Development of a Real-Time Monitor for Airborne Alpha Emissions

First Quarter Report, TTP AL 142003

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Introduction

Abstract

This is the first quarterly report for Fiscal Year (FY) 1994 for TTP AL 142003, Development of a Real-Time Monitor for Airborne Alpha Emissions.

Los Alamos National Laboratory (LANL) is developing a new technology for on-line, real-time monitoring of incinerator stacks for low levels of airborne alpha activity. While initially developed for incinerators, this new technology may well find other applications in continuous air monitoring, process monitoring, and monitoring during remediation activities. Referred to as the Large-Volume Flow Thru Detector System (LVFTDS), this technology responds directly to the need for fast responding, high sensitivity effluent monitoring systems.

With DOE EM-50 funding, LANL has fabricated a bench-top proof of concept detector system and is conducting tests to evaluate its performance. A second-generation prototype is being designed, based on requirements driven by potential field test sites. An industrial partner is being solicited to license the technology. Field trials of a full-scale detector system are planned for FY 95.

Accomplishments during the first quarter of FY 94 are chronicled in this report, including budgetary data. A schedule for the remainder of the fiscal year is also provided.

Background

This project began in FY 92, when LANL group INC-13 was asked by Rocky Flats to survey the state of the art of real-time alpha monitoring technology, that was currently, or could easily be adapted for use in incinerator stacks. The

primary motivation was the understanding that public opposition was one of the major factors preventing the building and operation of nearly all mixed and low-level waste incinerators. Much of this opposition was based on a lack of continuous real time monitoring of the stacks. With incineration being one of the best available treatments of much of the mixed and low level waste, and a lack of real-time monitoring hampering incinerator permitting, real-time emissions monitoring became a key requirement in the treatment of mixed and low-level waste.

We started by performing a detailed survey of commercial alpha monitoring technology. We found that, with some minor variations, nearly all commercial alpha monitoring techniques are based on a common approach, consisting of extracting a sample of the gas being monitored and passing it through a filter placed close to a detector sensitive to alpha decay radiation. Particulates bearing alpha emitting radionuclides are collected on the filter and subsequent alpha decays are measured by the detection system.

This approach, while useful in many applications, is inherently an integrating technique and not well suited to real-time applications. Additionally, the small volume of gas measured is assumed to be representative of the remainder of the stack. Sampling a relatively small fraction of the total flow in the stack limits the useful sensitivity of the instrument.

With these limitations in mind, we then began evaluating other possible alpha monitoring technologies. Based on concepts being developed for a different application, we proposed the development of a new monitoring technology.

This new technology uses parallel plates of scintillating plastic fabricated such that the entire stack gas stream flows directly through the inter-plate volume. Light from the scintillations produced by the alpha particles striking the plates is collected and processed to determine the concentration of alpha emitting radionuclides present in the stack gas stream.

Enough experimental work was done in FY 92 to establish a basis for some performance estimates of a detector built from this new technology. These estimates were quite promising, indicating the potential for more than an order of magnitude improvement in sensitivity at short integration times. A report was written, summarizing the results of the survey of the commercial systems and the performance estimates of the new proposed technology. A proposal was written for FY 93 to develop the technology up to a lab-scale prototype. This effort was funded by Rocky Flats, under the Fluidized Bed Incinerator Program, as part of the FFCA compliance effort.

During FY 93, we fabricated and tested the lab-scale detection system and successfully demonstrated the operation of the detector using the short-lived alpha-emitting radon daughter of ^{228}Th . The proof-of-concept detection system consists of 5 scintillating plates, each 1-mm thick and 930 cm² in area. The sensitive volume of the detector was 9.7 liters, and it demonstrated a detection limit of about 20 pCi/liter (with a 1 minute counting time). The demonstrated performance of this prototype is in excellent agreement with the predictions derived from the computer model, developed earlier in the project. The main

factor limiting the sensitivity is the detector background. A report was written documenting the experimental results, as well as the marketing survey work and the preparations being made for the industrial partner workshop

Also during FY 93, specific airborne alpha monitoring needs were identified within the Hazardous and Mixed Waste Destruction Integrated Program (HMWDIP) and a proposal (TTP AL 142003) for further development was submitted. Following a careful peer review, the continued development of this technology was selected for funding in FY 94.

Overview of FY 94 and Proposed FY 95 Efforts

TTP AL 142003 covered two years of continued development, culminating in a field test in FY 95. These two remaining years consist of two phases. In the demonstration phase (FY 94) we will develop a second generation full-scale test detector to be used for further performance evaluation. In the field test phase (FY 95) we will design, fabricate, install, and field test a full-scale operational detector system. The following table summarizes the major milestones for the next two years.

