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Fundamentals of Successful Monitoring, Reporting, and Verification under a Cap-and-Trade Program

John Schakenbach, Robert Vollaro, and Reynaldo Forte
U.S. Environmental Protection Agency, Office of Atmospheric Programs, Washington, DC

ABSTRACT

The U.S. Environmental Protection Agency (EPA) developed and implemented the Acid Rain Program (ARP), and NO_x Budget Trading Programs (NBTP) using several fundamental monitoring, reporting, and verification (MRV) elements: (1) compliance assurance through incentives and automatic penalties; (2) strong quality assurance (QA); (3) collaborative approach with a petition process; (4) standardized electronic reporting; (5) compliance flexibility for low-emitting sources; (6) complete emissions data record required; (7) centralized administration; (8) level playing field; (9) publicly available data; (10) performance-based approach; and (11) reducing conflicts of interest. Each of these elements is discussed in the context of the authors' experience under two U.S. cap-and-trade programs and their potential application to other cap-and-trade programs.

The U.S. Office of Management and Budget found that the Acid Rain Program has accounted for the largest quantified human health benefits of any federal regulatory program implemented in the last 10 yr, with annual benefits exceeding costs by >40 to 1. The authors believe that the elements described in this paper greatly contributed to this success. EPA has used the ARP fundamental elements as a model for other cap-and-trade programs, including the NBTP, which went into effect in 2003, and the recently published Clean Air Interstate Rule and Clean Air Mercury Rule. The authors believe that using these fundamental elements to develop and implement the MRV portion of their cap-and-trade programs has resulted in public confidence in the programs, highly accurate and complete emissions data, and a high compliance rate (>99% overall).

INTRODUCTION

The U.S. Environmental Protection Agency's (EPA) Acid Rain Program (ARP) was instituted in 1990 under Title IV of the Clean Air Act (CAA) and was established by EPA in 1995. The ARP regulates the sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions of electric generating units that burn fossil fuels, such as coal, oil, and natural gas, and that serve a generator >25 MW. For these units, Part 75 of Volume 40 of the Code of Federal Regulations (CFR) requires continuous monitoring and reporting of SO_2 mass emissions, carbon dioxide (CO_2) mass emissions (Section 821 of the Clean Air Act requires CO_2 emissions to be monitored and reported to EPA), NO_x emission rate, and heat input. The SO_2 component of the ARP is a "cap-and-trade" program, designed to reduce acid deposition by limiting SO_2 emission levels in the "lower 48" states of the United States. EPA controls NO_x emissions from coal-fired generating units through rate-based standards linked to boiler types and allows for companies to "average" rates for these generating units.

In October 1998, EPA added Subpart H to Part 75, which provides a blueprint for the monitoring and reporting of NO_x mass emissions and heat input under a state or federal NO_x emissions reduction program. The agency anticipated that such programs were likely to come into existence because of growing concern over health hazards associated with NO_x emissions from power plants and large industrial sources. NO_x is a precursor to ozone and fine particulate matter formation. Subpart H has since been adopted as the required monitoring methodology for NO_x mass emissions and heat input under the NO_x Budget Trading Program (NBTP).

According to the U.S. Office of Management and Budget, the ARP has accounted for the largest quantified human health benefits of any federal regulatory program implemented in the last 10 yr, with annual benefits exceeding costs by >40 to 1.[1] EPA has used the ARP as a model for other cap-and-trade programs, including the NBTP, which went into effect in 2003, and the recently published Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR). The monitoring components of CAIR and CAMR are scheduled to take effect in 2008 and 2009, respectively. These rules also require emission monitoring to be done according to Part 75.

A key element of the foundation of the EPA cap-and-trade programs is the requirement to obtain and report accurate emissions data by continuously monitoring key parameters, such as pollutant concentration and stack gas volumetric flow rate. All of the sources in the trading programs are required to monitor and report emissions according to a single set of rules, that is, Part 75. The basic monitoring requirement of Part 75 is to use continuous emission monitoring systems (CEMS) for all pollutants and parameters. However, Part 75 allows alternatives to

IMPLICATIONS

This paper discusses several elements that the authors believe were fundamental to the success of two U.S. cap-and-trade programs: the ARP and the NBTP. These elements may be useful to the design and implementation of other cap-and-trade programs both within and outside of the United States.

