotopic analysis followed the procedure used by FEMP. Chemical dissolution of the samples was followed by purification using ion exchange resins. The purified samples were then deposited onto a substrate which was then counted by alpha spectrometry. The chemical yield was determined using U-232 as a tracer. The sensitivity of this method is a function of the count time. Thus, sensitivity can be improved by increasing the count time, the only limitation being the background count level. Total uranium was calculated by mathematically combining the various uranium isotope contributions to obtain the sum of all the uranium present in the sample. It was assumed that the uranium isotopes were distributed in the same ratio as found in natural uranium. This assumption was required since the actual isotopic ratios for the archived samples were unavailable.

The radioanalyses focused on total and isotopic quantification of uranium in water and soil samples since that is the radiological contaminant of concern in FEMP's environmental samples. Both soil and aqueous samples were included in the studies. Some samples were prepared surrogates, others were actual environmental samples collected at FEMP. Samples containing mixtures of unknown contaminants were provided by FEMP personnel for the RTAL analysts to characterize qualitatively and quantitatively. Accurate records were maintained of all operations in the laboratories. Turnaround times were determined as the time from receipt of samples to delivery of complete analytical reports.

At the conclusion of the demonstration, operating personnel stowed all equipment, cleaned the interior of the RTAL modules, drained all water tanks, and changed the oil. This close-down procedure required 1.5 days. It is the same preparation required to prepare the RTAL for transport to another site. Upon arrival at another site, the analytical equipment would require system check-out and calibration prior to initiation of formal analyses.

RTAL PERFORMANCE

In all cases, the analyses performed in the RTAL were in excellent agreement with the FEMP analyses from conventional laboratories - all contaminants of concern were identified at the correct concentrations. Turnaround times ranged from 1 day for the VOA samples to 3.5 days for the TCLP Semi-volatile samples (including sample preparation, report preparation and record keeping). Sample throughput of 7 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. FEMP personnel were very impressed with the capabilities of the laboratories and the results obtained.

FEMP provided archive and surrogate samples to evaluate the analytical performance of the prototype RTAL, the turnaround times for the analyses performed, and the costs for performing the analyses in the RTAL. A total of 28 samples were provided to the Organic Chemical Analysis Laboratory. These consisted of 7 aqueous samples for Volatile Organics Analysis (VOA), 7 aqueous samples for Semi-Volatile Organics Analysis (SVOA), 7 soil samples for Toxicity Characteristic Leachate Procedure (TCLP) followed by Volatile Organics Analysis, and 7 soil samples for TCLP followed by Semi-Volatile Organics Analysis. The VOA samples were analyzed for 22 analytes and the SVOA samples were analyzed for 16 analytes. All of these analyses were in conformance with EPA SW-846 methods modified to allow for safe handling of radioactive samples. The VOAs were performed in accordance with Method 8260, the SVOAs in accordance with Method 8270, and the TCLP in accordance with Method 1311.

All surrogate samples were prepared by the FEMP Quality Control Laboratory. Surrogates were used for organics analysis because of concerns that archive samples may have degraded over time.

The isotopic and total uranium analyses were performed in the Radioanalytical Laboratory with 7 soil samples from FEMP archives. These analyses were performed by alpha spectrometry.

A total of 14 prepared aqueous samples were analyzed for RCRA metals by ICP Spectrometry in the USABRDL Chemical Analysis Laboratory. These samples were analyzed for 7 analytes. Surrogate samples were used to prevent exposure of the laboratory to radionuclides, as required by USABRDL.

FEMP Chain of Custody forms were maintained for all samples. These were used to determine the time the samples were introduced into each laboratory for analysis. Turnaround times were determined from the time of sample introduction to the time the reports of analytical results were provided to FEMP project staff. Reports included sample identification numbers, analytical results, and Quality Control sample results. The complete data package included all raw and supporting data. FEMP Quality Assurance staff performed surveillance during sample preparation and analyses to ensure compliance with documented analytical, quality control and assurance, and safety procedures.

During the course of the field demonstration, FEMP Quality Assurance personnel performed an assessment of compliance to the prescribed analytical methodology. Surveillance of all of the analytical activities were performed concurrent with sample preparation and analysis activities. The analytical functions performed were evaluated for adherence to the prescribed method or procedure, proper sample preparation techniques, proper instrument calibration, and proper documentation maintenance. The documented results of this extensive surveillance confirmed strict adherence to proper methodology.