Title	Fiscal Year	Date
Identification of Industrial Partner	94	2-28-94
Fabrication and bench test of unit complete	94	4-29-94
Mid-year progress report	94	3-31-94
Demonstration site determined	94	8-31-94
Decision point for continuing development	94	9-30-94
Final report issued	95	9-30-94
Fabrication and lab test of detector complete	95	5-01-95
Field test of detector complete	95	8-01-95
Final report delivered	95	9-15-95

Task Milestone Summary

A description of each of the major subtasks follows, taken from the proposal. A proposed schedule is included as Appendix A. The parenthetical numbers in the following paragraphs match the subtask numbers on the schedule.

Subtask 1.0. Second Generation Full-Scale Test Detector Design.

This subtask will build on the results of the past year (FY 93) in designing a second generation, full scale test detector. This unit will be approximately the size of the planned field test detector, and will employ scintillator and light guides prototypical of a unit designed for commercial manufacture. This subtask includes

the determination of a set of requirements (1.1), the detailed design steps (1.2), the fabrication (1.3), and the assembly and initial testing of the unit (1.4).

Subtask 2.0. Performance Validation and Engineering Design.

This subtask involves the detailed performance testing and characterization of the detector under a wide variety of conditions. Sensitivity (2.1), background reduction (2.2), and plate durability (2.3) will be studied. These studies will be conducted at a level reduced from the original plan in order to accommodate the new proposed budget. Accelerated wear tests of the plates will be conducted under contract by a university collaborator, and an expected performance over the anticipated lifecycle of the detector will be determined. The experimental results will be evaluated and reported (2.4) for use in both the field test detector design and in evaluating other applications. At this point a decision will be made (2.5) as to the suitability of the technology to the intended application. Should the technology fail to deliver the required performance, it would be most cost-effective to terminate development prior to the field trials.

Subtask 3.0. Field Test Site Selection.

In parallel with the first two subtasks, the selection of the field test site will be proceeding. Many of the operational requirements for the 2nd generation detector will be taken from one or more potential field test sites, identified as part of a site survey (3.1, 3.2). These operational requirements will be collected into a 'requirements superset' (3.3) that will serve as a guide to operating conditions the detector must be designed for. Out of this superset, a set of requirements will be extracted to support the Second Generation Test Detector design. A short-list of potential field test sites will be generated (3.4), and a site formally selected (3.5).

Subtask 4.0. Commercialization

The commercialization of the LVFTDS technology is a crucial part of the development effort, and is an integral part of every phase of the project. While these efforts are concurrent with the technology development, the activities are described here and grouped into this subtask for convenience. Building on the initial response from interested companies (FY 93) and the industrial partner workshop (4.1), the commercial partner will be chosen (4.2) and a licensing agreement negotiated (4.3). A detailed marketing plan will be formulated (4.4), including as part of the marketing strategy the field tests and demonstrations. Knowing that commercial success of the technology relies on developing applications outside of the incinerator market, the development of a broader customer base of other applications will be undertaken early on (4.5). Based on this effort a set of follow-on developments and adaptations to new applications will be outlined (4.6). From these guidelines a CRADA or Funds-in-Agreement program will be negotiated (4.7) to continue the research, development, performance improvement, and application of the concept technology. A task is included to provide commercial manufacturing support for both of the detector systems built (4.8) as described in Subtasks 1.0 and 6.0.

Subtask 5.0, Plant Engineering and Installation Design

Once the site has been selected the modifications needed to install the detector (5.1) and the detailed detector design can be determined (5.2). Since the Second Generation Test Detector design was based on requirements taken from potential field test sites, significant detector design changes at this stage are not anticipated.

Subtask 6.0, Full Scale Detector Fabrication and Test

The modifications needed to install the detector in the field test facility will be made (6.1), and the fabrication of the detector will be performed (6.2). In order to accommodate budgetary constraints it is assumed that the commercial partner will perform the detector fabrication as a commercial prototype. The detector system will be assembled and bench tested (6.3, 6.4) prior to delivery to the field test site for installation (6.5). Again, it is assumed that the industrial partners, along with the incinerator operators, will assume the cost of these tasks, with only supervisory oversight from us.

Subtask 7.0, Field Tests

The first step in conducting the field tests will be to verify the system performance (7.1). This will be done by calibration and by trace gas tests using radon, prior to any test burn. The performance verification will continue during a trial or normal burn cycle of the incinerator. The detector will remain in place and operational through a series of trial and operational burns, with periodic re-evaluation of expected performance, for a thorough life-cycle test (7.2). Once the field testing is complete a final report will be compiled and issued (7.4, 7.5). It is currently expected that the detector will remain at the field test facility for longer-term test and evaluation by the incinerator operators.

