U.S. Environmental Protection Agency (EPA)
Environmental Technology Verification (ETV) Program
Outreach Workshop
Meeting Summary

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U.S. EPA Region 4
Atlanta, GA

Tuesday, November 16, 2004

OPENING SESSION

Welcome and Introduction

Tom Baugh, Regional Science Liaison to EPA's Office of Research and Development (ORD), Region 4, welcomed participants to the outreach workshop. He stated that this meeting is an example of how ORD is cooperating with the EPA regional offices, and provides an opportunity for Region 4 to learn more about environmental technologies—in particular, those technologies that are being developed by small businesses. This meeting is also an opportunity for EPA's Environmental Technology Verification (ETV) Program to obtain information on the environmental technology needs of the Southeastern United States. Tom Baugh introduced Teresa Harten, Director of the ETV Program, who also welcomed participants to the workshop. Teresa Harten stated that this was the first ETV workshop to be held at an EPA regional office. An ETV Stakeholders Briefing was held on May 11-12, 2004, in Washington, DC, and was such a success that the decision was made to hold the next meeting at one of the regional offices. She stated that the goal of this workshop was to share information on the technologies being tested under ETV and to obtain input about technology needs that are specific to Region 4.

ETV Overview

Teresa Harten provided a brief presentation on the ETV Program. Highlights of the presentation include:

- ***ETV Objectives***—The ETV Program was started in 1995 under the Environmental Technology Initiative. The objectives of the ETV Program are: to provide credible performance data for commercial-ready environmental technologies to help solve high-risk environmental problems; and to aid purchasers in making decisions to purchase innovative technologies, permitters in making permitting decisions for innovative technologies, and vendors/developers in selling and further developing innovative technologies. ETV only accepts commercial-ready technologies for testing.

- ***R&D Continuum***—The technology Research and Development (R&D) continuum consists of research,

proof of concept, development, demonstration, verification, and commercialization/deployment. ETV enters the process after the demonstration component of the continuum. Once vendors are able to verify how their technologies work, they can use the verification data to further innovate their technologies. As a result, multiple vendors have brought second generation technologies to ETV for testing. Once a technology is commercial-ready, it may face what is referred to as the "valley of death," in which many technologies fail to transfer widely into the market because of a lack of funding for commercialization or credible information on technology performance to be used by purchasers in buying new technologies.

- ***ETV Verification Definition***—The ETV definition of verification is: to establish or prove the truth of the performance of a technology under specific, predetermined criteria or protocols and quality assurance procedures. ETV does not pass/fail, approve, or certify technologies.

- ***ETV Verification Process***—The ETV Program operates as a public-private partnership through competitive cooperative agreements between EPA and private testing and evaluation organizations. The ETV verification organizations (VOs) include: Battelle, RTI International, Southern Research Institute, NSF International, and Concurrent Technologies Corporation. These VOs establish ETV centers, which then establish stakeholder groups. EPA, VOs, and stakeholders identify technologies to be tested and develop test protocols and quality assurance (QA) test plans. Technology vendors are identified through outreach efforts, which include advertising and participation at major environmental conferences. Once technology testing is completed, a verification report and a signed verification statement are prepared, issued to the vendor, and posted to the ETV Web Site, which is the program's major outreach mechanism.

- ***ETV Successes***—The ETV Program has completed 312 verifications and 82 protocols. ETV supports the solving of important environmental problems. One of the successes of ETV is the increased funding from vendors and other partners. ETV was started with the premise that the program would eventually become totally privatized and that EPA would no longer be involved. This has proven not to be the case; however, ETV has been able to significantly leverage program funding with cost-share from other organizations. Vendor and other partner contributions are more than 50% (25% cash and 25% in-kind) of full program costs. There is increased participation from stakeholders, with 805 stakeholders in 21 groups/panels in the program. In the past year, there has been a significant increase in the number of visitors to the ETV Web Site, with an average of more than 1 million hits per year. ETV has also played a role in homeland security verifications.

- ***ETV Centers***—The base ETV Program consists of the following five centers and one pilot (with VOs):

  - ETV Air Pollution Control Technology Center (RTI International)
  - ETV Advanced Monitoring Systems Center (Battelle)
  - ETV Drinking Water Systems Center (NSF International)
  - ETV Greenhouse Gas Technology Center (Southern Research Institute)
  - ETV Water Quality Protection Center (NSF International)
  - ETV Pollution Prevention (P2) Coatings and Coating Equipment Pilot (Concurrent Technologies Corporation)

  ETV is going through a transitional period. Due to budget cuts, only two centers (ETV Air Pollution

Control Technology Center and ETV Advanced Monitoring Systems Center) will be funded in the future. The remaining three centers and one pilot will remain active, but will receive no new ETV funds; discussions are being held regarding EPA's limited involvement to provide technical and QA oversight.

- ***Major Verification Categories Planned for Fiscal Years (FY) 2004 and 2005—Base ETV***—In FY04 and 05, the major verification categories are:

  - Monitoring and Detection—Rapid and/or continuous emission monitors for mercury, ammonia, hydrogen sulfide (H_2S), dioxin, and beach pathogens

  - Drinking Water—Removal of pathogens, disinfection by-products, and arsenic

  - Air Pollution Control—Diesel engine retrofit technology, dust suppressants, and baghouse filtration products

  - Greenhouse Gas Reduction—Fuel cells, microturbines with combined heat and power, and waste-to-energy systems

  - Water Quality Protection—Water infrastructure rehabilitation, ballast water treatment, stormwater treatment, and animal waste treatment

  - Pollution Prevention—Low emissions coatings and equipment.

- ***ETV Redesign***—As part of the ETV redesign, the two centers mentioned above will continue. It is possible that other centers will continue with outside funding and EPA technical and QA oversight. In addition, a new program, Environmental and Sustainable Technologies Evaluation (ESTE), would be added and would be EPA-directed. ESTE would be targeted to the highest-risk Agency needs. Technology verifications would be initiated and managed by EPA. The scope would include all environmental technologies, with the exception of those technologies covered by the Superfund Innovative Technology Evaluation (SITE) Program. Cost-sharing and collaboration will be sought. The same ETV values of fairness, credibility, QA, and transparency will be maintained.

- ***ETV Partners***—The ETV Program has formed partnerships with a number of other federal and state agencies to verify a variety of environmental technologies. These partners include:

  - U.S. National Oceanic and Atmospheric Administration (multi-parameter water probes)
  - U.S. Coast Guard (ballast water treatment)
  - U.S. Department of Energy, States of Massachusetts and Connecticut, and the Illinois Clean Coal Institute (mercury continuous emission monitors)
  - U.S. Department of Defense (monitors for explosives, PCBs in soils, and dust suppressants)
  - States of Alaska and Pennsylvania (drinking water arsenic treatment)
  - States/Counties in Georgia, Kentucky, and Michigan (stormwater treatment)
  - States of New York and Colorado (waste-to-energy)
  - U.S. Department of Agriculture (ambient ammonia monitors, hydrogen sulfide monitors).

- ***ETV Web Site***—The ETV Program's major outreach mechanism is the ETV Web Site located at www.epa.gov/etv. The Web site has experienced an explosion of Web hits; there are currently more than one million hits per year and may soon increase to two million per year.

- ***ETV Outcomes***—There is a need to identify outcomes from the ETV Program. ETV has done a great job of producing protocols and verifications, and has successfully met Congressional commitments for each. However, ETV must demonstrate that these products or outputs are being used to meet EPA's mission to protect human health and the environment. ETV is trying to get from the production of protocols and verifications to long-term outcomes associated with use of this verification information. This will be achieved through surveys of vendors, purchasers, and permitters to determine how many of these technologies are being used in the marketplace. Case studies of ETV impacts and "success stories" will also be prepared.

ETV WATER AND WATER SECURITY SESSION

ETV Advanced Monitoring Systems Center

Teresa Harten introduced Amy Dindal, Battelle, who discussed the water and water security monitoring technologies verified by the ETV Advanced Monitoring Systems (AMS) Center.

Amy Dindal provided an overview of the AMS Center, which was initiated in October 1997. The center has verified 84 monitoring technologies, which includes 48 air monitoring technologies and 36 water and water security monitoring technologies. Outreach, stakeholder groups, and partnerships are an integral part of the AMS Center.

The focus of the AMS Center is on monitoring technologies. Priority water and water security technology categories that were discussed include: multi-parameter water quality probes and on-line monitors (on-going), portable arsenic analyzers, immunoassay test kits for biotoxins, atrazine test kits, rapid toxicity monitors, nutrient monitors, rapid polymerase chain reaction (PCR) instruments, and beach monitors. Where possible, the technology is compared to reference methods. Some of the parameters that are evaluated during testing include: accuracy, precision, false positives/negatives, ease-of-use of the technology, and how well the technology works in both the laboratory and the field.

Applications of water quality monitors include environmental scenarios (e.g., long-term monitoring, wellhead monitoring, and monitoring of open waters), as well as water security (e.g., early warning systems, monitoring drinking water distribution, and plant influent/effluent monitoring).

Amy Dindal reported that there have been two rounds of testing for multi-parameter water quality probes; two technologies were verified in round one (General Oceanics, Inc.'s Ocean Seven 316 Water Probe and YSI Incorporated's 6600 Extended Deployment System) and two technologies were verified in round two (AANDERAA Instruments, Inc.'s RCM MK II and YSI Incorporated's 6600 Extended Deployment System). These systems are designed to continuously monitor various water quality parameters in open waters. The tests

were conducted in partnership with the National Oceanic and Atmospheric Administration (NOAA), Center for Coastal and Environmental Health and Biomolecular Research in Charleston, SC. NOAA provided a test site and test operators, and conducted the reference analyses. The technologies were verified under three scenarios: saltwater, freshwater, and mesocosm, a laboratory controlled environment. The technologies monitored for one or more of the following analytes: dissolved oxygen, temperature, turbidity, pH, conductivity, and chlorophyll. The verification parameters that were evaluated included: pre- and post-calibration results, relative bias, a visual record of fouling, precision, linearity, and inter-unit reproducibility.