This evaluation is crucial since the RTAL laboratories will be used, in many cases, to supplement or replace fixed laboratory services. As a result, data comparability is a key issue when using the data generated in the RTAL modules for decision-making. This demonstration of the RTAL laboratories' ability to adhere to standard fixed laboratory standards allows the RTAL modules to be used to generate data which will be comparable to that obtained from fixed facilities.

FEMP project staff evaluated the accuracy and precision of the analyses performed in the RTAL. This evaluation is crucial to ensure data comparability with fixed laboratories. FEMP personnel found the RTAL laboratories adhered to the same quality control and assurance standards as fixed laboratories, generating data of equivalent quality.

For the aqueous VOA and SVOA samples, analytical accuracy was determined by calculating the percent recovery of the analytes in the samples. Additionally, precision estimates were determined by relative percent difference since replicate samples were used for all these analyses. TCLP results were not evaluated for accuracy and precision since no method currently exists to calculate the expected recovery of a TCLP extraction. For the isotopic and total uranium analyses, results in the RTAL were compared with previous results of the archived samples as well as the 95% confidence limits for the two surrogate samples. The RCRA Metals analyses had recoveries between 80% and 103%, well within the 80-120% recovery range specified by EPA SW846.

It is important to note that the accuracy and precision reported was obtained with analytical personnel having a typical experience level of 3-5 years performing environmental analyses. The analysts received routine training in the operation of the instrumentation in the RTAL laboratories. As a result, the performance achieved during the demonstration should be achievable in other situations using similarly experienced chemists.

Turnaround Times

One of the main advantages of the RTAL is its ability to perform high quality analyses on site with very fast turnaround times. Turnaround times were calculated as the time from sample delivery to the RTAL laboratories to report delivery to FEMP staff.

The sample turnaround times achieved by the RTAL are listed in Table 1. Typical and best turnaround times at laboratories used by FEMP are also listed for comparison. FEMP performs radioanalytical and inorganic analyses on-site and uses off-site laboratories for organic analyses. Off-site commercial laboratories typically have 21-45 day turnaround times. Table 1 clearly demonstrates that the RTAL's turnaround times were 1/3 to 1/2 of FEMP's and less than 1/10 those of a typical commercial laboratory.

The RTAL's short turnaround times are the result of its effective layout which maximizes operator efficiency and its incorporation of automated equipment. For example, the

Table 1

SAMPLE TURNAROUND TIMES

(Sample Receipt to Report Delivery)

		Turnaround Time, Days	
Procedure	RTAL	FEMP Best	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 U	3[a]	5[b]	5 - 10
RCRA Metals	<1	7	7 - 14

Notes:

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

Semi-Volatile Organic Analyses benefitted from the automated liquid-liquid extractor installed in the Organic Chemical Analysis Laboratory's Sample Preparation Room. This cut the normal 36 hour extraction used at FEMP down to 6 hours.

In addition, the location of the RTAL near an active project site is important in minimizing the overall turnaround time. FEMP personnel estimate the location of the RTAL near project activities cuts up to an additional 3 days off sample transport and introduction into the laboratory. These steps are effectively eliminated using the RTAL. Moreover, the dedication of the RTAL to a single project eliminates scheduling and capacity problems that slow down the performance of fixed laboratories.

All the chemists in the RTAL laboratories had typical experience of 3-5 years performing environmental analyses. None of the chemists received special training in the operation of the instrumentation in the RTAL laboratories. Thus, these turnaround times should be achievable by chemists with average experience. This performance supports the contention that the RTAL laboratories are no more difficult to operate than a standard laboratory.

Analytical Performance

The samples introduced into the RTAL laboratories had known results, allowing for an evaluation of accuracy and precision. The only exception was the TCLP analyses, which by their nature are not amenable to accuracy and precision evaluations.

The analytical reports generated by the RTAL analysts are provided in the following appendices:

Appendix A - Aqueous Sample VOA
Appendix B - Aqueous Sample SVOA
Appendix C - Soil Sample TCLP-VOA
Appendix D - Soil Sample TCLP-SVOA
Appendix E - Aqueous Sample RCRA Metals
Appendix F - Soil Sample Uranium (total and isotopic)

Appendix G provides a comparison (accuracy and precision) of the reported results with the analyte concentrations (for the 22 analytes) in the aqueous VOA samples. This comparison shows recoveries in the 75-105% range, comparable to recoveries observed for most performance evaluation samples analyzed by fixed laboratories. Precision for the volatile analytes ranged from 0.5% to 7.0% relative standard deviation, which is quite good when compared to fixed laboratory analyses.

