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The Future of the National Performance Audit Program (NPAP)

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16. ABSTRACT

The National Performance Audit Program (NPAP) is one of the major components in the quality assurance of the nation's air monitoring program. The nation's ambient air monitoring program contains approximately 5000 monitors collecting data for the six pollutants for which national ambient air quality standards (NAAQS) have been designated. The quality assurance/quality control program has several major components including the EPA Regional Systems Audits, the Precision and Accuracy Program, and the NPAP. The NPAP has historically been operated by EPA's Office of Research and Development (ORD). On January 1, 1998 EPA's ORD transferred the NPAP to the Office of Air Quality Planning and Standards (OAQPS). The future of this important performance evaluation program will be discussed.

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INTRODUCTION

The Nation's ambient air monitoring program contains monitors for the six criteria pollutants for which national ambient air quality standards (NAAQS) have been designated. These pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter smaller than 10 microns (PM-10) and particulate matter smaller than 2.5 microns (PM-2.5), and sulfur dioxide (SO_2). The standards for the criteria pollutants are shown in Table 1.

There are approximately 4,981air pollution monitors in the ambient air network. These monitors comprise the State and Local Air Monitoring Stations (SLAMS), the National Air Monitoring Stations (NAMS), and the Prevention of Significant Deterioration (PSD) sites. The distribution of monitors by pollutant is: SO_2, 645; CO, 540; NO_2, 373; O_3, 943; Pb, 418; and PM-10, 1584. The data from these monitors are reported to EPA's Aerometric Information Retrieval System (AIRS). Although the data from these monitors are used primarily for determining compliance with the NAAQS, they also support numerous other regulatory and research activities.

The federal regulations for the SLAMS/NAMS/PSD sites are codified in 40 CFR 58 including information pertaining to the quality assurance/quality control (QA/QC) program for these monitors. The QA/QC program has three major indexes of quality: the EPA Regional Office Systems Audits; the Precision and Accuracy System (formerly PARS); and the National Performance Audit Program (NPAP).

The NPAP was managed for the first 17 years of its existence by EPA's Office of Research and Development. On January 1, 1998, the management of the NPAP was transferred to EPA's Office of Air Quality Planning and Standards (OAQPS). The audit devices and materials associated with the NPAP have been supplied to the participating agencies and the resulting data managed by a contractor. The program has encompassed the 6 pollutants for which there are National Ambient Air Quality Standards (NAAQS) and those ozone precursors identified in 40 CFR 58. OAQPS will continue to manage the program through a contractor. The NPAP will continue to include the criteria pollutants and the ozone precursors identified in 40 CFR 58. The NPAP audit procedures for the volatile organic carbon (VOC) compounds are being reexamined and may change. EPA has recently promulgated a NAAQS for PM 2.5 and the regulations (40 CFR 58) now require a PM 2.5 Federal Reference Method (FRM) audit. This PM 2.5 FRM audit may be incorporated into the next NPAP contract. Internally the quality control on the EPA NPAP contractor was provided by the EPA ORD's "Standards Laboratory." This important function is now being carried out by EPA Region 7.

The NPAP is a cooperative effort among EPA's Office of Air Quality Planning and Standards (OAQPS), the 10 EPA Regional Offices, and the 170 state and local agencies that operate the SLAMS/NAMS air pollution monitors. Also included in the NPAP are approximately 135 organizations (governmental and private) that operate air monitors at PSD sites. Participation in the NPAP is required for agencies operating SLAMS/NAMS and PSD monitors as per Section 2.4 of 40 CFR Part 58, Appendix A and Section 2.4 of 40 CFR Part 58, Appendix B. The NPAP is operated by the Monitoring and Quality Assurance Group of OAQPS. Participation in the NPAP program is also mandatory for the 22 agencies which monitor for photochemical oxidants under EPA's Photochemical Assessment Monitoring (PAMS) program. These agencies monitor for carbonyl compounds, volatile organic compounds, No_x and ozone.

The NPAP's goal is to provide audit materials and devices that will enable EPA to assess the proficiency of

agencies that are operating monitors in the SLAMS/NAMS and PSD networks. To accomplish this, the NPAP has established acceptable limits or performance criteria, based on the data quality needs of the SLAMS/NAMS and PSD requirements, for each of the audit materials and devices used in the NPAP. Any device or material not meeting these criteria is not used in the program.

