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Special Report, Issues Concerning The Use of Precision And Accuracy Data

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SPECIAL REPORT
ISSUES CONCERNING THE USE OF PRECISION AND ACCURACY DATA

by

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In conjunction with the
Work Group on the Utilization of Precision and Accuracy Data:

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PREFACE

This report represents the efforts of the Work Group on the Utilization of Precision and Accuracy (P&A) data, which was formed to determine how we should utilize the P&A data relative to the regulatory decision-making process. The P&A data is reported by the National Aerometric Data Bank (NADB), along with the associated air quality. The P&A data bank is maintained by the Environmental Monitoring Systems Laboratory (EMSL) and contains the P&A data reported by the States to the Regional Offices and EMSL.

The Work Group was formed in December 1982 and is composed of people representing the Regional Offices, the Office of Research and Development, the Office of Policy and Resource Management, the Office of Air Quality Planning and Standards, and EPA consultants. The following individuals are members of this Work Group:

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The report would not have been possible without their technical assistance and overall guidance.

CONTENTS

INTRODUCTION

A cardinal element in the U.S. Environmental Protection Agency's administration, review, refinement, and revision of its air quality management, policies, and regulations is the record of ambient air pollutant concentrations monitored and reported by state and local agencies (referred to as reporting organizations). The data reside in the National Aerometric Data Bank (NADB); they are used by the EPA and others to identify trends in air quality, determine the attainment status of geographical areas, assess the efficacy of possible revisions to ambient standards, and for many other purposes.

Because of the importance of the reliability of these data, the state and local agencies are required, as part of regulation 40 CFR 58 promulgated on 10 May 1979, to maintain a quality assurance program that entails both quality control and quality assessment activities. Reporting organizations assess data quality by conducting precision checks and accuracy audits of the monitoring instruments (referred to as analyzers). Precision and accuracy summary statistics are stored in files maintained by the EPA's Environmental Monitoring Systems Laboratory (EMSL). In this report we discuss several issues concerning the utilization of the precision and accuracy data described in 40 CFR 58 Appendix A, "Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)."

There seem to be two areas of activity in which knowledge of the precision and accuracy of measured ambient concentrations, if used, could be very important. First, in determining whether a site is or is not in attainment of a National Ambient Air Quality Standard (NAAQS), it may be of use to decision makers to know the extent to which a concentration reported to be either above or below the standard is likely to be a result of measurement error. Second, in setting NAAQS, it is of interest to policy makers to judge the protection likely to be afforded by existing and possibly revised ambient standards on either a national or regional basis. Such a judgement may be influenced by measurement uncertainties. The two activities are complementary: In the first activity a decision maker may wish to avoid unjustly penalizing an organization for measurement error, whereas in the second activity a policy maker is required by the Clean Air Act to provide adequate protection by incorporating a margin of safety to compensate for uncertainties, including those due to measurements.

Our use of the terms "precision" and "accuracy" in this report should be explained. In usual quality assurance parlance, the precision of a measurement process or device refers to the repeatability or variability of measurements under prescribed conditions, usually quantified as the sample variance (or its square root, the sample standard deviation) of the measurements. Accuracy refers to the closeness of the measurements to some reference standard. Often a reference material, whose measure is known, is used to challenge the measuring device or process. Measurement accuracy is usually quantified as the sample bias of the measurements, i.e., the difference between the average of the measurements and the known correct value.

In this report, however, "precision" and "accuracy" refer to the precision checks and accuracy audits, respectively, required under federal regulations. We describe these requirements in the report, but the point here is that the sample bias and variance are relevant quantities that are computed for both the precision checks and the accuracy audits. Thus, to avoid confusion, we have reserved the term "precision and accuracy data" to mean the data collected under the program of precision checks and accuracy audits.

In the next section we describe the precision and accuracy (P&A) calculations and reported results. We then discuss several P&A issues. Each issue is presented in the form of a question.

DESCRIPTION OF PRECISION AND ACCURACY CALCULATIONS

Precision and accuracy checks currently required for State or Local Air Monitoring Stations (SLAMS) and consequently for National Air Monitoring Stations (NAMS) are described in Federal Register 44, 92: 27574-27577. These checks are intended to serve as a basis for assessing, and hence improving, the quality of monitoring data.

Table 1 depicts the concentration points at which biweekly precision checks and annual accuracy audits are made. Table 2 shows the precision and accuracy calculations that are made: $p_{\cdot jk}$ and $s_{jk}(p)$ are the average and standard deviation of the percentage differences p_{ijk} for the i^{th} precision check made during the j^{th} quarter on the k^{th} instrument (analyzer); $p_{\cdot j \cdot}$ and $s_{j \cdot}(p)$ are the average and standard deviation obtained by pooling the K instruments within a reporting organization. Similarly, $a_{\cdot m}$ and s_m (a) are the average and standard deviation obtained from auditing the K instruments at the m^{th} concentration level. Typically, there are $n = 6$ or 7 biweekly precision checks within a quarter. When this number varies across the instruments within a reporting organization, the pooled average and standard deviation are obtained from weighted averages. For TSP, the flow rate, rather than the concentration, is the audited quantity; each high-volume sampler is audited once per year.

