Environmental Technology Verification to Reduce the Risk of Using Innovative Coating Technologies

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ABSTRACT

The Environmental Technology Verification (ETV) Program's Coatings and Coating Equipment Pilot (ETV CCEP) was established in January 1997 to verify the environmental (and finishing) performance of innovative surface coatings, coating equipment, and related processes. It provides high quality data through the use of efficient and fully quality assured verification test protocols. The ETV CCEP is part of one of six ETV Technology Centers in the U. S. Environmental Protection Agency's (EPA's) ETV Program. EPA's partner for ETV CCEP is Concurrent Technologies Corporation (*CTC*) of Johnstown, Pennsylvania.

The ETV Program was originally established in October 1995 as a 5-year pilot by EPA's Office of Research and Development and provides independent, third-party verification of the performance of cost-effective innovative technologies and processes that provide an environmental benefit, hence accelerating their entrance into the marketplace and reducing the implementation risk of end users. The end product of the verification process for each technology is a Verification Statement, a summary of the testing and results, signed by the EPA and its partner testing organization, which the vendor can use to market its product. ETV is a voluntary program that seeks to make objective performance information available to all of the players in the environmental marketplace for their consideration and decision-making. Each pilot has at least one Stakeholder Group representing customers for that pilot's technology focus. The program does not rank, certify, approve, or disapprove technologies. The ETV Program focuses only on commercial-ready technologies; it does not evaluate technologies at the bench or pilot scale and does not conduct or support research.

This paper will present the key concepts of the ETV Program, review the scope of the ETV CCEP and its use of the verification process; discuss the benefits of verification; and review completed verification tests and those planned in the near future.

INTRODUCTION

The ETV Program was established by the U.S. EPA to accelerate the development and commercialization of improved environmental technologies through independent and credible third-party verification and reporting of performance. The ETV Program provides purchasers, permit writers, and developers with objective, quality-assured performance data on the technology they are buying, permitting, or marketing. Independent, third-party verification of

such technologies is intended to increase their marketability by reducing the implementation risk to technology end users. All significant ETV documents, including tests protocols, verification reports, verification statements, stakeholder information, and quarterly reports, can be found on the ETV website.[1] Since beginning in 1995 as a 5-year pilot program to test a variety of environmental technology verification approaches in different technology markets, the intent of the ETV Program has been to identify the most effective and efficient methods of verification. At the end of September 2000, the ETV Program concluded the 5-year pilot period and is currently transitioning into six ETV Technology Centers. EPA will make recommendations to the Congress during the year 2001 on whether and in what form an ETV Program should continue.

Initially, each ETV pilot selected a pilot organization(s) to oversee and conduct verification activities based on testing and quality assurance protocols developed with input from all major stakeholder/customer groups associated with the technology area. The ETV CCEP is currently operating under the ETV Pollution Prevention, Recycling, and Waste Treatment Systems Center. EPA partnered with Concurrent Technologies Corporation (*CTC*) – a nonprofit, professional services and testing organization – in conjunction with the Department of Defense's National Defense Center for Environmental Excellence (NDCEE) to establish a self-supporting, operational verification center to evaluate innovative coatings and coating application techniques for metal and other substrates. Standardized test protocols have been developed in coordination with industry trade associations and other appropriate stakeholders selected by EPA and *CTC* to facilitate broad acceptance of results.

Coating processes account for an estimated 20% of stationary source volatile organic compound (VOC) and significant hazardous air pollutant (HAP) emissions.[2] These emissions contribute to cancer and non-cancer health risks as well as ecological damage. In order to reduce these emissions and their effects, a multitude of new coating technologies are being developed and marketed without the use of standardized evaluation protocols to ensure that products provide an environmental benefit at equivalent or enhanced performance and cost. Many lower polluting products are not accepted by the marketplace as performance and cost effective. An unbiased, third-party coating verification center using standardized test protocols provides documentation to verify environmental as well as performance and cost benefits. Documentation is needed by users and permit writers to respond to existing regulatory forces. Increased market penetration of lower polluting products and sales of verified productions are expected to occur as a result of testing. The pilot has identified a niche and need for ETV of smaller companies with innovative products. Industry interest is growing steadily.

The key concepts of the ETV Program will be presented in this paper. The scope of the ETV CCEP, its use of the verification process, and the reaction of the vendor community will be summarized. Finally, completed and planned verification tests will be reviewed.

THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

Throughout its history, the U.S. EPA has evaluated technologies to determine their effectiveness in monitoring, preventing, controlling, and cleaning up pollution. Since the early 1990s, however, numerous government and private groups have determined that the lack of an organized and ongoing program to produce independent, credible performance data is a major impediment

to the development and use of innovative environmental technology. Such data are needed by technology buyers and permit writers, both in the United States and abroad, to make informed technology decisions. Vendors with innovative, better, faster, and cheaper technologies need independent evaluation to penetrate a conservative, risk-averse environmental marketplace.