Multi-parameter on-line monitors for water distribution systems were tested for water security applications in partnership with the EPA's Testing and Evaluation Facility in Cincinnati, OH. The verification test experimental design was comprised of four stages. Stage 1 used controlled solutions to test parameters. These parameters included: pH, chlorine, conductivity, redox potential, turbidity, temperature, and alkalinity. During Stage 2, contaminants were intentionally injected. The range of contaminants included: aldicarb, nicotine, arsenic trioxide, and *E. coli*. Stage 3 consisted of extended deployment (30 days) to evaluate maintenance and reliability. Stage 4 (only one technology participated) consisted of identification of the following contaminants: aldicarb, nicotine, arsenic trioxide, *E. coli*, glyphosate, sodium fluoroacetate, potassium ferricyanide, diclorvos, dicamba, lead nitrate, mercuric chloride, colchicine, and methanol. Participating vendors included: Analytical Technology, Inc., Rosemount Analytical, Clarion Sensing Systems, Hach Company, and Mantech, Inc. Testing has been completed and the verification reports are under preparation.

Amy Dindal reported that the AMS Center has also verified portable arsenic analyzers, which are technologies designed to be used in the field and can be marketed for monitoring at the new EPA drinking water standard of 10 parts per billion (ppb) (lowered from 50 ppb) [Note: the regulation will take effect in 2006]. These tests kits also are being used in third-world countries (e.g., India, Bangladesh) to monitor well water. Nine technologies have been verified to date in two rounds of testing. As part of the center's outreach efforts, the AMS Center participated in a conference on arsenic mitigation in India to present the results of testing for this technology category. In addition, the results were referenced in an *Environmental Science & Technology* research paper. The preparation of the manuscript for a peer reviewed journal is in progress. The four technologies that were verified in round one testing included: Envitop, Ltd.'s As-Top Water Test Kit; Industrial Test Systems, Inc.'s Quick™; TraceDetect's Nano-Band Explorer; and Peters Engineering's AS 75 Arsenic Test Kit. The five technologies verified under the second round of testing included: Industrial Test Systems, Inc.'s Quick™ II, Quick™ Ultra Low II, Quick™ Low Range, and Quick™ Low Range II; and Monitoring Technologies International's PDV 6000. The verified method detection limits (MDLs) ranged from approximately 4 to 30 ppb. There were some differences in technical and non-technical performances, but the operator skill level did not appear to have a significant effect on the results. The test kits/analyzers are portable and generally easy to use. The costs for the test kits are typically a few hundred dollars for multiple samples.

The AMS Center recently completed a verification test of immunoassay test kits for biotoxins. These test kits have water security applications. The technologies work by an antigen/antibody reaction that triggers color change when the analyte is present. The two types of test kits verified were test strips and an Enzyme-Linked Immunosorbent Assay (ELISA). For the test strips, a few drops of the sample are placed on the strip. "Positive" is indicated by the appearance of a red line within approximately 20 minutes. For the ELISA, samples are placed in a 96-well plate containing the antibodies. "Positive" is indicated by a solution color change within approximately four hours. The analytes tested were anthrax, botulinum toxin, and ricin. The

matrices tested included ASTM Type II water, and concentrated and unconcentrated dechlorinated drinking water (obtained by geographically dispersed sample collection). The four technology vendors that completed verification testing are: Tetracore, Inc. (ELISA); Tetracore, Inc. (test strips); Response Biomedical Corp. (RAMP test cartridges); and ADVNT Biotechnologies (BADD test strips). The verification reports are completed and posted on the ETV Web Site.

Amy Dindal provided a few general observations on the test results for the immunoassay test kits. The sensitivity of the immunoassay test kits for biotoxins was higher than expected. This was particularly true for anthrax, which had a detection capability of 10-10,000 times higher than expected. Botulinum toxin was up to 10 times higher and had a type difference (i.e., either Type A or Type B could be detected, but both types could not be detected) for two of the technologies. Ricin was up to 50 times higher than expected. The technologies were easy to use in or outside of a laboratory setting, and a non-technical operator was able to perform testing for test-strips. In general, cross-reactivity, metals, and concentrated drinking water did not cause matrix interferences.

Amy Dindal stated that the AMS Center has verified four immunoassay-based atrazine test kits, including three quantitative technologies and one qualitative ("dipstick") technology. Atrazine is the most widely used herbicide in the United States. Approximately 76 million pounds are applied in the United States each year in both agricultural and non-agricultural applications. Although atrazine is not likely to be carcinogenic, it appears to cause hormonal imbalances. EPA announced a program in 2003 to protect vulnerable drinking water systems from contamination by atrazine. The program involves intensive, targeted monitoring of raw water in areas of high atrazine use. The four technologies that were tested are: Silver Lake Research Corporation's Watersafe Pesticide Test; Abraxis, LLC's Atrazine ELISA Kit; Beacon Analytical Systems, Inc.'s Atrazine Tube Kit; and Strategic Diagnostic, Inc.'s RaPID Assay Kit. The verified test parameters included: accuracy, linearity, matrix interference, rate of false positives/negatives, precision, method detection limit, and cross-reactivity. For these tests, the AMS Center partnered with the Texas Commission on Environmental Quality; EPA Office of Prevention, Pesticides, and Toxic Substances; NOAA; and the University of Missouri-Rolla. The verification reports are posted on the ETV Web Site. Some general observations from the testing included: the MDLs for the quantitative technologies ranged from 0.06 to 0.10 ppb, some previous experience in performing immunoassays is important when using quantitative tests, all quantitative kits detected cross-reactive compounds, and several technologies showed apparent evidence of interference from brackish water matrix.

Another type of water security monitoring technology that the AMS Center tested was rapid toxicity monitors, which are designed to identify whether a water sample is toxic, but not monitor for a specific contaminant that might be causing the toxicity. The AMS Center Water Security Stakeholder Committee identified the following analytes and contaminants to be used in testing: aldicarb (carbamate pesticide), colchicine (pharmaceutical), cyanide (industrial chemical/common threat), dicrotophos (organophosphorous pesticide), thallium sulfate (metallic contaminant/rodenticide), botulinum toxin and ricin (biotoxins), and soman and VX (chemical agents). The technologies were evaluated for endpoint, false positives/negatives, precision, and toxicity threshold. The eight technologies that were tested included: Checklight, Ltd.'s ToxScreen-II; Hidex Oy's BioTox; Strategic Diagnostics, Inc.'s Microtox (only laboratory based technology) and Deltatox; InterLab Supply, Ltd.'s POLYTOX; Hach Company's ToxTrak; Severn Trent Services' Eclox; and AquaSurvey, Inc.'s IQ Toxicity Test. The verification reports for these technologies are posted on the ETV Web Site. Some general observations included: seven of the eight technologies were tested at a non-laboratory setting and had results

and performance that were very similar to the laboratory setting; and the sample throughput ranged from 15-50 samples per hour with the exception of two technologies at three samples per hour. For most of these technologies, there is a fairly high risk of false positive/negative results if the control sample is not very similar to the test sample. It is important to note that these technologies need to be deployed in the user's own natural water before using them. Knowing how the technologies respond to the user's own natural water in a non-threat scenario is key to understanding and interpreting post-threat toxicity analysis results.

The AMS Center is beginning work on a verification test of nutrient monitors for nitrates, nitrites, ammonium, and phosphate. Excessive nutrient loading is occurring from multiple sources and is causing problems such as: excessive growth of macrophytes and phytoplankton, harmful algal blooms, oxygen declines, imbalance of prey-predator species, public health concerns, and decline of aquatic resources. Nutrient sources include: fertilizer, sewage treatment plants, detergents, septic systems, combined sewer overflows, sediment mobilization, animal manure, atmospheric deposition, and internal nutrient recycling from sediments. Nutrient monitors have applications for: industrial waste processing, natural water systems, and municipal water supplies. The AMS Center is planning to collaborate with DuPont to test monitors for nutrients at one of their wastewater treatment plants. Discussions also are being held with the U.S. Geological Survey (USGS) on plans for testing of natural water systems in an environmental application at both brackish and freshwater sites. It is anticipated that testing will begin in spring 2005.

Verification testing of rapid polymerase chain reaction (PCR) technologies is another water security category that is close to completion. Rapid PCR is a technique used to detect and measure deoxyribonucleic acid (DNA), thereby making it a bacteria/contaminant selective technology. However, this technique cannot distinguish between live or dead bacteria. The AMS Center stakeholders were interested in rapid PCR because it is the application more likely to be deployed in a water utility scenario than quantitative PCR. Calibration solutions are needed with quantitative PCR (e.g., if you are monitoring for anthrax, you have to be able to run anthrax standards in real time along with the natural water samples). This is not very feasible or likely to occur at a water utility. Rapid PCR provides a qualitative detection/non-detection when you have specific reagents for certain biotoxins. Rapid PCR is gaining popularity for security applications, including: post-sampling decontamination confirmation, battlefield air monitoring for biological agents, and detection of waterborne pathogens. The three technologies that were tested by the AMS Center included: Applied Biosystems' TaqMan® *E. coli* O157:H7 Detection System, Idaho Technology, Inc.'s R.A.P.I.D® System, and Invitrogen Corporation's PathAlert™ Detection Kit. The technologies were tested using one or more of the following five contaminants: *Bacillus anthracis*, *Yersinia pestis*, *Francisella tularensis*, *Brucella suis*, and *Escherichia coli* O157:H7. Idaho Technology's system was the only technology that was tested for all five of these contaminants. The matrices used were: (1) drinking water, which included chlorinated surface water (filtered and unfiltered), filtered ground water, and filtered chloraminated surface water (all were concentrated to 400 times through ultrafiltration); and (2) ASTM Type II DI water—water spiked with contaminants at various levels and with interferents (humic and fulvic acids, calcium, magnesium). The concentration levels ranged from 0.20 to 5 x 10^4 cfu/mL. The verification reports are under preparation.

The last technology category discussed by Amy Dindal was beach monitoring. The application focus for this test was identified as rapid detection (less than eight hours) technologies for quantification of *enterococci* in estuarine and marine waters. The current approved detection standard requires results within 24 hours. This type of monitoring is designed to detect pathogens in recreational waters that are used for swimming. The

current scenario (which requires 24 hours for results) means that beach closures are based on yesterday's data. There is a great need for monitoring technologies to detect beach pathogens in a more rapid manner. Up to this point, the only reason these types of technologies were not verified by the AMS Center was that the technologies with the required sensitivity and speed were not commercially available. Vendor detection capabilities for *enterococci* have been on the order of 100 to 1,000 times higher than the regulatory level of 104 *enterococcus* colonies/100 mL. Additionally, most vendors had not worked with real matrices and had interference issues. However, vendor interest and readiness are increasing. Beach monitoring technology types include: PCR, immunomagnetic separation, flow cytometry, dual wave fluorimetry, and enzymatic techniques. Within the next three months, the AMS Center will follow-up with the vendors on their verification readiness. The AMS Center has been in active communication with potential partners, including the Southern California Coastal Water Research Program (SCCWRP) for assistance in prototype testing and development of test plans, and the Alabama Department of Environmental Management (ADEM). It is anticipated that testing will occur in June-August 2005.

