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Project Summary

Summary of Precision and Accuracy Assessments for the State and Local Air Monitoring Networks 1982

E. Gardner Evans, Raymond C. Rhodes,
William J. Mitchell and John C. Puzak

Precision and accuracy data obtained from State and local agencies during 1982 are summarized and evaluated. Some comparisons are made with the results previously reported for 1981 to determine the indication of any trends. Some trends indicating improvement in the precision and accuracy of monitoring data are given on a national and regional basis. The annual average results from each reporting organization are given so that comparisons may be made from 1981 to 1982 and also with other reporting organizations.

A comparison of the precision and accuracy from the Precision and Accuracy Reporting System and that from the independent performance audit program conducted by the Environmental Monitoring Systems Laboratory is given.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The purpose of this document is to report the second year of data from the Precision and Accuracy Reporting System (PARS). Federal regulations promulgated on May 10, 1979, require quality assurance precision and accuracy (P&A)* data to be collected. Collection started January 1, 1981, according to requirements set forth in 40 CFR Part 58 Appendix A. These requirements provide for more uniform Quality Assurance programs and specific precision and accuracy reporting requirements across all State and local air monitoring agencies.

The major portion of this report consists of summarizations and evaluations of the P & A data obtained by the efforts of the States and local agencies. In addition, comparisons have been made of the accuracy data collected for PARS with the results of the National Performance Audit Program (NPAP) which has been an ongoing program conducted by the Environmental Monitoring Systems Laboratory (EMSL) since the early 1970's.

These summarizations and evaluations of precision and accuracy data serve the following purposes:

1. Quantitative evaluations of the quality of their monitoring data are available to State and local agencies.
2. A comparison of the data from all the agencies can indicate the need to improve quality assurance systems in specific reporting organizations.
3. An evaluation of the results may indicate a need for improvement in monitoring methodology.

*When one speaks of precision and accuracy of measurement data[1], one really means the precision and accuracy of the measurement process from which the measurement data are obtained. *Precision* is a measure of the "repeatability of the measurement process under specified conditions." *Accuracy* is a measure of "closeness to the truth."

4. The assessments provide users of data from the State and Local Air Monitoring Stations (SLAMS) network a quantitative estimate of the precision and accuracy of the ambient air quality data.

Ambient air quality data, collected by States and local agencies since 1957, have been stored in the National Aerometric Data Bank (NADB). These data are used in (1) planning the nation's air pollution control strategy, (2) determining if the National Air Quality Standards are being achieved, and (3) determining long-term trends of air quality. Prior to the EPA air monitoring regulations of May 10, 1979, the procedures used in selecting monitoring sites, operating and controlling the equipment, and calculating, validating and reporting the data varied considerably among agencies. Frequently the procedures being used were not well-documented. These conditions made it difficult to intercompare data from different sites and agencies. Furthermore, little information was available on the reliability of the monitoring data.

To help alleviate these problems, EPA's air monitoring regulations imposed uniform criteria on network design, siting, quality assurance, monitoring methods, and data reporting after December 30, 1980. For example, only EPA reference, equivalent, or other EPA-approved air monitoring methods were to be used. Also, calibration standards were to be traceable to the National Bureau of Standards (NBS) or other authoritative standards. Further, the quality assurance systems of the states were required to be documented and approved by the EPA Regional Offices. Finally, the reporting organizations must also follow specific procedures when assessing the P&A of their measurement systems and must report the P&A data to EPA quarterly. Starting January 1, 1981, these regulations became effective for National Air Monitoring Sites (NAMS), and beginning January 1, 1983, for all State and Local Air Monitoring Stations.

The precision assessments were determined by performing repeated measurements on ambient-level "calibration" gases at two-week intervals for continuous methods, or by obtaining duplicate results from collocated samplers for manual methods. The accuracy assessments were generally determined by analyzing blind audit materials traceable to NBS. During each calendar year, each site or instrument must be audited at least once. Details concerning the specific procedures and computations used to assess P&A are contained in the regulations.

National Results

National Data Capture

The second year of data collected by State and local agencies for P&A has been compiled and summarized. Obvious improvements in the network operation have been made. Table 1 shows the improvement in data capture for the nation.