In October 1995, the EPA established the ETV Program to address this need. The ETV Program, which heavily emphasizes innovative, environmentally beneficial technologies and products, officially began operation as a pilot program. It began with a 5-year pilot period to test a wide variety of partner and procedural alternatives, as well as the true market demand for and public response to such a program. The ETV Program was created to accelerate the development and commercialization of improved environmental technologies through third-party verification and reporting of performance. EPA's independent Science Advisory Board stated in a recent memorandum,

> "The scarcity of independent and credible technology information is one critical barrier to the use of innovative environmental technologies.... Verification testing information provided by the ETV Program fulfills an essential need of the environmental technology marketplace[3]."

The ETV Program Verification Strategy, published in February 1997, sets out the goals of the ETV Program, the selection criteria for ETV pilots, and the operating principles for implementation of the program.[4] These operating principles are reflected in the program description that follows.

During this initial pilot period, the EPA operated 12 pilots that focused on many of the categories that environmental technology covers. The original 12 pilots are listed in Table 1.

Table 1. The 12 original Environmental Technology Verification Program pilots.

Advanced Monitoring Systems (Air, Water)	P2 Innovative Coatings and Coating Equipment
Air Pollution Control Technology	P2 Metal Finishing Technologies
Drinking Water Systems	P2 Recycling and Waste Treatment Systems
EvTEC (any technology area)	Site Characterization and Monitoring Technologies
Greenhouse Gas Technology	Source Water Protection Technologies
Indoor Air Technologies	Wet Weather Flow Technologies

For each pilot, EPA selected "verification partners" to oversee and conduct technology verification activities. The ETV Program has been carried out through a wide variety of partnerships with public and private testing and evaluation organizations. These "verification organizations" partner with EPA technology experts to create efficient and fully quality assured procedures that facilitate highly credible and objective performance verification of innovative

technologies. States, federal laboratories, and, most prominently, private sector organizations have joined EPA in these partnerships. These partners work with EPA technology experts to develop procedures for verifying the performance of innovative technologies. For each pilot, the efforts of each partner and EPA are guided by at least one Stakeholder Group that represents all of the customers for that particular technology sector. For each technology verified, the ETV partner organization develops a test plan in conjunction with the developer. An independent third party conducts testing. As a result of testing, the EPA issues a Verification Statement of three to five pages along with a Verification Report covering details of testing.

In addition, ETV is a voluntary program that seeks to make objective performance information available to all of the participants in the environmental marketplace for their consideration and decision-making. The ETV Program does not rank, certify, approve, or disapprove technologies. The ETV Program focuses solely on commercial-ready technologies; it is not a research or "scale-up" program. All vendors are welcome to participate. The ETV Program has developed and implemented a comprehensive outreach strategy to state and federal permit writers, the consulting community, and international markets. ETV is intended to change from being a primarily government-funded program to funding primarily from the private sector.

During its 5-year pilot period, the ETV Program successfully created 12 verification pilot programs that address different areas of the environmental technology market. These programs organized 18 Stakeholder Groups and held 80 Stakeholder Group meetings. By that time, the ETV Program developed 49 generic verification protocols for categories of technologies and 70 technology-specific test plans to guide the testing of specific products.[5] In addition, the ETV Program successfully verified 111 technologies in 35 different technology categories, exceeding its strategic goal of verifying 95 products during the 5-year pilot period. ETV Program funding during the pilot period peaked in 1997 and 1998 when Congress appropriated $10 million per year for verification. EPA has closely monitored the costs and effectiveness of the 12 pilot programs. The ETV Program is now analyzing its successes, shortcomings, and lessons learned to develop recommendations for the most effective and efficient verification program possible. This analysis will result in a Report to Congress that will contain recommendations for continuation of the ETV Program, both in terms of the overall program structure and specific procedures for successful verifications. The Report to Congress is scheduled for issue during 2001.

At the end of September 2000, the ETV Program concluded the 5-year pilot period. The ETV Program is now in its post-pilot operational phase. The 12 original pilots have been reorganized into the 6 ETV Technology Centers listed in Table 2.

THE COATINGS AND COATING EQUIPMENT PROGRAM (ETV CCEP)

The concepts of the ETV Program have been applied to the establishment of the ETV CCEP pilot since it began in October 1996. The purpose of ETV CCEP is to complete unbiased, third-party verification of the acceptability of lower polluting coatings and coating equipment for various substrates in a broad range of industries. EPA's partner organization for this pilot is Concurrent Technologies Corporation (*CTC*), a nonprofit technical services company headquartered in

Table 2. The six Environmental Technology Verification Program Technology Centers.

ETV Advanced Monitoring Technology Center – all media
ETV Air Pollution Control Technology Center – stationary and mobile sources
ETV Drinking Water Treatment System Center
ETV Greenhouse Gas Prevention Technology Center
ETV Pollution Prevention, Recycling, and Waste Treatment Systems Center – technologies and products
ETV Water Protection Technology Center

Pittsburgh, Pennsylvania. Testing has been completed in conjunction with the Department of Defense's (DOD's) National Defense Center for Environmental Excellence (NDCEE) in Johnstown, Pennsylvania. As have most of the other pilots, ETV CCEP followed the operations process steps identified in Table 3. Following these steps has helped ETV CCEP to develop a market presence, identify technological focus areas, enlist vendors for verification testing, complete tests, and report their results.

Table 3. The ETV operations process.