All audit devices and materials used in the NPAP are certified as to their true value, and that certification is traceable to a National Institute of Standards and Technology (NIST) standard material or device wherever possible. The audit materials used in the NPAP are as representative and comparable as possible to the calibration materials and actual air samples used and/or collected in the SLAMS/NAMS and PSD networks. The audit material/gas cylinder ranges used in the NPAP are specified in the Federal Register (Table 2).

The objectives for the NPAP audits are two-fold: (1) to complete at least 95% of the scheduled audits by the end of the year, and (2) to determine if the participants' performance exceeds the limits shown below.

Audit	EPA determined limits
High volume/PM-10 (SSI)	% difference > ± 15% for 1 or more flows
Dichot (PM-10)	% difference > ± 15% for 1 or more flows
Pb (analytical)	% difference > ± 15% for 1 or more levels
SO_2, NO_2, O_3 and CO	Mean absolute % difference > 15%
PAMS	The EPA determined limits were still being reviewed and developed at the time of this paper's publication

The NPAP audits are accomplished using a variety of mailable audit systems. The participants use these audit systems to generate pollutant concentrations and flowing air streams which are introduced into their sampling system. The pollutant concentrations and air stream flow rate are unknown to the audit participants. The outputs from the sampler that result from the use of the audit system are recorded on a data form, returned to EPA, and compared to the concentration or flow rate that should have been generated by the audit system under the environmental conditions at the site. The differences between the EPA expected (certified) values and the NPAP participants' reported values are calculated and returned to the participant.

DESCRIPTION OF NPAP AUDIT MATERIALS/DEVICES

High-Volume/PM-10 (SSI) Flow Audits

The reference flow (ReF) device used for the high volume flow audit consists of a modified orifice, a wind deflector, a manometer, and five resistance plates. The ReF for the PM-10 (SSI) flow audit is similar except a filter is used as the only resistance.

Sulfur Dioxide/Carbon Monoxide (GDS) Audits

The GDS consists of a dilution device, a zero air generator and a cylinder of gas containing approximately 30 ppm sulfur dioxide and 3000 ppm carbon monoxide.

Ozone (TECO 165) Audit

The audit device is self-contained with its own zero air and ozone generation system.

Lead Audit
The samples are 1.9 cm wide and 20 cm long glass fiber filter strips that have been spiked with an aqueous solution of lead nitrate and oven-dried. Two filter strips comprise a sample.

Dichotomous (PM-10) Flow Audit
The audit device consists of a laminar flow element (LFE), an inclined manometer, an altimeter, and a small dial thermometer. It measures fine flow (15.00 lpm) and total flow (16.7 lpm).

Ozone/Nitrogen Dioxide/Sulfur Dioxide/Carbon Monoxide (TECO 175) Audit
The audit device is a combination of the TECO 165 and the GDS audit systems. It uses the same zero air generation system as the GDS, the ozone generation system of the TECO 165, and a gas cylinder containing approximately 3000 ppm carbon monoxide, 30 ppm sulfur dioxide and 30 ppm nitric oxide. The ozone generation system is used with the pollutant gas to convert nitric oxide to nitrogen dioxide via a gas phase titration. The TECO 175s were introduced into the NPAP in the fall of 1994; however, flow stability problems delayed full utilization of the equipment. The problems were traced to the pre-set regulator and replacement was completed in time for the 1995 audits.

PAMS Volatile Organic Compound (VOC) Audit
This audit uses a gas transfer system (GTS), stock (concentrated) compressed gas mixtures containing PAMS compounds and 1.5L compressed gas (audit) cylinders. The stock mixtures are mixed and diluted using the GTS and the resulting mixture is placed in the 1.5L audit cylinders. These audit cylinders are pressurized to 500 psi to yield recoverable gas volumes of 40 to 60 L. Three audits are scheduled for each year. Each of the 22 PAMS agencies receives one cylinder for each audit. The cylinders contain between 15 and 35 PAMS analytes at concentrations from 10 to 60 ppbv as carbon. The PAMS VOC audit was added to the NPAP in 1995.

PAMS Carbonyl Compound Audit
This audit uses three glass tubes containing DNPH which have been spiked with solutions containing acetone, formaldehyde and acetaldehyde. Each tube contains from 0.2 to 10 micrograms of each carbonyl compound. The audit is conducted on the same schedule as for the PAMS VOC audit. Each PAMS agency recovers the carbonyl compounds from the three DNPH tubes and reports the results to EPA. The PAMS carbonyl audit was added to the NPAP in 1995.