An exception to the precision calculations presented in Table 2 occurs when precision is estimated from a pair of collocated instruments, rather than from challenges to a single instrument by a reference material of known concentration. This procedure, referred to as a manual method, is followed for instruments that intermittently monitor particulate matter, lead, or other air pollutants. (The other procedure, referred to as an automated method, is used for continuous analyzers.) In this case,

TABLE 1. Concentration points (in parts per million, ppm) for precision checks and accuracy audits.

	SO_2, NO_2, O_3	CO
One-point precision check once every two weeks	0.80 - 0.10	8 - 10
Four-point accuracy audit once per year	0.03 - 0.08	3 - 8
	0.15 - 0.20	15 - 20
	0.40 - 0.45	40 - 45
	0.80 - 0.90	80 - 90

TABLE 2. Precision and accuracy calculations.

Indexes

i - i^{th} precision check
j - j^{th} quarter
k - k^{th} instrument (analyzer)
m - m^{th} concentration level

Measured and Reference Variables

Y = Concentration (or flow rate in the case of TSP) as measured by the instrument

X = Known reference concentration (or flow rate)

Precision Calculations

$$p_{ijk} = 100 \times (Y_{ijk} - X_{ijk})/X_{ijk}$$

$$p_{.jk} = \frac{1}{n} \sum_{i=1}^{n} p_{ijk} \qquad s_{jk}(p) = \left[\frac{1}{n-1} \sum_{i=1}^{n} (p_{ijk} - p_{.jk})^2\right]^{1/2}$$

$$p_{.j.} = \frac{1}{K} \sum_{k=1}^{K} p_{.jk} \qquad s_{j.}(p) = \left[\frac{1}{K-1} \sum_{k=1}^{K} (p_{.jk} - p_{.j.})^2\right]^{1/2}$$

Estimated 95% lower (L) and upper (U) probability limits for precision:

$$L_j(p) = p_{.j.} - 1.96\, s_{j.}(p), \qquad U_j(p) = p_{.j.} + 1.96\, s_{j.}(p)$$

Accuracy Calculations

$$a_{km} = 100 \times (Y_{km} - X_{km})/X_{km}$$

$$a_{.m} = \frac{1}{K} \sum_{k=1}^{K} a_{km} \qquad s_m(a) = \left[\frac{1}{K-1} \sum_{k-1}^{K} (a_{km} - a_{.m})^2\right]^{1/2}$$

Estimated 95% lower (L) and upper (U) probability limits for accuracy:

$$L_m(a) = a_{.m} - 1.96\, s_m(a), \qquad U_m(a) = a_{.m} + 1.96\, s_m(a)$$

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one of the collocated instruments is designated as the ambient monitor (symbolized by Y in Table 2), and the other is designated as the reference (X). The calculations are modified by dividing the standard deviation $s_{j.}$ (p) by $\sqrt{2}$, to allow for the fact that the observed imprecision is due not only to the ambient measurement but also, in part, to imprecision in the reference concentration.

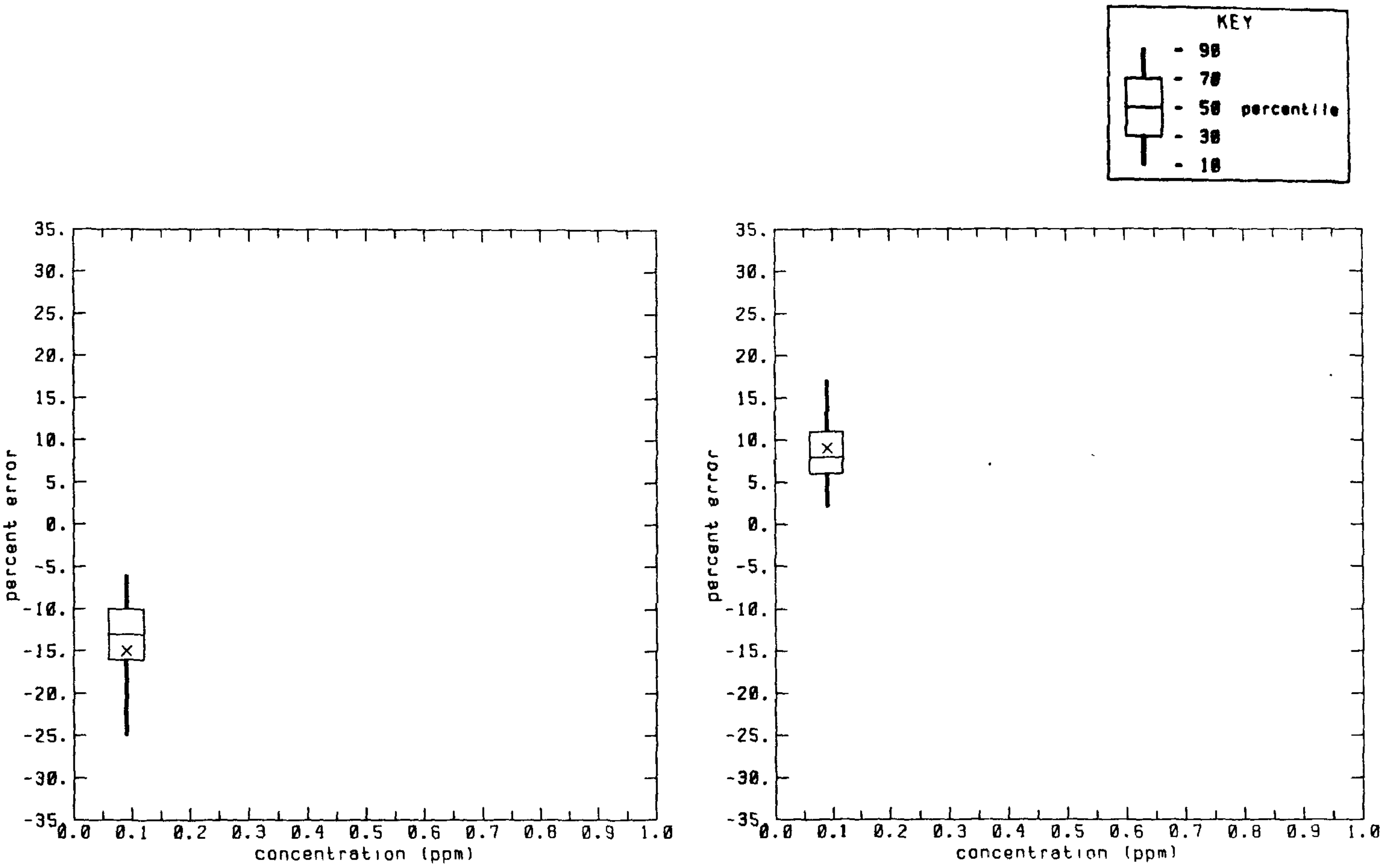
Several aspects of the reported P&A data are worth noting. The only P&A data that are required to be reported to the EPA are summary statistics consisting of the number of precision checks (n), accuracy audits (K), and the upper and lower 95% probability limits for precision and accuracy given in Table 2. Also, the reported probability limits pertain to the reporting organization rather than a specific instrument within a reporting organization. Thus, if we were to apply the probability limits to a specific monitor, we must assume that measurement errors are similar among the monitors within a reporting organization. Generally, reporting organizations have been formed from a collection of sites whose monitoring practices are reasonably homogeneous. There are, however, possible exceptions. In contrast to, for example, the State of New York, which constitutes one reporting organization made up of a collection of operating organizations, the State of Florida consists of 13 fairly homogeneous reporting organizations each consisting of one operating organization. Finally, the calculation of the probability limits follows from an assumption that measurement error, expressed as a percentage of the actual value (concentration or flow rate) is normally distributed.

