

EPA/600/R-07/115
September 2007

**New Technology for Environmental Solutions –
Collaborating for Results
U.S. EPA ETV and SBIR Programs
Regional Workshop,
May 8, 2007, U.S. EPA Region 6, Dallas, Texas
Meeting Summary Report**

by

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**Contract No. 68-C-02-067
Work Assignment No. 4-07**

for

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FOREWARD

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threaten human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Sally Gutierrez, Director
National Risk Management Research Laboratory

ACKNOWLEDGEMENTS

The U.S. EPA Environmental Technology Verification and Small Business Innovation Research Programs wish to extend their appreciation to U.S. EPA Region 6 for hosting this workshop and, in particular, to Terry Burton, Region 6 Hazardous Substance Technical Liaison, for his help in planning this workshop.

ABSTRACT

The U.S. EPA Environmental Technology Verification (ETV) and Small Business Innovation Research (SBIR) Programs hosted a workshop on May 8, 2007, at the EPA Region 6 office in Dallas, Texas. One goal of the workshop was to provide information about new innovative technologies to help solve important environmental issues, such as polluted air, land and water, and the need for cleaner energy. Another goal was to learn from the regional and local participants about their particular technology needs.

A sampling of the technologies that were discussed includes:

- ✧ Diesel retrofit and baghouse filtration for air pollution control
- ✧ Fuel cells, microturbines and geothermal systems, as well as low-cost biodiesel production for greener energy
- ✧ Stormwater and on-site residential wastewater treatment for protecting water quality
- ✧ Grouts, coatings, and linings for water infrastructure rehabilitation
- ✧ Mercury emission monitors and immunoassay test kits for better source and ambient air and water monitoring
- ✧ Water quality monitors for detecting pathogens and hormonal activity to protect drinking water, source water, and recreational waters
- ✧ Nano-, micro- and ultra-filtration, and reverse osmosis for drinking water treatment, as well as emergency mobile drinking water treatment units
- ✧ Cleaner coating processes for reduced volatile emissions.

Approximately 140 participants representing the EPA regional office, state and local governments, technology developers, academia, and others, participated in the workshop. Representatives from the ETV centers and their collaborators presented on recent and upcoming verifications. SBIR technology developers discussed technology development and commercialization supported by EPA. ETV and SBIR vendors exhibited and/or demonstrated their technologies, and ETV provided posters highlighting collaborative verifications. Representatives from EPA Region 6 presented on the regional technology information needs and priorities. A local television station highlighted the workshop with a brief news clip on the evening news.

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ABBREVIATIONS AND ACRONYMS

μm	micrometer
AFO	animal feeding operation
AMS	Advanced Monitoring Systems (Center)
APCT	Air Pollution Control Technology (Center)
ASTM	American Society for Testing and Materials
BEAM	Ballast Exchange Assurance Meter
BFP	baghouse filtration product
CAFO	confined animal feeding operation
CARB	California Air Resources Board
CCEP	Coatings and Coating Equipment Pilot
CEM	continuous emission monitor
CHP	combined heat and power
CIGMAT	Center for Innovative Grouting Materials and Technology
CMS	Compact Membrane Systems, Inc.
CO_2	carbon dioxide
CO	carbon monoxide
DG	distributed generation
DoD	Department of Defense
DOE	Department of Energy
DRT	drift reduction technology
DWS	Drinking Water Systems (Center)
EDC	endocrine disrupting chemical
ESTE	Environmental and Sustainable Technology Evaluations
ETC	Environmental Technology Council
ETV	Environmental Technology Verification
EUWP	Expeditionary Unit Water Purifier
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FRET	Fluorescence Resonance Energy Transfer
g/L	grams per liter
GHG	Greenhouse Gas Technology (Center)
HAP	hazardous air pollutant
HARC	Houston Advanced Research Center
HC	hydrocarbon
HCl	hydrogen chloride
HVLP	high-volume, low-pressure
ISO	International Organization for Standardization
IWS	International Wastewater Systems
klm	kilolumen
L	liter
LDAR	leak detection and repair
m^2/g	square meters per gram
mL	milliliter
MM Btu/h	million British thermal unit per hour
NEA	nitrogen-enriched air
NERL	National Exposure Research Laboratory
NACEPT	National Advisory Council for Environmental Policy and Technology
NASA	National Aeronautics and Space Administration
NCDC	National Clean Diesel Campaign
NOAA	National Oceanic and Atmospheric Administration

NO _x	nitrogen oxide
NRMRL	National Risk Management Research Laboratory
NTRD	New Technology Research and Development
NUATRC	National Urban Air Toxics Research Center
NYSERDA	New York State Energy Research and Development Authority
NZVI	nanocrystalline zero valent metals
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OEA	oxygen-enriched air
OPP	Office of Pesticide Programs
ORD	Office of Research and Development
ORP	oxygen reduction potential
OTAQ	Office of Transportation and Air Quality
OWHH	outdoor wood hydronic heaters
PCIS	personal cascade impactor sampler
PM	particulate matter
PM _{2.5}	fine particulate matter
POE	point of entry
POU	point of use
ppb	parts per billion
RETAN	Regional Environmental Technology Advocacy Network
RFID	radio frequency identification
RTA	Regional Technology Advocate
SBIR	Small Business Innovation Research
SCAQMD	South Coast Air Quality Management District
SCR	selective catalytic reduction
SETO	Senior Environmental Technology Official
SIP	State Implementation Plan
SMEHA	self-contained, microelectrochemical hybrid assay
SO ₂	sulfur dioxide
SSL	solid state lighting
TCEQ	Texas Commission on Environmental Quality
TE	transfer efficiency
TERC	Texas Environmental Research Consortium
TERP	Texas Emissions Reduction Plan
USCG	United States Coast Guard
USDA	United States Department of Agriculture
UV	ultraviolet
VOC	volatile organic compound
WQP	Water Quality Protection (Center)

SUMMARY

The U.S. EPA Environmental Technology Verification (ETV) and Small Business Innovation Research (SBIR) Programs hosted a workshop on May 8, 2007, at the EPA Region 6 office in Dallas, Texas. One goal of the workshop was to provide information about new innovative technologies to help solve important environmental issues, such as polluted air, land and water, and the need for cleaner energy. Another goal was to learn from the regional and local participants about their particular technology needs.

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WELCOME

Teresa Harten, Director, EPA ETV Program

Teresa Harten welcomed attendees to the first joint ETV and SBIR Programs Regional Workshop. She introduced Terry Burton, EPA Region 6, who was the host for the regional office and assisted in planning the workshop. She stated that the goals of the workshop are to provide information about new innovative technology to help solve important environmental issues and to obtain feedback from Region 6 and its states and localities on their environmental issues and the needs for technology solutions. This information will help in setting priorities for both the ETV and SBIR Programs. She encouraged attendees to actively participate throughout the workshop.

Sally Gutierrez, Director, EPA National Risk Management Research Laboratory (NRMRL)

Teresa Harten introduced Sally Gutierrez and stated that NRMRL is one of four national laboratories within the EPA Office of Research and Development (ORD). Sally Gutierrez thanked everyone, including the Canadian attendees from ETV Canada, for attending the

workshop. She introduced each of the ETV verification organizations. Within the last year, EPA has taken steps to reinvigorate its commitment to innovative environmental technology. A federal advisory committee, the National Advisory Council for Environmental Policy and Technology (NACEPT), was formed to provide advice to the Agency on environmental technology. The NACEPT Environmental Technology Subcommittee evaluated and made recommendations on EPA facilitation and use of environmental technology. As a result of their recommendations, EPA Administrator Stephen Johnson made a number of commitments in December 2006 to strengthen environmental technology work within the Agency. One of the commitments was to establish a Senior Environmental Technology Official (SETO) under the Office of the Science Advisor to help coordinate activities across the Agency. The regions are EPA's front line in dealing with environmental technology problems in the field and with environmental technology implementation issues at various stages of development and deployment. Making sure that problems and technologies are appropriately connected requires knowledge and advocacy. To accomplish this, the Agency will create a Regional Environmental Technology Advocacy Network (RETAN), which will consist of a Regional Technology Advocate (RTA) in each regional office. Two workshop attendees have been named as RTAs—Myron Knudson, Region 6, and Maggie Theroux, Region 1. Another commitment was to strengthen the role of the EPA Environmental Technology Council (ETC), with representation from all program offices and regions, to work on common problems and address technology solutions in a more strategic manner. The final commitment was to build on the success of the ETV Program by creating an Environmental Technology Assessment and Verification Staff coordinated by NRMRL to provide enhanced technology support to the SETO and the rest of the Agency on issues such as technology verifications, state-of-the-art assessments, technology development collaborations, and encouraging sustainability. Sally Gutierrez concluded by asking participants to provide any insights on where the Agency could do better work in these areas.

Carl Edlund, Director of the Multi-Media Planning and Permitting Division, EPA Region 6

Carl Edlund welcomed everyone to Region 6. He stated that one of the benefits of working in a regional office was seeing place-based problems, and the only way to solve them is to interact with many different people who have parts of the solution. He briefly discussed the passive monitor exhibited at the workshop by the Mickey Leland National Urban Air Toxics Research Center (NUATRC). The passive monitors can be calibrated to obtain readings on the full spectrum of volatile organic compounds (VOCs) and hydrocarbons. They can be used for easy and quick monitoring of hazardous pollutants, which is a big problem in many U.S. cities. NUATRC is working on a project with Region 6 in Houston, where there are 350 petrochemical plants and 4 million people who are concerned about the air quality. A new ozone standard should be issued by June 20, 2007. If there is a change to the law, then more passive monitoring will be needed. Some technology developed by the military is being used, such as infrared cameras that can show hydrocarbon emissions that previously were invisible. Refineries and petrochemical companies are moving forward to control emissions before there are any regulations. There are water quality problems in many areas resulting from animal feeding operations and it would be helpful if there was a quick and easy phosphorus monitor. He closed by saying that Region 6 was very happy to host this workshop as it is a wonderful way for people coming from different perspectives to provide their input on solving different environmental problems.

PLENARY SESSION

Region 6 Technology Information Needs and Priorities

Myron Knudson, Regional Technology Advocate, EPA Region 6

Myron Knudson began by stating that EPA was asked to help with the Columbia shuttle crash. Region 6 assisted in the clean-up by using a special camera, global positioning system, and personal digital assistant to document the location of 79,232 pieces of shuttle debris, and to complete forms required by the National Aeronautics and Space Administration (NASA). Using this improved technology, Region 6 was able to transmit forms to NASA each morning for the work done on the previous day. Region 6 is a massive food producer, and also has 72 percent of U.S. refinery capacity for the petrochemical industry. The Texas Commission on Environmental Quality (TCEQ) has 4,000 employees and is the second largest agency in the world. As a result, TCEQ does not need EPA. Region 6 is looking at how they can be innovative in air, water quality, and drinking water. There is a need for a handheld device that a single person can use to sample 50 yards per day. It usually takes 3 to 5 days to read the samples and obtain results. Region 6 has developed a computerized system to process samples from the time of sampling to obtaining the results, including quality assurance; they are the only region that is completely electronic.

