ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAMS: THE CURRENT "STATE OF THE ART"

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ABSTRACT

There are numerous technology verification programs that are meant to expedite technology deployment and commercialization. Currently, there are 23 different programs run by federal agencies (EPA, DOD, DOE), states and the Canadian government. Differences among key elements of the various programs are presented. At issue are a number of policy questions that affect the ultimate success of verification programs including: program reciprocity and acceptance by regulators, program motivation (environmental vs. economic), market impact, costs and impact on investment. Several significant efforts to ensure that verification results increase standardization and reciprocity between states (i.e., Six State MOU and ITRC) and countries (i.e., NAFTA, APEC, OECD) are detailed.

WHAT IS VERIFICATION?

It has been said, "if it doesn't work, then it must be technology." Technology verification aims to prevent the common problems encountered by new ideas and new technologies by "verifying," often through a third-party, that a new technology can do what is claimed. Verification aims to accelerate the pace by which technology is accepted into the market place by providing information about a technology's performance and therefore increasing certainty by users, regulators and the public.

The need for credible data is especially critical in the environmental arena where public health and environmental protection are at risk. For many years, state and federal regulatory agency personnel have often had to use best professional judgment on whether or not to permit new technologies. Vendors have had to incrementally build a body of evidence and experience on the appropriate use and applicability of their products, resulting in a slow and costly process. Given the broad concern about these barriers to using innovative environmental technologies, the White House included environmental technology verification as a priority in its *Bridge to a Sustainable Future: National Environmental Technology Strategy*.[i] Two primary goals of the *Strategy* that called for a national verification program were to: 1) facilitate the technology commercialization process, and 2) reduce the costs of environmental compliance through the use of innovative technologies.

Government agencies and the environmental industry have seized upon verification as a way to increase sales of value-added environmental products and services in both domestic and

international markets. Although not currently formally required by permits or other regulatory mechanisms, verification statements are expected to help companies decrease the regulatory costs for innovation and environmental compliance. Increased sales offer the hope that living wage jobs are created, revenues for environmental technologies increase, and the environment benefits from the application of innovative technologies.

VERIFICATION VS. CERTIFICATION: A DISCUSSION OF TERMS

The terms verification and certification are often used interchangeably and differently by different entities. *In general*, verification means an independent third-party testing and evaluation of vendor performance claims. Certification often implies a guarantee of performance into the future. Due to liability concerns, many programs explicitly "verify" but do not "certify." Some programs use certification (i.e., California EPA) to include the issue of reliability; others use the term certification when the meaning more closely allies with verification (i.e., Washington Department of Ecology). In addition, regardless of terminology, most programs explicitly do not equate verification or certification with an "approval," either regulatory approval or official "agency short-listing" of a technology.

As a starting point, these definitions are from the U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) program:[ii]

- Verify/Verification: To establish or prove the truth of the performance of a technology under specific, predetermined criteria or protocols and adequate data quality assurance procedures.
- Certify/Certification: To guarantee a technology as meeting a standard or performance criteria into the future.

However, it must be noted that there is *no one definition* for verification that is universally accepted by all programs. Nor is there, in fact, complete consensus among state and federal agency personnel about which programs ought to be considered a formal verification program, versus a *validation program*, which performs many of the functions of a verification program (e.g., gather cost and performance data).

The programs represent a spectrum of verification-related services. Rather than exclude programs when a lack of consensus exists, this paper includes both programs that consider themselves to be verification programs, and validation programs where cost and performance data are collected in order to facilitate more rapid technology deployment, often for the public sector (i.e., U.S. Department of Defense [DoD] and U.S. Department of Energy [DOE]). However, all programs described are voluntary in nature and are meant to have broad applicability. Specifically excluded are testing and validation programs that *are required* as part of a specific permitting, listing or accreditation process.

CURRENT EFFORTS: PROGRAMS YOU SHOULD KNOW ABOUT

The high level of interest in environmental technology verification has resulted in a proliferation of programs. This paper discusses 23 separate verification programs in the U.S. and Canada; although no attempt was made to include non-North American (i.e., European or Asian) programs. These 23 programs are categorized into four principle groups based on governmental affiliation: EPA programs, other federal programs, state programs and Canadian programs. It is important to note, however, that most of the programs are in fact public/private partnerships.