ISSUE 1

Issue. What precision and accuracy are currently being attained nationwide?

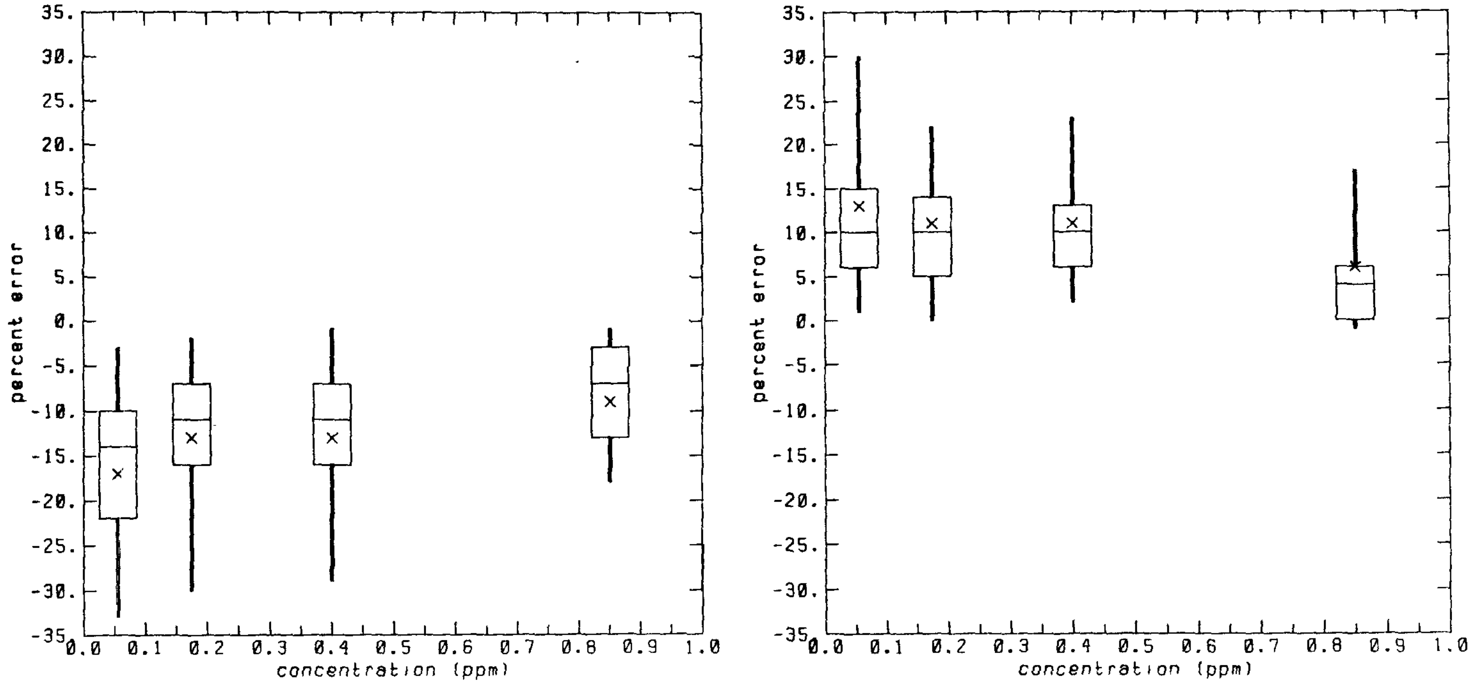
Discussion: From Figures 1-8, we see that few reporting organizations have measurement errors (95 percent probability limits) of more than 25 percent for automated (continuous) ambient monitors. Somewhat greater error limits are reported for manual (integrated) monitors. In addition, the accuracy audits show that percentage errors tend to decrease as the audited concentration increases.