CEMS for the following units and fuel types: (1) oil-fired and gas-fired units may use fuel flow metering and fuel sampling data to estimate heat input rate and hourly SO_2 emissions; (2) oil-fired and gas-fired peaking units may use fuel flow metering together with a correlation curve of NO_x emission rate versus heat input rate derived from emission testing to estimate hourly NO_x emissions; (3) any unit may use fuel sampling and fuel feed rates to estimate CO_2 emissions (although this option is allowed for coal-fired units, none of them use it; in the ARP and NBTP, all of the CO_2 emissions from coal-fired units are measured with CEMS); (4) low-emitting oil-fired and gas-fired units may use default emission rates and records of fuel usage to estimate SO_2, NO_x, and CO_2 emissions; and (5) coal-fired units with very low mercury (Hg) emissions may use a default Hg concentration derived from emission testing to estimate Hg mass emissions.

A recent multiagency report[2] to Congress concluded that (1) the ARP monitoring regulations include strict substitute data procedures to estimate emissions when approved methods are not used, provide strong incentive to minimize monitor downtime, and help ensure that emissions are not underreported; (2) all of the monitors are required to meet stringent quality assurance (QA) standards to demonstrate their accuracy, precision, and timeliness; and (3) the monitors used by sources to comply with the ARP have achieved an unparalleled level of performance with respect to all of these criteria.

The authors believe that as a direct result of implementing the strict quality-assurance requirements and substitute data procedures in their cap-and-trade programs, the regulated sources have provided EPA with highly accurate, reliable emissions data and have achieved a nearly perfect compliance record. However, these high levels of data quality and source compliance were not attained from the outset of the programs. Rather, they were achieved through several years of careful program implementation, working closely and cooperatively with the regulated community. The authors believe that in order for a cap-and-trade program to succeed, it is essential that the monitoring, reporting, and verification ([MRV] QA/quality control [QC]) elements of the program be based on principles that foster the development and maintenance of a strong program. The success of their cap and trade programs has, in large part, resulted from implementing the following key MRV elements: (1) compliance assurance through incentives and automatic penalties; (2) strong QA; (3) collaborative approach with a petition process; (4) standardized electronic reporting; (5) compliance flexibility for low-emitting sources; (6) complete emissions data record required; (7) centralized administration; (8) level playing field; (9) publicly available data; (10) performance-based approach; and (11) reducing conflicts of interest.

This paper briefly discusses the guiding philosophy and principles behind these MRV program elements as they have been implemented over the past 10 yr in the ARP and, more recently, in the NBTP. It also discusses how these principles may be applied to other cap and trade programs.

DISCUSSION

Compliance Assurance through Incentives and Automatic Penalties

U.S. Cap-and-Trade Experience. The ARP and NBTP are based on a monetary system of tradeable allowances (1 t of SO_2 or NO_x = 1 allowance) that requires rapid, end-of-year reconciliation of emissions and allowances. Because of this, EPA had to minimize the use of traditional enforcement procedures. (For the NBTP, which is an ozone season [May 1 through September 30] program, reconciliation is done at the end of the ozone season.) If EPA had to process many traditional enforcement cases through the court system, end-of-year reconciliation would be unacceptably delayed, introducing market uncertainty into the program and increasing costs. In the cap-and-trade programs, enforcement activity is minimized by creating incentives for compliance in the regulations and statutes, including: provisions for reduced frequency QA testing when superior test results are achieved, progressively stringent missing data requirements, comprehensive electronic record keeping and reporting requirements, and automatic statutory penalties that are greater than the cost of allowances. These provisions are discussed in the following paragraphs.

In both the ARP and NBTP, the QA provisions have built-in incentives for better accuracy and self-enforcement. For example, a source that uses fuel flow metering as one of its monitoring methodologies is required to calibrate the fuel flow meter annually, unless quarterly data analyses comparing the measured fuel flow rates to the corresponding unit loads are performed, demonstrating that the flow meter is still generating accurate data. In that case, the interval between flow meter calibrations can be extended for $\leq$5 yr.

Similarly, a source using a CEMS that achieves excellent relative accuracy (RA) test audit (RATA) results ($\leq$7.5%; results from RATAs under both the ARP and NBTP are averaging 2.5% accuracy or better) need only perform the RATA once per year instead of twice per year. A one-tailed *t* test (bias test) is required to be calculated from the RATA data. If the bias test fails, a correction factor must be applied to the reported emissions data to prevent underreporting. For many sources, the bias test provides incentive to find and correct any underlying monitoring problems causing underreporting and helps us avoid potential enforcement cases.

The missing (substitute) data provisions for CO_2, SO_2, and NO_x in 40 CFR Part 75 are required to be used by a source when its monitoring equipment or methodology is not working properly. Using historical data on the reliability of the types of CEMS used in the ARP, EPA developed monitor data availability "cut points" (e.g., 95% availability, 90% availability, etc.). As the monitor data availability drops below each successive cut point, the required substitute data values become more and more environmentally conservative. This causes the source to overreport its emissions and provides a strong incentive to properly maintain and QA the monitoring equipment. An excellent detailed description of the missing data provisions can be found in EPA's *Plain English Guide to the Part 75 Rule* (www.epa.gov/airmarkets/monitoring/plain_english_guide_part75_rule.pdf).