Dallas has an air pollution problem. The local energy utility wanted to build 16 new power plants. Region 6 has been promoting energy conservation. If everyone changed to fluorescent bulbs, they would not need another new power plant in Texas for the next 20 years. New technologies are needed to do things differently. There is a need in the region to reduce outside petroleum products. Region 6 has been trying to convince companies to build their ethanol plants on the site of old oil fields. When you digest to get the corn or soybean oil out, a lot of carbon dioxide (CO₂) is produced. It is easy to strip out the CO₂ and pipe it to the oil patch, and inject it for tertiary recovery. Approximately 92 percent of the CO₂ will be sequestered forever. There are power plants that are selling their CO₂ to oil companies. If we reduce our energy use and carbon footprint, then the air is cleaner. Region 6 is willing to work with any company with an innovative environmental technology. Recently, they discovered and are working with a HAWK infrared camera that sees VOCs. As a result, Region 6 is participating in the ETV Environmental and Sustainable Technology Evaluations (ESTE) project for portable optical and thermal imaging devices for leak detection at chemical plants. The Texas Chemical Council is providing \$180,000 and three chemical plants for site testing. Region 6 is very innovative. If a vendor has a new technology, Region 6 is willing to look at it and see if they can use it.

Environmental Technology Verification Program

Teresa Harten, Director, EPA ETV Program

Teresa Harten provided an overview of the ETV Program, including: program objectives, ETV support of technology commercialization and innovation, operational statistics, program scope as defined by its centers and pilot, ESTE projects, verification process, case studies and examples of verification human health and environmental outcomes, and international activities.

The ETV Program develops protocols and conducts verification testing to provide credible performance data for commercial-ready environmental technologies to speed their implementation for the benefit of purchasers, permittees, vendors, and the public.

Teresa Harten provided the following highlights of the ETV Program:

- ✧ Collaborations and vendor cost-sharing leverage ETV funding and generate approximately 50

percent of the total funds.

- ✧ A total of 386 verifications and 86 protocols have been completed.
- ✧ More than 500 stakeholders are active in ETV advisory groups and technical panels.
- ✧ The ETV Web Site has more than 3 million hits per year.
- ✧ New case study booklets document and project outcomes for 15 verified technology categories.

Small Business Innovation Research Program

April Richards, Deputy Director, EPA SBIR Program

April Richards provided an overview of the EPA SBIR Program, including: background on the Federal SBIR Program, annual budgets, proposal evaluation and selection process, annual solicitation schedule, and solicitation topics for 2007.

EPA issues annual solicitations for Phase I and Phase II research proposals from science and technology-based firms. Under Phase I, the scientific merit and technical feasibility of the proposed concept is investigated. EPA awards firm-fixed-price Phase I contracts of up to \$70,000 and the period of performance is typically 6 months. Through this phased approach to SBIR funding, EPA can determine whether the research idea (often based on high-risk advanced concepts) is technically feasible, whether the firm can do high-quality research, and whether sufficient progress has been made to justify a larger Phase II effort.

Phase II contracts are limited to small businesses that have successfully completed their Phase I contracts. The objective of Phase II is to commercialize the Phase I technology. Competitive awards are based on the results of Phase I and the commercialization potential of the Phase II technology. In Phase II, EPA awards contracts up to \$225,000 and the period of performance is typically 2 years.

During Phase I, EPA provides up to \$4,000 in commercialization technical assistance (e.g., market needs study). A Commercialization Plan is required to be submitted in the Phase II proposal. EPA also offers up to \$120,000 and one additional year as Phase II Options. This includes an additional \$70,000 available for firms with third-party financing for accelerating commercialization and an additional \$50,000 available for technologies accepted into an EPA verification testing program, such as the ETV Program. The total Phase II award that could be received with the base award (\$225,000) and options (\$120,000) is \$345,000.

Discussion

Teresa Harten opened the session for questions and discussion. Earl Beaver, Practical Sustainability, stated that he would like to get Mexico involved with both the ETV and SBIR Programs on a couple of projects. He asked if the workshop presentations would be available on the ETV Web Site. Teresa Harten responded that the presentations are usually not posted to the Web site but a copy could be sent to him. Earl Beaver asked if the presentations would discuss nanotechnology relating to the impacts of manufacture and use, and the end-of-life of products that contain nanomaterials. April Richards responded that there are two SBIR technology vendors working in the area of nanotechnology who will be presenting their technologies. They are very aware of the issues of worker safety and containment, and can answer questions during their

presentations. EPA initially focused their nanotechnology research on applications; there is now more research in the areas of exposure, fate and transport, and toxicity, as well as some research in the area of applications.

Earl Beaver asked if the ETV and SBIR Programs have had any success in getting Native American tribes involved in the programs. Myron Knudson responded that there are 65 tribes in Region 6 that are treated similar to states. Region 6 gives grants to develop programs to the tribes and to each of the five states in the region. The Navaho Nation has about 110 people working on environmental issues. The largest tribe within the region is the Cherokee tribe in Oklahoma which has about 35 people in the environmental field. The region works with them on a variety of issues, including science issues such as the risk to Tribal members from pollutants in air and food.

Debora Bradford, Small and Disadvantaged Business Coordinator, EPA Region 6, asked what the bridge was from the SBIR Program to the ETV Program. April Richards responded that the SBIR Program focuses on proof-of-concept and development. For commercial-ready SBIR technologies at the end of Phase II, there is an option whereby SBIR will help subsidize the testing costs for verification under the ETV Program. For some technologies, ETV is the next step after participation in the SBIR Program.

MORNING SESSION A: ETV FOR WATER

ETV Drinking Water Systems Center

Bruce Bartley, ETV Center Manager, NSF International

Bruce Bartley provided the history and background of the Drinking Water Systems (DWS) Center and stated that, based on a 2006 state survey, more than 30 states are using DWS verification reports and protocols, either to reduce pilot testing from state-to-state or site-to-site or, in some cases, the data are required as a first step in obtaining a state water permit. He discussed completed verifications for three technology categories: small system arsenic technologies, mobile drinking water treatment for emergency relief, and point of use (POU) and point of entry (POE) devices for water security. Arsenic treatment technologies include: chemical coagulation, flocculation and filtration; adsorption onto resin or media; and low pressure membrane separation (reverse osmosis). Of the 10 technologies tested, all but one verified technology reduced arsenic consistently below the maximum contaminant level of 10 parts per billion (ppb); most achieved arsenic reductions to the reportable detection limit (~ 2 ppb). The DWS Center has tested a mobile drinking water treatment technology, the Expeditionary Unit Water Purifier (EUWP), which was designed and developed by a program team from the U.S. Navy, U.S. Army, and U.S. Bureau of Reclamation. The technology functioned well in the laboratory, but the field results showed a lack of membrane integrity; the program team is working to fix this problem with the technology. Three POU commercial devices for residential protection and two POE systems (using reverse osmosis and a carbon system) for building protection were tested. Tables showing the chemical and microbiological test results for the technologies were presented.

DWS Center collaborations include: continued EUWP testing in seawater and freshwater; working with the State of New Hampshire on a uranium media verification; coordination and collaboration with the States of Pennsylvania, California, Minnesota, Washington, and Michigan on ultraviolet (UV) reactor validation for small systems; and coordination with the EPA SBIR Program on alternative technologies.

Questions and Answers

Earl Beaver stated that certain cultures cannot afford technology. Is there an economic component in the ETV Program that takes into consideration the cost per gallon of treated water? Bruce Bartley responded that ETV looks at cost factors during verification testing. The energy and capital needs are quantified in the operations and maintenance evaluation.

A participant asked if the ETV Program had a follow-up component to retest verified technology that is enhanced by the technology vendor. Bruce Bartley responded that developers can retest their technology under ETV.

ETV Water Quality Protection Center

Tom Stevens, ETV Center Manager, NSF International

Tom Stevens noted that the current technology areas of interest in the Water Quality Protection (WQP) Center are: stormwater treatment technologies (nine verified, one in progress), residential nutrient reduction technologies (six verified), UV disinfection for secondary wastewater treatment and reuse applications (three verified), urban infrastructure rehabilitation technologies, and ship ballast water treatment technologies. The WQP Center has completed 14 generic protocols and test plans (one is in progress), 32 test plans (one is in progress), and 31 verifications (two additional are in progress).

WQP Collaborations: Panel

Moderator: Tom Stevens

Tom Stevens stated that the WQP Center has had collaborative efforts with multiple agencies for stormwater treatment technologies, including: U.S. Geological Survey; Wisconsin Department of Natural Resources; and cities in the States of Georgia, Kentucky, Michigan, and Wisconsin. ETV verification data are being reviewed by a number of states (Florida, Massachusetts, North Carolina, Pennsylvania, and Washington) before they will allow implementation of residential nutrient reduction technologies.

Claude Smith, International Wastewater Systems (IWS)

Tom Stevens asked Claude Smith to provide comments on his experience with the ETV Program as a verified vendor. Claude Smith stated that IWS has installed approximately 20 wastewater treatment systems in two states. These systems cover subdivisions, hotels, churches, schools, and rural areas. The market is large and it is just beginning to take form. ETV verification was the most significant thing that allowed IWS to expand and succeed. Most states require a vendor to show technology operating results for many years. One state requires companies to show operating results for 5 years or to complete the ETV Program. Once a technology developer has been verified under the ETV Program, it is their entry card into the state. Even with good operating results from another state, it still takes a long time to get into a new state. A company with ETV verification will save 1 or 2 years of time and much money gaining entry into a state. IWS is in the process of being acquired by a major public company; they would not be in this position without undergoing ETV verification. The biggest problem IWS has is that potential customers do not believe that these remote packaged systems can be installed. An easy way for a land developer to sell lots is to use septic tanks. When it is economically and environmentally sound to install a packaged treatment system, it is the best alternative. The problem is at the county level with the final decision makers who do not have the knowledge of how the system works. The systems installed by IWS are remote controlled and are not difficult to maintain; IWS

trains a local person to maintain the system for 2 to 3 hours per week. There is a need for extra information at the county level so that the decision makers know that these systems really work and are economically justified.

C. Vipulanandan, Director of the Center for Innovative Grouting Materials and Technology (CIGMAT), Department of Civil and Environmental Engineering, University of Houston

Tom Stevens stated that large amounts of money will need to be spent on urban infrastructure in the United States. Many of the existing technologies could be verified under ETV to provide information to engineers and municipalities. ETV collaborated with the University of Houston and C. Vipulanandan, who had developed protocols and a program for coatings and grouts. C. Vipulanandan provided an overview of this collaborative effort. He showed photographs of pipelines that were corroded and had leaking joints, which could eventually cause sink holes. One way to control these leaks is to use grout materials; these can be polymer- or cement-based. The leaks can come from manholes, pipe joints, or laterals (i.e., where two pipes come together). These leaking joints could be grouted and leak detection could be monitored by remote control operations. The question is how to verify these technologies. ETV and CIGMAT collaborated to develop a protocol and test plan for verification of grouting materials, which would involve conducting a model test, to evaluate grout effectiveness under various leak control configurations and a leaking lateral joint test. CIGMAT is completing another testing protocol on coatings and liners for corroded pipes, to see how well the coatings bond to the corroded materials. In conclusion, the grouting protocol is in place. Testing would involve about 40 specimens being tested for 6 months; approximately 72 specimens would be tested for 6 months under the coating and liner protocol.