Appendix H provides a comparison (accuracy and precision) of the reported results with the analyte concentrations (for the 16 analytes) in the aqueous SVOA samples. This comparison shows recoveries in the 15-92% range. This compares quite favorably with normally expected recoveries for acids of 5-114% and for polyaromatic hydrocarbons of 30-114%. Reproducibility was excellent, with relative standard deviations of 10% or less for most compounds. This performance is very comparable to data generated by fixed laboratories.

Appendix I provides a comparison of the reported results with the analyte concentrations (for the 7 analytes) in the aqueous RCRA metal samples. This comparison shows recoveries in the 80-100% range. This compares very favorably with normally expected recoveries in the 80-120% range for data generated by fixed laboratories.

Appendix J provides a comparison of the reported total and isotopic uranium results for the soil samples provided with the historical FEMP data. The inherent inhomogeneity of soil samples makes direct comparisons difficult, but the RTAL data is quite comparable to the archived data on these samples.

Overall, the accuracy and precision achieved by the RTAL is very comparable to the performance of well-run fixed laboratories.

RTAL COST PROJECTIONS

ECO has been a strong proponent of high performance on-site laboratories as a way to lower sample analysis costs and reduce turnaround time while maintaining the highest levels of quality assurance and control. Shorter turnaround times also result in major project savings since the rapid availability of high quality data allows critical decisions to be made quickly, accelerating the overall project. The savings achieved through project acceleration can be very dramatic since expensive clean-up teams and equipment will be operating more efficiently.

This section compares the costs of performing high quality sample analyses in the RTAL with the cost of performing the same analyses in a well-run fixed laboratory. It does not include the significant savings achieved by project acceleration which depend on specific project circumstances.

FEMP personnel provided current costs for the environmental analyses performed in the RTAL during its evaluation at that facility. These costs are based actual costs for analyzing samples required for FEMP's National Pollutant Discharge Elimination System (NPDES) permit. FEMP analyzes a large number of these samples annually and these prices are discounted in consideration of the sample volume. The prices paid by FEMP are listed in Table 2. These prices are for a standard 21 day turnaround time.

The RTAL demonstrated daily throughput was 21 samples each for volatile organics, semi-volatile organics, TCLP-volatile organics, TCLP-semi-volatile organics, TCLP-RCRA metals, and 50 samples for RCRA metals. Table 2 also shows the total current FEMP cost, $11.0 million, for performing this number of samples 240 days per year (5 days per week for 48 weeks) at fixed laboratories. The 240 day per year schedule allows for federal holidays, down-time for equipment maintenance, and days when samples are not collected.

Table 3 provides the cost of performing the same number of samples 240 days per year in the RTAL complex. The analyses listed in Table 2 will be performed in the Radioanalytical Laboratory, Organic Chemical Analysis Laboratory, and Inorganic Chemical Analysis Laboratory, supported by the Operations Control Center. The annual capital costs for these RTAL modules and their analytical equipment are provided in the first category in Table 3. The 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. The second category in Table 3 is the annual personnel costs for operating the laboratories. This is based on a conservative level of staffing with full-time, trained and experienced analytical chemists. Each laboratory module would be staffed with three analysts for two shifts and one analyst for the third shift. In addition, a full-time laboratory manager to oversee operations is also projected, for a total of 22 man-years per year. This staffing level ensures reliable performance during busy periods and provides personnel coverage during illnesses, vacations, etc. The average annual cost (fully loaded) per person is assumed to be $150 K, also a conservative assumption. Table 3 also provides conservative estimates for maintenance costs, chemical and fuel costs (based on actual usage during the demonstration), and costs for other consumables. Finally, a 20% contingency factor is provided to ensure the conservative nature of this cost projection. The total cost for performing the analyses listed above 240 days per year in the RTAL is $7.71 million, 30.1% less than the cost of a fixed laboratory.

If the cost comparison is based on 300 operating days during the year, Tables 2 and 3 show the costs for the RTAL to be $8.51 million versus $13.8 million for a fixed laboratory, a 38.3% savings.

These projections show that annual cost savings of $3.32 million (240 operating days per year) to $5.28 million (300 operating days per year) can be achieved through the use of a single set of RTAL modules. The use of RTAL modules at several sites increases the savings proportionately.