EPA Programs

EPA has 13 different formal verification programs under its management. The **Superfund Innovative Technology Evaluation program (SITE)**, the earliest evaluation/verification program created by EPA, was designed to support the Superfund program's technical requirements. The **ETV program** has 12 pilot programs that are linked by a common strategy and are coordinated with each other. However, the ETV pilots are quite distinct because they focus on different types of technologies, use different verification partner organizations, have their own stakeholder groups, and ultimately serve different markets. The ETV Pilots are presented in Table I.

Table I. EPA ETV Pilots and Partner Organizations

Pilot Name	Partner Organization
Advanced Monitoring Systems (Water & Air)	Battelle
Air Pollution Control Technology	Research Triangle Institute
Drinking Water Systems	NSF International
Environmental Technology Evaluation Center (EvTEC) – independent entity	Civil Engineering Research Foundation
Greenhouse Gas Technology	Southern Research Institute
Indoor Air Products	Research Triangle Institute
P2: Innovative Coatings and Coating Equipment	Concurrent Technologies Corporation
P2:Metal Finishing	Concurrent Technologies Corporation
P2, Recycling, Hazardous Waste Treatment Technologies	California Environmental Protection Agency
Site Characterization and Monitoring Technologies	EPA Las Vegas Lab; DOE's Sandia and Oakridge Labs
Source Water Protection Technologies	NSF International
Wet Weather Flow Technologies	NSF International

Other Federal Programs

Federal agencies with direct environmental management and trade responsibilities are also interested in verifying and deploying innovative technologies. DoD has developed the **Environmental Security Technology Certification Program (ESTCP)** and the **Environmental Tech Center** to address DoD-specific needs. DOE has funded the **Hemispheric Center for Environmental Technology (HCET)** and the **Innovative Treatment Remediation Demonstration Program (ITRD)** to address DOE-specific needs. The **Rapid Commercialization Initiative (RCI)** is a collaborative effort among federal agencies (led by the

U.S. Department of Commerce), state associations and California to facilitate technology commercialization.

State Programs

States have been quite active in developing new programs to address verification issues. Initiatives by states provide one of the most dynamic arenas in the verification field. The **California Environmental Protection Agency (Cal/EPA)** developed the first state program for certifying environmental technologies. The **Massachusetts Strategic Envirotechnology Partnership (STEP)**, **New Jersey Corporation for Advanced Technology (NJCAT)** and **Washington State Department of Ecology** have all created programs to focus state resources on verifying innovative environmental technologies. These programs are all partnerships, sometimes between state agencies and sometimes with private sector participants.

Canadian Programs

The Canadian government, working with the environmental industry, has created the Canadian Environmental Technology Verification Program administered by **ETV Canada Inc.** to serve a verification function for Canadian companies.

SUMMARY MATRIX

Table II, located at the end of the paper, presents key information about each of the programs. For more detailed information, the programs and their web sites should be consulted directly. Key factors addressed in the matrix and profiles include:

Program Description

Nature and Scope of Program:

- Program Sponsor - the governmental sponsor is described; specific linkages to other governmental entities, private sector partners and/or testing organizations (e.g., labs, field sites) are noted.
- Purpose - the fundamental goal and purpose of each program varies; some programs emphasize strict performance information while others are oriented towards regulatory issues or commercialization.

Technologies Verified:

- Technology/Product Types - programs vary on what types or categories of technology they address; some programs address a narrow range while others are not limited.
- Media Focus - some programs have a media specificity, while others cover all media
- Selection Criteria - how mature technologies must be in the commercialization process differs between programs, with many programs requiring “commercially ready” technologies.

Collection and Review of Data:

- The role and who conducts the testing (i.e., the verification program, a third-party, or the vendor) varies significantly between programs; acceptability of existing data, test plan requirements and the existence of pre-existing program protocols also vary significantly.

Process and Costs

- Verification Timeframe - the time it takes to "get verified" varies tremendously from technology to technology and between programs; however, a rough order of magnitude is given (i.e., a number of months or over one year); re-verification requirements are noted where applicable.
- Program Responsibilities and Costs - vendor and program responsibilities are delineated; although actual costs per verification are difficult to generalize, how costs are allocated between the vendor, the program and others differs considerably between programs.

Results and Products

- Verification Form and Content - programs differ on what vendors get once a technology is verified, from a one page summary, to a detailed technical report, to a program logo to use in marketing.
- Product Market - the primary and secondary markets where programs believe their verification has the most benefits: private sector markets, public sector markets (e.g., DoD and DOE) and international markets.
- Other Services - some programs offer complementary commercialization services for technology vendors and developers such as: business or financial planning assistance, product marketing, assistance with regulatory concerns; programs that are initiating inter-program cooperation or reciprocity are noted.