Gail Roderick, Project Manager, U.S. Coast Guard (USCG), Research and Development Center

Tom Stevens stated that the WQP Center is collaborating with the USCG on verification of ballast water treatment technologies. He asked Gail Roderick to discuss the ballast water management program and the ETV/USCG collaboration efforts. Gail Roderick commented that she has worked with both the ETV WQP Center and the ETV Advanced Monitoring Systems Center. The ballast water testing program is an enormous undertaking, requiring 90,000-gallon ballast water testing tanks and very complex protocols. Some of the problems encountered in developing the testing protocol have included: How do you inject the surrogate species into the system to make sure that they are evenly distributed? And, how do you obtain a representative sample after treatment? There are different treatment types such as inline treatment before water goes into the ballast tank, in-tank treatment, and treatment upon discharge. There are a tremendous number of protocols dealing with the whole scope of ballast water issues that are still being developed. Under USCG regulations, ships must either exchange or treat their ballast water. This ETV project is related to the treatment systems. The USCG decided to play the role of observing the vendors who were bringing in third-party testers. This would present an opportunity to determine what the state-of-the-science was in ballast treatment systems. Many of the test groups had thrown together an experimental design; there was no standard and some of the testing was not objective because the vendors were able to influence the testing procedures. There was no guidance and the research groups did not know what to test. As a result, the USCG decided that they needed some mechanism whereby they could provide a test facility for vendors.

After reading an article on ETV, Gail Roderick contacted Tom Stevens. The USCG did not have the infrastructure or a testing program such as ETV. They ended up collaborating with the Naval

Research Laboratory in Key West, Florida, and the ETV WQP Center. The USCG wanted independent verification of system performance, standard protocols, best experimental designs, quality control, and certified laboratories. There is a stakeholder group and a technical panel, which includes 25 subject matter experts, who have helped to guide the development of the protocols. One benefit of the ETV Program is objective testing—the vendors work with them, everyone signs off on the tests, the tests are fair, and there is a public test and report. In conclusion, she stated that they are very happy working with the ETV Program.

ETV Advanced Monitoring Systems Center
Karen Riggs, Product Line Manager, Battelle

Karen Riggs presented an overview of the Advanced Monitoring Systems (AMS) Center, which has verified 67 water and water security monitoring technologies, and provided a list of the verified water technology categories. She provided a brief description of the following technology categories: immunoassay test kits for atrazine (four verified), multi-parameter water quality monitors (nine verified, one in progress), site monitoring technologies, immunoassay test kits for microcystins, chemical oxygen demand technologies, and ballast water exchange screening tools.

Karen Riggs stated that the AMS Center has collaborated with four organizations on verification of multi-parameter water quality monitors. They collaborated with National Oceanic and Atmospheric Administration (NOAA) on the open water probes and with the EPA Test and Evaluation Facility (Cincinnati, Ohio) on the drinking water distribution systems. Currently, they are collaborating with the city of Columbus, Ohio, and the Texas Commission on Environmental Quality (TCEQ) on a grab sampler, which is in progress.

The generic test protocol has been finalized for the rapid soil toxicity technologies and the AMS Center is recruiting vendors to participate in the verification test and identifying test collaborators.

Karen Riggs stated that the center has added a new technology category—immunoassay test kits for microcystins, which are compounds that come from blue-green algae. They have identified at least four immunoassay-based kits that are commercially available, and they are conducting discussions with several potential collaborators—Nebraska Department of Environmental Quality, California Statewide Blue-Green Algae Workgroup, Klamath Blue-Green Algae Workgroup, and California Water Resources Board.

Karen Riggs stated that they are recruiting vendors and plan to test chemical oxygen demand analyzers in collaboration with DuPont in summer 2007.

Karen Riggs stated that there are additional collaborations planned for two new technology categories: (1) EPA NRMRL, National Exposure Research Laboratory (NERL), and Regions 3 and 5 for testing of estrogen immunoassay test kits; and (2) a National Institute of Environmental Health Sciences SBIR vendor interested in testing a groundwater sampler at U.S. Department of Defense (DoD) sites.

AMS Collaborations: Panel
Moderator: Karen Riggs

Karen Riggs stated that the AMS Center has numerous collaborations for water monitoring technologies, including collaborations with four organizations for verification testing of atrazine

test kits—TCEQ, EPA Office of Pesticide Programs, NOAA, and the University of Missouri-Rolla.

Alan Cherepon, Geologist, TCEQ

Alan Cherepon stated that TCEQ wanted to collaborate with ETV because a major part of their program is immunoassay analysis for atrazine and triazines. They also wanted to share what they have learned. They have a Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) grant from EPA, and their FIFRA-Pesticide Management Plan program includes collaboration and education/outreach activities. TCEQ has received many benefits from this collaboration. They have increased their knowledge of immunoassays and the quality assurance/quality control processes involved, and they are helping others to benefit from their work and experiences. As a result of the collaboration, TCEQ has corrected and improved their pipetting technique and has compared and contrasted the available kits/methods to determine which one is best for their specific needs. TCEQ also was able to keep the leftover reagent kits for their use. Alan Cherepon stated that this collaboration was a very positive experience, especially the knowledge obtained to improve their techniques and methods. An added benefit was the opportunity to speak with the vendors who developed the test kits. He provided a few recommendations for improving the program including: (1) communicating in greater detail the step-by-step procedures and identifying potential problems that might be encountered, (2) not assuming that everyone is at the same level of understanding, (3) looking at every step through “new eyes,” and (4) conducting a final brainstorming conference call of all people directly involved in the process. He commented that the University of Missouri has refined some of the test kits to remove some of the false positives. TCEQ recently has started to do urban pesticide immunoassays.

Gail Roderick, Project Manager, USCG, Research and Development Center

Gail Roderick discussed her experiences with the ETV collaboration with the USCG on ballast water, and stated that in this project, they looked at ballast water exchange under the regulations as compared to the ballast water treatment being done under the WQP Center. USCG is responsible for determining compliance under the regulations. Currently, compliance is determined using salinity, which is a poor diagnostic for determining ballast water exchange. Open ocean water has high salinity levels, and coastal areas, where the water is being discharged and exchanged, have brackish water. During the exchange, the brackish water organisms are introduced to high levels of salinity, hopefully destroying the nonindigenous species. The problem is with Mediterranean coastal areas, which have high levels of salinity; it is difficult to determine whether there was an exchange of ballast water. Several years ago, the USCG used the SBIR Program to issue a solicitation to obtain ideas on how to determine whether ships have exchanged ballast water. One of the respondents was Dakota Technologies, Inc., who proposed a ballast water exchange screening tool. The USCG asked them to develop a device that is hand-held, distinguishes between exchanged and unexchanged water, and is simple to operate. Dakota Technologies developed the Ballast Exchange Assurance Meter (BEAM), a hand-held fluorometer, which is designed to determine the amount of dissolved organic matter in ballast water. The USCG is interested in purchasing the technology but wanted to have it tested for reliability and accuracy. The USCG selected the AMS Center because the testing program included EPA oversight and involvement, a highly regarded program, a third-party objective assessment, good laboratory practices, and quality assurance. She stated that their experience has been wonderful and they are very pleased with the program. Karen Riggs stated that it is anticipated that the verification report for this technology will be issued in September 2007.

Karen Riggs stated that ETV collaborations provide: enhanced technical credibility, opportunities to leverage resources, a framework of real-world applications and users, and the key to a sustainable program. The AMS Center has been able to verify 125 technologies because of the assistance provided by collaborators.

ETV ESTE Project – Anaerobic Digestion of Animal Manure

John Haines, ETV Project Manager, EPA

John Haines provided a brief presentation on the ESTE project for Anaerobic Digestion of Animal Manure, including animal waste issues, a description of the digester, and the current status of the evaluation. He stated that the AgSTAR program is a voluntary effort jointly sponsored by EPA, the U.S. Department of Agriculture (USDA), and the U.S. Department of Energy (DOE). The program encourages the use of methane recovery (biogas) technologies at confined animal feeding operations (CAFOs) that manage manure as liquid or slurries. The AgSTAR program is mostly evaluating conventional technology. John Haines stated that they identified a small engineering firm at the State College of Pennsylvania that has built and installed an innovative digester. The digester has been operating for approximately 1 year in eastern Pennsylvania, and it is part of the Pennsylvania energy recovery program. Cow manure can generate methane, which can fuel generators for electricity. The digester is a very highly engineered system that includes a premixer and preheater to stabilize the reactor feed. It is thermophilic, which reduces the microorganism load, and has a secondary digester to reduce the carbon load. The digester treats mixed poultry and beef cattle waste. The system includes a phosphorus recovery component to reduce the load in the Chesapeake watershed, and recycles modern (rather than fossil) carbon to create energy. Work on this evaluation should begin in June 2007; testing will be conducted for 1 year. It is hoped that as more of these systems are developed and proven, the agriculture community will begin to use them for energy recovery.

Discussion

Teresa Harten opened the session for questions and discussion. John Neate, ETV Canada, asked when the estrogen immunoassay protocol would be completed. Karen Riggs responded that the protocol would not be started until the vendors and collaborators have been identified. At that time, the AMS Center will write a specific test plan for the verification test.

A participant commented that there are 1.2 billion chicken broilers grown in northwest Arkansas. There is a lot of chicken litter, but very little cow manure. He asked what the ratio of chicken waste versus cow waste was in the digester. John Haines responded that he was not sure but thought that it might be close to 50:50.

A participant asked about the status for beach monitoring technologies and if a verification test would be conducted. Karen Riggs responded that the AMS Center is tracking the commercially available technologies but they have had difficulty in finding collaborators for the verification test. The protocol is almost completed.

A participant asked what the typical cost was for verification testing of monitoring technologies. Karen Riggs responded that the cost depended on the technology, and could range across the ETV Program from \$60,000, which includes the test plan, report, and quality assurance, to several hundred thousand dollars.

MORNING SESSION B: SBIR FOR AIR AND ENERGY

Emissions Reductions via Air Separation Membranes

Donald Stookey, Director of Industrial Technology, Compact Membrane Systems, Inc. (CMS)

Donald Stookey stated that CMS is a technology development company based in Wilmington, Delaware. He described the CMS air separation membranes, which can be used for: (1) VOC recovery at fuel storage tanks, (2) nitrogen oxide (NO_x) emission reductions, and (3) oxygen-enriched air (OEA) applications. In the first area, their goal was to develop a membrane-based vapor processor that will maintain fugitive emissions from retail gasoline stations below the new California Air Resources Board (CARB) limit of 0.38 pounds of gasoline lost per 1,000 gallons of station throughput. CMS developed a simple membrane gasoline vapor recovery system that exceeds the new CARB standards. The system has passed all requirements for certification by CARB and Underwriters Laboratories, Inc. CMS will begin installations later this year once the CARB paperwork is completed. CMS will supply the membrane element and Vapor Systems Technology will supply the processor.

In the second area, CMS generated nitrogen-enriched air (NEA) from cooled turbocharged air using an air separation membrane integrated into the diesel engine; it is sufficiently compact for use on board diesel powered trucks and mobile equipment. The field durability test program included five Caterpillar diesel-powered class 8 trucks outfitted with NEA membranes; there was no evidence of membrane fouling after more than 150,000 miles. CMS plans to demonstrate and verify the NEA membrane on new engine platforms such as biodiesel and ethanol-diesel fueled engines and in combination with other technologies.

In the third area, CMS is developing OEA applications. In the area of high temperature combustion, they are supplying OEA to high-temperature burners used in compact, energy-efficient photo-voltaic and photo-electric devices. CMS is looking at other applications, such as reformat for hydrogen for fuel cells, oxidant for improved efficiency fuel cells, partial oxidation for synthesis gases, and staged combustion.