At the conclusion of these tasks a fully functional commercial prototype unit will be installed and field tested. At this point LANL's role will be one of cooperating with the technology licensee to further develop applications and improvements by providing scientific expertise. It will be the responsibility of the commercial partner to bring the final commercial product to the market.

First Quarter Progress

Budget

Funding for this project was not received at LANL in time for the October financial plan. As a result, no costs were permitted and no work performed under this proposal. Work performed in October was directed towards preparing for the industrial partnership workshop, and charged against the FY 93 carryover.

This project is funded at \$400K for FY 94. At the time of this report (late December) financial information was not available for the month of December. As a result, cost information is through the month of November.

Fiscal year costs to date total \$47.1K.

Schedule

Since funding was not available in October, work on this effort was not started until November. As a result, several of the milestones have been slipped to accommodate the late start.

Milestone M2, Identification of the Industrial Partner, has been slipped to 2-28-94. This is an additional month later than was reported in the November PTS. The original delay was made to accommodate the industrial partner's preparing their partnership proposals. With the workshop being held in early November, and the December holidays, we felt that a mid-January deadline for proposals was the earliest reasonable date. In mid December, one of the potential industrial partners asked for an extension. In an effort to be sensitive to industry's needs, we agreed to allow a 30 day extension, thus delaying the partnership proposal deadline to February 11th, 1994. All potential industrial partners were contacted and advised

of the extension. Assuming that we receive at least one viable industrial partnership proposal by the current deadline, we should be able to make a decision by the end of February. The completion of the final negotiations will, of course, take much longer.

Milestone M3, Fabrication and Bench Scale Testing, has been reset for the end of April 94. This slip is due to the delay in starting the project.

Technical Status

The following discussions on technical status are divided into sections, with one section for each of the major efforts undertaken during the past quarter.

Industrial Partner Workshop

The single most significant activity of the quarter was the industrial partner workshop. This workshop was held November 9th, 1993, at the Fred Harvey Best Western in Albuquerque, New Mexico. Copies of the invitation brochure and the agenda are attached as Appendix B.

The purpose of the workshop was to provide all potential industrial partners with all of the pertinent information concerning the technology in an efficient and equitable manner. Over 350 companies were contacted, and approximately 70 expressed interest in attending, and were sent invitations. Eight companies sent representatives to the workshop.

The workshop was divided into a morning session and an afternoon session. The morning session was used for formal presentations on the technology, the market analysis, and the industrial partner expectations and selection criteria.

The afternoon session was set aside for one-on-one sessions with the companies. Three parallel tracks were set up, with concurrent sessions for discussing technical details, the marketing information, and the technology transfer process. These sessions were held with the appropriate LANL staff and the companies, one at a time. This allowed each company representative to ask questions without concern about revealing any company private information to the other attendees.

This two session approach was well received. During the morning session all of the companies were presented the same information at the same time, thus satisfying the equal access to information issue. The one-on-one sessions were very popular with the industrial representatives, as it allowed them to ask their detailed questions in private.

We also brought the lab-scale detector plates to the workshop, and set up a poster session. This allowed all other companies to see first hand a working implementation of the technology.

Copies of the workshop briefing book, containing the material distributed at the workshop, are available from the report author.

This workshop represented an enormous amount of work. Since it was the first time our division had undertaken a project of this nature, it was subjected to both a long learning curve, and a great deal of scrutiny. In an effort to shorten the learning curve for others, and to document this process, a report dealing exclusively with the preparation for and the holding of a workshop of this nature is being prepared. This report will include the basis for many of our decisions, and detail on the lessons learned.

Limited post-workshop follow-up was done, and it was during this follow-up that one of the companies requested the extension, resulting in the additional slipping of the Industrial Partner Decision milestone. Additional follow-up will be done in early January.

Project Relocation

Partly due to a change in project staff, we decided to relocate the development effort to Technical Area 48. This move was made in early December, and necessitated the relocation of a technician. At present, we have an entire laboratory room dedicated to the project, including a chemistry hood suitable for conducting further tests with radon.

Potential Field Test Site Visit

Much of the design performed this fiscal year will be based on the requirements of the field test site. As a result, efforts are underway to identify the field test site. Early in December two members of the project attended a Rocky Flats program review for the Fluidized Bed Incinerator development project at the Energy and Environmental Research (EER) Corporation's Irvine, California office. Attending this meeting were representatives of Rocky Flats, EER, and the EPA.