Figures 1 through 8 illustrate the precision and accuracy attained by monitors of sulfur dioxide (Figures 1 and 2), ozone (Figure 3), carbon monoxide (Figure 4), nitrogen dioxide (Figures 5 and 6), total suspended particulate (Figure 7), and lead (Figure 8). Each figure consists of parts (a) through (d), which in the notation of Table 2 shows the frequency distribution across reporting organizations of $L_j(p)$, $U_j(p)$, $L_m(a)$, and $U_m(a)$, respectively.



(a) precision - lower prob. limit.

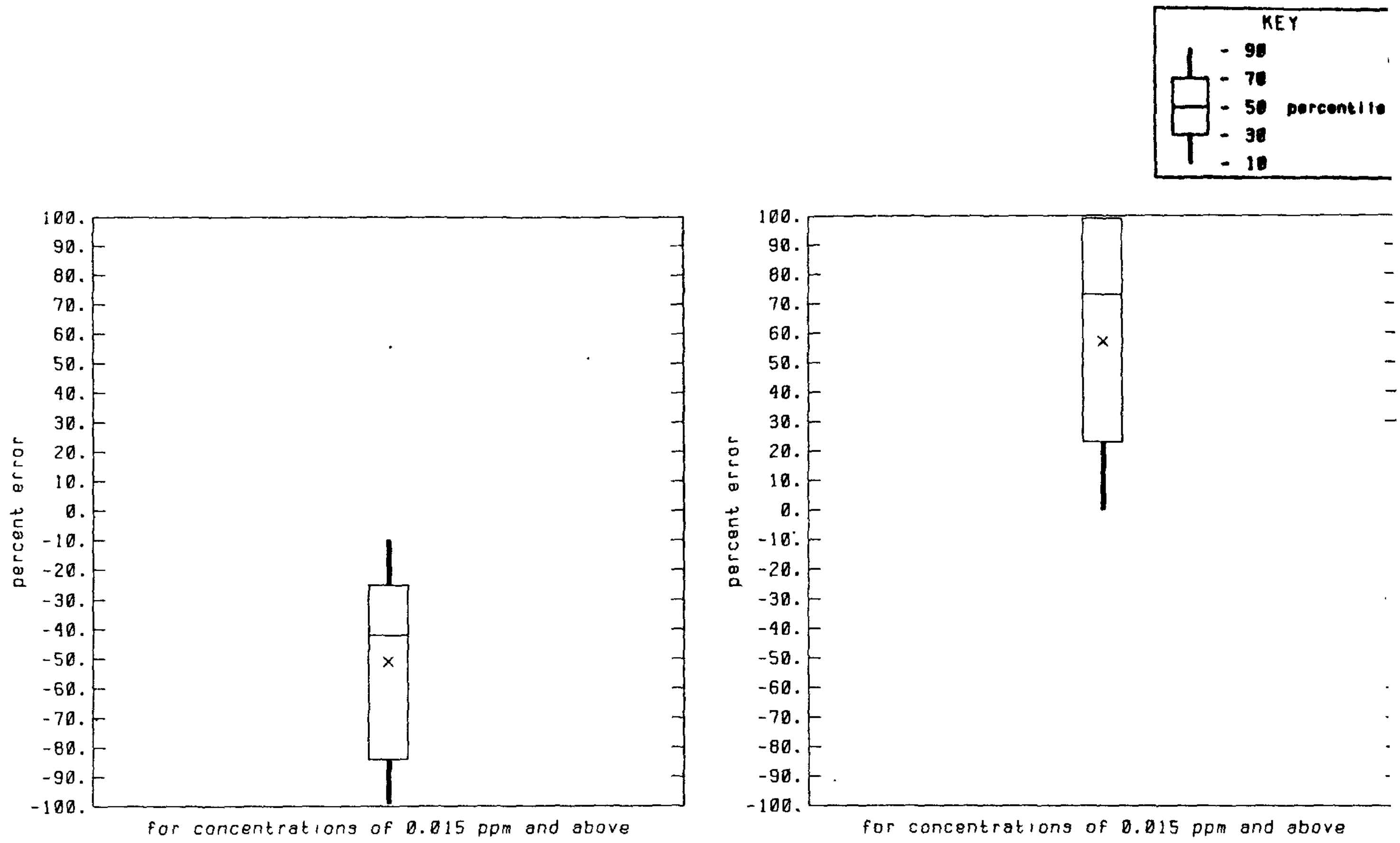
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