Form Stakeholder Group(s) and conduct regular meetings
Research, identify, and prioritize focus areas
Conduct open solicitations within each focus area via direct mailings, notices in publications, Commerce Business Daily (CBD) announcements, etc.
Develop test and quality assurance (QA) protocols
Conduct verification testing
Evaluate test results and quality and provide reports to EPA
Issue Verification Statements
Conduct ongoing outreach

To date, products verified by the ETV CCEP include high-volume, low-pressure (HVLP) paint spray guns, and the Laser Touch™ Targeting Device which was developed to improve the efficiency of manual spray operations by providing real-time feedback to the painter. Examples of products that are currently or will soon be in the verification process include liquid coatings, an ultraviolet (UV) response coating system, a conversion coating for magnesium, a UV-curable coating, and a powder coating gun that small- and medium-sized businesses can afford.

The Operations Process

Stakeholder Group

ETV CCEP is guided and shaped by using the expertise of its Stakeholder Group. The group consists of representatives of all verification customer groups: buyers and users of coating technology, developers and vendors, and, most importantly, technology "enablers," *i.e.*, the state technical assistance providers, consulting engineers, industry trade associations and professional societies that recommend technology alternatives to purchasers, and the state permit writers and regulators who allow it to be used. For example, ETV CCEP has 27 stakeholders: 4 representing state and federal technical assistance programs, 5 from coatings and coating equipment vendors and end users, 7 from state and federal regulatory agencies, 2 from industry consultants, 5 from industry trade associations (*e.g.*, Chemical Coating Association International [CCAI] and RadTech International), 2 from professional societies (*e.g.*, the American Society for Testing and Materials [ASTM] and the Association for Finishing Processes, a division of the Society of Manufacturing Engineers [AFP-SME®]), and 2 from DOD. Stakeholders assist in the development of procedures and protocols, help prioritize types of technologies to be verified, assist in defining and conducting outreach activities appropriate to the coatings industry, and serve as information conduits to their particular constituencies.

ETV CCEP's Stakeholder Group has met eight times and has held three conference calls since first coming together during March 1997. Past and future scheduled meetings are identified in Table 4. A list of stakeholders and copies of meeting summaries are available.[6, 7]

Focus Areas and Solicitations

The ETV CCEP targets key technology focus areas for pollution prevention in the coating industry based on market research and stakeholder guidance. This has been an iterative process. At the initial stakeholder meeting in March 1997, we decided to conduct a market study using information and statistics from industry trade associations and publications. Prioritization criteria, such as multimedia pollution prevention potential and user impact, were to be applied to this information. As a result, three focus areas were identified before the second stakeholder meeting on October 30, 1997. These were epoxy powder coatings, UV-curable coatings, and HVLP paint spray guns. Solicitations for two of these areas, HVLP guns and epoxy powder coatings, were released during July 1997.[7] Vendor meetings for these areas were held during October 1997. Powder coating industry representatives were polite and appeared to express some interest. The HVLP vendors were excited about testing.

The results of the focus area study and our experiences to date were presented to the stakeholders at the October 1997 meeting. The group decided to test HVLP guns as quickly as possible, to search for a way to generate interest from the powder coating manufacturers, and to develop a solicitation for UV-curable coatings. Between meetings, ETV CCEP found that the proposed powder and UV-curable coatings technology verification areas were not readily accepted by coating manufacturers because they felt these coatings were already accepted by users and they did not identify a substantial benefit from the program. In May 1998, ETV CCEP released an

Table 4. Past and future Stakeholder Group meetings and conference calls.

DATE	LOCATION
Week of October 14, 2001	COATING 2001™, Orlando, FL
June 4, 2001	Finishing 2001, Chicago, IL
March 15, 2001	Conference Call
November 9, 2000	Research Triangle Park, NC
August 10, 2000	Conference Call
April 27, 2000	Conference Call
September 20, 1999	COATING '99™, Dallas, TX
April 15, 1999	Research Triangle Park, NC
November 5, 1998	Research Triangle Park, NC
May 6, 1998	Research Triangle Park, NC
October 30, 1997	NDCEE, Johnstown, PA
March 21, 1997	Research Triangle Park, NC

open-ended solicitation for powder and UV-curable coatings to leave the door open to industry vendors for testing should they have a change of heart.

Given this low level of interest, during the May 1998 stakeholder meeting we decided to issue a much broader solicitation to the entire coatings industry to determine where industry's interest might lie. ETV CCEP personnel developed an approach that allowed a much wider range of products to be evaluated, thus allowing truly innovative technologies to benefit from the program. Solicitations for the new Innovative Technologies focus area were mailed to vendors and published in the Commerce Business Daily (CBD) in late May.[7] From the responses of over 30 vendors, ETV CCEP personnel noted a grouping of interested liquid coating vendors. We gave these our highest priority and held a successful vendor meeting on November 4, 1998.

For the November 5, 1998, stakeholder meeting, ETV CCEP personnel created a list of the remaining 17 respondents, most of whom would require tests of unique technologies. Of these, the 6 most critical technologies were identified by the stakeholders as:

(1) UV-curable coatings
(2) Laser-guided spray gun (Laser Touch™)
(3) Spray gun cleaning equipment
(4) Powder/H_2O slurry application
(5) Waterborne coatings for wood
(6) Supercritical CO_2 paint spray application

ETV CCEP has pursued these areas/technologies to determine the degree of interest of the vendors in participating. Of these, verification of the Laser Touch™ has been completed.