Amy Dindal stated that the AMS Center has also conducted verification testing for on-line turbidimeters, nitrate analyzers, and cyanide monitors. Testing results for these water and water security technology categories are posted on the ETV Web Site.

During FY05, the AMS Center plans to conduct verification testing for nutrient monitors and rapid detection technologies for beach safety. The reports for the verification tests of rapid PCR technologies, portable cyanide analyzers (Round 2), and on-line multi-parameter water monitors will be completed. The AMS Center also is tentatively planning to initiate verification tests of enzymatic test kits for chemical agents, lead test kits, and biosensors.

In conclusion, Amy Dindal stated that the AMS Center is looking at a variety of water and water security monitoring technologies. They are emphasizing risk reduction and environmental improvement when considering technology prioritization. The AMS Center has had very successful partnerships with the EPA Test and Evaluation Facility; EPA Office of Prevention, Pesticides, and Toxic Substances; NOAA; and Texas Commission on Environmental Quality. These organizations have been invaluable in helping the center to leverage EPA funding and lending technical credibility to the verification tests. Amy Dindal closed with the following quotation from the U.S. EPA Assistant Administration for Water, which was published in an editorial in the January/February 2004 issue of Water Environment Research/WEF: "We must build strong partnerships at the federal, state, and local levels to facilitate the sharing of comparable data and the use of multiple monitoring tools."

ETV Drinking Water Systems Center

Teresa Harten introduced Bruce Bartley, NSF International, who manages the ETV Drinking Water Systems (DWS) Center.

Bruce Bartley stated that the DWS Pilot was established in October 1995, with a focus on small system technology needs. Prior to 1995, there had been certain obstacles and barriers to innovation and, traditionally, there were problems in getting approval for drinking water technologies, especially for small systems. Small systems usually had very poor financial resources, unlike larger systems that could afford to conduct more

extensive research and pilot studies. The ETV Program provided a way to facilitate greater acceptance of new technologies and address barriers by providing uniform testing procedures, providing regulators and users with independent data on performance, and performing testing under real world conditions. At the first ETV stakeholders meeting, everyone strongly stated that it was very important to have states' buy in, approval, and involvement in the ETV process. The crucial reason for this is that under the 1996 State Drinking Water Act, states have the primary authority to ensure that public water supplies have safe drinking water.

Bruce Bartley described four of the DWS technology categories for verification: water security, including residential and building protection systems (three verifications completed, three verifications in progress, and one test pending); filtration technologies (microorganism reduction) (thirteen verifications completed), most of which are skid-mounted on a tractor trailer and can be part of the emergency water supply system in the event of a disabled water supply system due to accidents, environmental problems, or deliberate sabotage; ultraviolet (UV) and other disinfection technologies (seven verifications completed); and arsenic treatment technologies [in 2006, small communities will have to comply with EPA's new maximum contaminant levels (MCLs)] (eight verifications completed, four verifications in progress).

Under the water security technology area, the DWS technical panel recommended residential point-of-use (POU) reverse osmosis (RO) systems using two phases of testing: microbiological and chemical removal. The microbiological test plan includes surrogates based on size and physical properties similar to the actual agents. Verification testing of three technologies is completed and the verification reports were issued in 2004. Testing for chemical agent removal began in May and the verification reports are anticipated to be completed in spring/summer 2005. The three vendors who participated in the POU RO testing are: Watts Premier, Kinetico/Pall, and Sears/EcoWater Systems, Inc. The test plans were developed with the assistance of numerous experts, including representatives from EPA ORD National Homeland Security Research Center (NHSRC), Centers for Disease Control and Prevention (CDC), U.S. Army, water utilities, and academia. The preliminary results for microbiological agents for viruses and bacteria show reductions from 2.3-2.9 log reduction for viruses and 1.6-8.4 for bacteria. One system was designed, not as a typical RO unit for homeowners, but with a bacteria/virus filter added for homeland security applications. It performed as well as or better than the other systems tested.

Bruce Bartley reported that another DWS water security area is building protection systems or point of entry systems that can be used to protect government buildings, homes, and hotels. Discussions are underway with one vendor, Kinetico, in partnership with Pall Corporation and Trojan Technologies, Inc., who uses a multi-barrier approach for treatment of microbiological and chemical agents. Their approach uses a combination of technologies commensurate with the threat and off-the-shelf sensors to trigger the system. The water security multi-barrier approach uses a RO membrane, bacteria/virus ultrafilter, UV light, and carbon. A combination of these technologies commensurate with the threat are used as part of a treatment train. These systems will operate at 50-60 gallons/minute (point-of-use technologies only operate at 0.25-0.50 gallons/minute).

Bruce Bartley stated that DWS has completed eight verification reports for arsenic treatment technologies: three RO systems, three coagulation with filtration systems (which were done in partnership with the State of Utah), and two adsorption technologies (disposable media, ion exchange, or regeneration media). There are an additional four tests in progress (two coagulation with filtration, and two adsorption). All of the verified technologies reduced arsenic to 5 ppb or less, and many of them reduced arsenic to the minimum detection limit

of 1-2 ppb. The tests were performed in the field at small communities. The operation and maintenance costs vary by technology type. The reduction of arsenic in drinking water can reduce the risk of bladder cancer and other diseases by a factor of 10 or more.

In closing, Bruce Bartley stated that the Association of State Drinking Water Administrators (ASDWA) has been involved and has supported the ETV DWS Center since its inception. ASDWA has provided members to serve on the DWS steering committee. The annual states survey has shown increasing member support for the ETV DWS Center. ETV's independent, third-party reports have helped states in the approval of alternative technologies and in streamlining approvals.

ETV Water Quality Protection Center

Teresa Harten introduced Tom Stevens, NSF International, who manages the ETV Water Quality Protection (WQP) Center.

Tom Stevens provided a brief history of the WQP Center. WQP was formed by combining two separate ETV pilots—the Source Water Protection Pilot and the Wet Weather Flow Pilot. These pilots were merged in 2002 to form the WQP Center; the efforts that were underway in each of the pilots have been continued under the center. Tom Stevens introduced Ray Frederick, who is the EPA Manager for the WQP Center. The current technology areas of interest in the WQP Center are: decentralized wastewater treatment technologies, watershed protection technologies, urban infrastructure technologies, ship ballast water treatment technologies, and technologies with water security applications. There are six different stakeholder groups for the current six technology areas addressed by the WQP Center.

The WQP Center has completed 14 generic protocols and test plans (one is in progress); 32 test plans (two additional ones are in progress); and 21 verifications, which includes one water security verification. It is anticipated that in FY05, eight to ten verifications should be completed, and in FY06, four to six verifications should be completed.

The WQP Center focused their presentation on four technology categories: residential nutrient reduction, stormwater treatment, animal waste treatment (solids separators), and ship ballast water treatment.

Six residential nutrient reduction systems have been verified by ETV. Testing was conducted at controlled dosing sites over a 12-month period to cover a broad range of seasonal conditions. Testing was conducted for the usual parameters (BOD, TSS, pH, DO), nutrients (N-series), and alkalinity, based on vendor claims. To date, no vendor has submitted performance claims for phosphorus reduction. Operational measurements (power, maintenance, residuals, etc.) were included in the evaluations. The mean effluent results showed that there was a tight range (14 to 19 mg/liter) for total nitrogen between the technologies. Some of the technologies are better at nitrifying and show greater concentrations of nitrate/nitrite; other technologies are better at removing the nitrate/nitrite.

Tom Stevens provided a brief discussion on stormwater treatment. The types of systems that are being evaluated range from single catch basins to larger systems that treat multiple catch basins or whole systems. The complexity of the systems ranges from very simple to very complex, and includes gravity settling,

adsorption, or filtration. The testing period is long (more than 16 months) as it includes 15 qualified storm events. Two verifications were completed in 2004. It is anticipated that seven to nine verifications will be completed in FY05, and one to three verifications will be completed in FY06. USGS has been involved in the verification tests in Milwaukee and Green Bay, WI, and has used telemetry so that they can adjust samplers to storm events and conduct ongoing monitoring. The best that they have been able to do is to collect 15 qualified storm events in about a year and a half of testing.

Zeta Technologies, Inc.'s Arkal Pressurized Stormwater Filtration System was the first verification to be completed in this area. The test was conducted in Green Bay, WI, treating stormwater generated from a 5.5-acre hospital parking lot and grounds. Over the course of 15 storm events, there was an 82% reduction in total suspended solids (TSS) and suspended sediment concentration (SSC). Total phosphorus was reduced by 55% and total Kjeldahl nitrogen (TKN) was reduced by 26%, both mostly related to solids. This system was highly complex and power intensive, consuming about 78 kilowatt hours (kWH) per event. Maintenance and disinfection were required to control biogrowth on the prefilters.

The second stormwater treatment system verified was Stormwater Management, Inc.'s Stormwater Management StormFilter® Using ZPG Filter Media. The test was conducted in Milwaukee, WI, at a 0.187-acre elevated highway. Over the 16-month test period, the system achieved a 46% reduction in influent TSS, and a 92% reduction in influent SSC. Total phosphorus was reduced by 38% (solids related). No power is required for this system, and no maintenance was required during the test.

Another WQP technology category being tested is flushed swine waste solids separation. Three verifications have been completed for three different types of technologies. The verified technologies included: Hoffland Environmental, Inc.'s, Drag Screen and Clarifier, comprised of an inclined screen/clarifier-concentrator; Brome Agri Sales, Ltd.'s Maximizer Separator, Model MAX 1016, comprised of an inclined screen, worm screw, and perforated cylinder; and Triton Systems LLC's Solid Bowl Centrifuge, Model TS-5000. One of the systems achieved a 28% solids recovery, which was 18% dry solids. There was recovery of 7.4% total nitrogen and 12% total phosphorus. This system is a simple technology with low power consumption of less than 1.5 kilowatts (kW). The centrifuge system had 55% solids recovery (26% dry solids). There was recovery of 20% total nitrogen and 42% total phosphorus. This system was more complex to operate and maintenance was required, and the power consumption was higher than the other two technologies at less than 20 kW. The third system had 9.7% solids recovery (12% dry solids). There was recovery of 5.2% total nitrogen and 5.6% total phosphorus. This system is a simple technology with low power consumption of less than 1.5 kW. Users would need to look at these systems and determine the costs and benefits that they would receive from recovering the additional solids.