Diesel Retrofits and Other Innovative Technologies

Brian Hennings, Systems Integration Group Leader, Lynntech, Inc.

Brian Hennings stated that there are more than 2 million pieces of off-road diesel equipment in the United States, of which approximately 95 percent do not meet last year's NO_x emissions requirements. To combat this massive source of pollutants, a technology that can be retrofitted onto existing equipment that reduces pollutants—in particular, NO_x, carbon monoxide (CO), and unburned hydrocarbons (HCs)—is needed. The addition of hydrogen in the combustion chamber creates a stronger reducing environment during combustion, inhibiting the formation of NO_x and CO. Lynntech, Inc., based in College Station, Texas, is proposing to generate the hydrogen *in situ* in the fuel line. This simplifies installation and makes operation transparent to the operator. Lynntech's plasma process also preferentially shortens the average hydrocarbon chain length of the fuel passing through the chamber. This results in further reduction of NO_x emissions, reduction of HCs, and increased fuel economy.

Brian Hennings briefly described another SBIR Phase I project—an inexpensive biological and chemical decontamination solution from a powdered concentrate. This project involves a dry powdered formulation that can be easily and rapidly dissolved in water to yield a formulation capable of decontaminating all stockpiled chemical and biological warfare agents and does not require specialized delivery equipment. The proposed technology uses novel oxidants that can

destroy chemical warfare agents, inactivate viruses, and kill vegetative organisms and bacterial spores. Preliminary results have demonstrated the capability of these oxidants to rapidly destroy both sulfur mustard and nerve gas surrogates.

Low-Cost Biodiesel Production Process Using Meat Rendering Wastes, Recycled Greases and Unrefined Vegetable Oil Feedstocks

Brian Elliott, Principal Investigator, TDA Research, Inc.

Brian Elliott stated that TDA Research, Inc., based in Wheat Ridge, Colorado, will develop, test, and evaluate a new process for producing biodiesel from much less expensive high free fatty acid vegetable oil and animal fat feedstocks. The new process will promote increased use of biodiesel by reducing the cost of the fuel. Additionally, the new process will be more energy efficient and will not produce aqueous waste like the current process. The expected SBIR Phase I results include performance data (reaction kinetics and yields) for the new biodiesel process and an engineering and economic feasibility study. The environmental benefits of the proposed process include: reduced CO₂ emissions, conversion of waste into liquid fuels, a more energy efficient process, and no significant waste stream generation.

Discussion

Regarding the presentation by Lynntech, a participant commented that the agent would have to be on the surface. If the agent was something that was entirely dispersed in the gas stage, then agents such as sarin and others would not be affected by Lynntech's decontamination solution. Brian Hennings responded that this particular gel is for surface use only. However, Lynntech has a technology that can help with airborne contaminants from nerve agents and biological agents.

A participant asked if there were any plans to test the gel on coarse surfaces such as wallboard where there are crevices that could conceal contaminants. Brian Hennings responded that they plan to test the gel using a very aggressive matrix of surfaces and materials, one of which is drywall.

A participant asked if Lynntech was using a standard off the shelf plasma torch or corona discharge. Brian Hennings responded that they build their own plasma systems. For the electronics that drive and power the plasma, they tend to use off the shelf components, such as automotive components.

Mike Kosusko, EPA, asked if Lynntech has looked at the amount of power it would take to generate the plasma versus how much efficiency is obtained. Brian Hennings responded that they are at the early stage of development. They are trying to determine the right amount of hydrogen and how much power it will take to get the hydrogen so that they then can determine the efficiency of the process.

One participant asked whether the plasma process would change the performance of the engine; Brian Hennings affirmed that it will change the performance. The process requires very small amounts of the hydrogen and hydrocarbon chain link to get the benefits in NO_x emission reductions. Once the process is optimized, they will look at the impact to the operational performance of the diesel engine.

In response to a question, Brian Hennings responded that he thinks that the hydrogen is the true benefit of the process because of the complete combustion throughout the cylinder at even temperature.

A participant asked Brian Elliott about the oxidation stability of the product. Brian Elliott responded that it varied widely by a number of factors including how unsaturated the fats and oils are that are used in the process. Fortunately, a lot of waste greases and fats are saturated, so they tend to be more stable against oxidation.

A participant asked if the product will result in American Society for Testing and Materials (ASTM) grade biodiesel. Brian Elliott responded that it will. The question is what the economics will be and whether there will be a need for added purification steps.

COLLABORATIVE PANEL: ETV AND SBIR

Diesel/Nitrogen Oxide (NO_x) Reduction – EPA Coordination With the Texas Commission on Environmental Quality

Moderator: Andrew Trenholm

Andrew Trenholm stated that this panel would address the ETV and SBIR collaborations with TCEQ on diesel retrofit technology for NO_x reduction.

Sandra Rennie, Mobile Source Team Leader, EPA Region 6

Sandra Rennie presented an overview of the status of air quality in Texas, which provided background for the remaining panel presentations. The pollutant of interest in Texas is ozone. There are two sources of ozone: VOCs and NO_x. When these two precursors get into the atmosphere in the presence of sunlight, a photochemical reaction occurs and ozone is formed. The major Texas pollution problem areas are Dallas-Fort Worth, Houston-Galveston, and Beaumont-Port Arthur. The predominant source of NO_x in the Dallas area is from mobile sources, with a smaller amount coming from industry. In Houston, the predominant source of NO_x is from industry, with a small amount from mobile sources. She provided an example of the ozone challenge in the Dallas-Fort Worth area. Currently, they are meeting the 1-hour standard, but are not meeting the 8-hour standard. Showing data from 1990 through 2005, the precursors (VOCs and NO_x) are beginning to decrease as the State Implementation Plans (SIPs) get implemented. However, Houston has a larger challenge as they are dealing with a greater level of precursors. Texas is addressing the challenges that must be met through implementation of the SIPs. The development of the SIPs involves modeling, developing control strategies, looking at permit limitations, incorporating Federal and state rules, and incorporating voluntary programs to reduce emissions. The SIP process involves public comment on the plan when the state proposes it. The SIP then goes to EPA for review and consideration. In the EPA rule-making process, there is also an opportunity for public comment. Sandra Rennie concluded by stating that the next presentation was a voluntary program that is being implemented, and it is considered a premier program in the country.

Joe Walton, Team Leader for Grant Management and Monitoring, Texas Emissions Reduction Plan (TERP) Section, TCEQ

Joe Walton provided a presentation on TERP, which is a voluntary program. It provides incentive grants for projects that reduce NO_x emissions. Certain areas of the state are in noncompliance with the Federal Clean Air Act requirements for ozone. The primary areas of concern are Dallas-Fort Worth, Houston-Galveston-Brazoria, and Beaumont-Port Arthur; the secondary areas of concern are Longview, Austin, and San Antonio, and to a lesser extent are Victoria and Corpus

Christi. They are not looking at El Paso under the TERP program. He provided grant project funding data through August 2006. Grants are awarded by emission source and include: locomotive, marine, non-road, on-road, and stationary. The criteria for the last funding round limited the projects to the Dallas-Fort Worth, Houston-Galveston-Brazoria, and Beaumont-Port Arthur non-attainment areas; a second round expanded into the Austin, San Antonio, and Longview areas. Non-road equipment projects that will be used on public works projects were given a higher funding priority. In reviewing funding, they calculate a cost per ton by the old engine versus the new engine or retrofit to determine the NO_x cost efficiency over the life of the project. The fiscal year 2007 funding round has available funding of \$122,975,626. They received 421 applications covering 948 vehicles and pieces of equipment. The total grant amounts requested were \$72,879,007. For non-road projects, 118 applications were received for 432 pieces of equipment, and the total grant funding requested was \$36,718,820. For non-road public works related projects, 21 applications were received for 167 pieces of equipment, and the total grant funding requested was \$10,214,478. Most of these projects will be funded.

Rudy Smaling, Senior Research Scientist, Houston Advanced Research Center (HARC), Texas Environmental Research Consortium (TERC)

Rudy Smaling presented an overview of the New Technology Research and Development (NTRD) Program, which was set up as an addendum to the TERP Program to stimulate the development of new technologies and to have the technologies verified through the ETV Program. TERP will then be able to claim the credits under SIPs. The legislative mandates are to: (1) expedite the verifications of new technologies to maximize NO_x reductions; (2) facilitate the development of new technologies to further reduce NO_x emissions; and (3) promote economic development in Texas through new technology development and verification. The Texas ozone non-attainment areas represent: 70 percent of the state's population, 76.4 percent of aggregate employment, 83.4 percent of personal income, 83 percent of Gross State Product, and 85 percent of Texas manufacturing activity. The seven key elements of the NTRD Strategic Plan are to: (1) focus on major NO_x emissions sources; (2) expedite emissions technology verification and implementation; (3) stimulate development of new, low-emissions engine technologies; (4) stimulate development of engine upgrade kits and retrofits; (5) stimulate the development of exhaust treatment retrofit technology; (6) study and pursue alternative fuels and fuel additive improvements; and (7) seek opportunities to support development of hybrid powertrain projects. He presented a chart of the diesel NO_x emissions per day for the Houston-Galveston-Brazoria and Dallas-Fort Worth areas. The NTRD Program has funded 23 projects (\$12,228,204) in the following areas: 2 studies (inventory, duty/drive cycle of engines); 11 selective catalytic reduction (SCR) retrofit technology development; 5 lean NO_x trap/lean NO_x catalyst retrofit technology development; 4 engine/vehicle retrofits, and 1 hybrid technology. Total available project funding is \$15,952,726. HARC has close collaborations with the following organizations: TCEQ, ETV Program, EPA Office of Transportation and Air Quality (OTAQ), EPA Region 6, EPA SBIR Program, and North Central Texas Council of Governments.

April Richards, Deputy Director, EPA SBIR Program

April Richards provided an overview of the EPA SBIR Program and HARC collaboration. For the past 2 years, the SBIR Program, TERC, NTRD Program, and HARC have worked together to develop subtopics under the general topic area of engine and vehicle emissions reductions for the SBIR solicitations. This topic area includes three subtopics: (1) retrofitting off-road diesel construction equipment for NO_x reduction; (2) fuel additives to reduce emissions from gasoline engines; and (3) new non-ethanol and non-biodiesel liquid biofuels. HARC assisted in reviewing some of the SBIR proposals that passed peer review, and some of the projects have been funded.

Most importantly, collaboration between these Texas programs and SBIR awardees, including assistance with prototype development, demonstration, and verification testing programs, is possible in Phase II and beyond. The Texas NTRD Program also provides non-SBIR grants for technologies that show potential for commercialization and significant reduction of NO_x emissions. This is an important component of the collaboration because SBIR can assist companies during technology development but not commercialization. April Richards stated that she looked forward to continuing this collaboration.

Andrew Trenholm, ETV Center Manager, RTI International

Andrew Trenholm provided an overview of two additional EPA programs—the National Clean Diesel Campaign (NCDC) and the ETV Program—that are involved in the collaborations discussed by the other panel members. EPA OTAQ is the program office that develops the rules for diesel engines and they operate the NCDC. The NCDC is a voluntary program designed to reduce emissions and improve the emission performance of existing diesel vehicles and equipment. The ETV Program develops testing protocols and verifies the performance of innovative technologies, including air pollution control technologies.