A presentation was given on the LVFTDS technology, including the requirements for a field test site, with a discussion following the presentation.

In general, the technology was well received, with the representative of the EPA agreeing that this technology represented the ideal for on-line monitoring. The representative of EER, while receptive to the technology, expressed concern over the need to test the detector during a trial burn with a spike of radioactive gas. Although a natural element (namely radon) would be used, EER was uncomfortable with the idea of dealing with radioactivity. It was agreed that more detailed discussions should be held at a later date.

A tour of the EER facility was also accomplished, which allowed us to see and discuss first hand the installation and support issues.

Following this meeting, contacts were made with other sites, including the controlled air incinerator at Los Alamos, and a commercial incinerator in Tennessee.

Summary of Major Accomplishments

The two major accomplishments and their implications are listed below.

Industrial Partner Workshop

The holding of an industrial partner workshop such as this is a crucial part of the overall culture change within the DOE and the Laboratories. This specific workshop was important both for this project and for EM programs as a whole. The documentation of the planning, execution, and the lessons learned in this type of industrial interaction will start to establish a knowledge base as important to future projects as the technology itself.

Field Test Site Visit

Field test site visits such as the one made in December are important steps in the development of a technology that is proven and field-ready. The discussions held with EER served to highlight the importance of finding a site that will be able to adequately test the technology.

Second Quarter Plans

Technical Plans

Effort in the second quarter will be concentrated in three areas; Industrial Partnership Development, Second Generation Detector Design, and Field Test Site Visits. Each of these efforts and the plans for the second quarter are detailed below.

Industrial Partnership Development

Work in this area is targeted towards selecting the right industrial partner for this technology. Follow-up will be done prior to the proposal deadline (in mid-February). In particular, those companies that elect not to bid on the technology will be contacted, to better understand their reasons for not pursuing the technology. Following the receipt of the bids, they will be evaluated based on the selection criteria developed prior to the workshop. The best industrial partner will be chosen, and a negotiation team will begin the formal partnership agreement negotiations.

The industrial partner selection decision will be made and documented in February, meeting milestone M2.

Detector Design

Based on input received during the field test site visits, the design parameters for the second generation detector will be determined. This detector is being called 'nearly full scale', since it is an intermediate step between the current detector, and the unit needed for actual field tests. Development work will concentrate on plate

engineering issues such as survivability and improved light collection, and on detector background reduction.

Field Test Site Visits

Visits to two more potential field test sites are planned. At present, those sites will most likely be the Controlled Air Incinerator here at Los Alamos, and a Commercial Incinerator at Oak Ridge, Tennessee. Based on the lessons learned during the EER visit a primary point of emphasis will be the testing and verification of performance during the field tests. Current plans call for using a spike of radon gas as a known positive signal for performance verification. We expect to need to spike the stack gas at the few to tens of picoCuries per liter level. We had not expected this to be a problem, but it appears to be a considerable concern. The ability to support this spiking test may be the largest consideration in choosing the field test site.

Other Efforts

Several other tasks need to be performed during the upcoming quarter, including:

- Submit the technology as a candidate for the R&D 100 award competition.
- See that the patent application is completed and submitted. The application is currently in the LANL legal department.
- Attend the Seattle, Washington Outreach to Industry meeting in late January.
- Prepare to present the technology at the 1994 Incineration Conference, being held May 9-13 in Houston, Texas.

Appendix

Appendix A

Attached is a revised program schedule.

Appendix B

Attached are copies of the workshop invitation brochures and the meeting agenda.

ID	Name	4Q93			1Q94			2Q94			3Q94			4Q94			1Q95			2Q95			3Q95		
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
53	7.5 Final report completed [M11]																								
54																									
55	8 Reporting																								
56	8.1 First Quarter Report, FY94 [M1]																								
57	8.2 Mid Year (second quarter) Report, FY94 [M4]																								
58	8.3 Third Quarter Report, FY94 [M5]																								
59	8.4 Final Report, FY94 [M6]																								
60	8.5 First Quarter Report, FY95																								
61	8.6 Mid Year (second quarter) Report, FY95																								
62	8.7 Third Quarter Report, FY95																								
63	8.8 Final Report, FY95																								

Project LVFTDS Development
Date 1/3/94

Critical

Noncritical

Progress

Milestone

Summary

Rolled Up

INDUSTRIAL PARTNERSHIP OPPORTUNITY:

Large-Volume Flow-Through Detector System

A new technology for real-time, on-line monitoring of incinerators and other stacks

"There is no more ambiguity; the government expects us to enhance our efforts to work with American Industry to improve American competitiveness in the international marketplace."