The most challenging area that WQP has faced is ship ballast water treatment, which addresses issues related to aquatic nuisance species, such as zebra mussels, European green crabs, and mitten crabs—issues with worldwide implications. A Memorandum of Understanding (MOU) between EPA ETV and the U.S. Coast Guard (USCG) was signed in June 2001, and defines the roles of each organization in the cooperative effort leading to verification of ballast water treatment technologies. A technical panel is drafting a test protocol, which will be reviewed by the WQP Center stakeholders. It is clear that WQP is well ahead of anyone else in developing an approach for evaluating ballast water technologies. On May 20, 2004, EPA and the Institute of Environmental Science and Engineering (IESE) in Singapore signed a Letter of Intent (LOI) for the

development of a testing facility for the verification of environmental technologies, with the initial effort being in the ballast water treatment technology area. (Editor note: the LOI with IESE broadly states the desire of EPA and Singapore to collaborate on protocol development and verification, starting with ballast water treatment technology.)

Tom Stevens provided the target dates for verification activities regarding ballast water treatment technology. An initial draft of the protocol was completed in April 2002; a second draft was completed in August 2003. The final draft protocol is expected to undergo stakeholder review in fall 2004. Through the partnership between ETV and USCG, the USCG is funding pilot testing of the protocol at the Naval Research Laboratory in Key West, FL; this pilot testing is anticipated to occur in late winter 2004 or early spring 2005.
It is hoped that additional information will result from this pilot test that will aid in finalizing the protocol.

Discussion

Teresa Harten asked the audience if there were any questions or comments about the presentations and requested their input on what types of technologies ETV should be testing in the future.

One participant, representing the U.S. Army, asked if there were plans for future testing of constructed wetlands or living machines (smaller version of constructed wetlands) for stormwater management. Tom Stevens replied that talks were initiated with a manufacturer of a living machine type of technology, but the vendor has not stepped forward to undergo verification. One issue that ETV faces in the verification of stormwater management technologies is that there are a number of Best Management Practices (BMP), such as swales and constructed wetlands, that can be used as treatment methods. These are generic types of technologies; there are no associated vendors. Thus, it would be very difficult for ETV to complete the verification process. He suggested that it would be a good idea for ETV to look into these types of technologies, as they are accepted as BMPs even though there really is not a great deal of information pertaining to their performance. Teresa Harten added that the ETV program is geared more toward "off the shelf" technology, rather than toward the evaluation of BMPs. Some work is being done on constructed wetlands in ORD.

Another participant suggested that there was a need for Karst topography in relationship to the remediation of wastes before they go down sinkholes.

More information was requested about the ESTE Program. Teresa Harten noted that, at this time, ETV's funding level stands at about $2.2 million per year, approximately one-half of which will be used to fund the ESTE Program. Formulation of the ESTE Program will take place this year, and it is anticipated that it will begin operations in FY06. It is expected that the ESTE Program will maintain the same kind of stakeholder process, and similar aspects of transparency and fairness, as in the base ETV Program.

A participant from EPA Region 4 stated that technologies to remove intestinal viruses from septic systems were needed.

A participant commented about a recently published study of problems with fish in Ohio streams. The study described fish found in streams that received discharged water containing chemicals that mimic estrogen–called endocrine disrupters (EDCs). The fish exhibited both male and female characteristics. The wastewater

treatment facilities confirmed that the chemicals were from detergents, and that they were aware of the discharges of these chemicals, but that there were no control mechanisms to remove them from the water. The question was asked as to whether ETV is looking into this matter or had plans to do so in the future. Teresa Harten replied that ETV has only looked at the ability of the on-site treatment systems to remove nutrients from water discharged into streams.

A participant from the U.S. Army asked whether the ESTE Program will be integrated with the existing U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. The Army has an installations sustainability program that is in its infancy. In trying to plan for the future, it was recognized that, on the base operations side (not military), construction and purchasing activities need to be radically redesigned. One of the major concerns is the identification of products with lower environmental impact, and evaluating the claims of vendors to determine their validity. It was suggested that it would be very useful if ETV's new ESTE Program would rate products across all environmental media, instead of taking the traditional approach of addressing separate media such as air or water. Teresa Harten responded that ORD's laboratory in Cincinnati works on life cycle approaches, clean products, and reducing toxics in products. ETV hopes to collaborate with this laboratory; however, ETV is stakeholder driven. There has not been a request from the stakeholders for these types of sustainability metrics for environmental technologies. ETV is beginning to address these sustainability metrics [e.g., testing addresses such things as maintenance, operator requirements (if a technical person is required), energy consumption, and waste generation].

A participant commented that there is a push in the commercial industry to use sustainable building products and on the environmental side, to use recyclable and organic media. There are architect engineers that obtain LEED accreditation. Teresa Harten asked if the LEED program looked at environmental treatment technologies or mainly building materials. The participant responded that the LEED program provided both environmental and building credits. Teresa Harten commented that the LEED program metrics might be useful for the ESTE Program. Perhaps ETV could incorporate LEED standards into the program rather than creating new metrics.

ETV AIR AND ENERGY SESSION

ETV Advanced Monitoring Systems Center

Teresa Harten introduced Karen Riggs, Battelle, who manages the AMS Center.

Karen Riggs stated that her presentation would address the air monitoring and detection technologies verified by the AMS Center. The scope of the AMS Center includes verification of air monitoring technologies for source, ambient, and indoor environments. A total of 48 air monitoring technologies have been verified. The AMS Center has an extensive outreach program, which includes a monthly newsletter. There are three active stakeholder committees (i.e., water monitoring, water security, air monitoring). Some of the organizations represented on these committees are the California Air Resources Board, EPA Office of Air Quality Planning and Standards (OAQPS), American Petroleum Institute, and a broad range of other organizations that represent purchasers and users of these types of technologies. The AMS Center uses the stakeholder committees to prioritize technologies to be verified, design the verification test, provide peer review of test plans and verification reports, and conduct outreach to their respective organizations. Stakeholder committee meetings

are held in different areas of the United States to promote ETV verified technologies in different regions of the country.

Karen Riggs discussed a recently completed verification test of ambient ammonia (NH_3) monitors at animal feedlots. Ammonia is the only significant gaseous base in the atmosphere. It plays an important role in nitrogen deposition and aerosol formation. This verification test used ambient monitors to measure ammonia emitted from concentrated animal feeding operations (CAFOs), which are the largest source of atmospheric ammonia emissions in the United States (contributing approximately 70% of total emissions). There were seven participating vendors and the testing took place in fall 2003, at two animal feeding operations in Iowa, a swine finishing farm (Ames, IA) and a cattle feedlot (Carroll, IA). One of the reasons that testing occurred at two locations was to test the monitors under different varying concentrations of the ambient ammonia. At the swine finishing farm, concentrations of ambient ammonia ranged from 100-1,400 parts per billion (ppb) based on the reference measurements; at the cattle feedlot, concentrations were 0-300 ppb. The monitors were operated in the field for one month at each of these sites. This test was done in partnership with the U.S. Department of Agriculture (USDA). Ammonia emissions, odor problems, and nitrogen release from these facilities are issues of concern for the USDA. USDA was very supportive in providing in-kind support at both of these facilities and helping ETV conduct the test. USDA staff arranged for host sites for testing, operated the monitors, and provided reference measurements. The verification reports are completed and posted on the ETV Web Site.

The seven vendors who participated in the ambient ammonia monitors test included: Aerodyne Research, Inc. (tunable diode laser spectroscopy); Bruker Daltonics, Inc. (open-path infrared spectroscopy); Molecular Analytics (ion mobility spectrometry); Omnisens SA (infrared laser spectroscopy with photoacoustic detection, tested at the cattle feedlot only); Pranalytica, Inc. (near infrared laser spectroscopy with photoacoustic detection); Mechatronics Instruments BV (membrane diffusion with conductivity detection); and Thermo Electron Corporation (conversion to nitric oxide with chemiluminescence detection). One of the parameters that was measured was response time, and results ranged from less than one second to about one hour for individual measurements. The detection range for all of these technologies was 0-2,000 ppb.

Karen Riggs reported that a Phase 3 verification test is in progress for mercury continuous emission monitors (CEMs). The objective is to test mercury CEMs in operation on a challenging flue gas matrix at a coal-fired power plant. Phase 1 testing was conducted at an EPA pilot-scale facility. Phase 2 was conducted at the U.S. Department of Energy (DOE) Toxic Substances Control Act (TSCA) hazardous waste incinerator in Oak Ridge, TN. The Phase 3 test will be conducted in partnership with the Connecticut Department of Environmental Protection, who provided co-funding of $50,000; and the Illinois Clean Coal Institute (ICCI), who provided co-funding of $170,000. In-kind support of approximately $25,000 is being provided by EPA ORD for mercury reference analyses. The ICCI support requires testing at a facility fired with Illinois coal. The best candidates for the host facility are Coffeen Station (Ameren Energy) and Vermillion Station (Dynegy). It is anticipated that the final host site will be selected in November 2004. Vendor agreements have been sent to nine vendors who have expressed interest in the test. Possible vendors include: Genesis Laboratory Systems, Tekran, Opsis, and Nippon Instruments. Opsis participated in Phase 1 testing and Nippon participated in both Phase 1 and Phase 2 testing. All of the instruments and the tests are designed to look at vapor phase mercury only. Testing is scheduled to begin in March 2005 and run for one month. The test procedures will target PS-12A performance requirements. It is anticipated that the verification reports will be completed and posted on

the ETV Web Site by September 2005.