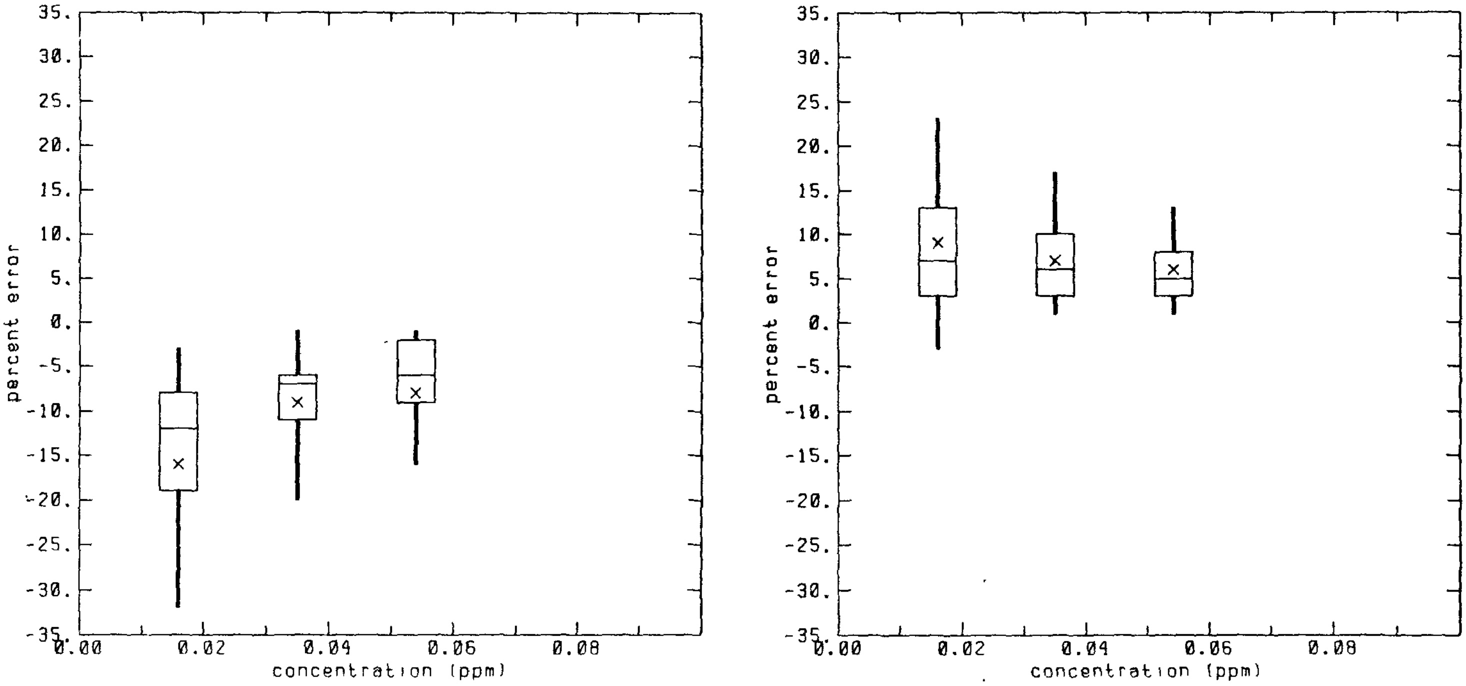
(d) accuracy - upper prob. limit

FIGURE 1. Distribution of sulfur dioxide precision and accuracy (percentage error, automated analyzer) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

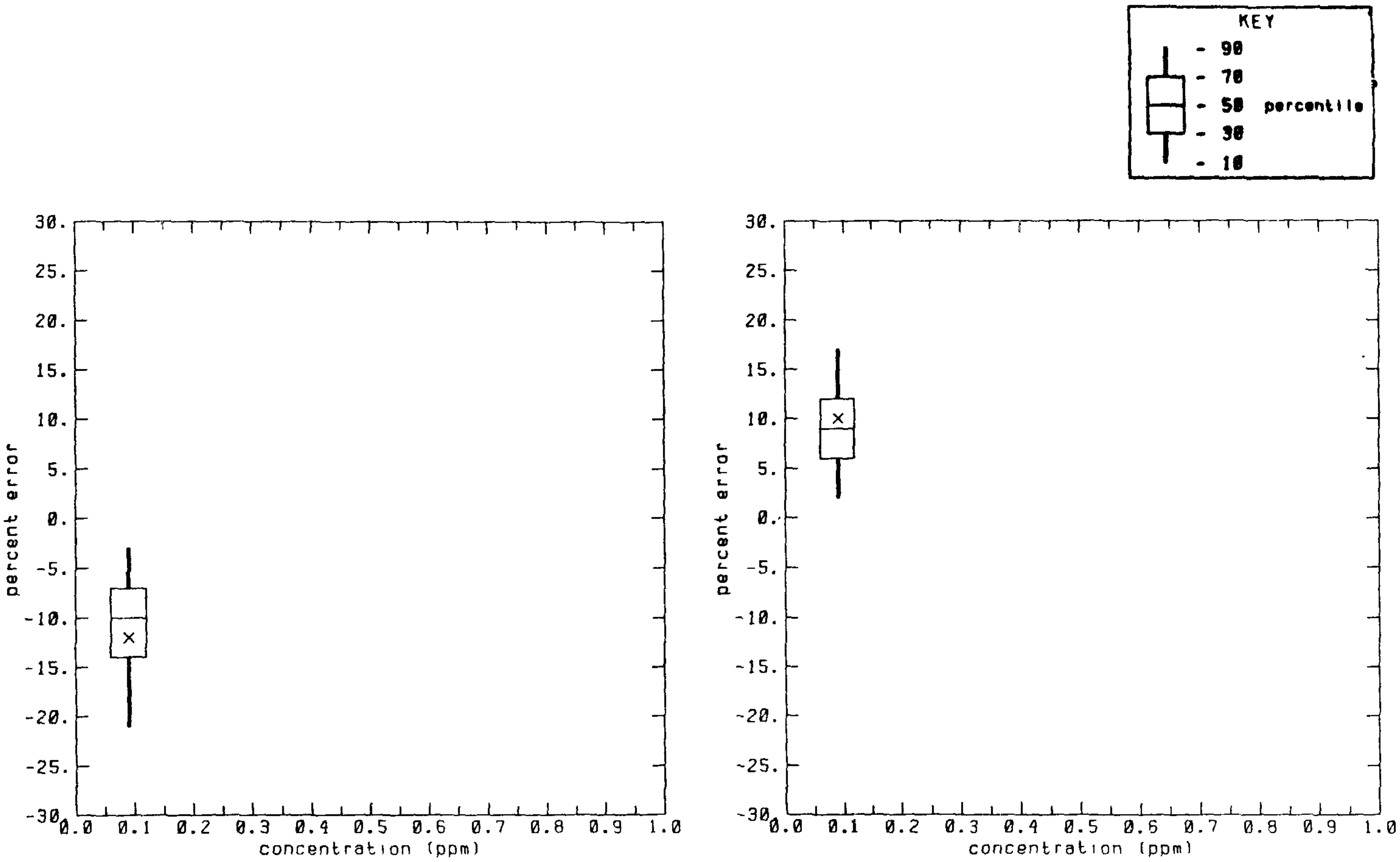
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