NCDC provides grants to communities, verifies technologies, and provides data on verified technologies on their Web site. These verified technologies can be used under the grants for communities to retrofit school buses. The verified technologies also can be used to obtain SIP credits. The NCDC is a source of information on the performance and evaluation of technologies that feeds back to the Texas programs and the SIP process. The ETV Program fits into the collaboration in two ways: (1) ETV is a source of high quality technology performance data; and (2) the developers can use the datasets generated by ETV verification of their technology to participate in the Texas and OTAQ programs.

Andrew Trenholm provided an overview of a simplified retrofit verification process, which included the following steps: (1) the manufacturer applies to NCDC (OTAQ) and ETV (RTI); (2) NCDC, RTI and the manufacturer develop a test plan; (3) RTI, the testing organization, and the manufacturer develop and sign a statement of work; (4) the testing is performed and documented; (5) RTI generates the ETV report which is published and provided to the manufacturer; (6) the manufacturer submits the data to NCDC; (7) NCDC evaluates the data and includes the technology on their verified technology list; and (8) both OTAQ and Texas might then explore expanding the verification to other engines.

Andrew Trenholm provided a brief description of the OTAQ and ETV Program coordination activities. OTAQ evaluates the operating conditions of the technologies, criteria for the operating conditions, unique technical issues and testing, in-use operation, scope of verification, interpretation of results, and in-use testing requirements. ETV evaluates the test protocols, laboratory documentation and procedures, data quality, statistical analyses, and reporting.

Discussion

A participant asked Joe Walton why they had a second round of funding. Was it because of additional funding or the lack of applications/types of equipment? Joe Walton responded that their money is based on a biannual cycle. The money must be allocated by August 31 and a new cycle will start in September. The first funding round was limited to the three geographical areas mentioned; the second funding round will add the three secondary non-attainment areas.

AFTERNOON SESSION A: ETV FOR AIR AND ENERGY

ETV Air Pollution Control Technology Center

Andrew Trenholm, ETV Center Manager, RTI International

Andrew Trenholm presented an overview of the Air Pollution Control Technology (APCT) Center. The focus of the APCT Center is on technologies for controlling emissions of particulate matter (PM), NO_x, VOCs, and hazardous air pollutants. Seven test protocols have been completed. He discussed completed verifications for two technology categories: baghouse filtration products (BFP) and mobile sources devices. A testing protocol was developed for BFP; the initial focus was on verifying the penetration of fine particulate matter (PM_{2.5}) through bag fabrics to determine the removal efficiency. The ETV procedure was adopted as ASTM Method D6830, Characterizing the Pressure Drop and Filtration Performance of Cleanable Filter Media. This procedure also is under review by an International Organization for Standardization (ISO) committee to adopt it as an ISO standard. In fall 2005, the South Coast Air Quality Management District (SCAQMD) issued a rule for the cement industry that the frequency of compliance tests was reduced from 1 to 5 years when verified fabrics are used. The APCT Center completed a verification for Southern Filter Media as a direct result of the rule. Since fiscal year 2005, three verifications have been completed, and four verifications are in progress.

The APCT Center collaborated with the EPA OTAQ NCDC for diesel retrofit emissions control technologies. As mentioned previously, the NCDC-listed technologies are associated with SIP credits and OTAQ grants. He presented two slides depicting the various verification interactions between the different collaborators, including: the APCT Center, TCEQ, NTRD, TERC/HARC, EPA OTAQ, CARB, and EPA grant recipients. Three test protocols have been completed for mobile sources devices, fuels, and SCR. Diesel retrofit technology types include: devices (diesel exhaust catalysts, diesel particulate filters, engine modifications, and other devices), SCR, and fuels (alternative fuels, reformulations, fuel additives, and lubricants and lubricant additives). Nine verifications have been completed and two verifications are in progress.

Andrew Trenholm briefly described a new collaboration for the APCT Center. The EPA Office of Air Quality Planning and Standards (OAQPS) developed a voluntary program for Outdoor Wood Hydronic Heaters (OWHH). The OWHH Program encourages manufacturers to improve air quality through development and distribution of cleaner, more efficient outdoor wood-fired hydronic heaters. A test method was developed by an ASTM work group and EPA. An ETV protocol will be prepared this summer, which incorporates EPA's test method and procedures. The APCT Center will verify the performance of these outdoor wood-fired hydronic heaters, and the test results can be used by the vendors to participate in the OWHH Program. The Northeast States for Coordinated Air Use Management is developing a model rule that states, tribes, and local authorities may elect to use, in whole or in part, if they choose to regulate outdoor wood-fired hydronic heaters.

ETV Greenhouse Gas Technology Center

Tim Hansen, ETV Center Manager, Southern Research Institute

Tim Hansen provided an overview of the Greenhouse Gas Technology (GHG) Center, including technology categories, collaborations, current verifications, in-process and planned verifications, other planned activities, and outcomes/case studies. The GHG Center has completed 34 verifications. Their focus areas include: oil and gas industries, transportation industry, GHG monitoring, power industry, and energy efficient/green building technologies. The GHG Center has had collaborations with the New York State Energy Research and Development Authority

(NYSERDA) for a number of years. NYSERDA has contributed support for 10 distributed generation (DG)/combined heat and power (CHP) technology verifications under ETV, and there is potential to collaborate with them for additional verifications in other areas. The GHG Center provided ETV verification information to four vendors who were applying for SBIR Phase II funding. Tim Hansen provided examples of the oil and gas industry collaborations that the center has had within Region 6, where the stakeholders want to see testing under real field conditions at their facilities.

The GHG Center technologies are the subject of three ETV case studies: microturbine-CHP systems, an oil and gas vapor recovery system, and fuel cells. These case studies summarize the results of verifications, and provide estimated outcomes of broader market penetration, emission reductions, cost savings, and other factors. He presented examples of outcomes from the case studies for the microturbine-CHP systems and the vapor recovery system. Tim Hansen briefly discussed four recent and in progress verifications, planned and potential verifications, planned stakeholder meetings, and other planned activities.

Questions and Answers

A participant asked whether the NYSERDA database will include emissions factors and emissions reductions for technologies. Tim Hansen responded that NYSERDA is developing a national database and trying to integrate as much data as possible on technology verifications and demonstrations being conducted under state energy programs and other programs. The database will include ETV verification data, which contains emissions reductions.

A participant asked when the next transportation stakeholder meeting would be held. Tim Hansen responded that it would be in the last quarter of 2007.

ETV Advanced Monitoring Systems Center ***Karen Riggs, Product Line Manager, Battelle***

Karen Riggs presented an overview of the AMS Center, which has verified 58 air monitoring technologies. Her presentation included a description of the following technologies: personal cascade impactor samplers (PCIS), mercury emission monitoring systems, dioxin emission monitoring systems, and ambient ozone monitors. The AMS Center collaborated with the Mickey Leland National Urban Air Toxics Research Center (NUATRC) (Houston, Texas) on the PCIS verification test. One technology, the SKC Sioutas PCIS with the Leland Legacy[®] pump, was tested. The objectives of the verification test were to evaluate the comparability of the technology with more well-known samplers and to evaluate the operating performance of the Leland Legacy[®] pump battery. The test has been completed and the ETV report is undergoing peer review. The potential outcomes of the PCIS test included: (1) increased use of personal particle impaction to assess personal exposures to fine particles; (2) improved identification of sources and personal activities contributing to personal particle exposures; and (3) reductions in personal particle exposures, with consequent health benefits.

Karen Riggs stated that the Clean Air Mercury Rule issued in 2005 requires utility plants emitting more than minimal amounts of mercury to begin reporting stack gas mercury levels by January 1, 2009. Recently, the AMS Center completed four verifications for two types of mercury emission monitoring systems: continuous emission monitors (CEMs) and sorbent systems. The AMS Center collaborated with the Illinois Clean Coal Institute, which provided funding for the test, and the Northern Indiana Public Service Company, which provided the testing site and logistical

assistance at the site. Nine additional CEMs were verified in previous verification tests in collaboration with the State of Massachusetts and DOE.

The AMS Center recently verified four dioxin emission monitoring systems: two automated sampling systems with laboratory analysis and two semi-continuous sampling systems with laser ionization and mass spectrometric detection. These verification tests were conducted in collaboration with the EPA Office of Solid Waste and Emergency Response, EPA OAQPS, EPA ORD, and the Chlorine Chemistry Council. The center is planning to conduct a verification test of an ambient ozone monitor, which is based on solid phase chemiluminescence, in collaboration with the American Petroleum Institute. It is anticipated that testing will begin in May 2007.

AMS Collaborations: Panel

Moderator: Karen Riggs

Lata Shirname-More, Research Director, Mickey Leland NUATRC

Lata Shirname-More provided her perspective as a collaborator on the PCIS ETV verification test. She stated that the Clean Air Amendments of 1990 established a control program for hazardous air pollutants (HAPs) that potentially pose health risks to the public. At the same time, Congress created the Mickey Leland NUATRC to establish a research program to understand how these pollutants impact health. The center was formed as a public-private research organization. It is directed by a Scientific Advisory Panel consisting of representatives from industry, government, and academia. The mission of NUATRC is to identify the research gaps, provide funding to academic institutions to conduct research, and publish research results in peer-reviewed literature. In establishing its research program, NUATRC determined that they needed to identify what people were being exposed to, their personal exposure levels, the relationship of these exposures to ambient concentrations, and the sources of exposure to determine the health effects. There also was a need to further develop the exposure monitors. The devices had to be specific, accurate, light-weight, and user friendly. NUATRC focused a major effort into developing these personal dosimeters to measure exposure to air toxics. Many of the existing dosimeters had limitations, such as the ability to measure only one particle size at a time and low flow rates. The sampler that was developed can simultaneously collect four sample sizes, measure metals, incorporates a higher flow rate, and includes a stronger pump (the Leland Legacy[®] pump). To use the sampler and pump in large epidemiology studies, it was necessary to do an independent verification with a field study of personal use of the technology. One of the goals of the study was to see if the sampler could collect sufficient metals materials to establish metal content. NUATRC looked for an organization that had experience in conducting technology verification tests, developing testing protocols, and had an established quality assurance/quality control program. They were referred to the AMS Center. The Mickey Leland NUATRC has had a very good relationship with the AMS Center; it has been a 50-50 collaboration and cost share, and they have had input into the development of the test plan and other aspects of the testing. Technology development is going to be an important component of NUATRC's research and they are interested in developing other sensors, such as nanosensors. The ETV Program is a great resource for Mickey Leland, and they will use ETV for verification testing of other technologies as they are developed. They have been very satisfied with this relationship and collaboration.

ETV Pollution Prevention Coatings and Coating Equipment Pilot

Robert Fisher, ETV Pilot Manager, Concurrent Technologies Corporation

Robert Fisher provided a summary of the verifications of coating application equipment tested under the ETV Pollution Prevention Coatings and Coating Equipment Pilot (CCEP). They

developed a protocol for high-volume, low-pressure (HVLP) spray guns and have completed verifications for five HVLP spray guns. CCEP has collaborated with SCAQMD to develop a protocol for high transfer efficiency (high-TE) spray guns, and three verifications have been completed for high-TE spray guns. One high-TE, non-HVLP spray gun (ANEST IWATA W400) has gained regulatory approval as equivalent to HVLP in several local jurisdictions, in addition to SCAQMD. Robert Fisher briefly discussed some of CCEP's successes and outcomes. The CCEP liquid coatings protocol has been used to develop the ASTM International Method D7270-07, Standard Guide for Environmental Performance of Factory-Applied Liquid Coatings. CCEP is evaluating the possibility of having the high-TE protocol converted to another ASTM International Standard Guide. Verified technologies have gained widespread exposure and increased market share. For example, the LaserPaint (formerly LaserTouch) targeting and training device, which has been verified to reduce air emissions from manually operated coating operations by 11 percent, has become popular in both the industrial and DoD sectors. In closing, Robert Fisher stated that core funding for CCEP will end in June 2007. Verifications may continue on a non-funded basis, where the vendors pay all of the test plan development, testing, and reporting costs. Several vendors have expressed interest in future verifications of their technologies, and are prepared to pay the required costs.