Current focus areas include additional high transfer efficiency equipment, such as HVLP spray guns, innovative liquid coatings, UV-curable coatings, cleaning systems for painting equipment and surface preparation, and individual innovative products.

Table 5 summarizes the status of ETV CCEP's solicitations. ETV CCEP has completed open solicitations for highly prioritized focus areas. Any technology vendor within each technology focus area selected for verification is welcome, but in no way required, to participate. The ETV CCEP accepts applications from any interested vendor that has an innovative, environmentally beneficial and commercially available (market-ready) coating, coating application method, or related product.

Table 5. ETV CCEP technology solicitations.

SOLICITATION TOPIC	OPEN DATE	CLOSE DATE	COMMENTS
High-volume, Low-pressure (HVLP) Spray Equipment	July 14, 1997 (CBD) September 8, 1997 (RFT)	July 31, 1997 October 17, 1997	Vendor meeting, NDCEE, Johnstown, PA, October 29, 1997
Epoxy Powder Coatings	July 14, 1997 (CBD) September 5, 1997 (RFT)	July 31, 1997 September 26, 1997	Vendor meeting at the Powder Coatings '97 Conference, Charlotte, NC; October 6, 1997
Powder and UV-curable Coatings	May 1, 1998 (CBD)	May 29, 1998	Solicitation open-ended per RFT
Innovative Technologies	May 26, 1998 (CBD)	June 30, 1998	Liquid Coatings vendor meeting, November 4, 1998 Solicitation open-ended per RFT

CBD - Commerce Business Daily Notice
RFT - Request for Technology

Generic and Product-specific Test Protocols

ETV CCEP develops two types of test protocols, the Generic Protocol and the product-specific Testing and Quality Assurance Project Plan (TQAPP). Generic Protocols are developed for each technology area based on the ETV CCEP Quality Management Plan.[8] Each contains a wide range of test parameters that apply to the technology area being verified. Included in the protocol will be all testing required to gather sufficient data for environmental verification of the technology. *CTC* project personnel, EPA, and the Stakeholder Group design the Generic Protocol with input from the vendor community. The Generic Protocol includes the following sections:

- Purpose and objectives of planned testing
- Verification description including approach, experimental design, performance criteria, measurements to be taken, and critical and non-critical parameters

- Personnel and responsibilities
- Data quality objectives such as accuracy, precision, comparability, representativeness, and completeness including calculations
- Sample collection including site selection, sampling procedures, and sample frequency
- Analytical procedures, calculations, and calibration
- Data collection, reduction, validation, and reporting
- Internal quality control checks, audits and corrective action.

After meeting with coating technology vendors and being assured of their interest in participation, product-specific TQAPPs are developed by ETV CCEP personnel for acceptance by each vendor. A TQAPP applies the Generic Protocol to each product to be tested, documenting the parameters specific to that product. The TQAPP details the exact settings for each test. Each TQAPP is reviewed and approved by the organization requesting verification testing and ETV CCEP managers from EPA and *CTC* prior to the initiation of testing. All Generic Protocols and TQAPPs are available on the ETV website and are listed in Table 6.[5]

Table 6. Generic Protocols and product-specific TQAPPs for ETV CCEP.

TITLE	REVISION #	APPROVAL DATE
Evermore Paints and Coatings Formula 5 Coating - Test and Quality Assurance Project Plan (TQAPP)	0	October 12, 2000
Liquid Coatings Generic Testing and Quality Assurance Protocol	0	February 16, 2000
HVLP Coating Equipment Generic Testing and Quality Assurance Protocol	1	December 22, 1999
Laser Touch™ Beta Model - Test and Quality Assurance Project Plan (TQAPP)	0	September 16, 1999
Sharpe Platinum 2013 HVLP Spray Gun - Testing and Quality Assurance Project Plan (TQAPP)	0	February 25, 1999
ITW DeVilbiss GTI-600G HVLP Spray Gun - Testing and Quality Assurance Project Plan (TQAPP)	0	December 15, 1998
ITW DeVilbiss JGHV-531-46FF HVLP Spray Gun - Testing and Quality Assurance Project Plan (TQAPP)	0	December 15, 1998
ITW DeVilbiss FLG-631-318 HVLP Spray Gun - Testing and Quality Assurance Project Plan (TQAPP)	0	December 11, 1998
UV-curable Coatings Generic Testing and Quality Assurance Protocol	Draft	March 24, 1998
Powder Coating Generic Testing and Quality Assurance Protocol	Draft	February17, 1998

Testing and Evaluation of Results

Testing is then completed at a very high level of QA, and test results are evaluated according to the approved TQAPP. EPA has completed three QA audits during HVLP testing. ETV CCEP/ *CTC* personnel oversaw testing of the Laser Touch™ device at the Iowa Waste Reduction Center (IWRC) and completed a QA audit using non-project personnel. A complete set of results and statistical data analyses are captured in a Data Notebook for each verification test. The Data Notebook is maintained by *CTC* and is used as the basis for further reporting. Data collected from both process and laboratory testing is included.