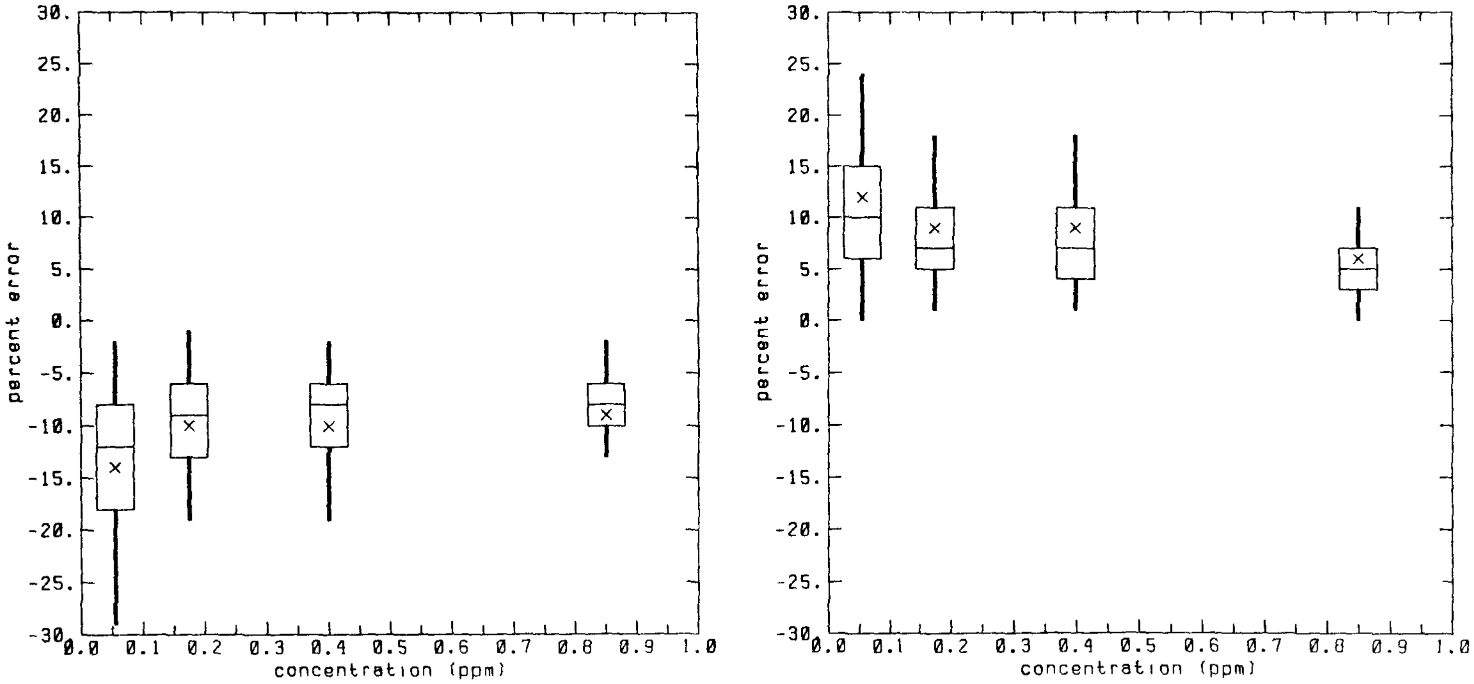
(d) accuracy - upper prob. limit

FIGURE 2. Distribution of sulfur dioxide precision and accuracy (percentage error, manual method) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