ETV Environmental and Sustainable Technology Evaluations (ESTE) Projects

Teresa Harten stated that the ESTE projects were competed within EPA and represent Agency priorities for verification. The ESTE projects are led by EPA ORD project managers and have strong partnerships with EPA program offices and/or regional offices.

ETV ESTE Project – Pesticide Drift Reduction Technologies

Kerry Bullock, Environmental Engineer, EPA

Kerry Bullock stated that the driving force behind the ESTE projects is Agency needs. They are collaborating with the EPA Office of Pesticide Programs (OPP) on this ESTE project to encourage the use of technology for reducing pesticide spray drift exposure risk in row and field crop applications. Core funding for the project is provided from the ETV Program. The motivation for this work is the increased sensitivity to spray drift issues from suburban development and endangered species concerns. The growers/applicators currently manage drift using the regulations that are written into the pesticide product labels. EPA ORD, in collaboration with OPP and various stakeholders, is constructing a research program to determine the feasibility of establishing a drift reduction technology (DRT) process that will: (1) verify performance of DRTs; (2) incorporate incentives for using verified DRTs as drift mitigation; and (3) ultimately increase the use of these verified DRTs in the United States to reduce spray drift and the associated inadvertent pesticide exposures and risks. Examples of DRTs for use with row crops include: low drift nozzles/atomizers, adjuvants, electrostatic sprayers, shields/shrouds, and air assisted sprayers. The collaborations and partnerships for this project include: EPA OPP, Pesticide Program Dialogue Committee, a Federal Advisory Committee Act group working to develop product labeling; EPA ETC; Crop Life America; and USDA. The stakeholder group includes: pesticide registrants, adjuvant producers, applicator groups, sprayer manufacturers, and academic researchers. The DRT protocol focuses on ground or aerial applications to row crops, and includes three testing options: (1) low-speed wind tunnel, (2) high-speed wind tunnel, and (3) field. ESTE funded the development of the DRT performance protocol and is expected to subsidize testing of the initial DRTs to validate the protocol. The testing focus will be on the low-speed and high-speed wind tunnels; site-specific test plans will be developed for the testing scenarios. They anticipate testing one or two nozzle or nozzle/adjuvant combinations for each type of wind tunnel, beginning in summer 2007. Once the ESTE project is completed, OPP is

interested in having vendors verify their technologies using the validated protocol, and the ETV APCT Center has expressed an interest in potentially using the validated protocol for verification testing. There also is the potential for expansion to other applications, such as field testing and orchard spraying.

ETV ESTE Project – Microbial Resistant Building Materials: Gypsum Wallboard

Timothy Dean, ETV Project Manager, EPA

Timothy Dean stated that approximately 90 percent of the interior finished surfaces of buildings in the United States are covered with gypsum products. More than 40 percent of all homes in North America contain unhealthy or abnormal fungal growth, with gypsum wallboard being a primary growth material. Removal of growth substrates from building materials or the incorporation of antimicrobial agents in the manufacturing of building products may prevent mold growth and the spread of biological contaminants. There are several gypsum products readily available that can reduce mold growth in the indoor environment. However, there is no nationally accepted testing and verification program to guide consumers and building professionals on how to select or specify the best gypsum products for their needs. The objective of this project is to evaluate the different types of microbial resistant gypsum products that currently are being marketed. Different manufacturers have come up with separate methods of controlling or eliminating microbial growth on gypsum products, including removing microbial growth substrates and adding different antimicrobial compounds to the products. This ESTE gypsum wallboard test will evaluate the following: (1) microbial resistance, (2) VOC emissions, and (3) moisture resistance. The vendor group consists of Georgia Pacific, American Gypsum, National Gypsum, Temple-Inland, and the Gypsum Association. This project is collaborating with the EPA Office of Air and Radiation (OAR) Indoor Environments Division, Government Services Administration, Air Quality Sciences, and the Gypsum Association. It is anticipated that verification testing and reports will be completed by the end of 2007.

Questions and Answers

One participant asked how a person would know what they are buying if they purchase gypsum wallboard from Home Depot or Lowes. Timothy Dean responded that currently you do not know. Ultimately, in collaboration with the EPA OAR Indoor Environments Division, EPA hopes to develop a labeling system that will use ETV data to advise consumers on the best product to meet their needs, whether it be for home or hotel use.

Lora Johnson, EPA, commented that paperless wallboard is sold at Home Depot and asked if it was useful to test for mold growth on a product that does not have a substrate. Timothy Dean stated that it is a Georgia Pacific product that uses glass fiber. It is useful to test for mold growth because mold can still grow if the product has even a little dust or dirt on it.

A participant asked if there were any issues associated with fiberglass on materials. Timothy Dean responded that the concerns are with cutting and installation of the product and worker inhalation of the particles. However, for the purposes of this project, the main concerns are whether the product prevents mold growth and whether there are any off-gases.

ETV ESTE Project – Fuel Characteristics and Emissions from Biomass-Fired Boilers

Tim Hansen, Contractor, Southern Research Institute

Tim Hansen stated that the co-firing of biomass in coal-fired boilers offers the opportunity of reducing the emissions of criteria pollutants and greenhouse gases while also reducing the use of

finite fossil fuel resources. This ESTE project will measure the reductions of these emissions from biomass co-fired boilers in the 100 to 1000 million British thermal unit per hour (MM Btu/h) size range. The primary objectives of this project are to: (1) evaluate changes in boiler emissions due to biomass co-firing; (2) evaluate boiler efficiency with biomass co-firing; (3) determine if the value of ash for beneficial uses is reduced due to added carbon and metals content; and (4) evaluate sustainability indicators including sourcing of biomass and disposal of ash. Testing was conducted on two industrial boilers that are capable of co-firing woody biomass: University of Iowa Main Power Plant's Boiler 10, which co-fires wood-derived pelletized fuel with coal; and Minnesota Power's Rapids Energy Center Boiler 5, which co-fires bark with coal. Testing at both sites was completed in March 2007, and the final reports will be completed within the next 2 months. Testing results for the University of Iowa boiler showed: 13 percent reduction in sulfur dioxide (SO₂) emissions while co-firing at the 15 percent biomass blend; 10 percent increase in NO_x emissions; 30 percent reduction in total particulate emissions; 28 percent reduction in hydrogen chloride (HCl) emissions; no significant impact on direct CO₂ emissions; and no significant change in metals emissions. Testing results for the Minnesota Power boiler showed: 90 percent reduction in particulate emissions while co-firing at the 92 percent biomass blend; elimination of SO₂ emissions; 92 percent reduction in NO_x emissions; 78 percent reduction in HCl emissions; insignificant change in CO₂ emissions; and 47 percent reduction in primary metals emissions.

Questions and Answers

Bob Wright, EPA, asked if there were any other current uses for biomass if it is not diverted to boiler use. Tim Hansen responded that there is no current use for the biomass, the waste product goes to the landfill.

ETV ESTE Project – Radio-Frequency Identification (RFID) Tracking of Hazardous Waste Across International Borders

Katrina Varner, ETV Project Manager, EPA

Katrina Varner stated that this ESTE project has strong EPA collaboration from the Office of Enforcement and Compliance Assurance, OAR, ORD, and Region 6. Mexican law requires that all hazardous waste generated by U.S.-owned manufacturing plants be shipped back to the United States, resulting in thousands of shipments of hazardous waste each year. The current paper-based system does not allow for near-real-time confirmation of cradle-to-grave tracking as required by the Resource Conservation and Recovery Act. The emergence of radio-frequency identification (RFID) technology has important implications for tracking the movement of hazardous wastes and other materials. RFID is a potential tool for tracking the international transport of hazardous waste into the United States for disposal. This project will work to combine RFID technology with hazardous waste electronic manifest capability. RFID is an automated data capture technology that can be used to electronically identify, track, and store information contained on a tag or transponder. The tag will be affixed to the waste container, which will be packed inside a truck's trailer. The information on the tag will transmit data to a reader at specific points along the route, such as: generator facility, United States/Mexico border crossing, highway weigh stations, and entrance to the treatment/storage/disposal facility. ETV testing will take place under conditions that simulate truck transportation scenarios and warehouse storage conditions. The performance, cost, and scalability of the RFID technology will be evaluated; interferences (i.e., use of metal drums and chemicals in metal drums) that may degrade the RFID signal will be evaluated; and the impacts of tag-reader configuration on signal strength will be verified. Use of RFID technology could potentially augment EPA's paper-based manifest system and future e-manifest systems, provide notification via alert mechanisms, help streamline border crossings

without compromising security, and increase environmental protection along the United States/Mexico border zone.

Questions and Answers

Bob Wright, EPA, asked if the RFID technology can detect all of the drums on a truck. Katrina Varner responded that one of the scenarios for ETV testing will be to detect multiple tags at the same time. The difficulty may depend on how the drums are packed on a truck.

In response to a question, Katrina Varner stated that the tags cannot be placed directly on the metal drums because of interference. They are working with the vendors to identify other options for affixing the tags to the drums.

ETV ESTE Project – Portable Optical and Thermal Imaging Devices for Leak Detection at Petroleum Refineries and Chemical Plants

David Williams, ETV Project Manager, EPA

David Williams stated that refineries and chemical plants emit HAPs. These industries are permitted to release a certain amount of emissions. Fugitive, or unknown, leaks can degrade regional air quality and cause non-attainment of air quality standards. Therefore, efficient monitoring methods are required. Leak detection and repair (LDAR) programs are costly and time-consuming, and leaks are hard to locate. Less than 6 percent of emissions are from repeat leaks. New monitoring technologies have been developed for leak detection. The handheld specialized thermal cameras can rapidly search for leaks; the number screened at a refinery in 1 day would take 3 weeks using EPA Method 21. A thermal camera system can be mounted on aerial platforms (e.g., helicopters) for rapid surveillance and monitoring, and the cost is approximately \$75,000. Many companies and agencies are using these cameras. A new alternative work practice for leak detection is being finalized—an alternate Method 21 that allows the use of these cameras and other optical and thermal technologies. The test plan developed under this project will evaluate the camera's applicability, performance, detection limits, and sensitivity. Battelle is developing the verification and test plan. A stakeholder group has been formed and approximately seven vendors expressed an interest in participating in verification testing in the future. The AMS Center has expressed interest in using the test plan to perform verification testing. The chemical industry has tentatively agreed to help fund the project at \$200,000 with some in-kind support, and the petroleum industry will continue to work with ETV on the project. It is anticipated that verification testing will begin in summer or fall 2007. They have an aggressive schedule because the verification test data will be used to support industry's use of the alternative work practice.

Questions and Answers

Bob Wright, EPA, commented that the camera is a thermal technology and asked whether there were any environmental limitations such as the technology only working on bright sunny days, but not working on cloudy days. David Williams responded that the cameras are extremely sensitive to temperature within a hundredth of a degree tolerance and are quite capable.