Verification Reports and Verification Statements

The resulting products of each verification test are a final Verification Report and a three- to five-page Verification Statement, signed by the Director of EPA's National Risk Management Research Laboratory (NRMRL) and *CTC*'s representative. Verification test results are first documented in the Data Notebook, as mentioned above. The Data Notebook is summarized in the Verification Report. This report includes a QA section that documents data quality indicators, deviations from the approved TQAPP, and confidence intervals associated with the data.

Most importantly, a Verification Statement is issued that includes the tests performed and results, statistical analysis of the data, process information, and a QA/quality control (QC) narrative. The EPA and *CTC* review each Verification Report and Verification Statement prior to publishing the information. Once the Verification Statement is issued, it will be published on the ETV website where it will be available to the public.[9] The key portion of the Verification Statement is the listing of verification factors and associated results. Verification factors are those critical parameters that are measured during verification testing that address environmental performance and marketability and allow readers to evaluate the technology for their applications. For example, an environmental verification factor was the improvement of paint transfer efficiency using each HVLP gun. A key marketability verification factor was the quality of the finish provided by each HVLP gun. Verification factors are carefully selected for each Generic Protocol and product-specific TQAPP to make sure that the full benefits of testing are obtained. ETV CCEP Verification Statements are listed in Table 7.

Outreach

ETV CCEP's outreach activities have focused on: 1) involving state representatives in Stakeholder Groups that are designing the protocols and procedures, 2) developing an ETV CCEP fact sheet, 3) feeding up-to-date information to the ETV website, and 4) representing ETV CCEP and the ETV Program at numerous national meetings. Information on the activities of the ETV CCEP, including Verification Statements, Verification Reports, test protocols, and stakeholder meeting announcements and minutes, can be obtained at the ETV website or through the authors.[10]

The ETV Program has an extensive outreach program. It has developed and maintained the ETV website. All test procedures, Verification Reports, and Verification Statements for all ETV pilots are available within hours of finalization.[1, 5, 9] The ETV Program publishes quarterly program

Table 7. Verification Statements prepared by ETV CCEP.

TITLE	ISSUE DATE
ITW Automotive Refinishing - DeVilbiss FLG-631-318; Liquid Organics Coatings Application	September 23, 1999
ITW Automotive Refinishing - DeVilbiss GTi-600G; Liquid Organics Coatings Application	September 23, 1999
ITW Industrial Finishing, Binks•DeVilbiss - DeVilbiss JGHV-531-46FF; Liquid Organics Coatings Application	September 23, 1999
Sharpe Manufacturing Company - Sharpe Platinum 2013; Liquid Organics Coatings Application	September 30, 1999
Laser Touch and Technologies, LLC - Laser Touch™ Model LT-B512	May 18, 2000

updates, prepares and distributes the monthly ETVoice Listserv, has developed a brochure and fact sheet about the ETV Program, and provided an ETV exhibition booth at numerous conferences, exhibitions, and symposia. EPA has held a national ETV conference, and provided verification training to an international audience from India, the Philippines, Thailand, and Malaysia.

Reaction of the Vendor Community

ETV CCEP initially received a mixed response from the coatings industry. Industry's impression continues to become more positive as their knowledge of the program increases and as products are verified and reported upon. The vendor community has readily accepted ETV concepts for use with coating equipment, but not for coatings. Five equipment verifications have been completed and many more are in the pipeline. ITW Industrial Finishing, Binks•DeVilbiss and ITW Automotive have used the verification results for their three HVLP paint spray guns as the centerpiece of a new marketing campaign during the past year. Laser Touch and Technology, LLC, has seen a tremendous increase of sales since releasing their laser-guided paint spray gun targeting device, the Laser Touch™, and completing verification testing. Equipment vendors have found value in EPA's issuance of the Verification Statement.

On the other hand, industry has been much less excited about verifying innovative coatings. The powder and UV-curable coatings segments of the industry rejected our initial approach and some negative press was generated.[11] These vendors generally believe that their research reputation and success penetrating the market provide the credibility that they need to continue gaining market shares. They question what ETV CCEP can verify that would provide them with a market advantage. They are also concerned that coating formulations are fine-tuned for each customer and that the coatings available in the marketplace change too quickly for verification testing to be of value. In order to overcome industry apprehension, we have been challenged to provide a

stronger rationale for their participation. Our stakeholders have substantially helped to market the program and overcome our challenges. Upon seeing positive results for coating equipment and receiving feedback from ETV CCEP's stakeholders, at least one of our early critics has had a change of heart, generating favorable press for ETV CCEP.[12] Several liquid coatings are slated for testing before the end of this year and many vendors have expressed interest in future testing. Recently, UV-curable coating vendors have begun to express their interest, and we plan to test our first UV-curable coating soon.

RESULTS

The ETV CCEP has completed verification testing of four HVLP paint spray guns and of the Laser Touch™ laser-guided targeting device for manual paint spray guns. ETV CCEP tested its first liquid coating during March 2001. Another six technologies are on our short list of excited, interested participants for which TQAPPs are being developed. These include a chromate-free conversion coating, a UV-curable coating, a high transfer efficiency paint spray gun, a UV-light sensitive architectural/maintenance painting system, and two powder coating technologies. ETV CCEP plans to solicit innovative coating technologies in several trade journals. Special emphasis will be placed on UV-curable coatings.