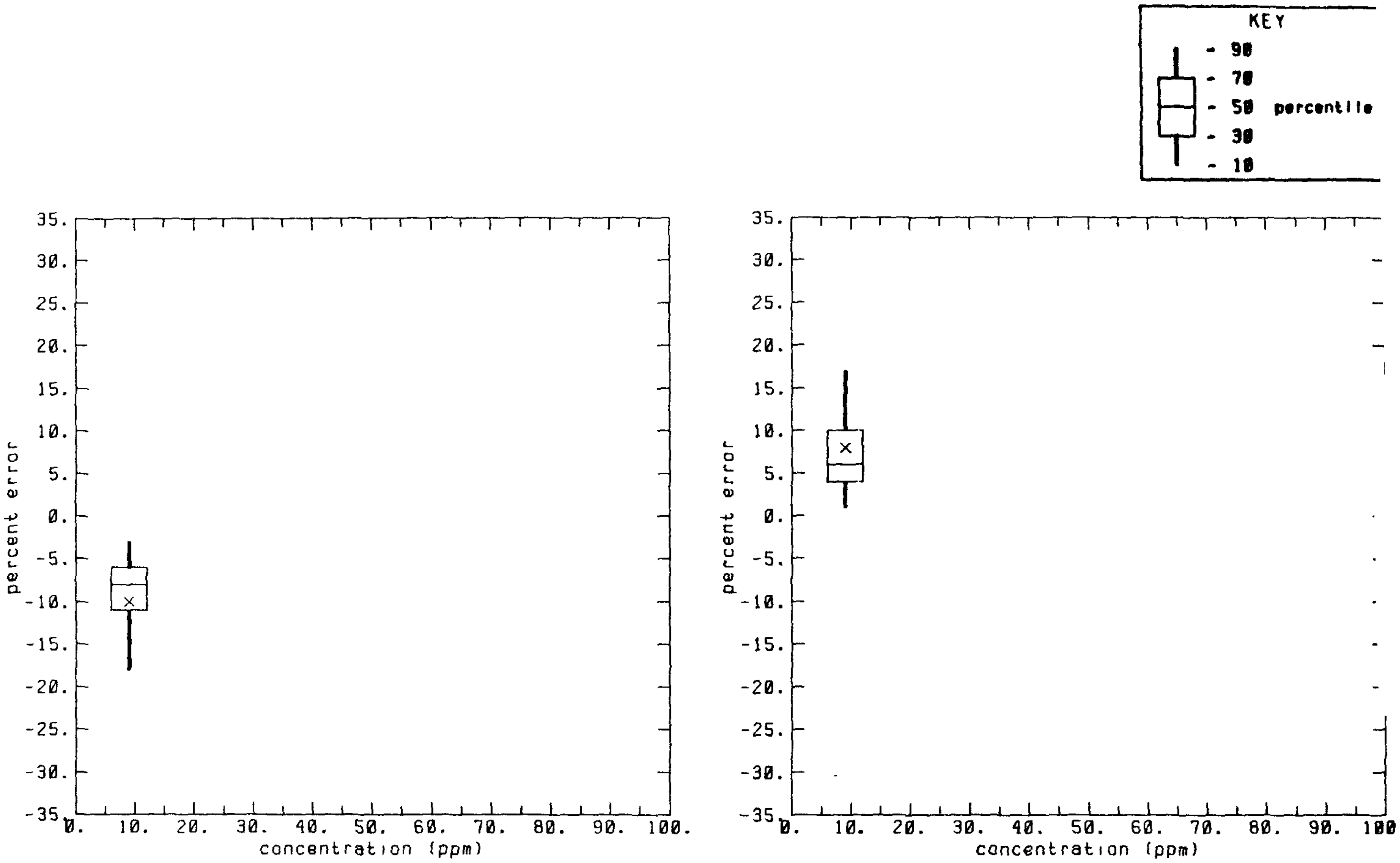
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