SITE SELECTION
Historically, the State and local agencies have been allowed to select the NPAP sites to be audited. The 1989 General Accounting Office (GAO) audit raised concerns about the NPAP site selection process. The GAO believed there could be a possible bias in the NPAP data base because (1) NPAP participants selected the samplers to be audited, and (2) NPAP participants may have performed unscheduled calibrations on samplers prior to the audits. In 1991 EPA sent an audit team to 79 SLAMS monitoring stations located in all ten EPA regions. The audit team used the equipment and procedures of the NPAP to assure that their audits simulated as closely as possible a normal NPAP audit. To ensure that the SLAMS agencies did not take any special precautions, the audit team notified the agencies only 1 to 2 days prior to arrival. Also, the site log books were checked by the audit team to verify that the samplers had not been calibrated prior to the audit. In all 172 samplers were audited including samplers for CO (53), $NO\text{-}NO_2$

(25), SO_2 (38) and 0_3 (34). Ninety- seven of the samplers had been audited in the NPAP during 1989 - 1990, but the rest had not. Based on a statistical analysis of the data from the 1991 study and the 1989 and 1990 NPAP, EPA concluded that (1) overall the NPAP participants were auditing their samplers properly and not conducting special unscheduled calibration tests, and (2) the assumption that the NPAP data base was biased because the participants selected the sampler to be audited was not supported. EPA additionally responded to the GAO comments by developing site selection criteria (Table 3) that were incorporated into the 1993 NPAP. Priority 1 site selection criteria should be audited annually; priority 2 at least once every 2 years; priority 3 at least once every 3 years; priority 4 at least once every 4 years. All other sites should be audited at least once every 5 years. Based on this criteria, EPA now selects specific sites that are to be audited in the NPAP. The criteria are reviewed annually, and site selection is updated accordingly.

RESULTS

The number of NPAP audits performed from 1993 through 1997 is shown in Table 4.

In 1997, 100% of the scheduled audits were completed with the exception of NO_2 (84%). At the present time, EPA does not have enough equipment to meet the demand for NO_2 audits. Due to the current budgetary constraints, this may be a long term problem.

The percentage of 1997 NPAP participants whose performance fell within the EPA guidelines of 15% of the certified values was: CO, 99%; SO_2, 98%; NO, 98%; NO_2, 84%; O_3, 96%; hi-vol/PM-10 (SSI), 96%; dichot (PM-10), 80%; and Pb (analytical), 94%. These percentages have remained similar since 1993 for O_3, SO_2, CO, hi-vol/PM-10 (SSI), Pb, NO, and NO_2. PM-10 (dichotomous) (70% to 80%) has increased substantially which may be attributable to increased familiarity with the audit equipment.

CONCLUSIONS

EPA's Quality Assurance Guidance mandates that all data collected for regulatory or research purposes be of known and documented quality. The NPAP is a critical component in the SLAMS/NAMS/PSD programs for accomplishing this goal. The defensibility of the decisions resulting from the SLAMS/NAMS/PSD ambient air data is enormously important. The data from these networks are used for determining compliance with the NAAQS and result in input to the State Implementation Plans (SIPS) These SIPs can have very large economic impacts.

EPA uses the NPAP to independently quality assure the SLAMS, NAMS, PSD, and PAMS monitoring data it is receiving and permanently storing on its Aerometric Information Retrieval System (AIRS). The AIRS is the conduit for which the research community, commercial and industrial communities, and the public at large, gain access to the EPA's monitoring data. EPA also uses the NPAP as its only available national, independent mechanism for continually assessing the quality of the ambient air quality data necessary to develop and defend its research initiatives.

The cornerstone of any data collection system is the quality assurance component. The data utilization resulting from the Nation's air monitoring network continues to increase in importance. The strategies developed from the information can cost millions of dollars. Henceforth, we must remain vigilant in our efforts to maintain the integrity of this important data set. In these efforts, the NPAP continues to be refined. The NPAP has expanded to include all the criteria pollutants, volatile organic compounds and carbonyl compounds. The associated instruments and equipment have been improved to incorporate the

latest technologies. The NPAP continues to respond to comments from the GAO audits as well as state and local agency contacts. With the increased interest in the data from the nation's air monitoring community, it was inevitable that the site selection process would also be modified. These modifications were incorporated into the 1993 NPAP. The most important sites are now audited each year through the NPAP and every site is expected to be audited minamally once in a five year period.

In summary, the importance of the NPAP can not be understated. It has proven to be an important safe-guard on one of the most important environmental data bases in the country. The NPAP is now being managed by a different organizational unit of the EPA. This organizational unit, OAQPS, recognizes the importance of this program and unequivocally states that this program will continue in the future. It will continue to improve as it has under the management of EPA's ORD.