Table 1. National Percent Data Capture for Required Precision and Accuracy

Pollutant	*1981*	*1982*	*Relative % Change*
CO	*77*	*89*	*16*
SO_2	*82*	*93*	*13*
NO_2	*56*	*72*	*29*
O_3	*83*	*89*	*7*
TSP	*94*	*97*	*3*

The automated NO_2 analyzers which tend to break down quite often had the worst percent data capture for the first two years. However, these analyzers had the largest increase in data capture from 1981 to 1982 of 29%, which indicates a substantial improvement. CO had the next largest percent change, an increase from 77% to 89%. SO_2 increased from 82% to 93%. TSP had the lowest % change between years, but it had very little room for improvement in collection of the precision and accuracy flow data.

1982 Results from the PARS Program

The measures of precision and accuracy are required to be computed and reported by the States and local agencies as percentage values. For precision, the repeatability for each check is measured as the deviation from expected values as a percentage of the expected value. For accuracy, the deviation of the audit value from the true value is measured as a percentage of the true value. For both precision and accuracy, 95 percent probability limits are computed for the percentage values from the average and standard deviations of the individual percentage values:

$$\bar{D} \pm 1.96\ S$$

where $\bar{D}$ = the average of the individual percent differences;

S = the standard deviation of the individual percent differences;*

1.96 = the multiplication factor corresponding to 95% probability.

It is these upper and lower 95% probability limits which are reported and discussed in this report.

Moreover, it should be noted that the data and the evaluations presented in this report include any outlier values which may have been reported by the States and local agencies. It is possible that the presence of outliers might influence such comparisons by having undue impact on average values.

Table 2 exhibits the national averages for each of the manual pollutants. By examining the numbers of valid collocated data pairs (16,233) and the number of audits (6461) performed for TSP, one can estimate the amount of effort being spent in this country to obtain these data quality assessments.

The precision limits reflect the repeatability of the methodology used in the field to collect and analyze the samples at ambient levels. The spread of the limits may be somewhat inflated due to measurements at relatively low concentration levels.

The accuracy of the manual methods indicates the limits at predetermined concentration levels for the chemical analysis performed in the samples for lead, sulfur dioxide, and nitrogen dioxide. For the particulate matter, the accuracy measurement is for the flow rate only. The probability limits for manual accuracy are very good and reflect the quality of work done in the chemical laboratories for lead, sulfur dioxide, and nitrogen dioxide analyses, and in the field for flow rate measurement for particulate matter. Because of the continual replacement of the manual SO_2 and NO_2 methods with continuous methods, further discussion of the manual methods is limited. The detailed results, however, are tabulated in Appendix B for each reporting organization.

The precision and accuracy limits for automated methods are presented in Table 3. Apparent from the number of precision checks, for example 23,144 for SO_2, the effort expended for the collection of quality assurance precision and accuracy data is appreciable, but neces-

*For the precision of manual methods obtained from paired observations, the standard deviation, S, is divided by $\sqrt{2}$, to obtain variability estimates that apply to individual reported values

Table 2. *National Precision and Accuracy Probability Limit Averages for Manual Methods*

	Precision			Accuracy					
					Probability Limits (%)				
	Number of Valid Co-located Data Pairs	Probability Limits (%)		No. of Audits	Level 1		Level 2		Level 3	
Pollutant		Lower	Upper		Lower	Upper	Lower	Upper	Lower	Upper
TSP	16,233	-12	+13	6,461	—	—	-07	+07	—	—
Lead	1,669	-15	+16	692	-11	+08	-07	+04	—	—
Sulfur Dioxide	706	-38	+42	551	-13	+08	-09	+07	-08	+05
Nitrogen Dioxide	1,168	-29	+34	583	-07	+08	-07	+06	-05	+06

Table 3. *National Precision and Accuracy Probability Limit Averages for Automated Analyzers*

	Precision			Accuracy						
					Probability Limits (%)					
	No. of Precision Checks	Probability Limits (%)		No. of Audits	Level 1		Level 2		Level 3	
		Lower	Upper		Lower	Upper	Lower	Upper	Lower	Upper
SO_2	23,144	-14	+09	1,367	-16	+10	-12	+09	-12	+09
O_3	18,964	-10	+09	1,524	-12	+10	-09	+08	-09	+08
CO	13,089	-09	+07	1,208	-11	+10	-06	+06	-06	+05
NO_2	6,876	-13	+13	479	-21	+17	-14	+10	-12	+07

sary to assess data quality. Details of the results are discussed in the analysis section.