The result of these incentives is a >99% overall compliance rate. This means significantly less time spent on enforcement cases. Reviewing the nine monitoring-related enforcement cases over 10 yr, each case can require ~40 person-hours, which include technical analyses, management briefings, liaison with other EPA offices and the U.S. Department of Justice, and conference calls with the offending source. These enforcement activities often hinder the progress of a source in meeting its emission reduction goals.

Even with relatively few enforcement actions required, those few are vigorously pursued. In the authors' view, no mandatory emission reduction program, including a cap-and-trade program, can succeed in the long run without vigorous enforcement. Vigorous enforcement of violators sends a message to the entire regulated community that noncompliance will not be tolerated. Key components of a strong enforcement program include record keeping, reporting, and penalties.

Record keeping and reporting requirements are essential for a strong enforcement program. Standardized electronic data reports submitted to EPA once per quarter allow for tracking of the quality of the emissions data throughout the year, as well as the status of emissions compared with the allowances held. The authors have found that having the ability to check for problems at least once per quarter allows more timely corrections by the source before end-of-year reconciliation and often allows a source to avoid significant penalties.

Data to be reported and kept on-site by the source include: (1) hourly emissions data; (2) heat input and load (output) data; (3) the results of any required QA tests; (4) source operating hours for the quarter and cumulative operating hours for the calendar year; (5) tons of SO_2, NO_x, and CO_2 emitted quarterly and cumulatively; and (6) other information useful for verifying the mass emissions of a source. EPA requires the data to be submitted electronically, because of the large volume of information that must be reported. The agency provides a standard electronic data reporting (EDR) format that must be used and provides monitoring data checking (MDC) software that can be used by the source to perform QC checks on the data before data submittal. This software allows formatting, inadvertent omissions, and similar problems to be fixed faster. Occasionally, the checking software uncovers problems that are not fixable, for example, when a QA test has not been done properly and data must be invalidated. Although use of the MDC software is optional, EPA encourages it, because using MDC will cut down on the number of resubmissions and save time and money. Using several software programs, EPA processes each quarterly report through rigorous QC checks to verify data accuracy and conformance to the required format. After the review, EPA sends notifications to the affected sources, indicating whether the quarterly data are acceptable or unacceptable.

For an ARP source that fails to comply with the allowances it holds for a particular calendar year, Section 411 of the Clean Air Act provides for stringent automatic penalties. The excess emissions penalty for SO_2 or NO_x is \$2000/t, adjusted for inflation each year, and payable without demand to the U.S. Treasury. This statutory penalty is significantly higher than the value of an allowance. In practice, after end-of-year true-up, EPA sends a letter to any source with excess emissions; the source must pay the EPA Administrator within 30 days. With this automatic penalty, there is generally no need for EPA to go through the courts to collect the penalty.

Section 411 of the CAA also requires a source that violates its emission limitation or the allowances it holds to offset the excess emissions by an equal tonnage amount in the following calendar year. Details of the excess emissions penalties may be found in 40 CFR Part 77 (www.access.gpo.gov/nara/cfr/waisidx_04/40cfrv15_04.html).

In 2004, the SO_2 excess emission penalty was \$2963/t (this is inflation adjusted from the 1990 amount that Congress set of \$2000). The owners of four units (of 3391 total units in the program) were assessed a penalty of approximately \$1.4 million for emitting 465 t of SO_2 in excess of the allowances held in their accounts. Had these sources bought allowances, they would have collectively spent only \$139,500 (assuming the 2004 high spot auction bid price of \$300 per allowance).

Final decisions under Part 77 Excess Emissions may be appealed under Part 78 Appeal Procedures for ARP. A source must exhaust the appeals procedures under Part 78 before seeking judicial review. EPA may impose a discretionary civil penalty of less than or equal to \$25,000 per day per violation (see Section 113 of the CAA [42 United States Code, USC, 7613]). Accounting for inflation (see the Federal Civil Penalties Inflation Adjustment Act of 1990 [28 USC 2461] and the Debt Collection Improvement Act of 1996 [31 USC 3701]) in 2006, this penalty is \$32,500 per day per violation. Although EPA has not needed to assess a criminal penalty under the ARP or the NBTP, such a penalty is also provided for in Section 113 of the CAA.

These tough statutory provisions provide strong incentives for a source to comply and are useful because they remove some agency discretion in assessing penalties. Statutory provisions are also more difficult to change than are similar regulatory provisions.