Discussion

Teresa Harten opened the session to questions. There were no questions. She thanked the participants for attending the workshop and announced that the meeting minutes would be posted on the ETV Web Site, which also contains the verification reports of all technologies tested under

the ETV Program.

AFTERNOON SESSION B: SBIR FOR WATER

Rapid Test Kit for Quantifying Hormonal Activity in Animal Feeding Operation (AFO) Wastewater

Douglas Fort, President, Fort Environmental Laboratories

Douglas Fort stated that there is a widespread problem with pharmaceuticals in wastewater effluents and surface waters across the United States. Estrogenic activities have been found in effluents. Anabolic steroid and growth hormones used in CAFOs are released into the environment. Potency potential positive interactions with other waste materials threaten serious impact on resident aquatic life. Vertebrate development and reproduction are controlled in part by the endocrine system. Currently, no standardized and well-validated screening technology is available. Fort Environmental Laboratories, based in Stillwater, Oklahoma, is conducting a research project to develop, standardize, validate, and commercialize an endocrine disrupting chemical (EDC) screening kit based on the amphibian oocyte maturation model for evaluating unknown ecological hazards produced by CAFOs. The proposed test kit should provide a valuable means of testing for EDC activity and potential toxicological effects. A test model was developed for evaluating the toxicological activity of the waste runoff from CAFOs by monitoring the hormonally-induced process of oocyte maturation in *Xenopus laevis* oocytes *in vitro*. The results suggested that trace levels of feed additives or sub-dermal livestock steroids released to the environment via waste run-off are capable of interfering with endocrine systems and reproductive processes in amphibians. CAFO samples collected from cattle, sheep, hog, and poultry sites each contained varying levels of EDC activity. Based on benchmarks, the following preliminary potency assessment was established:

- ✧ Progesterone-Induced: Cattle(+)>poultry(-)≥hog(+)>>sheep(-)
- ✧ Androgen-Induced: Cattle(+)>>hog(+)>>sheep(-)>poultry(-)

The field portable test kit prototype functioned well in the field and in the laboratory.

Questions and Answers

A participant asked if the results were from beef or dairy cattle. Douglas Fort responded that they mostly work with beef cattle. Beef cattle tend to have greater estrogen and androgen activity, which is tied to the type of supplements they are given. Dairy cattle have estrogen and androgen activity that is characteristic of what is seen in beef cattle, but it is not as potent. The waste run-off from cattle CAFOs tends to have greater estrogen and androgen activity than CAFOs with other livestock. Waste run-off from dairy cattle operations is quite a bit lower, but does show some activity as well.

A participant asked if the model would apply to municipal or domestic waste. Douglas Fort responded that we have known about pharmaceuticals and hormones in wastewater effluent for a number of years and there has been some effort to monitor for EDC activity. Monitoring of CAFOs, being a non-point source discharge and thus, more difficult to regulate, has lagged behind. The model is directly applicable to wastewater effluents and they have studied it in different wastewater situations. The model is remarkably sensitive and it will pick up estrogen and androgen activity. Pharmaceuticals and hormones are very potent and they are difficult to degrade in wastewater.

A participant asked if any chemical analyses were conducted. Douglas Fort responded that chemical analyses were conducted to identify what materials might have activity. In cattle operations, they can find estrogen in the wastewater at very low concentrations. They have conducted more analyses with the cattle and poultry, and less with sheep and hogs. They know what hormones to expect in the feeding operations, but they do not know what materials exist that have unknown endocrine activities.

Handheld FRET-Aptamer Sensor to Satisfy the Beaches Act

John Bruno, Senior Scientist, Operational Technologies Corporation (OpTech)

John Bruno provided an overview of the goals of their research project and a description of the technology. OpTech, based in San Antonio, Texas, proposes to couple the ultrasensitivity of fluorescence-based detection with the high affinity and selectivity of DNA aptamers as improved replacements for antibodies to detect fecal indicator organisms in fresh and marine recreational waters. Aptamers are essentially artificial antibodies made of DNA/RNA, instead of protein. Aptamers have several major advantages over antibodies: they do not require animal hosts for production, they generally have greater affinity and specificity, it costs less to produce aptamers versus antibodies, and there is greater reproducibility once the aptamer is sequenced. Fluorescence Resonance Energy Transfer (FRET) aptamer assays for fecal indicator organisms will be demonstrated. The aptamer FRET assays will be developed to detect less than the EPA recommended 126 *Escherichia coli* and 33 enterococci per 100 milliliters (mL) in freshwater and 35 enterococci per 100 mL in saltwater samples, which will enable rapid compliance with the Beaches Act. John Bruno described a number of preliminary FRET aptamer assays that OpTech has successfully developed under other agency SBIR programs such as the U.S. Army (chemical and biological defense), National Institute of Health (botulinum toxin), and USDA (foot-and-mouth disease). OpTech is in the early stage of their EPA SBIR Phase I project. Their specific targets are *E. coli*—Lipopolysaccharide moieties and *Enterococcus faecalis*—teichoic acid. They hope to have assay data available by next year.

Questions and Answers

A participant asked if the technology could be used for wastewater systems. John Bruno responded that it is a possible application. A few years ago, he was funded to develop an aptamer column that would filter out pesticides. They did pull out some of the pesticides, but the problem was residence time. When you want to pump a lot of water, it is an affinity column and you need time for the binding interaction.

April Richards stated that the current available technology is a 24-hour test, which means that people are swimming in contaminated water until the test results are completed. The goal is to develop real-time technology test results.

A participant asked about the sensitivity difference between an aptamer and an ELISA test kit. John Bruno responded that the aptamer was more sensitive.

A Hybrid Pathogen Detection System

Zoraida Aguilar, Principal Investigator, Vegrandis LLC

Zoraida Aguilar provided a brief overview of prototype products being developed by Vegrandis, such as an automated electrochemical analyzer, a manual electrochemical analyzer, bigger microarray chips, a disposable functionalized lab-on-a-chip, and reagent kits. In their SBIR Phase I project, Vegrandis, based in Fayetteville, Arkansas, successfully demonstrated its chip-based,

self-contained, microelectrochemical hybrid assay (SMEHA). The assay involved an immunoassay followed by a DNA hybridization assay to confirm viability of the oocysts. Both assays, which took approximately 90 minutes to complete, were demonstrated in an 8 by 3 array of 50 micrometers (μm) diameter cavities. Phase I of the project proved the ability to detect live *Cryptosporidium* oocysts down to 5 oocysts per 10 liters (L) of pelleted surface water samples in less than 90 minutes. In their Phase II project, Vergrandis will develop disposable SMEHA cartridges for the quantification and viability assessment of waterborne pathogens, to meet the need for fast warning of pathogen outbreaks and possible dispersal of bioterrorism agents. The focus will be on the detection of *Cryptosporidium* oocysts and *Giardia* cysts. Both protozoans seriously threaten the nation's water supply because they resist ordinary water treatment processes and do not respond to common antibiotics. Currently, alpha and beta testing of the fully automated instrument is being conducted. Vergrandis will be outsourcing bulk fabrication of the chips, bulk manufacturing of disposable cartridge components, and professional manufacturing of the assay platform components.

Questions and Answers

A participant asked if the chips were reusable or discarded after one use. Zoraida Aguilar responded that the chips developed in-house were reusable but the outsourced manufactured chips will be contained in disposable cartridges. The purchaser can dispose of the cartridges or send them back to Vergrandis, who will buy back the disposable cartridges, dismantle them, and remove and reuse the chips.

AFTERNOON SESSION C: SBIR FOR NANOTECHNOLOGY APPLICATIONS

Affordable, Large-Scale Manufacturing of High Surface Area Iron Powder *John Freim, Principal Investigator, OnMaterials, LLC*

John Freim stated that emerging *in situ* groundwater remediation technologies include: nanocrystalline zero valent metals (NZVI), emulsified zero valent iron, and functional ceramics. NZVI targets groundwater contaminants such as halogenated hydrocarbons (e.g., carbon tetrachloride, trichloroethylene), halogenated aromatics (e.g., polychlorinated biphenyls, pesticides), and metals (e.g., hexavalent chromium). OnMaterials, based in San Diego, California, developed a scalable manufacturing process to produce affordable, submicrometer and nanocrystalline zero valent metal powders. This work led to the development of Z-Loy™, a nonaqueous zero valent metal suspension. The discrete particle size is advantageous because other NZVI particles, prepared by chemical precipitation or thermal reduction, typically are aggregated into larger particles that hinder underground mobility to remediate deeply embedded substances. Z-Loy™ particles have highly reactive surfaces that enable the rapid elimination of toxic substances without producing toxic daughter products (e.g., vinyl chloride). Z-Loy™ offers a metallic surface area of 15 square meters per gram (m^2/g); this provides exceptional reactivity because reaction kinetics scale with surface area. A first-order measure of reactivity is obtained by making a 10 grams per liters (g/L) aqueous suspension and measuring the oxygen reduction potential (ORP). ORP quantifies the ability of the metal particles to accomplish electrochemical reduction. Laboratory studies using gas chromatography show the rapid and near-complete elimination of aqueous-phase chlorinated hydrocarbons from very concentrated solutions. Additionally, the resulting reaction products consist primarily of innocuous, nonchlorinated gaseous hydrocarbons with little or no toxic chlorinated byproducts formed. Z-Loy™ has been commercialized and is being sold in the remediation marketplace. OnMaterials is developing other products: nanocrystalline calcium carbonate powders to be injected into the ground for pH

control, emulsified zero valent iron for dense non-aqueous phase liquids treatment, and sub-micrometer ceramics for long acting reductants.

Questions and Answers

A participant asked for a range in cost per ton for the product. John Freim responded that the cost ranges from \$10 to \$20 per pound.

A participant asked if field site data on the technology were available. John Freim responded that the data are available and suggested that the participant talk to him after the meeting.

Non-Toxic Nanocrystals for Solid State Lighting

David Goorskey, Principal Investigator, Nanomaterials & Nanofabrication Laboratories

David Goorskey provided a brief overview of solid state lighting (SSL). SSL saves energy, which benefits the environment. Reduced electrical energy consumption results in reduced: consumption of crude oil; CO₂ emissions; number of power plants; and SO₂ (acid rain), mercury, radioactive materials, and other pollutants from coal-burning power plants. Nanomaterials & Nanofabrication, based in Fayetteville, Arkansas, is conducting a project to combine nontoxic doped semiconductor nanocrystal phosphors with existing high-efficiency blue/ultraviolet InGaN light-emitting diodes to produce bright, efficient, and affordable SSL as a replacement for mercury-containing fluorescent lights. Doped semiconductor nanocrystal phosphors that do not contain heavy metals, such as lead, mercury, or cadmium, are ideal for such an application because, unlike bulk phosphors that suffer from scattering losses, the extremely small size of nanophosphors makes them immune to Mie-type scattering. Also, their synthesis and production methods are relatively cheap and easy, they can be processed from solution in a wide variety of solvents, and they can be blended with polymers and other encapsulants to form highly fluorescent composite materials conformable to nearly any surface. Their emission color can be tunable over a large visible range, and, unlike intrinsic semiconductor nanocrystal emitters, doped nanocrystals have no reabsorption or fluorescence resonance energy transfer losses and can be deposited in high-packing densities for maximum luminous output and efficiency. The Phase I project is focused on developing the nanophosphor encapsulation composite material that will be used to coat the light emitting diode chip.