High Transfer Efficiency Painting Systems

High-Volume, Low-Pressure (HVLP) Guns

Product Description

HVLP coating equipment is a paint application method that was developed to reduce VOC and HAP emissions that typically result from organic finishing operations. The low air pressure of HVLP coating equipment results in a low-velocity air stream with larger average paint droplet size and lower paint particle momentum, when compared to traditional spray application equipment. These conditions combine to create less paint overspray, thus improving transfer efficiency (TE) of the coating process, which in turn leads to reduced paint usage, VOC and HAP emissions, solid and liquid waste disposal, and spray booth maintenance costs. Regulations requiring the use of coating technology that is at least as efficient as HVLP coating equipment have been adopted throughout the United States, with the intention of reducing VOC and HAP emissions. For example, Rule 1511 of California's South Coast Air Quality Management District established the following definition of HVLP coating equipment on June 13, 1997:

> "Equipment used to apply coatings by means of a spray gun, which is designed to be operated and which is operated between 0.1 and 10 pounds per square inch gauge (psig) air pressure measured dynamically at the center of the air cap and at the air horns[13]."

Verification Factors

The HVLP coating equipment verification tests involved performance tests, in which the equipment applied a coating to standard test panels, followed by laboratory analysis, in which the

conditions and results of the performance tests were characterized. The performance characteristics were then grouped into environmental and marketability verification factors.

The environmental factors are:
- Relative TE Improvement
- Emissions Reduction
- Cost Savings
- Output Air Pressure (<10 psig at cap)

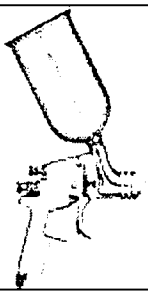
The marketability factors are:
- Dry Film Thickness Uniformity
- Distinctness-of-Image (DOI)
- Gloss
- General Visual Appearance

Each of the four HVLP spray guns was compared to a coating reference standard and a traditional air spray baseline, in which each baseline consisted of three traditional spray guns with similar fluid delivery systems using the same coating material as the HVLP gun.

Testing and Results

Four products from two vendors participated in verification testing of HVLP paint spray guns. The four HVLP guns are shown in Figure 1. The vendors selected the coatings used based on the target market of the HVLP gun they submitted for testing. The first three verification tests were conducted during the week of January 11, 1999. ITW Industrial Finishing, Binks•DeVilbiss submitted one pressure-feed HVLP spray gun and ITW Automotive Refinishing submitted two gravity-feed HVLP spray guns for testing. Both ITW divisions are based in Maumee, Ohio. The fourth verification test evaluated an HVLP spray gun provided by Sharpe Manufacturing Company of Santa Fe Springs, California, on March 17-18, 1999.

Figure 1. The ETV CCEP-verified High-volume, Low-pressure Paint Spray Guns

			
DeVilbiss JGHV **ITW Industrial Finishing, Binks· DeVilbiss**	**DeVilbiss GTi** **ITW Automotive Refinishing**	**DeVilbiss FLG** **ITW Automotive Refinishing**	**Sharpe Platinum** **Sharpe Manufacturing Company**

Each of the tested guns showed improved environmental performance. Relative transfer efficiencies improved from 16 to 37%. Calculated emissions reductions per kilogram of solids applied ranged from 0.3 to 1.5 kg. Calculated paint usage reduction per kilogram solids applied ranged from 1.2 to 5.6 L. Solid waste reduction per kilogram solids applied ranged from 0.8 to 1.8 kg. There was no significant difference in the quality of the finish.

Laser Touch™ Targeting Device

Product Description

The ETV CCEP evaluated the pollution prevention capabilities of the Laser Touch™ model LT-B512 targeting device for manual spray painting operations. The test was conducted under representative factory conditions at the IWRC's Painting and Coating Compliance Enhancement (PAC^2E) facility in Cedar Falls, Iowa. The Laser Touch™ attaches to any manual spray gun using an adapter bracket designed for each particular gun. The device is battery operated and emits two laser light beams that overlap when the spray gun is operated at a preset distance from the product being coated. This provides an environmental benefit through improved TE and consistent coating finish quality. The Laser Touch™ device is manufactured by Laser Touch and Technologies, LLC, of Waterloo, Iowa.

Verification Factors

This test was designed to verify the performance of the Laser Touch™ model LT-B512 and compare its environmental benefits with unassisted manual spray application systems, while maintaining or improving the finish quality of the applied coating. The performance characteristics were then grouped into environmental and marketability verification factors.

The environmental factors are:
- Relative TE Improvement
- Emissions Reduction
- Cost Savings

The marketability factors are:
- Dry Film Thickness Uniformity
- Gloss
- General Visual Appearance

Testing and Results

The Laser Touch™ model LT-B512 provided an increase in TE of up to 15.8 percentage points, at an average of 5.7 percentage points, which equates to a relative improvement of up to 38.8% over the unassisted baseline, at an average of 11.1%. This TE improvement equates to a reduction of volatile emissions of 0.1 kg/kg solids applied when compared to the unassisted baseline. The TE improvement also provides an economic advantage in terms of reduced paint usage (0.2 L/kg solids applied) and solid waste generation (0.2 kg/kg solids applied) when compared to the unassisted baseline. The quality of the finish improved.