Potential Application to Other Programs. Automatic penalties built into a statute or regulation can reduce the burden on any implementing agency by decreasing the amount of discretion allowed in calculating penalties and by reducing the amount of time adjudicating them. A provision similar to the appeal procedures in 40 CFR Part 78 may also be useful in reducing the workload on a judicial system.

QA provisions with built-in compliance incentives similar to those in the United States could be developed for the specific measuring equipment being used in any cap and trade program. An implementing agency could also develop substitute data provisions that are tailored to the specific technology being used in their cap and trade program to provide incentive for compliance.

Strong QA

U.S. Cap-and-Trade Experience. Strong QA is critical to any cap-and-trade program. Strong QA helps maintain the

"level playing field," discussed later, helps maintain confidence in the value of allowances, and better ensures that emission reduction goals are achieved. Good QA includes (1) strong equipment performance standards, (2) competency of testing personnel, (3) electronic audits (these audits are possible because sources submit data to EPA in standardized electronic format), (4) field audits using independent equipment and calibration gases that are traceable to the National Institute of Standards and Technology, (5) targeted audits using a documented set of criteria, and (6) audits on randomly selected sources.

The ARP and NBTP were built on strong performance specifications for CEMS, fuel flow meters, and fuel sampling and analysis. The level of QA is based on the pollutant mass emitted from a source sector. High-emitting units, for example, coal-fired power plants, have greater QA and accuracy requirements than lower emitting units, for example, gas-fired peaking units.

EPA provides a QA software tool to the regulated sources so that they can routinely check their electronic report formatting and calculations before submittal to EPA. This minimizes the number of problem submittals and reduces the number of resubmittals required. EPA uses this same tool to automatically verify the formatting and calculations for each hour in the standardized electronic data submissions from regulated sources and to provide automatic, fast feedback to each source.

EPA also uses other electronic audit tools that are not provided to the regulated community. One of these tools produces a list of sources for targeted field audits based on statistical criteria, run on various parameters submitted in each quarterly electronic report, for example, poor correlation between unit heat input and electrical output at a power plant. Other electronic audit tools allow EPA to check specific problem areas on an ad-hoc basis, for example, to check for proper missing data substitution.

Field audits provide another important means of quality assuring the emissions data. These audits generally consist of preaudit preparation (i.e., review of the unit's monitoring plan data, examination of the historical emissions data, etc.), on-site inspection of the monitoring equipment, records review (including review of maintenance logs and examination of the QA plan for the unit), QA test observations, and interviews with plant personnel. Some field auditors also have the necessary equipment and expertise to conduct independent performance tests of the monitoring systems.

There are many benefits of field audits, including (1) providing incentive for managers to commit resources to emission monitoring; (2) fostering improvements in monitoring practices; (3) encouraging sources to periodically evaluate the quality of their data; and (4) verifying that the required QA and QC activities are being implemented. Occasionally a company performing emission testing on a stack either performs the test or calculations incorrectly but does not notify the source until weeks later. If the source finds out that they actually failed a QA test, they must use punitive missing data procedures, which cost them money. There is an effort now by EPA and others to certify the competence of stack testing organizations to avoid similar problems. One recently available standard for doing so is American Society for Testing and Materials (ASTM) D 7036-04 *Standard Practice for Competence of Air Emission Testing Bodies* (available for purchase at www.astm.org).

Potential Application to Other Programs. Strong QA can be used to improve any program, but it is essential to market-based programs to maintain the integrity of the emission reductions and confidence in the value of allowances. For a cap-and-trade program, the authors believe that performance standards for equipment used to determine emissions should be documented and be as strong as possible and applied consistently to affected sources with significant emissions. Performance standards for sources with insignificant contributions to the total emissions need not be as stringent but should also be documented and applied consistently.

Any emission reduction program can benefit from electronic audits performed on regulated sources. If an implementing agency checks for problems on a quarterly or more frequent basis, the necessity for end-of-year enforcement action is reduced. To perform electronic audits most effectively, a standardized electronic reporting format, such as Extended Markup Language (XML), with sufficient data elements to verify that mass emissions were properly determined, should be required.

It may also be useful for sources in a cap and trade program to run their data through standardized checking software before submitting it to an implementing agency. This allows formatting, inadvertent omissions, and similar problems to be fixed faster and reduces the number of required resubmittals. Data checking software needs to be written in a computer language that is compatible with the operating system and hardware limitations of those who will be using the software. Occasionally, the checking software may uncover problems that are not fixable, for example, when a QA test has not been done properly and data must be invalidated.