Dr. Siegfried Hecker, Director
Los Alamos National Laboratory

Workshop

LANL will host a workshop for potential partners on Tuesday, November 2, 1993, at the Fred Harvey Best Western, Albuquerque, New Mexico. The purpose of this workshop will be to explain in detail the large-volume flow-through detector system technology, including status of development and expected performance. Topics to be covered include selection criteria, financial considerations, and the licensing and CRADA development process. Sessions with individual companies will be held to answer specific questions. LANL Non-Disclosure agreements must be executed prior to the workshop. A schedule and registration information are available upon request.

Contact

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The Los Alamos National Laboratory

Over the past 50 years, Los Alamos National Laboratory (LANL) has been a premier research center, developing high-technology solutions for our national defense needs. The mission of the National Laboratories now includes applying their scientific and technological expertise to environmental and industrial problems. In support of this mission, Laboratory Director Siegfried Hecker has established a goal for industry-driven collaborations to make up 20% of all Laboratory programs. LANL is now confronting environmental problems using two approaches. The first relies on engineering concepts to decrease and prevent waste from reaching the environment; the second focuses on remedying contamination problems. LANL and its collaborators are using these two approaches to find answers for a variety of environmental problems. This brochure outlines only one aspect of our work.

A New Technology for Stack Gas Monitoring

LANL is currently developing a new technology for monitoring alpha emitting radionuclides in stack gasses. Development of this technology, called the Large-Volume Flow-Through Detector System (LVFTDS), is being driven primarily by the public's demand for real-time, on-line monitoring of incinerators and other stacks. Although current monitoring systems extract a sample of the gas for measurement, the LVFTDS detector resides in the stack and monitors the entire volume of stack gas *in situ*. A large active volume and the absence of any sampling filter ensure a rapid response with high sensitivity. A detector of this type would typically be installed in the stack following HEPA filters and any off-gas treatment equipment to provide the final alarming monitor. LANL has applied for a patent covering the LVFTDS technology and anticipates that the successful commercialization of this technology will provide significant short- and long-term benefits to the economy of the United States.

Industry Opportunities

LANL is seeking an industrial partner to enter into a licensing agreement for commercial application of detector systems based on the LVFTDS technology. Once a licensing agreement is in place, LANL is interested in continuing development of related and spin-off applications as part of a CRADA, Funds-In, or other agreement. The partner must be a company located and manufacturing in the United States. LANL is particularly interested in teaming with small businesses on licensing and CRADA agreements.

Funding Profile

The Department of Energy, through the Office of Technology Development, has invested a total of \$750,000 to develop this stack-gas monitoring technology. Funding for Fiscal Year 1994 is anticipated to be \$400,000.

**Real-Time Stack Gas Monitoring
Using LVFTDS Technology**

CORRECTION!

The date of the LVFTDS workshop has been moved to **November 9th, 1993**. It will still be held at the Fred Harvey Best Western in Albuquerque, New Mexico. We look forward to seeing you there!

**LARGE VOLUME FLOW THROUGH DETECTOR SYSTEM WORKSHOP
DRAFT AGENDA NOVEMBER 9, 1993
FRED HARVEY BEST WESTERN, ALBUQUERQUE, NEW MEXICO**

7:45	Registration	Rio Grande Room Coffee & Donuts
8:15	Welcome	Al Sattelberger Acting Division Director Chemical Sciences and Technology
	Industrial Interaction Perspective	Sarah Hayes Applied Environmental Technologies
	AET Management Overview	Bruce Erdal Applied Environmental Technologies
8:30	Technology Overview	Russell Gritz Principal Investigator
10:00	Break	Coffee & Donuts
10:15	Market Analysis	Deborah Thornton Marketing Specialist
10:45	Industrial Partner Expectations Selection Criteria	TBA
11:15	Technology Transfer Tools	Industrial Partnership Center
11:45	Lunch	On Your Own
12:30	Individual Question & Answer Sessions	
	Concurrent Sessions Will be Scheduled Following Receipt of Registration and PIA	
	A - Technical Details	Brazos Room
	B - Marketing	Taos Room
	C - Technology Transfer Tools	Pecos Room
1:15	Individual Question & Answer	
2:00	Individual Question & Answer	
2:45	Individual Question & Answer	
3:30	Individual Question & Answer	
4:15	Individual Question & Answer	
5:00	Individual Question & Answer	
5:45	Individual Question & Answer	

END

DATE

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3/21/94