Another verification that is in progress is dioxin emission monitoring systems. The AMS Center is collaborating with Brian Gullett, EPA ORD. Co-funding is expected from the EPA Office of Solid Waste (OSW) ($50,000), EPA OAQPS ($20,000), and Chlorine Chemistry Council ($35,000 to $50,000). Testing will be conducted at EPA's pilot scale incinerator located in Research Triangle Park, NC. At least three vendors are expected to participate in the test. Potential vendors include: bm becker Messtechnik; Dioxin Monitoring Systems; Cooke Companies, Int. with Oy Enemi, Ltd.; IDX Technologies, Ltd.; and NKK/JFE Steel. The testing may involve automated sampling for subsequent analysis, rather than *in situ* analysis. Preliminary characterization of the flue gas from the pilot scale incinerator will be conducted in January 2005. The draft test and QA plan is expected to be prepared by February 2005, and testing should begin in April. The draft verification reports should be completed in June 2005. Karen Riggs asked that if anyone had an interest in these technologies, to let her know what performance data they would like to see.

Karen Riggs reported that another verification is in progress for personal impactor samplers, which are designed to be worn to collect contaminants for exposure assessment. The AMS Center was approached by the Mickey Leland National Urban Air Toxics Research Center (NUATRC) (Houston, TX) to collaborate on a verification test. The verification test will be co-funded by NUATRC and ETV. Possible participants in the test include: SKC, Inc. (Sioutas Personal Cascade Impactor with Leland Legacy Personal Sampling Pump); Rupprecht & Patashnick Company, Inc. (Respirable Particulate Sampler and ChemPass 3400 Personal Sampling System); BGI, Inc. (BGI 400 Personal Sampling Pump); and MSP Corporation (Personal Particle Speciation Sampler). These samplers collect particulate matter in the air; most of them also separate the size and distribution of the particulate matter. The test will include a comparison to a reference impactor at a fixed site. Operational testing may be conducted with the sampling devices worn by several people in work and residential settings. The collected samples will be analyzed (e.g., for metals) to assess the adequacy of sample size. Testing is anticipated to begin in winter 2005.

The AMS Center is in the preliminary stage of planning a potential verification test of hydrogen sulfide monitors at CAFOs. Worker exposure is an issue, as well as facility emissions and odor complaints. The test depends upon securing USDA as a partner; they will support the test in similar ways as they did for the ambient ammonia monitors verification test. The test is planned to begin in April 2005 at a swine finishing farm and run for 6-8 weeks. Vendor agreements have been sent to: Ecotech (HTO1000 Oxidizer and EC9850 SO_2 Analyzer); Environment S.A. (Converter CH_2S and SO_2 Analyzer, Model AF21M); Arizona Instrument (Jerome 631-X); Ionics Instruments [SSA 5504 (also SCD 355)]; Teledyne-Advanced Pollution Instrumentation (API) (H_2S and TRS analyzers); Boreal Laxer (GasFinder); Thermo Electron (Model 45C); and Detection Instruments (OdaLog Low Range Gas Logger and OdaLog Gas Logger if high range).

Karen Riggs reported that the AMS Center is projecting to complete 15 air technology verifications in FY05. These tests include: four mercury CEMs, three dioxin emission monitors, three personal impactors, and five H_2S monitors. There is a lot of demand and interest in the performance data for air monitoring technologies. The interest and demand are demonstrated by the number of vendors contacting the AMS Center and the number of partners that are collaborating with the center.

ETV Air Pollution Control Technology Center

Teresa Harten introduced Andrew Trenholm, RTI International, who manages the ETV Air Pollution Control Technology (APCT) Center. Andrew Trenholm introduced Mike Kosusko, the EPA Manager for the APCT Center.

Andrew Trenholm stated that the APCT Center operates similarly to the other ETV centers. They have an overall stakeholder advisory committee, which provides advice on priorities and direction for center activities. The primary focus of APCT is on particulate matter (PM), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). Test protocols have been completed for paint overspray arrestors, baghouse filtration products, NO_x control technologies, dust suppressants, mobile source retrofit controls, and biofiltration systems.

Andrew Trenholm briefly described an early NO_x control technology verification that was conducted for Catalytica Combustion Systems, Inc.'s Xonon Cool Combustion System, which was a full-scale test conducted at a facility. This is a gas turbine catalytic system with a combustion chamber for NO_x control. This technology was verified for its ability to achieve below 2 parts per million (ppm) NO_x emissions out of the stack.

Andrew Trenholm also discussed another verification test conducted for fine PM emissions from fugitive dust and unpaved roads. Fugitive dust contributes approximately one-third of the ambient fine PM in the atmosphere, and unpaved roads are a major source of that amount. APCT looked at dust suppressants used on these unpaved roads to control fine PM. The test lasted one full year so that seasonal effects could be determined. The U.S. Army Corps of Engineers Laboratory in Champaign, IL, provided funding to develop a new test method. The first verification test, which included five products from three vendors, was conducted at Fort Leonard Wood, MO. Fort Leonard Wood provided the roads and helped to conduct the testing. The second test, which included two products from one vendor, was conducted in Maricopa County, AZ, which has a different climate and soil type. Maricopa County helped to select the roads and controlled activity on the roads during testing. Both of these tests have been completed and the verification reports are being prepared.

The most recent protocol APCT has completed is for VOC control. The technical panel suggested that the initial focus should be on bioreaction systems because there were many innovative technologies in the marketplace, though not widely utilized (accepted). New designs have improved performance and reliability. This is a good example of where verification could really help in marketing the technologies. The biofilter measurements included: performance in terms of percent reduction in VOC and target compounds and the mass balance of gas and liquid streams; by-product air emissions for VOCs and microbes; wastewater effluent for VOC and target compounds, microbes, pH, total dissolved solids (TDS) and chemical oxygen demand (COD); and energy consumption and makeup water.

Andrew Trenholm reported that APCT has also developed a protocol that addresses performance of baghouse filtration products (BFPs). The initial focus is on bag fabrics to determine the removal efficiency for $PM_{2.5}$. The ETV procedures that were developed for conducting the test were later adopted as ASTM D6830 "Characterizing the Pressure Drop and Filtration Performance of Cleanable Filter Media." There are 15 completed verifications of BFPs. Andrew Trenholm presented a chart depicting the BFP verification test results for membrane fabrics and non-membrane fabrics, including pressure drop, total mass, and fine PM penetration.

He stated that the pressure drop needs to be looked at in combination with penetration. In a couple of cases, there are distinctions between membrane versus non-membrane fabrics.

Andrew Trenholm provided a brief discussion on the mobile sources technology category. There is increasing recognition of the environmental significance of diesel engine emissions, and innovative technologies are needed and are being developed. The EPA Office of Transportation and Air Quality (OTAQ) has a program called the Voluntary Diesel Retrofit Program (VDRP) that verifies the performance of diesel retrofit technologies. The testing results may be posted to the OTAQ Web Site. One outcome of this process is to qualify manufacturers' retrofit technology to be posted on the OTAQ Verified Technology List, making it available for State Implementation Plan (SIP) credits and for use by stakeholders interested in engaging in retrofit projects. ETV partnered with OTAQ to establish a technical panel and develop test protocols. The three mobile source protocols that have been completed are: devices (retrofit hardware), which includes diesel exhaust catalysts (DECs), PM filters, and engine modification units; fuel and lubricant modifications, which includes alternative fuels (emulsions, biodiesel), reformulations, fuel additives, and lubricants and lubricant additives; and selective catalytic reduction (SCR).

OTAQ's VDRP works with the APCT Center and the stakeholders in protocol development and provides technical support for test plan development. VDRP uses the data from the ETV verification results, in addition to other data, to determine the scope of application for the technology in terms of engine types. VDRP is communicating with technology users for fleets and evaluating in-use performance.

Andrew Trenholm provided a brief overview of three of the verifications that were completed for mobile sources technologies. They are: Clean Diesel Technologies, Inc.'s Platinum Plus Purifier Systems (two technologies) and Lubrizol Engine Control Systems' Purifilter™. The Platinum Plus is a fuel-borne catalyst (FBC) used in conjunction with a diesel oxidation catalyst or a catalyzed wire mesh filter. This technology is soluble in and compatible with all diesel fuels [No. 2D, No. 1D, ultralow-sulfur diesel (ULSD), and biodiesel blends]. The two systems verified were a FBC and a diesel oxidation catalyst (DOC) and a FBC and catalyzed wire mesh filter (CWMF). The FBC/DOC resulted in a PM reduction of 25-41% for low sulfur diesel (LSD) and 40-50% (plus 5% NO_x) for ULSD. The FBC/CWMF resulted in a PM reduction of 55-60% for LSD and 65-76% (plus 5-9% NO_x) for ULSD.

Lubrizol's Purifilter™ is a passive regeneration diesel particulate filter for retrofit on diesel engines. It has an unique silicon carbide filter for enhanced durability. The emissions reductions were: 90% for PM, 75% for carbon monoxide (CO), and 85% for hydrocarbons (HC).

Including the Clean Diesel Technologies and Lubrizol verifications, the APCT Center has completed six mobile source verifications, which have focused on PM. The PM control efficiencies ranged from 20-95%. These reports are completed and posted on the ETV Web Site. Other firms are discussing verification testing (PM and NO_x control) with the APCT Center and OTAQ. The Texas Commission on Environmental Quality (TCEQ) has a grant program for development and verification of technologies. Their focus is on technologies for NO_x control, but includes diesel retrofit controls. APCT is coordinating with TCEQ when their grants include verifications.

ETV Greenhouse Gas Technology Center

Teresa Harten introduced Tim Hansen, Southern Research Institute (SRI), who provided information on verification activities in the ETV Greenhouse Gas Technology (GHG) Center.

Tim Hansen stated that the mission of the GHG Center is to locate promising GHG mitigation and monitoring technologies, subject them to comprehensive performance testing, and report the results to the public, in hopes that this information will accelerate the use of good environmental technologies. The GHG Center was established in 1997.

GHG interacts with vendors and industrial hosts. Based on stakeholder input, almost all of the verification tests have been performed in the field, under real-world conditions. Often, industrial sites offer their facilities as host sites for verification testing. GHG also works with a number of different partners, including the New York State Energy Research and Development Authority (NYSERDA), Association of State Energy and Research Technology Transfer Institutions (ASERTTI), TCEQ, Colorado Governor's Office of Energy Management and Conservation, and EPA's Natural Gas STAR Program. These partners fund different activities under ETV, such as testing. They also offer tools and suggest priority technology areas to be tested. The center works with stakeholders, whose prime mission is to help GHG connect with their constituencies and promote the center, its activities, and verification test results. These stakeholders include representatives of the Coalition of Northeastern Governors (CONEG), New England Governors Conference (NEGC), Petroleum Technology Transfer Council (PTTC), and United States Combined Heat and Power Association (CHPA).