Field audits are best performed by properly trained personnel who have no conflicts of interest. Such personnel may be provided by the implementing agency or an independent third party organization. It is best that any calibration devices or gases used to perform field audits be traceable to a national standards organization, for example, the National Physical Laboratory in England, the Netherlands Measurement Institute, the National Institute of Standards and Technology in the United States, or a similar organization. Care should be taken if surprise field audits are used, because the source may be shut down when the auditors arrive at the facility. Organizations performing emission testing or providing data QA, for example, third party verifiers, should be certified as competent or accredited to a common, consensus standard (International Organization for Standardization, ASTM, or other).

Collaborative Approach with a Petition Process

U.S. Cap-and-Trade Experience. A key lesson to be learned from the ARP and NBTP is that working with the regulated sources in a preventive and collaborative manner, rather than using a "command and control" approach to program implementation, achieves a better compliance rate

(most problems are resolved at an early stage), saves resources in the long term, and makes day-to-day relationships much more productive. From >10 yr of implementing the ARP, the authors have found that the vast majority of source owners or operators want to do the right thing. Most problems are traceable to a misunderstanding of the regulatory requirements. When people know what to do, most will do it. The authors have also found that allowing the maximum possible flexibility within rule requirements reduces the number of required enforcement actions and improves the working relationship between the implementing organization and regulated sources without sacrificing emission reduction goals.

Before developing the ARP emission monitoring regulations, EPA held meetings with the affected sources to get their ideas and to discuss MRV issues. These meetings gave EPA some workable solutions for the regulation and helped achieve buy-in from the regulated community. The meetings also made EPA aware of the difficulties and issues that the industry had when trying to comply with the potential regulatory requirements. EPA was able to see the program from their perspective. This enabled the agency to create a program that achieves the required emission reductions but is easier and less costly for the regulated community to implement.

Today, EPA still holds meetings with industry representatives to discuss rule interpretations. These postregulation meetings allow EPA to clarify misunderstandings and resolve implementation concerns. Through the years, several beneficial new rule provisions have originated from these types of interactions.

During regulation development and subsequent revisions, source representatives stated that they wanted flexibility in the rule to cover, for example, unexpected problems in performing QA tests on time. In response, EPA provided grace periods that allowed more time to conduct the test in certain situations. Over the years, based on industry comments received, many other options were added to the regulations to add flexibility.

EPA has consistently followed the principle that a high degree of flexibility in the regulations is desirable, provided that environmental goals are not sacrificed. However, it should be noted that added regulatory flexibility is often accompanied by greater rule complexity and length. Therefore, before adding new compliance options to a regulation, this should be taken into account.

Sometimes even providing many compliance options in a rule cannot always provide a clear course of action to a source with a unique situation. To accommodate these sources, Part 75 has a provision that allows a source to petition EPA for clarification and guidance. On average, EPA answers several petitions per month from regulated sources. Not all of the petitions are approved. If there is a clear rule provision that contradicts the petition request, EPA disapproves the petition.

Even with flexibility built into the rule and a petition process, differing interpretations are sometimes possible. Over the years, EPA has found that by working with a noncompliant source and providing as much flexibility as possible within regulatory requirements, a swift, appropriate penalty can be implemented without the need for judicial action and without unduly delaying any required allowance surrenders or emission offsets.

To assist the regulated community in gaining a better understanding of Part 75, EPA developed a comprehensive MRV question and answer manual. The manual helps clarify the rule and ensures that it is correctly interpreted. This policy manual is comprehensive and is currently ~380 pages long. EPA has also developed a document titled *Plain English Guide to the Part 75 Rule*, which provides an overview of Part 75 requirements. Both the Part 75 policy manual and the Plain English Guide can be downloaded from www.epa.gov/airmarkets/monitoring.

The authors also spend significant time on the telephone and with e-mail each week answering technical questions from regulated sources (especially new or newly affected sources). One result of this effort is that EPA achieves a better understanding of power plant or industrial boiler particulars and the type of specific issues that can make compliance challenging. Another result is that regulated sources will often actually report a problem or possible violation that would otherwise have gone unreported.

In summary, using a collaborative approach with regulated sources builds credibility, trust, good will, a sense of ownership, and mutual pride in the program. This implementation strategy has resulted in a 99% overall compliance rate in the ARP and NBTP (discussed previously under "Incentives for Compliance").

Potential Application to Other Programs. Using a collaborative approach to implementation should enhance any cap and trade program. Regulatory flexibilities similar to those in the ARP or NBTP programs should be considered. Preregulation and postregulation meetings between the sources and the implementing agency may be useful to clarify misunderstandings and to resolve implementation concerns before real problems develop. An implementing agency could address technical questions from regulated sources by telephone and e-mail. Each implementing agency could also develop a question and answer manual to help interpret regulatory requirements. Such a manual could be updated as needed and posted on a web site or otherwise made available to the regulated sources.