Table 1. National ambient air quality standards.

	Primary standard (health related)		Secondary standard (welfare related)	
Pollutant	Type of average	Std. level conc.[a]	Type of average	Std. level conc.
CO	8-hr[b]	9 ppm (10 mg/m^3)	No secondary standard	
	1-hr[b]	35 ppm (40 mg/m^3)	No secondary standard	
Pb	Maximum quarterly average	1.5 μg/m^3	Same as primary standard	
NO_2	Annual arithmetic mean	0.053 ppm (100 μg/m^3)	Same as primary standard	
O_3	Maximum daily 1-hr average[c]	0.12 ppm (225 μg/m^3)	Same as primary standard	
PM-10	Annual arithmetic mean[d]	50 μg/m^3)	Same as primary standard	
	24-hr[d]	150 μg/m^3	Same as primary standard	
SO_2	Annual arithmetic mean	80 μg/m^3 (0.03 ppm)	3-hr[b]	1300μg/m^3 (0.50 ppm)
	24-hr[b]	365 μg/m^3		

[a]Parenthetical value is an approximately equivalent concentration.

[b]Not to be exceeded more than once per year.

[c]The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1, as determined according to Appendix H of the Ozone NAAQS.

[d]Particulate standards use PM-10 (particles less than 10 micrograms in diameter) as the indicator pollutant. The annual standard is attained when the expected annual arithmetic mean concentration is less than or equal to 50 μg/m^3; the 24-hour standard is attained when the expected number of days per calendar year above 150 μg/m^3 is equal to or less than 1, as determined according to Appendix K of the PM NAAQS.

Table 2. NPAP audit material/gas cylinder concentration ranges.

	Audit level	Concentration range, ppm[1]
SO_2, O_3, and NO_2	1	0.03-0.08
	2	0.15-0.20
	3	0.35-0.45
CO	1	3-8
	2	15-20
	3	35-45
	Audit level	Concentration range, μg/strip[1]
Pb	1	100-300
	2	600-1000

[1]Federal Register, 40 CFR Part 58, Appendix A, revised July 1, 1987.

Table 3. Site selection criteria for the 1997 NPAP audits.

Pollutant	Priority	Criteria
O_3	1	Sites with expected average exceedances of the O_3 NAAQS≥ 1.1 days from 1992 through 1994.
PM-10	2	Sites recording values > the 24-hr. NAAQS in 1994.
	3	Sites recording values > the 80% but < 100% of the 24-hr NAAQS in 1994.
	4	Sites recording values > 50% but ≤ to 80% of the 24-hr NAAQS in 1994.
CO	3	Sites recording exceedances of the CO NAAQS from 1993 through 1994 plus selected CO sites within CO nonattainment areas.
	4	Sites recording CO values between 7.5 ppm and 9.4 ppm from 1993 through 1994.
Pb	1	Sites located near sources which are subject to potential regulatory compliance, out of compliance, and/or subject to a consent decree or above the NAAQS for 1994.
	2	Sites located near sources that are either in compliance with no violations, are closed for business, or are well below the Pb NAAQS with no significantly questionable data.
SO_2	2	Sites recording values > the 24-hr SO_2 NAAQS in 1994.
	3	Sites recording values between 80% and 100% of the 24-hr SO_2 NAAQS in 1994.
	4	Sites recording values > 50% but < 80% of the 24-hr SO_2 NAAQS in 1994.
NO_2	3	Sites recording values > 50% of the annual NO_2 NAAQS

Table 4. NPAP audits - 1993 to 1997.

Pollutant		1993	1994	1995	1996	1997
CO	Labs	142	146	135	135	144
	Samplers	300	303	311	310	331
SO_2	Labs	154	167	150	162	153
	Samplers	321	364	309	357	350
NO part of NO_2	Labs	105	104	98	107	112
	Samplers	182	183	170	203	227
NO_2	Labs	55	3	62	69	97
	Samplers	122	3	185	146	201
O_3	Labs	157	163	182	176	180
	Samplers	426	480	519	562	609
SSI/hi-vol	Labs	322	299	292	301	314
	Samplers	1315	1551	1481	1489	1743
Dichot (PM-10)	Labs	17	11	10	18	20
	Samplers	52	29	28	41	43
Pb	Audits	352	336	320	291	287
VOCs	Audits	-	-	72	36	101
Carbonyls	Audits	-	-	32	24	48