Tim Hansen described the typical GHG verification parameters. The main focus is on methane and carbon dioxide reductions for greenhouse gas emissions. Other air emissions (criteria, toxics) also are evaluated. The emission reductions are compared to a baseline. Other parameters include operational performance, secondary environmental impacts (i.e., effluent discharges, solid wastes), and economics (simple payback)– which is a driver for getting the technologies to the marketplace.

Tim Hansen presented a chart showing greenhouse gas emissions in the United States for 1990 through 2000. Electricity generation, transportation, and the industrial sector had the largest GHG emissions and the highest growth. The GHG Center works mainly in these three areas. In the electricity sector, GHG is focusing on distributed generation (DG). DG applications produce power using small power production devices located at the point-of-use. In the transportation area, the focus is on light-duty and heavy-duty vehicles, including gasoline and diesel-fired trucks, which are responsible for a fair fraction of the total GHG emissions in the entire transportation sector. In industry, the focus is on the oil and gas sector. The kinds of technologies that reduce greenhouse gases in this sector also make money for the people who use them, making it easier for GHG to work in this nonregulated area. In the agricultural area, the focus is on animal waste, primarily animal waste-to-energy. Animal waste is a renewable source of energy with a number of issues. GHG is just beginning work in this area. In the residential and commercial sector, the focus is on combined heat and power (CHP). This area is similar to DG except that CHP technologies convert the heat value of the exhaust stack from the small units into usable energy at the point-of-use in a commercial or residential building.

GHG has verified or is in the process of verifying the following technologies: oil and natural gas industries (five leak mitigation devices and three process technologies); transportation industry (three fuels/lubricants and three

engine modification devices); GHG monitoring technologies (two emission devices); and electrical power industry (six distributed power and CHP fossil fuel systems, five distributed power and CHP renewable fuel systems, and three renewable fuel conditioning systems). Many of these technologies also fall under the sustainable technology category.

Tim Hansen reported that GHG completed five verifications in FY04. GHG evaluated the NATCO Group, Inc.'s Paques THIOPAQ Gas Purification Technology, a gas conditioning system that uses a caustic scrubber to remove H_2S while also digesting waste into a sulfur product to reduce hazardous effluent and regenerating and recycling sodium hydroxide (NaOH) into the scrubber. Testing of the biogas system has been completed at a wastewater treatment plant (WWTP) in Cedar Rapids, IA. In 2005, testing will be conducted on the sour gas treatment system (high pressure). Selected test results for the biogas system include: H_2S removal efficiency of 99.8%; bioreactor H_2S vent concentration of 9.29 parts per billion in volume (ppbv); 0.12 gallons NaOH/1,000 cubic feet (cf) biogas; and 59.2% sulfur solids product produced.

Another technology verified was the United Technologies Corporation (UTC) PC25C Phosphoric Acid Fuel Cell. This system uses biogas from anaerobic digesters at a Brooklyn (NY) WWTP to fuel a 200 kW phosphoric acid fuel cell to provide power to the site and heat for digester temperature maintenance. Selected test results for the system include: electrical efficiency of 37.5%; potential total efficiency of 93.8%; NO_x emissions of 0.013 ppm; and estimated emissions reductions of 1346 tpy for CO_2 and 1.82 tpy for NO_X. The power quality met or exceeded IEEE standards.

GHG also evaluated the US Filter Gas Processing Unit for Biogas Conditioning for the UTC PC25C Fuel Cell. US Filter produces a gas processing unit that is used to remove H_2S and other contaminants in biogas from anaerobic digesters, allowing treated gas to be used in DG-CHP applications, such as the UTC PC25C fuel cell. The technology uses a dual carbon bed gas processing unit that limits outages. The field test was conducted at the Brooklyn (NY) WWTP. Selected test results for the system include: H_2S removal efficiency of greater than 99.996%; VOC removal efficiencies ranging from 17.5% for vinyl chloride (VC) to 99.9% for toluene. There were limited effects on the gas composition.

Tim Hansen reported that GHG evaluated a Capstone 30 kW Microturbine DG-CHP and a Martin Machinery 100 kW reciprocating engine at a 5,000-head swine farm in Lamar, CO. These generating units are fueled by biogas produced by the digestion of swine waste in an anaerobic digester at the site. The power was used on-site at the farm and for grid sales. Waste heat was recovered from the systems to maintain the digester. Selected test results for the Capstone's microturbine include: electrical efficiency of 20.4%; power output of 19.9 kW; system efficiency of 53.7%; and emissions of 3.45 pounds per kilowatt hour (lb/kWh) for CO_2, 8.21E-5 lb/kWh for NO_x, and 0.0027 lb/kWh for total hydrocarbon (THC). Selected test results for the Martin Machinery's reciprocating engine include: electrical efficiency of 19.7%; power output of 44.7 kW; system efficiency of 52.1%; and emissions of 1.97 lb/kWh for CO_2, 0.012 lb/kWh for NO_x, and above detection limits (ADL) (greater than 10,000 ppm) for THC.

The findings for both of these technologies were: high sulfur, NO_x, CO emissions from the engine; and low microturbine generator (MTG) electrical efficiency (due to altitude and compressor load).

GHG has a number of verifications in progress for FY05. These include: ECR Technologies Earthlinked

Geothermal Water Heating System; EnviroFuels Diesel Fuel Catalyzer (fuel additive); White Sands CleanBoost combustion catalyst for diesel engines; Legend Power Electrical Harmonizer (power quality and efficiency device); Aisin 6kW Engine-CHP System (Toyota lean burn NG engine); NCI Condensator diesel engine crankcase filtration system; Aircare Fuel Preheater (light duty vehicles); and Universal Cams Dynamic Cam Diesel Engine Retrofit.

Tim Hansen briefly discussed two of these technologies. EnviroFuels' Diesel Fuel Catalyzer is a diesel fuel additive for locomotive and other heavy-duty equipment. The vendor claims about a 3% fuel economy and a 12-18% improvement in NO_x and HC emissions. Testing was completed in October 2004 at a site hosted by Genesee and Wyoming Rail using an actual locomotive with an EMD 645 3000 HP engine. The treated fuel is being compared to a standard diesel fuel for fuel economy and emissions. The results should be available in early 2005.

ECR Technologies' Earthlinked Geothermal Water Heating System is a commercial scale ground source hot water system that uses refrigerant loops in the ground as the heat source for commercial water heating. The vendor claims increased efficiency and significant (70%) power consumption. The technology will be installed at an elder care facility in Florida. Testing will consist of a direct comparison between two installed systems—Earthlinked versus an electric hot water heating system. The testing parameters include: electric power consumed, efficiency/coefficient of performance (COP), and emissions reductions. Testing will be completed in late 2004.

Tim Hansen provided a brief overview of future activities for GHG. In the past year, there has been a significant increase in the number of applications for transportation technologies. GHG expects more applications for combined heat and power, especially in renewable fuels, new devices, and engine modifications. In the next few years, as greenhouse gas regulations become more inevitable, they expect to see more work in the areas of adaptation, sequestration, and sustainability. There continues to be an increase in the number of "walk-in" applicants who come into the ETV GHG Center.

Discussion

Teresa Harten thanked the speakers and asked the audience if there were questions or comments pertaining to what technologies ETV should test next.

An audience member, interested in alternative energy sources and resources, asked for references for operational Stirling engines or those soon to be on the market. He also asked if any of the ETV centers were doing air quality testing in city environments, analyzing automotive pollution and/or indoor air quality in residential and commercial buildings. Tim Hansen responded that there are not many commercially available Stirling engines. In the last year, several engines have come into the market (e.g., DTE Energy Technologies, Inc.; STM Power, Inc.). In the past, they have not been successfully marketed, but there seems to be renewed interest. Karen Riggs responded to the question about indoor air quality. This is an area of high interest to the AMS stakeholders, and AMS may move into this area in the future.

With respect to a question about vehicle exhaust, Karen Riggs responded that the AMS Center has verified one technology specifically focused on vehicle exhaust—an on-board vehicle emission analyzer. Testing included

real-time measurement of exhaust constituents and provided results on a gram per mile basis, depending upon the parameter being examined. The intent of the vendor was to offer this technology as an alternative to dynamometer testing for vehicles. The verification report is posted on the ETV Web Site.

Tim Hansen added that work has been done by the APCT Center in the area of retrofit technology for diesel engines. The technologies being examined are ones that would be applied to vehicles running in urban environments, such as school buses and garbage trucks. With respect to indoor air, the GHG Center is not testing specific technologies at this time; however, ETV is verifying air filtration devices and similar technologies applied to the indoor air quality area under the homeland security portion of ETV, which will be discussed later in this meeting.

A participant requested information regarding air sampling techniques that can be used in a residential home. Karen Riggs responded that one of the AMS stakeholders on their air monitoring committee represents an insurance firm. This stakeholder has expressed major concerns with respect to mold issues. Indoor air quality is a major concern for the insurance industry. There is a need in this area, but ETV has not yet moved into this arena.

A participant, a manufacturer of highly efficient oil filters and filtration systems for Class A trucking, asked if three different products, put together, could be tested. He wanted to know if anyone else had tried to combine a series of technologies to get an overall reduction of fuel usage. He was very interested in the process for testing combined technologies. Andrew Trenholm responded that in the past, technologies have been combined and they are looked at as a system. Vendors have approached ETV with a system of multiple technologies for testing and verification. This approach does not constitute a problem for ETV verifications.

A participant asked if there were any technologies to measure THC and $PM_{2.5}$ for less than $250,000. Karen Riggs responded that she had not seen anything come through ETV. The AMS Center verified the performance of one on-board emissions monitor, and she thought that THC was measured during the testing. Tim Hansen commented that in addition to fuel economy testing, there has been a great deal of stakeholder interest in on-road fuel economy testing and undertaking emissions evaluations at the same time. There are systems that can measure $PM_{2.5}$, basically the full sweep because a laboratory is essentially taken to the field, as in the case of the locomotive test. The systems are not portable and are costly. There are several of these systems (EPA, Canada, University of West Virginia) whereby laboratory equipment is strapped onto the vehicular equipment.