National Precision Results Comparison

While this report represents the second year of precision and accuracy data, it is too early to determine reliably any trends analysis. However, some tentative observations can be made. As can be seen in Figure 1, some minor changes have occurred since the start-up in 1981. O_3 and CO showed the most overall change in precision with a decrease in the limit spread for both upper and lower limits. For TSP and SO_2 the upper limits stayed the same while the lower limit increased from -13 to -12, decreasing overall variability only slightly. The spread or variability for NO_2 precision probability limits remained the same but did exhibit an upward shift, possibly eliminating a slight average bias which existed the first year.

National Accuracy Results Comparison

Accuracy for TSP, which is determined from an air flow measurement on the high volume sampler, deteriorated slightly from 1981 to 1982. Figure 2 displays the national accuracy average for TSP and each of the three levels for continuous O_3, CO, SO_2, and NO_2.

For the continuous analyzers, it is obvious from Figure 2 that the first level of each pollutant has a wider range than the other levels. This is to be expected with low concentration values. Levels 2 and 3 are expected to be similar to each other and show less variability than level 1, as expected.

Examination of Figure 2 demonstrates the improvements that have been made across the country in the accuracy measurements. For each level of ozone, the range of the limits have decreased from 1981 to 1982. The same trend occurs for both SO_2 and CO. NO_2 improved dramatically for level 1 measurements, while the range of the limits for Levels 2 and 3 remained basically the same.

Comparison of Results from the PARS and the Performance Audit Program

A general comparison between the accuracy data of the PARS program and the Performance Audit (PA) data is included in this report. The audit data are the results of an independent check, the National Ambient Air Audit Program, conducted by the Quality Assurance Division (QAD) of the EMSL. Blind samples are sent to laboratories that perform the State and local agencies' analyses. The samples are analyzed and results are sent to QAD where they are evaluated.

Since precision assessments are not made in the PA program, only accuracy can be compared across the PARS and the PA programs. For the purpose of this report, the results from PARS and the PA system are compared at approximately

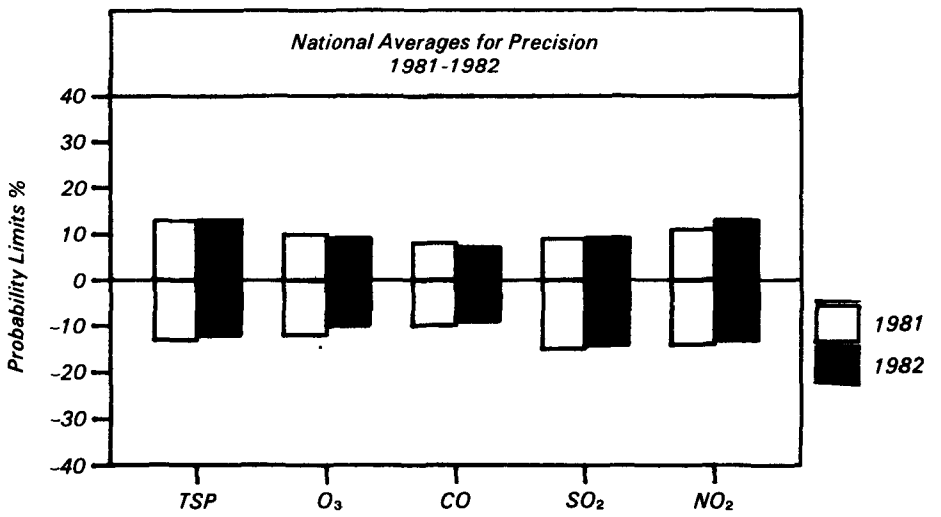

Figure 1. *National precision averages for 1981 to 1982.*

the same levels by matching laboratories and reporting organizations. Since the PARS data are presented with outliers, the same approach was taken with the audit data. Knowledge of the historical audit data reports, however, indicates that the presence of outliers may make a significant difference in the average audit results for the PA.

Comparisons of the national *averages* of the probability limits (Table 4) exhibit good agreement between the results of the two programs. However, there is considerable variation between the results of the two programs when comparisons are made on Regional and reporting organization bases. Lack of better agreement results from several factors. First, the inclusion of outlier values in the PA data appears to have introduced some excessive distortion of general trends. Second, even though the PARS averages in Table 4 are weighted by the number of audits, variations due to many sources of error for both data sets are averaged together to obtain the national averages, thereby masking any correlations which may have existed for the results of individual agencies. Third, the concentration levels for the two systems do not coincide exactly at each of the audit levels. Fourth, the PA data are the results of independent *external* audits, while the PARS accuracy data are based on the results of independent *internal* audits. The expected effects of the last-mentioned factor would cause the spread of the limits for the PA to be wider than that for the PARS. Examination of the results (see Table 4) confirm these expectations.