Standardized Electronic Reporting

U.S. Cap-and-Trade Experience. In other parts of the air program, EPA receives hard copy excess emission and compliance reports from regulated sources for opacity, SO_2, NO_x, and other pollutants. These reports are not submitted in any standard format and, therefore, are not easy and are labor intensive to review and analyze. When the ARP was being developed, EPA realized that given the enormous amount of emissions data that must be received, the information would have to be reported electronically in order for the program to succeed. In view of this, the agency developed a standardized EDR format that must be used by all sources in the program. When emissions data are reported in a standardized electronic format, computer software can be written to efficiently analyze and quality assure the data, thereby reducing or

eliminating errors, facilitating end-of-year compliance determinations, and saving significant amounts of time and money.

Potential Application to Other Programs. A flexible, standardized electronic reporting format, such as XML, with sufficient data elements to verify that mass emissions were properly determined, should be required. Data checking software needs to be developed and should be made available to all, perhaps via the Internet. Data checking software should be written in a computer language that is compatible with the operating systems and hardware limitations of those using the software (i.e., the regulated sources, the implementing agencies, and third-party organizations).

Compliance Flexibility for Low-Emitting Sources

U.S. Cap-and-Trade Experience. One lesson learned from implementing several cap and trade programs is that it is a more efficient use of resources to either exclude sectors that do not contribute significantly to emissions of concern or allow them to use conservative, simpler default factors. Selecting an appropriate low-emitter cutoff point is of critical importance. On the one hand, if the cutoff point is too low (i.e., too exclusive), it would not be cost-effective for the regulated sources and would greatly increase the burden on the regulatory agencies to implement and maintain the program. On the other hand, if the cutoff point is too high (i.e., too inclusive), this would create inequities in the trading market, because a significant percentage of emissions would be overestimated.

Over the years, EPA has used a de minimis (the term "de minimis," as applied here, means that the emissions from a source sector have minimal environmental impact) concept to either exempt low-emitting sources from monitoring or to allow these sources to use less rigorous, lower cost techniques to monitor emissions instead of installing CEMS. This approach has not only reduced compliance costs for the regulated sources, but has greatly eased the administrative burden on EPA. Some examples of EPA's use of the de minimis concept and low mass emitter provisions are described below.

In the preamble of the 1993 ARP final rule (see 58 FR 3593, January 11, 1993), EPA's Acid Rain Division (now the Clean Air Markets Division) first used the de minimis concept to exempt certain new utility units from the ARP (i.e., units $\leq$25 MW that burn only fuels with a sulfur content $\leq$0.05% by weight).

EPA allows gas-fired and oil-fired peaking units to use the less costly methodology in Appendix E of Part 75 to estimate NO_x emissions instead of using CEMS, because the agency's analyses indicated that projected NO_x emissions from these units represent $<$1% of the total NO_x emissions from ARP units.

Lastly, in 1998, EPA promulgated low mass emissions (LME) provisions in section 75.19 for SO_2 and NO_x (see 63 FR 57484, October 27, 1998). These provisions require the use of conservatively high default emission rates to quantify SO_2, NO_x, and CO_2 emissions from gas- or oil-fired sources. EPA determined that sources emitting $\leq$25 t of SO_2 and $<$100 t of NO_x annually would qualify to use the LME methodology. The selected threshold values were based on a de minimis concept, that is, the SO_2 and NO_x emissions from the units that could potentially qualify to use the LME methodology represented $\leq$1% of the emissions from all of the affected units.

Potential Application to Other Programs. Similar LME provisions could be effective in any emissions reduction program by reducing the cost of compliance, providing environmental benefits, and reducing administrative burden. Appropriate low-emitter cutoff points could be determined using the de minimis concept, as described above.

Complete Emissions Data Record Required

U.S. Cap-and-Trade Experience. To ensure that emission reduction goals of a cap and trade program are met, it is important that all of the emissions from affected sources are monitored and reported, including start-up, shutdown, and upset or uncontrolled conditions. Therefore, both the ARP and NBTP require a complete emissions data record for each source. That is, emissions must be reported for every hour of unit operation. In the ARP and NBTP, this is accomplished by rule provisions that require: (1) the full-scale measurement range of each continuous monitoring system to be set appropriately (in some cases, e.g., for a coal-fired unit with add-on SO_2 or NO_x emission controls, two measurement scales (low and high) may be needed to record all of the emissions data); and (2) conservative substitute data values to be reported when the monitoring systems are not able to provide quality-assured data.