Reciprocity: What is it and how are we Getting There?

The issue of reciprocity (i.e., having one governmental body accept the findings, permit decisions or approvals of another government) lies at the heart of the problem in obtaining faster and broader market acceptability for environmental technologies. This issue applies to all levels of government, from localities within one state to an issue between nations. Although formal reciprocity between states is unlikely in the near future, states are working on developing mechanisms that encourage sharing and cooperation regarding information requirements for permits and other regulatory requirements. There are two primary processes, both at the interstate level, that are attempting to address the problem of information consistency and regulatory cooperation. In addition, some initial steps are being taken to address the issue for U.S. interests internationally.

Six-State Memorandum of Understanding (MOU)

Six states have joined together to determine what is technically and operationally required for a technology to be approved for use in their respective states. California, Illinois, Massachusetts,

New Jersey, New York, and Pennsylvania have signed an MOU to define a process for reciprocal evaluation, acceptance, and approval of environmental technologies. The process will enable the six states to consider the data, approvals and permits from another state as if they had been produced in their respective state.

The states propose using a three-tiered process for reciprocal acceptance of data and performance tests. Tier I corresponds to vendor guidance to develop credible data pertaining to all technology classes. Tier II relates to comprehensive performance testing for a specific technology class. Tier III provides vendors and state permit writers regulatory and technical guidance for specific technology types. The MOU process specifically acknowledges the incorporation of verification programs and related protocols under Tier III guidance documents.

The MOU process has not been easy or rapid, and the results of this effort indicate the challenges of obtaining formal reciprocity agreements between a large number of states. However, three verification states (i.e., California, Massachusetts and New Jersey) are part of the MOU process and hope to develop increased reciprocity and markets for technologies that are verified under their respective verification programs.

Interstate Technology and Regulatory Cooperation Work Group (ITRC)

The ITRC is a state-led, national coalition whose mission is to create tools and strategies to reduce interstate barriers to the deployment of innovative hazardous waste management and remediation technologies. Over 25 states, three federal agencies (DOE, DoD and EPA), public and private stakeholders, and two state associations participate. A primary goal of the ITRC is to produce permitting and test results that can be accepted by the other participating states. The primary method for obtaining this type of reciprocity is through the development and use of technical guidance documents, of which over 22 have been developed by ITRC committees. Eleven have been Technical/Regulatory Requirements: these guidance documents reflect a consensus of state technical/regulatory concerns that should be considered when approving the use of a specified technology or in demonstrating a technology. Eleven have been Informational Reports, which come in the form of benchmarking of state practices, case studies, or status reports on emerging technologies for use in identifying barriers and preliminary findings/guidance.

Specifically related to verification, the ITRC has established a Verification Team to evaluate 11 verification programs that address remediation and characterization technologies to determine what information is needed by states to increase use of verification program results. The Verification Team's overall goal is to "make information on state needs available to environmental technology verification programs and to provide a forum for discussion of topics of interest to verification programs and states."

In 1998, the ITRC Verification Team identified state needs for environmental technology verification. It is anticipated that if these needs were included in existing verification programs, it would enhance states' confidence in the results of verification and allow them to make more informed decisions regarding use of remediation technologies. The needs are summarized in the

report entitled *Multi-State Evaluation of Elements Important to the Verification of Remediation Technologies*.[iii] Plans in 1999 include:

- communicating the state needs from environmental technology verification, which would permit states to make more informed decisions regarding the use of remediation technologies;
- providing this information to verification programs so that they can use it and thus enhance states' confidence in verification results; and
- encouraging and supporting consistency in verification programs and among states.

International Reciprocity

International reciprocity has two main implications: increasing markets for verified technologies (and thus the value of verification programs) and preventing the creation of non-tariff trade barriers. Clearly, where verification results have the acceptance from other national governments, the potential increase in market acceptance can be significant. Likewise, if many different standards for environmental technologies are created without addressing trade considerations, there may be some concern over creating non-tariff trade barriers to international trade.