More importantly, the use of the RTAL can accelerate clean-up projects, resulting in dramatic reductions in project costs. The rapid availability of high-quality data can result in more efficient utilization of expensive field personnel and equipment, accelerating project completion which translates into significantly reduced overall project costs.

Table 2

FIXED LABORATORY ANALYTICAL CHARGES

Analyses	Price per Sample
RCRA Metals	$143
Volatile Organic Analytes (VOA)	97
Semi-volatile Organic Analytes (SVOA)	145
TCLP-VOA	380
TCLP-SVOA	675
TCLP-RCRA Metals	340
Uranium (total and isotopic)	150

The RTAL production rate is:

Analyses	Samples per Day
RCRA Metals	50
Volatile Organic Analytes (VOA)	21
Semi-volatile Organic Analytes (SVOA)	21
TCLP-VOA	21
TCLP-SVOA	21
TCLP-RCRA Metals	21
Uranium (total and isotopic)	21

At this production rate, fixed laboratory charges would be:

240 operating days per year - $11,031,360

300 operating days per year - $13,789,200

Table 3

RTAL ANALYTICAL CHARGES

<u>Depreciation</u> Radioanalytical Laboratory Organic Chemical Analysis Laboratory Inorganic Chemical Analysis Laboratory Operations Control Center	$ 340,260
<u>Personnel</u> 22 man-years @ $150K per man-year (21 analysts + 1 Lab Manager)	$3,300,000
<u>Maintenance</u> Radioanalytical Laboratory Organic Chemical Analysis Laboratory Inorganic Chemical Analysis Laboratory Operations Control Center	$ 38,000
<u>Fuel (diesel)</u> 40 gal/lab-day(avg.) x $1/gal. x 4 modules x 365 days/year	$ 58,400
<u>Chemicals</u> $11,039 per operating day x 240 days/year	$2,649,360
<u>Other Consumables</u> $50/lab-day(avg.) x 3 labs x 240 days/year	$ 36,000
Contingency (20%)	<u>$1,284,400</u>
For 240 operating days per year, TOTAL	<u>$7,706,420</u>
For 300 operating days per year, TOTAL	<u>$8,512,030</u>

CONCLUSIONS

The prototype Road Transportable Analytical Laboratory system was successfully demonstrated at the Fernald Environmental Management Project. This multi-modular integrated laboratory system was operated independently and continuously in the field through the unusually harsh winter of 1996. The prototype system was successful in demonstrating:

- Analytical performance equal to a well-run fixed laboratory
- Sample turnaround times 1/3 to 1/2 of FEMP's best times
- Analytical costs at least 30% less than fixed laboratory costs
- Additional savings by eliminating shipment charges for samples analyzed in the RTAL
- Major savings by accelerating remediation projects as a result of the rapid availability of high quality data on which to base critical decisions
- Ability to operate effectively and independently in the field under harsh environmental conditions
- Ability to move to new high priority projects, ensuring long-term utility

The capabilities of the Road Transportable Analytical Laboratory system integrate with those of fixed laboratories. The integration of RTALs into the DOE's analytical support network will minimize costs and maintain the DOE's ability to rapidly obtain high quality analytical data necessary for making critical project decisions.

RTAL systems will provide the DOE with significant time and cost savings, accelerating and improving the efficiency of clean-up and remediation operations throughout the DOE complex. When the RTAL is no longer needed for a specific project, the modules can be readily moved to support other high priority projects. This adaptability ensures the RTAL's future value in supporting the DOE's extensive remediation efforts.

FUTURE ACTIVITIES

The prototype RTAL system will remain at FEMP to support its high priority remediation projects. The design of the RTAL provides for modular changes in the analytical suite within each laboratory. This ensures that these laboratories maintain their state-of-the-art capabilities as improved analytical equipment becomes available. The high quality of the RTAL construction and the fine environmental control within the laboratories ensure their ability to generate data of the highest quality well into the future.

ECO provides the Road Transportable Analytical Laboratory System as a commercial off-the-shelf (COTS) product, providing full warranties and guarantees. ECO can provide RTAL systems on a sale or lease basis. ECO also provides maintenance and fully trained operating personnel to support RTAL operations. The RTAL system has been integrated into ECO's existing family of TERMM™ and Superfund TERMM™ modular transportable analytical laboratory and operational support systems. Discussions to provide RTAL systems at other DOE sites, e.g. Idaho, Rocky Flats, Savannah River and Hanford, have been initiated. In addition, application of the RTAL technology is under discussion for non-DOE sites with extensive hazardous waste contamination.