Potential Application to Other Programs. To ensure that emission reduction goals are met, any cap-and-trade program should require and provide incentives for all of the emissions from regulated sources to be reported. Cap-and-trade programs should also require use of properly sized measurement scales, appropriate sampling equipment calibration, and conservative substitute data procedures when the sampling equipment is not working (providing incentive for the source to fix the monitoring equipment).

Centralized Administration

U.S. Cap-and-Trade Experience. EPA experience in implementing the ARP and NBTP has shown that for cap-and-trade programs, centralized program implementation, including data reporting and verification, is efficient and works well. This is particularly true when the designers of the program also implement it. There are several reasons for this: (1) all data go through the same quality checking software, both at the source and at the regulatory agency; software updates are easily provided to everyone via downloads from the regulatory agency's web site; (2) all sources in the program are subject to the same regulatory requirements; (3) the sources in the program are covered by the same interpretations of the regulatory requirements and resolution of petitions; (4) the same audit procedures are used on all of the sources in the program; (5) all data are publicly available; and (6) sources within the program are subject to common penalties and enforcement procedures.

Potential Application to Other Programs. Cap-and-trade programs benefit greatly from centralized administration. However, even when program administration is decentralized, many of the benefits of centralization can still be obtained if (1) one of several implementing agencies develops data quality checking software and seeks to reach agreement with all of the other implementing agencies to use it; (2) during regulation development, each implementing agency solicits comment from: companies having sources in multiple jurisdictions, other implementing agencies, and the interjurisdictional public, in an effort to better harmonize disparate regulations; (3) the implementing agencies have regular meetings and/or teleconferences to better harmonize regulation interpretations, petition responses, and audit and enforcement procedures and penalties; and (4) each implementing agency makes public all of the data reported to it; perhaps a common Web site could be created for this purpose.

Level Playing Field

U.S. Cap-and-Trade Experience. In a cap-and-trade program, it is important that each allowance is perceived as being equal to any other allowance to maintain credibility and confidence in the allowance trading market. This creates a level playing field for all of the sources in the program.

A level playing field does not mean that all of the affected sources must use the same monitoring methodology. As noted in the Introduction section, above, not all of the units in EPA cap and trade programs are required to monitor emissions with CEMS. (However, EPA believes that SO_2, NO_x, and CO_2 emissions from a coal-fired source will be more accurate if measured by CEMS because of the variable composition of coal and the potential inaccuracies of many coal consumption techniques.) Rather, a level playing field means that the highest emitting sources must use the most accurate monitoring methods, whereas low emitters may use less rigorous monitoring options, provided that the alternative methodologies are environmentally conservative and do not underestimate emissions.

A level playing field also means that the QA requirements of each monitoring methodology are fair to all of the sources (both high and low emitters) using the method. With regard to the CEMS methodology, Part 75 ensures this by providing alternative performance specifications for low emitters. For example, at low SO_2 concentrations, the principal RA specification of 10% may be difficult to meet, because the equation used to calculate the percentage of RA magnifies small differences between the CEMS and reference method (RM) readings. To address this, Part 75 specifies that when the 10% RA specification is not met, the RATA results are still acceptable if the difference between the mean CEMS and RM values does not exceed 15 ppm.

Potential Application to Other Programs. The level playing field concept is important to a cap-and-trade program, because it helps maintain credibility and confidence in the allowance trading market. As a general principle, data from the highest emitting sources in the program should be held to the most stringent QA standards. Data from low-emitting sources need not be as accurate, but the emissions estimates from these sources should be environmentally conservative. For certain monitoring methodologies (e.g., CEMS), alternative QA specifications for lower emitting sources may be needed to ensure a level playing field.

Publicly Available Data

U.S. Cap-and-Trade Experience. Making cap and trade program data publicly available creates confidence in the program. Publicly available, high-quality data are essential for allowance market pricing to work efficiently and for achieving emission reductions at the lowest possible cost. Publicly available data allow brokerage firms, testing organizations, academic institutions, and other third parties to access and analyze the data. These analyses help keep the program healthy and provide impetus for future program improvements and impact assessments. By making the data publicly available, EPA enlists the public in the oversight of the program and enhances the public's acceptance of the program.

Potential Application to Other Programs. By making the emissions data publicly available, any cap and trade program should be able to reap the same benefits as have been reaped by the existing U.S. cap-and-trade programs.

Performance-Based Approach

U.S. Cap-and-Trade Experience. During ARP preimplementation meetings and the public comment period for the draft rules, there was strong support for a performance-based approach. This approach requires equipment used by regulated sources to meet certain performance standards rather than requiring a source to use a particular type of fuel meter, emission monitor, or piece of control technology. It also allows sources freedom to install the appropriate emissions control technologies or to switch to different types of fuel to ensure that the emission reduction goals of the program are met. Thus, sources are free to implement the most cost-effective approach to monitoring and emissions control. This provides incentive for market competition among equipment vendors and fuel suppliers.