The three main venues for this discussion relative to the U.S. are 1) the North American Free Trade Agreement (NAFTA), 2) the Asia Pacific Economic Cooperation Forum (APEC), and 3) the Organization for Economic Co-operation and Development (OECD). There are ongoing talks, but no current formal agreement, between NAFTA signatory countries (i.e., U.S., Canada and Mexico) about what technology verification programs are adequate and what should be required to ensure adequacy and/or reciprocity. APEC, currently 21 member economies from the Pacific Basin, has taken initial steps towards discussing verification under its Industrial Science and Technology Working Group. At an Environmental Technology Verification Workshop, held in Seattle during September 1998, international delegates from APEC members discussed existing programs and resources, the need for verification, prioritizing technology needs, strategies for pilot programs, and approaches for information exchange. An Action Plan for the APEC Industrial Science and Technology Working Group will address follow-up activities. The OECD, made up primarily of North American and European members but also including Japan, South Korea, Australia, New Zealand and some Eastern European countries, has recently commissioned a study of technology verification programs with an interest in understanding what policy mechanisms are available for its members. As OECD membership includes all NAFTA participants and a few APEC members, there seems to be some opportunity for collaboration among the various organizations.

Programmatic reciprocity is somewhat different than governmental reciprocity in that individual programs can agree to reciprocal agreements acknowledging each other's verification programs without leading to a direct or formal governmental acceptance. Even so, verification program reciprocity does not necessarily increase markets by itself, but it can increase visibility and awareness for verified technologies. At the programmatic level, ETV Canada has developed reciprocity agreements with both Cal/EPA and NJCAT (see these program profiles for details).

Reciprocity and the "Patchwork"

The issue of reciprocity between states, between programs and between countries will remain a major challenge. The progress of the six states and the ITRC, while important, remains tediously slow for companies trying to improve quarterly sales figures. The existing "patchwork" of programs remains another concern. Although the "Underwriter's Laboratory (UL) model" is frequently referred to, the existing national approach is far from a single testing and verification entity. Will the "patchwork" approach work? Will the number and diversity of programs confuse either the developers (who may not know which program to use) or the users (who may not know which program to trust)? Will some form of standardization emerge among programs that is not "reciprocity"?

Ultimately, some programs and entities will prevail by being recognized by the market. For some foreign buyers, an EPA or U.S. state logo on a verification statement may be enough. However, most overseas buyers still want to make sure that the technology will work under their country's specific conditions. Internationally, the differences between programs may appear slight and moot. Domestically, the differences may not be so insignificant. The issues of reciprocity and market acceptance tie together, because the degree to which a verification statement is formally recognized by various governmental entities will have a direct impact on available markets and potential sales.

Program "Motivation"

For vendors seeking to verify their technology, a program's fundamental orientation or motivation may be an important consideration. Economic development and market access drive some programs while others are strongly oriented towards environmental problem solving as a primary goal. This may be manifest in who is required to conduct the verification testing, how detailed the testing must be, and who participates in the program (from partner organizations, to stakeholders and advisory panels). Direct access to additional business services (e.g., financing, marketing assistance or business plan development) may be more linked with the economically motivated programs.

The target market for the program (i.e., who does the program envision using their verification information) is another essential ingredient. For companies explicitly interested in public sector or international markets, some programs are clearly better than others. For increasing access to private markets, other programs will likely provide an advantage.

Market Impact

Despite all of the program development activity, how environmental technology verification programs will succeed in commercializing new technologies is relatively unknown. Besides the fact that many of the programs have only been around for a few years, there have been no comprehensive studies that evaluate what impacts voluntary verification programs have made on technology sales, cost savings for technology users, economic development, or increased environmental protection.[iv] Governments, both federal and state, see the potential benefits of

increased commercialization for both the economy and the environment. But the ultimate arbiter of verification's value will remain the market place.

From a technology developer's perspective, the main question is: "Will verification of my technology increase use and sales?" For technology users, the primary issues are cost and reliability, "How well will verification *ensure* that the product will *reliably* do what is claimed within the cost range I expect?" Although the results of verification programs are not intended or designed to provide such assurance, performance information obtained from a verification process is expected to assist technology users make technically sound decisions. Currently, very few verification programs collect or verify cost data, including operations and maintenance costs. Some programs do try to capture costs as "cost factors," the units of labor or energy required to operate a technology. Because cost is one of the prime drivers for technology users, how this information is incorporated into programs could be a significant issue as programs mature. If verification programs can provide confidence to technology buyers that the technology decreases risks and costs, then both users and developers should benefit.

Ultimately, the value of verification programs will be determined by the number of companies that seek verification of their technologies and by the number of technology users that demand verified technologies. Not unlike the International Standards Organization's ISO 14000 standards, the market will determine how valuable and necessary technology verification will be. Given the current concerns with a flat U.S. environmental industry growth and a general rethinking of command and control regulatory structures, the opportunities for new, cost-saving technologies are bound to increase. Verifying these technologies' capabilities will likely be an important part of the marketing, investment and deployment process.