Bob Wright, EPA, asked if there are any information sources that described the whole ETV Program. Teresa Harten responded that ETV maintains a Web site with a brief description of the program on the home page. Additionally, the program as a whole and each center has a fact sheet, which are updated on a regular basis. The center fact sheets provide information on the priority technology categories, and the technology categories that are currently active. The ETV Web Site has a link to "recent additions," which is a list of documents, such as verification reports and statements, that have recently been posted to the Web site. There is a monthly newsletter that lists the technologies recently verified, the technology categories for which vendors are being solicited, upcoming meetings, and events at which the ETV exhibit will be displayed. Another publication is the quarterly report, which is another type of newsletter. It provides updated information on the centers, what technologies are being verified, and a list of all technologies verified by the ETV Program. The ETV Web Site also includes the minutes of the stakeholder's meetings, and a quality management plan that defines the process

by which ETV operates, including the roles and responsibilities of EPA and the centers.

Tom Baugh asked how individuals could participate on ETV stakeholder committees. Teresa Harten stated that there are 21 stakeholder groups. ETV would like to see additional participation from the regions and the organizations that are represented at this meeting. On the ETV Web Site, listed under each center, is a list of the stakeholder groups. Meetings are open to the public; participants do not need to be official members of a stakeholder group to attend.

A participant expressed concern that there seems to be a potential for overlap and duplication of effort between ETV and other EPA programs (e.g., work related to transportation and animal feeding operations). How does ETV coordinate with other EPA programs to minimize duplication of effort? Teresa Harten responded that ETV is unique because it deals only with commercial-ready technologies. ORD programs and other EPA programs are involved with research and development and developing new technologies. ETV is not trying to optimize the operation of a commercial-ready technology. ETV does develop test plans, and tests technologies against those test plans. Many of the other EPA programs that look at commercial-ready technologies may do some tinkering to optimize the technology performance. ETV makes a concerted effort to communicate and collaborate with other EPA programs. There is a new EPA Web site (http://www.epa.gov/etop) called the Environmental Technology Opportunities Portal (ETOP) that has been established as a result of the Congressional budget. EPA was asked to create a one-stop shop for technologies. ETOP provides links to EPA environmental technology programs, such as ETV, Superfund Innovative Technology Evaluation (SITE) Program, Small Business Innovation Research (SBIR) Program, Science to Achieve Results (STAR) Program, and National Environmental Technology Competition (NETC). There is a concerted effort in ORD to link these R&D and technology diffusion programs. ETOP also provides links and targeted information for technology developers and users.

A participant asked Tim Hansen and Dave Kirchgessner if they were working with the SmartWay Transport Partnership program in OTAQ. Tim Hansen responded that they have been holding discussions with OTAQ and they anticipate working with SmartWay in the future. OTAQ is still trying to decide what type of data they need and how they will obtain it. The participant commented that OTAQ does not provide a link under the SmartWay program from the technologies to the vendors.

Teresa Harten thanked the participants for attending the ETV Air and Energy Session.

ETV TOXICS AND PREVENTION SESSION

ETV Pollution Prevention (P2) Coatings and Coating Equipment Pilot

Teresa Harten introduced Mike Kosusko, the EPA Manager for the ETV P2 Coatings and Coating Equipment Pilot (CCEP).

Mike Kosusko stated that EPA's verification organization for this pilot is the U.S. Department of Defense's National Defense Center for Environmental Excellence (NDCEE) in Johnstown, PA. The pilot is operated by Concurrent Technologies Corporation (CTC), which has managed the pilot since its inception. The pilot is

focused on verifying technologies for control of VOCs, HAPs, and waste generation. They have completed, or are in the process of completing, five test protocols, which reflect the technical areas of the pilot. The test protocols include: high-volume, low-pressure (HVLP) paint spray guns; high transfer efficiency (TE) paint spray guns; ultraviolet (UV)-curable coatings; innovative liquid coatings; and powder coatings.

Mike Kosusko provided a brief overview of the verifications completed for HVLP paint spray guns, which included verification of improved TE while maintaining product quality. Four verifications were completed in 1999, and one product was verified in 2003. One product (EXEL Kremlin Airmix) is currently in testing. This product is not an HVLP paint spray gun, but it has high TE characteristics. The Kremlin Airmix product will be tested against a conventional air paint spray gun baseline. The protocol for HVLP paint spray guns is available on the ETV Web Site.

In 2003, CCEP verified an HVLP automotive refinishing spray gun developed by ANEST IWATA Corporation (LPH400-LV), that provided a relative TE improvement of 64% over a conventional air spray gun baseline. Increased TE reduces paint usage, volatile emissions, and waste generation. This results in material savings and reduced waste disposal costs. The spray guns provide a comparable finish quality at a higher TE.

CCEP developed a test protocol for high TE paint spray guns to verify TE at levels comparable to or above HVLP paint spray gun levels. The test included a three-part California-compliant coating system, including primer, top coat, and a clear coat; and the TE was measured for all three coats. CCEP coordinated with California's South Coast Air Quality Management District's (SCAQMD) Coating, Printing, and Aerospace Operations personnel to facilitate equivalency determinations. Two verifications were completed in 2004 and these reports are on the ETV Web Site. One report (ITW Automotive Refinishing DeVibiss GFG-670 'Plus' Spray Gun) is in review. The protocol has been drafted and is in review; it should be completed and posted to the ETV Web Site within a few months.

For UV-curable coatings, CCEP verified lower VOC and HAP content with maintained coating quality. One product, the Allied PhotoChemical KrohnZone 7014, was tested in 2003. The protocol has been approved and will be posted to the ETV Web Site in the near future.

In 2003, one innovative liquid coating product (Evermore Paints and Coatings, Inc.'s Formula 5 Coating) was verified. The protocol is available on the ETV Web Site, and is under consideration as an ASTM method. One product (Technology Applications Group's Tagnite Coating/Anodizing System for magnesium alloys) will be tested in 2005. The present systems used to protect magnesium alloys contain chromate or manganese, which is a large hazardous waste problem. The Tagnite Coating System uses safer solutions that are [purported to be] nonhazardous.

One laser targeted paint application device was tested in 2000. The product was developed by a start-up company, Laser Touch and Technologies, LLC (Laser Touch Model LT-B512). The verification factors included painter TE and finish quality. This device helps the painter to paint at the right distance with a higher TE. Testing results included: painter TE was improved by 11.1%; volatile emissions were reduced by 0.1 kg/kg solids applied; paint usage was reduced by 0.2 L/kg solids applied, and solid waste was reduced by 0.2 kg/kg solids applied.

CCEP has verified ten technologies and has three more in progress. Four protocols have been completed and one more is expected to be completed in 2005.

ETV SAFE BUILDINGS SESSION

Teresa Harten stated that the homeland security portion of ETV consists of the water security area discussed previously and the safe buildings area. The safe buildings verification area has three parts: ETV Building Decontamination Technology Center, ETV Safe Buildings Monitoring and Detection Technology Effort, and ETV Safe Buildings Air Filtration and Cleaning Technology Effort. Within the next year, ETV will be spinning off the verification of homeland security technologies to the National Homeland Security Research Center (NHSRC), which is part of ORD. NHSRC will conduct their own technology verification program, because they have slightly different verification needs than ETV can provide. NHSRC wants to be able to purchase and test/compare technologies, whereas ETV is a voluntary program. There are also unique information security needs related to homeland security work.

ETV Building Decontamination Technology Center

Teresa Harten introduced Karen Riggs, Battelle, who discussed some of the activities of the ETV Building Decontamination Technology (BDT) Center.

Karen Riggs provided a brief overview and background on ETV's role in the homeland security area. ETV was established in 1995, and was fully operational with all of the centers conducting technology verifications by 1997 to1998. EPA has a mission to protect and clean-up public buildings and to ensure the safety of the Nation's drinking water supplies. Part of that mission was to ensure that technologies were available to secure safe buildings and safe water. After September 11th occurred, EPA was looking for a way to conduct evaluations of these types of technologies. The ETV Program was operational and had been very successful in verifying technologies. There was a need to minimize startup costs and time, and to quickly conduct the technology verifications and provide performance data. There was an existing testing process in place under ETV, and the ETV stakeholders were amenable to including homeland security in the centers' missions.

Karen Riggs stated that the BDT Center was established in January 2003. Its mission is to verify the performance of commercially available technologies that can decontaminate indoor surfaces in buildings and structures following an intentional release of chemical or biological agents. The BDT Center tests the effectiveness of decontaminating biological and/or chemical agents and surrogates on indoor air surfaces. The general testing approach is to dose live chemical and/or biological agents or surrogates onto samples of indoor materials, and apply the decontamination process.

There are certain commonalities in the testing procedures. The representative materials tested were those that would ordinarily be found in an office building. Seven materials were used for testing, including: industrial-grade carpet, bare wood (pine lumber), glass, decorative laminate, galvanized metal ductwork, painted (latex, flat) wallboard paper, and painted (latex, semi-gloss) concrete cinder block. Coupons were cut from each of the materials. The coupons are about ½ to ¾ inch wide and about 3 inches long. These coupons, typically in triplicate, were inoculated with spores or chemicals, either dried or weathered, and then put into a modified

glove box for a decontamination exposure period that was specified by each vendor. After the treatment or the decontamination technology had been applied, the coupons were extracted and analyzed to determine residual amounts of the agents and surrogates, and then the results were tabulated and written up.

The organisms used in the building decontamination tests included: *Bacillus anthracis* Ames, *Bacillus Subtilis* (ATCC 19659), and *Geobacillus stearothermophilus* (ATCC 12980). The biological indicators included: *Bacillus Subtilis* (ATCC 19659) and *Geobacillus stearothermophilus* (ATCC 12980). Commercially available spore strips containing *Bacillus atrophaeus* (ATCC 9372) were used. The chemical agents used in the building decontamination tests included: VX and HD (sulfur mustard). The chemical surrogates included: malathion as a surrogate for VX and thioanisole (methyl phenyl sulfide) as a surrogate for HD.

The BDT Center has completed verification testing of three technologies (BIOQUELL, Inc.'s CLARUS C Hydrogen Peroxide Vapor System; Certek, Inc.'s 1414H Formaldehyde Gas Generator; and CDG Research Corporation's Bench-Scale Chlorine Dioxide Generator) for decontaminating indoor surfaces contaminated with biological agents, and one technology (CDG Research Corporation's Bench-Scale Chlorine Dioxide Generator) for chemical agents. These verification reports are completed and posted on the ETV Web Site.