At the November 2000 stakeholder meeting, Rick Klein of IWRC discussed marketplace reaction to the Laser Touch™ verification results and the effect the verification has had on the marketing of the product. Klein noted that the pollution prevention findings appear to be the most valuable results to the end users. He highlighted immediately increased sales upon release of the Laser Touch™ Verification Report, which had continued to be sustained.

Airmix® Paint Spray Gun

Product Description

The Airmix® paint spray gun is manufactured by Kremlin, Inc., of West Chicago, Illinois. Airmix® uses a patented air cap with a unique fluid tip design that produces fine atomization of coatings in a very uniform spray pattern at extremely low paint velocities and is expected to result in high TE. Verification factors would be similar to those used for HVLP paint spray guns. Kremlin is committed to verification testing.[14] The TQAPP is nearing completion, and testing could occur as early as March 2001.

Innovative Liquid Coatings

Paint and coating vendors are continually developing new formulations that meet or improve upon regulatory limits for VOC and HAP content. Compliance with regulatory limits drives the use of innovative, lower VOC and HAP content coatings in most areas and industries. However, regulatory limits do not necessarily help to market formulations that are available with VOC and HAP contents well below regulatory limits. ETV CCEP would like to verify the VOC and HAP content and performance of these coatings. One barrier to such verification is the development of the precise and accurate measurement techniques for very low, near-zero VOC content. Also, industry has little impetus to use very low VOC coatings if they are not forced to do so by environmental regulations. ETV CCEP believes that its interaction with state permit writers will encourage the use of very low VOC coatings.

ETV CCEP has designed the Generic Protocol for liquid coatings to include both mandatory and optional verification factors.[5] All environmental factors and two of the marketability factors are mandatory. The mandatory environmental verification factors are VOC and HAP content. The mandatory marketability verification factors are dry film thickness uniformity and general visual appearance. A large selection of optional marketability (performance) tests are available to the vendor should it choose to pay for their completion. Many of these optional factors are identified in the discussion of Evermore Paints and Coatings.

Evermore Paints and Coatings, LLC - Formula 5 Coating

Product Description

Evermore Paints and Coatings of Tulsa, Oklahoma, developed Formula 5 as a high-performance, water-reducible, architectural and industrial coating that is low in VOC and HAP content. It is a polyamide-epoxy-silicone-modified coating that can be air-dried or oven-cured.

Verification Factors

In addition to the mandatory verification tests for all liquid coatings, Evermore has selected a

number of optional marketability/performance tests for completion. These include gloss, MEK (methyl ethyl ketone) rub, tape adhesion, color, mandrel bend, pencil hardness, direct impact, color difference, abrasion resistance, weather resistance, salt spray, and humidity resistance.

Testing and Results

The Evermore TQAPP has been approved and testing was completed on March 23, 2001, at the NDCEE facility in Johnstown, Pennsylvania.

Technology Applications Group, Inc., Tagnite®

Product Description

The Technology Applications Group of Grand Forks, North Dakota, developed Tagnite® to be a chromate- and permanganate-free anodic conversion coating for magnesium alloys. Traditional anodic coatings use chromate or permanganate in either the coating itself or in one of the associated, pretreatment coatings.[15, 16] Both are toxic compounds.

Testing and Results

Aside from the mandatory verification factors for liquid coatings, the main environmental verification factors for Tagnite® will be the avoidance of chromium or permanganate in waste streams and the reduction of liquid waste volume. Additional marketability verification factors may be corrosion resistance, paint adhesion, and abrasion resistance. Technology Applications Group has committed to working with ETV CCEP on a test plan for verification testing.[17] The TQAPP is nearing completion, and testing is expected to begin this spring.

Allied PhotoChemical – KZ 1007

Allied PhotoChemical of Marysville, Michigan, has developed KZ 1007, a one-part urethane coating which is capable of direct application to the substrate. It is 100% UV-curable with no heat required for curing. The coating emits virtually no VOCs or HAPs since, in theory, all of the liquid coating package becomes part of the cured coating film. KZ 1007 can be applied via vacuum, roll, or spray coating.

Allied PhotoChemical has committed to working with ETV CCEP on a test plan for verification testing.[18] The TQAPP is under development, and testing is expected to begin this spring.

Process Technologies

Most process technologies submitted to ETV CCEP will require the development of a TQAPP for each individual verification test. Initially, ETV CCEP will develop TQAPPs only for process technologies. In time, a Generic Protocol will be developed.

The Superior Coatings, Inc., Ultraviolet Response (UVR) Coating System

Product Description

The UVR Coating System was developed by Superior Coatings, Inc, of Chillicothe, Missouri. It is expected to assist both manual and automatic coating applications with obtaining a uniform film thickness across the surface being coated and to aid these application processes in the more efficient use of the coatings being applied. Utilizing the properties of ultraviolet light and energy, the UVR Coating System was designed to aid in the reduction of VOC and HAP emissions by helping to meet the targeted dry film thickness and minimizing the dry film thickness variation across the coated surface.