Costs of Verification

A key factor affecting vendor participation in verification program activities is cost. At one end of the spectrum are those programs that have funding to underwrite all program and testing costs; vendors are responsible only for their own operation and mobilization costs, as applicable. Programs that have programmatic costs paid by government grants represent the mid-point but direct costs, such as testing or expert panel travel, must be borne by the vendor. Other programs are required to be run on a cost recovery basis, where vendors must pay for staff time in addition to all testing and mobilization costs. Vendors must carefully consider how the colloquialism "you get what you pay for" pertains to their situation.

Regardless of program costs, verification will almost always cost more than an individual demonstration because, by its nature, verification is trying to show the performance of a technology over a range of circumstances and operating conditions. Of course, one of the ultimate goals of verification is to reduce the need for multiple testing and demonstrations and save costs over the technology introduction lifespan. However, if test and demonstration plans are designed in conjunction with a verification program, the incremental cost would be lower than if a separate verification testing program is required (this is especially true for field technologies or those that have significant mobilization costs). Thus, advance planning for

technology verification can best serve the developer or vendor from a logistics and cost perspective.

It is always important to keep in mind that technologies that already have widespread market acceptance do not require verification. In addition, a verified technology is not guaranteed to be cheaper or necessarily perform better than a non-verified technology. The fundamental attributes of the technology (i.e., what it does and how it performs) remain an essential element of its market application and acceptance.

Investment in Environmental Technologies

Will a more predictable market for technologies, brought about by faster regulatory approvals due to verification, result in increased funding for environmental technology research and development? Current investment in new environmental technologies is disproportionately funded from the federal government. Many technologies that have been under government sponsorship fail to "make the cut" when private sector investment is required. The lack of an easily penetrated market, due to risks of the technology and a lack of reciprocity, often result in good technologies being left in what is commonly known as "the valley of death." The valley of death means that adequate investment is not available to bring a technology to full commercialization and market acceptance. Contributing to the lack of capital are competing demands for capital from other high technology sectors. If verification with widespread reciprocity can make environmental markets more consistent and predictable, and capital investment in environmental technologies expands, the value of verification programs would be enormous. Both policy makers and industry will closely watch the impact of verification programs on the level of investment in environmental technologies in order to measure success.

CONCLUSIONS

The mid- to late-90s has seen explosive growth in the number of verification programs. The field remains highly dynamic, with new state and federal initiatives developing regularly. Market niches are re-defined, new programs are created to meet demand or perceived demand, and more vendors enter the process. However, some programs are already seeing that it is difficult to attract the number and types of vendors that were expected. Barriers described above have limited the number of applications and the extent of innovative technology implementation. Potentially, some verification programs will suffer from lack of participation; mergers, attrition and change will occur. However, this is a positive process where the vendors and markets define what is essential, what adds value and what mechanism best delivers those services.

Implementing innovative technologies in the environmental arena is not an easy task. Until widespread regulatory reform changes the nature of the existing command and control system, incentives for using new technologies will likely remain inadequate. Rather than dwell on this large-scale regulatory, bureaucratic and philosophical change, verification programs have arisen as a practical incremental approach to fill a need in the regulatory and commercialization realm. There are many cases where verification does not provide added value in terms of marketing, regulatory processes or stakeholder awareness. However, what this paper is meant to make clear

is where verification *can* play a role in accelerating technology use and deployment, vendors have a plethora of useful and diverse choices.

ACKNOWLEDGMENTS

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ENDNOTES

[i] National Science and Technology Council. 1995. *Bridge to a Sustainable Future: National Environmental Technology Strategy*. Interagency Environmental Technologies Office, Washington DC. 87 pp.

[ii] U.S. Environmental Protection Agency. 1997. *Environmental Technology Verification Program: Verification Strategy*. EPA/600/K-96/003. Office of Research and Development, U.S. Environmental Protection Agency, Washington DC. 18 pp.

[iii] ITRC. In preparation. *Multi-State Evaluation of Elements Important to the Verification of Remediation Technologies*. Interstate Technology and Regulatory Cooperation Work Group, Verification Team.

[iv] For an early assessment see: Environmental Law Institute. 1995. *Environmental Technology Verification: A Study of Stakeholder Attitudes*. ELI, Washington DC. 43 pp. + appendices. Also, EPA's ETV program as a whole will undergo an evaluation and several other programs will conduct individual self-assessments.