Karen Riggs showed a table of the decontamination effectiveness of anthrax spores by BIOQUELL, Inc.'s CLARUS C Hydrogen Peroxide Vapor System. Efficacy for decontamination of biological organisms is defined as the "log reduction" or log (base 10) of the number of spores killed/inactivated during decontamination. The more effective the technology, the higher the log kill. The test results showed that porous materials were more of a challenge than were nonporous materials.

ETV Safe Buildings Monitoring and Detection Technology

Karen Riggs reported that the Safe Buildings Monitoring and Detection Technology effort, managed by Battelle, is similar to the AMS Center; it verifies the performance of monitoring and detection technologies. The focus is on technologies used by first responders for the detection of chemical or biological contamination in buildings and other public spaces. Chemical contamination may involve toxic industrial chemicals (TICs) such as hydrogen cyanide (HCN), chlorine (Cl_2), arsine (AsH_3), phosgene ($COCl_2$), and cyanogen (CICN), or chemical warfare agents (CWAs) such as sarin (GB) and HD. In addition to testing for accuracy, precision, and detection limit, other testing parameters (realistic interferences, cold and hot start conditions, battery life) were included in these tests.

The first technology category selected by ETV for testing in this area was ion mobility spectrometers (IMS). These are hand held instruments that collect a sample of air, ionize the sample with a small radioactive source, and measure the ions as they drift through an atmospheric pressure region in the detector. These instruments can typically identify what chemical is being detected and can detect both TICs and CWAs. Testing has been completed for the Bruker Daltonics, Inc.'s RAID-M IMS; Environics USA's M90 IMS; and Microsensor Systems' HAZMATCAD Plus Surface Acoustic Wave (SAW) detector. Environic USA has indicated interest in verification testing of their ChemPro 100 IMS.

The testing results for Bruker Daltonics, Inc.'s RAID-M IMS showed that response time was always less than 10 seconds and there was nearly 100% accuracy of identification of the TIC or CWA. The response thresholds

were 3 to 100 times lower than the IDLH (immediately dangerous to life and health) levels. Temperature and relative humidity had minimal effects. There were some interferent effects. A false negative response was given for chlorine, sarin (GB), and sulfur mustard (HD) in the presence of interferents such as latex paint, floor cleaners, and air fresheners. There were false positives for VX in the presence of ammonia cleaner. The battery life was 6.5 to 8 hours. A cold start from any storage condition initially resulted in low responses and long recovery times. As the instrument warmed up, it would come up to normal operation. The verification report is completed and posted on the ETV Web Site.

Karen Riggs reported that there is active stakeholder involvement in the safe buildings area. Stakeholder groups include representatives from EPA, U.S. Department of Homeland Security (DHS), Centers for Disease Control and Prevention (CDC), Federal Bureau of Investigation (FBI), Department of Defense (DoD), and first responders. Outreach efforts include a newsletter (*The Detector*) and presentations of testing results at various technical conferences. Journal articles also have been prepared and accepted for publication. The ETV process has been effectively applied to evaluation of technologies used for protecting public buildings.

Teresa Harten stated that a rapid ETV process was established for the homeland security area. There was a need to shorten the normal average time to complete a verification from 15 months for a base ETV verification to six months for homeland security verifications.

ETV Safe Buildings Air Filtration and Cleaning Technology

Teresa Harten introduced Debbie Franke, RTI International, who presented on the ETV Safe Buildings Air Filtration and Cleaning Technology effort. Debbie Franke stated that Bruce Henschel is the EPA Manager for this effort.

Debbie Franke stated that the objective/focus of the ETV Safe Buildings Air Filtration and Cleaning Technology effort is on air cleaners that can treat: incoming or recirculating building air (duct-mounted) and in-room air (free-standing, self-contained), generally in large buildings. The focus is on the removal of chemical or biological warfare agents or TICs. The air cleaners can remove particulates, destroy microbials, and sorb/neutralize gases (TICs, VOCs).

The technologies for ducted ventilation systems include: general ventilation media filters, electronic air cleaners [e.g., charged media, electrostatic precipitators (ESPs)], ultraviolet radiation, photocatalytic oxidation, carbon and other sorbers, and plasma and other energy devices. There also are self-contained fans that are used for room air cleaners. These products, popular for indoor air quality allergy issues, are now being sold for homeland security approaches. There also are newer innovative system approaches that include in-duct sprays.

Debbie Franke stated that 14 general media filters have been tested thus far for bioaerosol removal. The filters tested by ETV ranged from a minimum efficiency reporting value (MERV) of 7 to 16. These filters are representative of the filters specified for commercial buildings.

During ETV testing, the ASHRAE Standard 52.2 (for PM removal only) was used. The ASHRAE 52.2 test is a fractional efficiency test that uses a full particle size range from 0.3 to 10 µm diameter. Potassium chloride (KCl) aerosol particulate was used to condition the filter. The filter was then loaded with ASHRAE test dust.

The ASHRAE 52.2 test was run for the clean filters and for five different levels of dust loading. The results are reported as MERV ratings. MERV ratings are now widely used in filter marketing. In addition, a modified 52.2 test was run with biological agents. Three surrogate agents were used: *Bacillus atrophaeus* (formerly *B. subtilis v. niger* and *B. globigii*, BG), which is a surrogate for *B. anthracis* spore; *Serratia marcescens*, which is a surrogate for vegetative bacteria; and MS2 bacteriophage, which is a surrogate for viruses. Testing was not designed to kill the agents, just to filter them out. The filters also were tested for inert particles that were 0.03 to 10 µm, which is a larger size than the regular ASHRAE 52.5 testing. This size range should be able to handle all of the bioaerosols, including viruses.

Debbie Franke showed a graph depicting typical Standard 52.2 results from a filter with a MERV rating of 14. The filter efficiency decreases to 80% for a loaded filter and approximately 55-60% for an unloaded filter. She also presented a table summarizing the test results for the 14 filters that were verified. Filters with a MERV rating of 7 or 8 are 2-inch filters, and the ones with higher MERV ratings are either a 12-inch filter or a bag filter. Filters with a high MERV rating have a higher pressure drop, which results in higher energy costs. If the filter has a MERV rating of 16 or above, it typically filters out approximately 99% of the bioaerosols. If a filter has a MERV rating of 7, it is not as effective. The verification reports are posted on the ETV Web Site.

Debbie Franke stated that testing would resume in 2005 under the NHSRC. A stakeholder committee meeting will be held to assist EPA in identifying which air cleaner technology should be tested next; the UV devices are a likely candidate.

Discussion

A participant asked Debbie Franke if the verifications completed for air filtration systems were concerned solely with the evaluation of technologies for commercial buildings. Debbie Franke responded that the focus is on commercial buildings at this time. It is unlikely that individuals would utilize the UV lights in the ductwork of their homes because the energy costs are prohibitively expensive.

When asked for a recommendation for an air filter for a home, Debbie Franke responded that most air filters sold at retail stores are below the MERV scale, and that they are intended to protect the furnace, rather than the occupants of a home. Most filters are sized to fit only commercial, not residential duct work.

Closing Remarks

Teresa Harten stated that this outreach workshop has been very fruitful. She extended her thanks and appreciation to the speakers, vendors, and other attendees at the meeting. Meeting participants were invited to attend the ETV team meeting following the workshop.

U.S. Environmental Protection Agency
Environmental Technology Verification (ETV) Program
Outreach Workshop

November 16, 2004
U.S. EPA Region 4
Atlanta, GA

Vendor Displays/Demonstrations

Aanderaa Instruments, Inc.
Verified Technology: RCM 9 Mk II with Optode 3830
Technology Type: Multi-Parameter Water Quality Probe
Myron L. Spaulding, Sales & Application Engineer
182 East Street, Suite B
Attleboro, MA 02703-4209
Telephone: (508) 226-9300
Fax: (508) 226-9306
myron.spaulding@aanderaa.no
www.aanderaa.com

ADI International
Verified Technology: ADI Pilot Test Unit No. 2002-09 with MEDIA G2 System
Technology Type: Adsorptive Media for Arsenic Removal from Drinking Water
Kiron Senapati, P.E., Senior Engineer
P.O. Box 46727
Tampa, FL 33647
Telephone: (813) 890-9500, ext. 108
Fax: (813) 249-8169
ksenapati@att.net
www.adi.ca

Atlantic Ultraviolet Corporation
Verified Technology: Megatron Unit Model M250
Technology Type: Ultraviolet Radiation for Microbiological Inactivation and Disinfection in Drinking Water
Amy Wysocki
375 Marcus Boulevard
Hauppauge, NY 11788
Telephone: (631) 273-0500
Fax: (631) 273-0771
awysocki@atlanticuv.com
www.ultraviolet.com

Clean Diesel Technologies, Inc.
Verified Technologies: Platinum Plus Purifilter Fuel-Borne Catalyst with CleanAir System's Diesel Oxidation Catalyst (FBC/DOC) and Fuel-Borne Catalyst with Mitsui/PUREarth Catalyzed Wire Mesh Filter (FBC/CWMF)
Technology Type: Mobile Sources Devices for Diesel Engines
Glen Reid, Vice President
300 Atlantic Street, Suite 702
Stamford, CT 06901
Telephone: (203) 327-7050
Fax: (203) 323-0461
greid@cdti.com
www.cdti.com

Conestoga-Rovers & Associates, Inc. (CRA, Inc.), Customer for C Tech Development Corp.
Verified Technology: C Tech Development Corp.'s Environmental Visualization System Pro (EVS-PRO)
Technology Type: Decision Support Software
Thomas J. Cook, Project Manager
2055 Niagara Falls Boulevard, Suite 3
Niagara Falls, NY 14304
Telephone: (716) 297-6150
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Hydranautics
Verified Technology: Hydranautics ESPA2-4040 Reverse Osmosis Membrane Element Module System
Technology Type: Reverse Osmosis Technology for Arsenic Removal from Drinking Water
Kevin L. Kaiser, Central Region Market Manager
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Telephone: (404) 434-8376
Fax: (770) 926-0866
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Lubrizol Engine Control Systems
Verified Technology: Lubrizol Engine Control Systems Purifilter Particulate Filter
Technology Type: Mobile Sources Device for Diesel Engines
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Fax: (905) 853-5801
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www.lubrizol.com/enginecontrol

Stormwater Management, Inc.
Verified Technology: Stormwater Management StormFilter Using ZPG Filter Media
Technology Type: Storm Water Source-Area Treatment Device
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