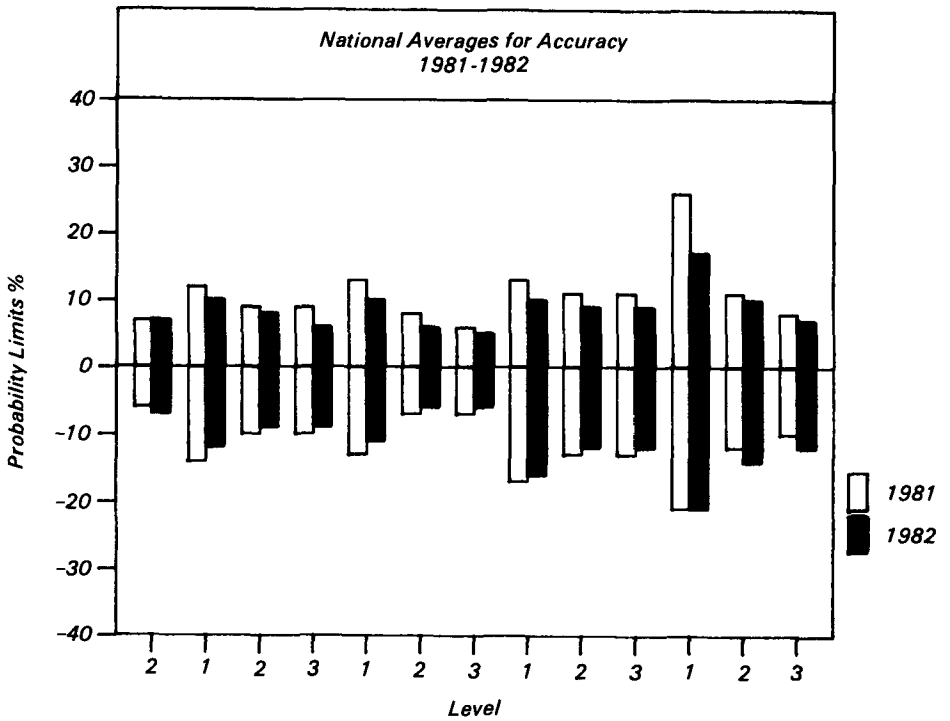

Figure 2. *National Accuracy Averages for 1981 to 1982.*

Table 4. *Summary Comparison of EMSL Performance Audits (PA) vs PARS Accuracy Audit Data for Year 1982*

Pollutant & Method Code	Audits	National Averages Probability Limits (%) Level 1 Lower	Level 1 Upper	Level 2 Lower	Level 2 Upper	Level 3 Lower	Level 3 Upper	Level 4 Lower	Level 4 Upper
CO									
PA	1704	-17	+12	-7	+8	-7	+7		
PARS	(1122)	(-15)	(+15)	(-7)	(+8)	(-7)	(+7)	(-3)	(+3)
NO_2									
PA	127	-24	+21	-20	+15	-25	+19	-23	+16
PARS	(526)	(-11)	(+12)	(-8)	(+9)	(-7)	(+7)		
SO_2									
PA	130	-32	+22	-21	+20	-15	+2	-13	+9
PARS	(445)	(-18)	(+11)	(-12)	(+8)	(-10)	(+7)		
LEAD									
PA	377	-37	+35	-24	+20	-22	+14		
PARS	(529)	(-16)	(+11)	(-11)	(+8)				
HIV									
PA	2860			-13	+12				
PARS	(5475)			(-7)	(+7)				
SO_2 (Cont)									
PA	363	-27	+21	-25	+21	-25	+21	-22	+20
PARS	(656)	(-19)	(+14)	(-17)	(+13)	(-16)	(+13)	(-16)	(+12)

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*E. Gardner Evans, **Raymond C. Rhodes** (also the EPA Project Officer, see below), William J. Mitchell, and John C. Puzak are with Environmental Monitoring Systems Laboratory, Research Triangle Park, NC 27711.*

The complete report, entitled "Summary of Precision and Accuracy Assessments for the State and Local Air Monitoring Networks 1982," (Order No. PB 85-208 171/AS; Cost: $16.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Environmental Monitoring Systems Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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