For a performance-based approach to be successful, the performance specifications for the monitoring equipment must be demonstrated to be reasonable and achievable. For established monitoring technologies, historical data can be used for this purpose. However, for newer technologies, independent field testing must be performed to determine realistic initial and perhaps long-term performance standards. Then, as the technology is developed, adjustments to the standards can be made, as needed.

In the original 1993 ARP monitoring regulations, EPA required coal-fired units to install stack gas flow rate monitors. To be consistent with the performance specifications for other CEMS in the program, the agency desired to set an RA standard of 10% for the flow monitors. However, before 1993, stack flow monitors were not widely used, and it was not clear that 10% RA could be achieved. EPA initiated several field tests of a number of different types of flow monitors, and it was determined

that 15% RA was immediately achievable and that 10% RA could likely be attained with a few refinements in the technology. In view of this, the agency published a two-phase RA standard for flow monitors. A 15% RA standard would be in effect until December 31, 1999, and a tighter 10% RA standard would take effect on January 1, 2000. This gave flow monitor vendors, in partnership with the regulated sources, 7 yr to refine the technology and to meet the more stringent RA standard. Many commenters on the proposed Part 75 rule believed that the tighter flow monitor RA standard could not be met. However, driven by the regulatory requirement, the technology advanced to the point where the mean RA for the year 2000 for all flow monitors in the program was 3.3%.

Potential Application to Other Programs. A performance-based approach with its built-in cost savings and flexibility can work for other cap-and-trade programs. Performance standards for emission monitoring equipment should be reasonable and achievable. For newer technologies, implementing agencies could undertake independent field testing to determine realistic initial and long-term performance standards. The ability of a performance-based approach to force improvements in monitoring technology should not be underestimated.

Reducing Conflicts of Interest

U.S. Cap-and-Trade Experience. Under the ARP and NBTP, a regulated source determines its own emissions and performs QA testing using either in-house test teams or private testing companies. Either way, the testers are paid by the regulated source. To mitigate this apparent conflict of interest, sources are required to notify EPA and the state air agencies when QA testing is planned so that these agencies can send observers. These observers help ensure that proper testing procedures are followed.

Sources in EPA's cap-and-trade programs also report their own emissions data or pay a private company to do so. This, too, may appear to be a conflict of interest. To help eliminate any appearance of impropriety, EPA requires an electronic signature and a certification statement from a responsible source representative, declaring that the QA and all of the other reported data is valid and complete, under penalty of fine or imprisonment. The following is an example certification statement:

"I am authorized to make this submission on behalf of the owners and operators of the affected source or affected units for which the submission is made. I certify under penalty of law that I have personally examined, and am familiar with, the statements and information submitted in this document and all its attachments. Based on my inquiry of those individuals with primary responsibility for obtaining the information, I certify that the statements and information are to the best of my knowledge and belief true, accurate, and complete. I am aware that there are significant penalties for submitting false statements and information or omitting required statements and information, including the possibility of fine or imprisonment."

Potential Application to Other Programs. The procedures used in EPA's cap-and-trade programs to mitigate conflicts of interest could be applied to other cap-and-trade programs. For example, the same (or similar) electronic signature and certification statement from an authorized source representative could be required to accompany each emissions report. It may also be possible for an independent, competent, third party organization to verify and submit emissions data to an implementing agency if the third party can be held legally accountable along with the owner or operator of the source. Also, the regulated sources could be required to provide notice of scheduled QA testing to the implementing agency in advance so that agency personnel can make plans to observe the tests.

CONCLUSIONS

Over the past decade, the ARP and NBTP have achieved unparalleled levels of SO_2 and NO_x emissions reduction in the United States. The success of these cap-and-trade programs is largely because of many years of implementing comprehensive and strict, yet realistic, MRV requirements based on sound principles. EPA believes that for any regulatory agency desiring to build a successful cap-and-trade program, these MRV requirements and principles would provide a strong and essential foundation for the program.

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About the Authors

John Schakenbach, environmental scientist, Robert Vollaro, environmental engineer, and Reynaldo Forte, branch chief, are with the Emissions Monitoring Branch of the Clean Air Markets Division of the U.S. Environmental Protection Agency. Address correspondence to: John Schakenbach, USEPA, Mail Code 6204J, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460; phone: +1-202-343-9158; fax: +1-202-343-2359; e-mail: schakenbach.john@epa.gov.