Verification Factors

Environmental verification factors are:
- VOC Content of the UVR Primer
- HAP Content of the UVR Primer
- Dry Film Thickness
- Dry Film Thickness Variation

Marketability/performance factors are:
- General Visual Appearance
- Gloss
- Adhesion
- Salt Spray
- Humidity Resistance
- Weather Resistance
- Abrasion Resistance

Dry film thickness and its variability impact the volume of topcoat materials used for the application. The closer and more consistently the painter can achieve the desired dry film thickness without having too thin a coating layer, the less paint that will be used. Using less paint equates to fewer air emissions.

Testing Status

The draft TQAPP is completed, undergoing EPA review, and nearing approval. Tests could occur as early as April 2001.

Supercritical CO_2 Paint Spray Application

Supercritical carbon dioxide (CO_2) painting system manufacturers have approached the ETV CCEP to explore the possibility of verification testing. Supercritical CO_2 painting systems are designed to reduce VOC and HAP emissions by replacing a significant portion of the solvents in paints with supercritical CO_2 liquid. At one point, Linden Industries, Inc., of Cuyahoga Falls, Ohio, was very interested in pursuing verification testing. However, since the impending merger of Union Carbide with Dow Chemical was announced, this project has been on hold. Union Carbide holds the patents on the Unicarb® CO_2 system which would be verified. ETV CCEP continues to watch this opportunity and hopes to complete testing during the next year.

Powder Coating Technologies

Easthill Group, Inc., HotCoat® Powder Gun

Easthill Group, Inc., of Malvern, Pennsylvania, has developed inexpensive spray guns for powder coating application for use both at home and in small- to medium-sized manufacturing facilities. The company notes that affordable applications include automotive, appliances, tools, sports equipment, marine, aviation, and industrial uses. It is anticipated that ETV CCEP will verify that use of this device will allow the replacement of liquid coatings and spray paints in the marketplace, substantially reducing VOC and HAP emissions, reducing solid waste (*e.g.*, spray cans), and reducing user costs. Easthill Group has committed to working with ETV CCEP on a test plan for verification testing.[19] The TQAPP is under development.

MSC PreFinish Metals, Inc., Powder Cloud™

The MSC Powder Cloud™ is a coil coating process that anticipates high powder coating deposition efficiency, a high degree of dry film thickness control, and reduced amounts of coating waste. MSC PreFinish Metals, Inc., of Elk Grove, Illinois, has installed Powder Cloud™ technology on its production line in Middletown, Ohio. The company hopes to license the technology to other coil coating facilities. Line speeds comparable to those with liquid coatings are anticipated with powder film thicknesses of 0.4 to 5.0 mils.[20]

MSC PreFinish Metals sent a representative to ETV CCEP's November 2000 stakeholder meeting and has committed to working with ETV CCEP on a test plan for verification testing.[21] The TQAPP has not yet been started.

CONCLUSIONS

This paper has presented the key concepts used by the ETV Program since its inception in 1995 and throughout the program's pilot period that ended on September 30, 2000. It has reviewed the scope of ETV's Coatings and Coating Equipment Pilot and how that pilot applied the verification process. The paper has also discussed the benefits of verification and the response of the vendor community. Finally, verification tests completed by ETV CCEP have been reviewed and future testing has been summarized. Additional information about the ETV Program and ETV CCEP can be found on the ETV website.[1, 10] On the site, you can find information about future ETV CCEP stakeholder meetings. Please feel free to attend these meetings.

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DISCLAIMER

This paper has been peer and QA reviewed by U.S. EPA and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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KEY WORDS

Environmental Technology Verification Program (ETV)
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Product-specific test protocol
Testing and Quality Assurance Project Plan (TQAPP)
Verification Report
Verification Statement
Coating equipment
National Defense Center for Environmental Excellence (NDCEE)
Volatile organic compound (VOC)
Hazardous air pollutant (HAP)
High-volume, low-pressure (HVLP) paint spray gun
Paint transfer efficiency
Stakeholder Group

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16. ABSTRACT The paper discusses the use of environmental technology verification (ETV) to reduce the risk of using innovative coating technologies. It presents key concepts of the ETV program, reviews the scope of the ETV program's coatings and coating equipment pilot (CCEP) and its use of the verification process, discusses benefits of verification, and reviews completed verification tests and those planned in the near future. The program's CCEP was established in January 1997 to verify the environmental and finishing performance of innovative surface coatings, coating equipment, and related processes. It provides high quality data through the use of efficient and fully quality assured verification test protocols. EPA's partner for the CCEP is Concurrent Technologies Corporation (CTC) of Johnstown, PA. The ETV program was established in October 1995 as a 5-year pilot by EPA's Office of Research and Development and provides independent, third-party verification of the performance of cost-effective innovative technologies and processes that provide an environmental benefit, hence accelerating their entrance into the marketplace and reducing the implementation risk of end users. The end product of the verification process for each technology is a verification statement, a summary of the testing and results, signed by the EPA and its partner testing organization.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Coating Processes	Stationary Sources	13H
Coatings		11C
Verifying		14B
Risk		12B
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