Questions and Answers

A participant asked if a target price per kilolumen (klm) has been established to get this technology into residential homes. David Goorskey responded that DOE has a technology roadmap for SSL that indicates the technology will be successful if the cost is around \$1 per klm. The cost has to be lower than fluorescent light bulbs or people will not switch to the new technology.

April Richards thanked everyone for their participation in the workshop.

CONCLUSION

The ETV and SBIR Programs Regional Workshop in Region 6 was well attended, with over 140 participants representing the EPA regional office, state and local governments, technology developers, academia, and others. EPA NRMRL senior management emphasized the important role of technology development and evaluation in meeting EPA's mission. Representatives from

EPA Region 6 provided general feedback on priority technology needs in the Region, such as emissions monitoring and control technologies for refineries and the petrochemical industry, water monitors for measuring phosphorus from animal feeding operations, and energy efficiency technologies. Representatives from the ETV centers and their collaborators, such as the Texas Commission on Environmental Quality and the University of Houston, presented on recent and upcoming verifications. SBIR technology developers discussed technology development and commercialization supported by EPA. ETV and SBIR vendors exhibited and/or demonstrated their technologies, and ETV provided posters highlighting collaborative verifications. The ETV and SBIR Programs plan to continue outreach of program information to the Regions, and to host future, similar regional workshops to further this type of interaction with end-use audiences for environmental technology and technology performance data.

APPENDIX A

Participants List

Zoraida Aguilar
Vegrandis LLC

Elmer Akin
MDB, Inc

Mike Barber
International Wastewater Systems, Inc.

Jeff Barghout
Southern Research Institute

C. Bruce Bartley
NSF International

David Battaglia
Nanomaterials and Nanofabrication
Laboratories

Earl Beaver
Practical Sustainability, LLC

Janet Bearden
U.S. Environmental Protection Agency

Ellen Belk
U.S. Environmental Protection Agency

Jerry Black
Black and Associates

Debora Bradford
U.S. Environmental Protection Agency

Barry Brannon
International Wastewater Systems, Inc.

Amanda Brimmer
North Central Texas Council of
Governments

John Bruno
Operational Technologies Corporation

Kerry Bullock
U.S. Environmental Protection Agency

Terry Burton
U.S. Environmental Protection Agency

Adele Cardenas Malott
U.S. Environmental Protection Agency

Alan Cherepon
Texas Commission on Environmental
Quality

Timothy Dean
U.S. Environmental Protection Agency

Nancy Dorsey
U.S. Environmental Protection Agency

Dionne Driscoll
Contech

Carl Edlund
U.S. Environmental Protection Agency

Brian Elliott
TDA Research, Inc.

Julius Enriquez
U.S. Environmental Protection Agency

Abe Finkelstein
Environment Canada

Robert Fisher
Concurrent Technologies Corporation

Rick Flammang
Go Green Fuel

Miguel Flores
U.S. Environmental Protection Agency

Mark Flusche
Lynntech, Inc.

Todd Foret
Foret Plasma Labs, LLC

Douglas Fort
Fort Environmental Laboratories

Ray Frederick
U.S. Environmental Protection Agency

John Freim
OnMaterials

Robert Fuerst
U.S. Environmental Protection Agency

Rick Galceran
City of Dallas

Robert Garcia
Bernalillo County

Abbas Ghassemi
WERC

Joe Gilson
Southwest Synthetics

David Goorskey
Nanomaterials and Nanofabrication
Laboratories

Paul Groff
U.S. Environmental Protection Agency

Christine Grubb
North Texas Regional Center for Innovation
and Commercialization

Sally Gutierrez
U.S. Environmental Protection Agency

John Haines
U.S. Environmental Protection Agency

Teresa Harten
U.S. Environmental Protection Agency

Evelyn Hartzell
U.S. Environmental Protection Agency

Brian Hennings
Lynnntech, Inc.

Latrice Hertzler
Future Link Technologies, Inc.

Lora Johnson
U.S. Environmental Protection Agency

Robert Kirkland
U.S. Environmental Protection Agency

Raymond Klicius
Environment Canada

Myron Knudson
U.S. Environmental Protection Agency

Deborah Kopsick
U.S. Environmental Protection Agency

Angel Kosfiszer
U.S. Environmental Protection Agency

Michael Kosusko
U.S. Environmental Protection Agency

Julia Levinson
W. L. Gore & Associates

Henry Liao
U.S. Environmental Protection Agency

William Madison
City of Dallas

Damon McElroy
U.S. Environmental Protection Agency

Michael Miller
U.S. Environmental Protection Agency

Judson Miner
Pronucleotein Biotechnologies, LLC

Ted Mizutowicz
U.S. Environmental Protection Agency

Gerald Mokry
U.S. Environmental Protection Agency

Darren Morrissey
Arkansas Department of Environmental
Quality

John Neate
ETV Canada

Akin Olubiyi
Texas Commission on Environmental
Quality

Suran Peiris
U.S. Environmental Protection Agency

Clint Rachal
U.S. Environmental Protection Agency

Sarah Radovan
Natural Resources Canada

Larry Reed
MDB, Inc.

Carrie Reese
North Central Texas Council of
Governments

Sandra Rennie
U.S. Environmental Protection Agency

Carlos Rincon
U.S. Environmental Protection Agency

April Richards
U.S. Environmental Protection Agency

Karen Riggs
Battelle

Gail Roderick
U.S. Coast Guard Research and
Development Center

Stephen Schmelling
U.S. Environmental Protection Agency

Ray Schubert
Texas Commission on Environmental
Quality

Lata Shirname-More
Mickey Leland National Urban Air Toxics
Research Center

David Sledge
Premier Erosion Control, LLC

Rudy Smaling
Houston Advanced Research Center

Claude Smith
International Wastewater Systems, Inc.

Jeffrey Smith
International Wastewater Systems, Inc.

Tom Stevens
NSF International

Donald Stookey
Compact Membrane Systems, Inc.

Steve Strong
MIRATECH Corporation

Stephen Sturdivant
U.S. Environmental Protection Agency

Bryan Swain
WERC

Patty Taylor
U.S. Environmental Protection Agency

Maggie Theroux
U.S. Environmental Protection Agency

Charles Thomas
New Mexico Environment Department

Scot Tims
W.L. Gore & Associates, Inc.

Drew Trenholm
RTI International

Katrina Varner
U.S. Environmental Protection Agency

Cumaraswamy Vipulanandan
University of Houston

Abby Waits
U.S. Environmental Protection Agency

Joe Walton

Texas Commission on Environmental
Quality

Tim Ward

Oklahoma Department of Environmental
Quality

Chad Weaver

International Wastewater Systems, Inc.

Daniel Westerheim

Lynntech, Inc.

David Williams

U.S. Environmental Protection Agency

Max Winkler

Cleanair Catalyst, Inc.

Gene Wossum

U.S. Environmental Protection Agency

Larry Wright

U.S. Environmental Protection Agency

Robert Wright

U.S. Environmental Protection Agency

James Yarbrough

U.S. Environmental Protection Agency

Young Yee

Mkey Technologies, LLC

Contractor Support

Joan Cox

The Scientific Consulting Group, Inc.

Angela Hays

The Scientific Consulting Group, Inc.

APPENDIX B

Exhibitors List

Compact Membrane Systems, Inc.

Technology Type: Emission Reductions via Air Separation Membranes

EPA Small Business Innovation Research (SBIR) Vendor

Dr. Donald J. Stookey

325 Water Street

Wilmington, Delaware 19804

Phone: (302) 999-7996

E-mail: dstookey@compactmembrane.com

Web Site: www.compactmembrane.com

Compact Membrane Systems, Inc. (CMS), has developed a family of high-flux, chemically resistant, gas separation membranes. The CMS exhibit provides an overview of gas separation membranes and an introduction to three applications dealing with atmospheric emissions. The exhibit highlights membranes for gasoline vapor recovery, nitrogen oxide (NO_x) reduction for diesel engines, and oxygen enriched air generation for high temperature and staged combustion.¹

International Wastewater Systems, Inc.

Technology Type: Model 6000 Sequencing Batch Reactor System for Decentralized Wastewater Treatment

EPA Environmental Technology Verification (ETV) Vendor

Claude Smith

2020 Charlotte Street

Bozeman, Montana 59718

Phone: (406) 570-1942

E-mail: claudes1985@yahoo.com

Web Site: www.iwwsystems.com

The International Wastewater Systems Model 6000 Sequencing Batch Reactor System is a wastewater treatment system for users who do not have access to municipal sewer service. Applications include residential subdivisions, commercial development, schools, motels, Native American lands, and remote locations of all types. This technology provides nitrogen and phosphorus removal.¹

Mickey Leland National Urban Air Toxics Research Center (NUATRC)

EPA ETV Collaborator

Dr. Lata Shirname-More

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Houston, Texas 77030

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¹ Technology description was provided by the vendor/developer. EPA does not endorse the purchase or sale of any of the products or services mentioned above. The views expressed by these companies are their own and do not necessarily reflect those of the U.S. Environmental Protection Agency.

The Mickey Leland National Urban Air Toxics Research Center (NUATRC) is a research facility that has been specifically charged to sponsor and gather scientific information on the human health effects caused by exposure to air toxics, as defined by the 1990 Clean Air Act. By law, NUATRC is a nonprofit corporation, financed by government and private funds. The Center's research program, developed collaboratively by scientific experts from academia, industry and government, seeks to fill the gaps in scientific data that are required to make sound environmental health public policy decisions. The NUATRC is collaborating with the EPA ETV Advanced Monitoring Systems Center on the verification of personal cascade impactor samplers.

Nanomaterials & Nanofabrication Laboratories (NN-Labs, LLC)

Technology Type: Colloidal Nanocrystals for Solid State Lighting

EPA SBIR Vendor

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NN-Labs produces high-quality colloidal nanocrystals for use in applications that have the potential to drastically change our world. NN-Labs offers a variety of nanocrystal products including luminescent and stable core and core-shell semiconductor nanocrystals, nano-gold, iron oxide nano-magnets, and their most recent invention, transition metal ion-doped ZnSe nanocrystals without heavy metals. NN-Labs provides these high-quality nanomaterials in both organic solvents and water with the option of bio-functionalized dendron ligands that provide superior stability and functional ability over conventional organic capping species. In addition, NN-Labs pursues active research programs geared toward accelerating the development of real-world applications based on nanocrystal technology.¹

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Web Site: www.epa.gov/etv

The ETV Program was established in 1995 to speed the implementation of new, improved environmental technology to solve high-risk environmental problems. ETV develops testing protocols and verifies the performance of commercial-ready innovative technologies that have the potential to improve protection of human health and the environment. The goals of the ETV Program are to accelerate the entrance of new environmental technologies into the domestic and international marketplace, and to provide credible, high-quality data on the performance of promising environmental technologies for the benefit of purchasers, permittees, vendors, and the public.

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The SBIR Program is an important part of EPA's research and development efforts and helps the Agency achieve its mission to protect human health and safeguard the natural environment. Through the SBIR Program, EPA makes awards to small, high-tech firms to help develop and commercialize cutting-edge environmental technologies. SBIR is intended to support the development of environmental technologies that ultimately will be commercialized and improve our environment and quality of life, create jobs, increase productivity and economic growth, and improve the international competitiveness of the U.S. technology industry.