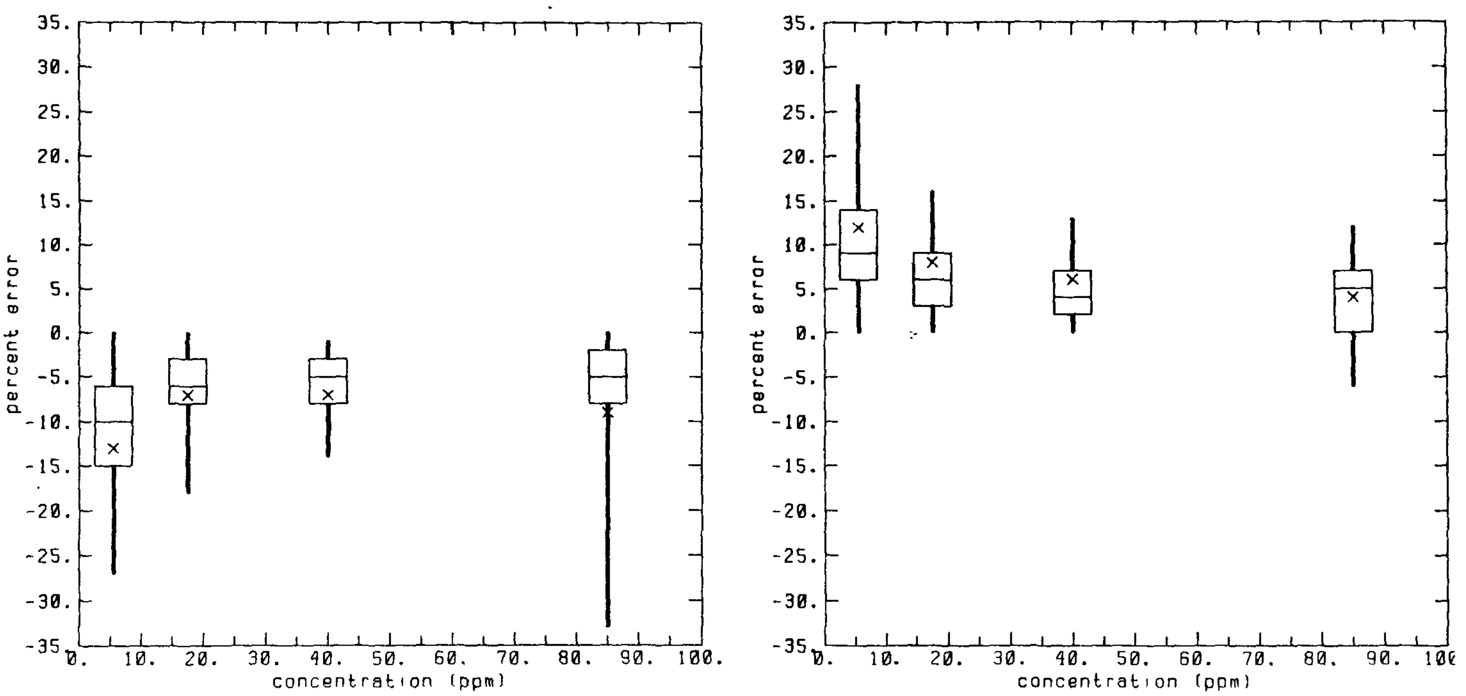
(d) accuracy - upper prob. limit

FIGURE 3. Distribution of ozone precision and accuracy (percentage error, automated analyzer) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

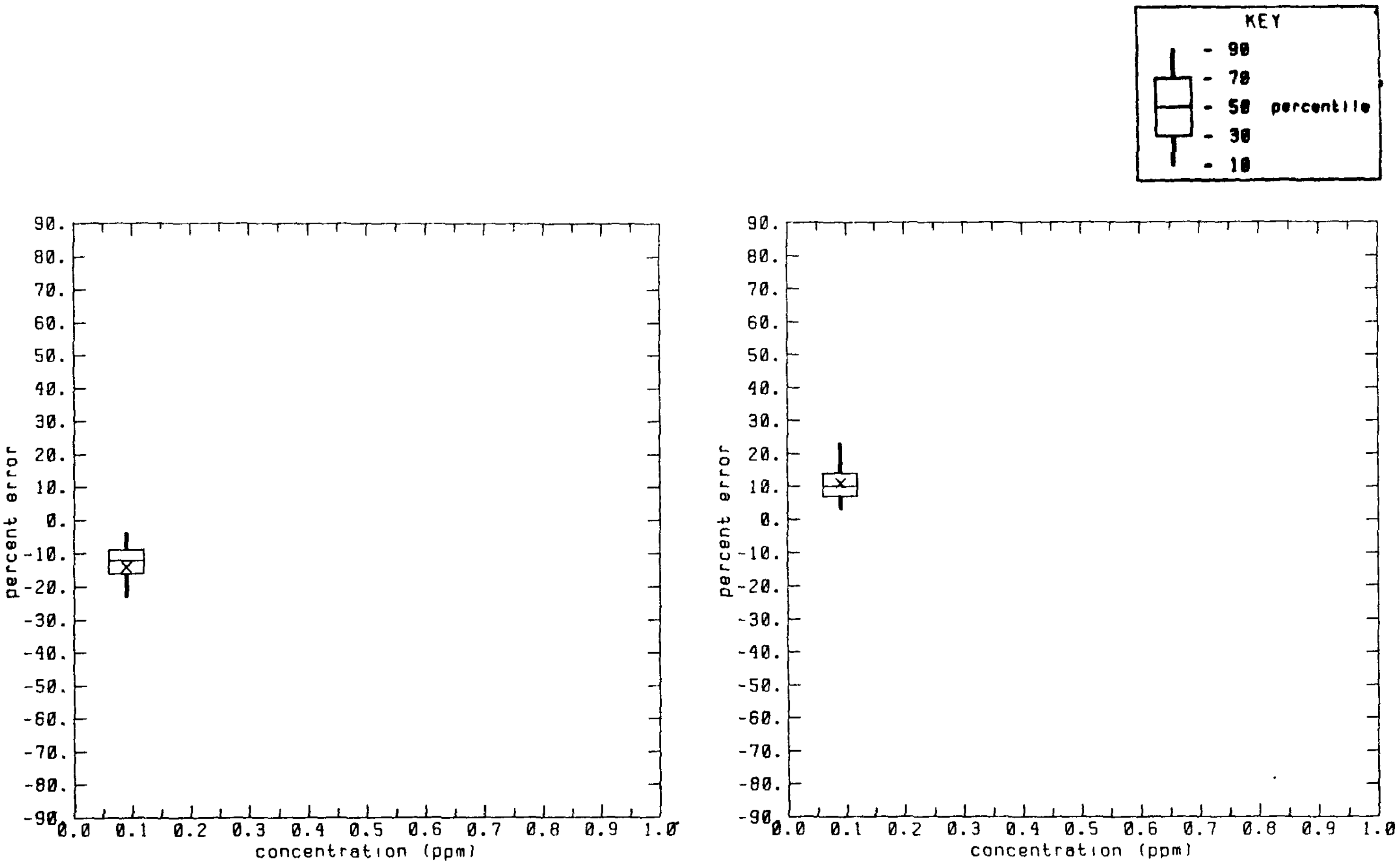
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

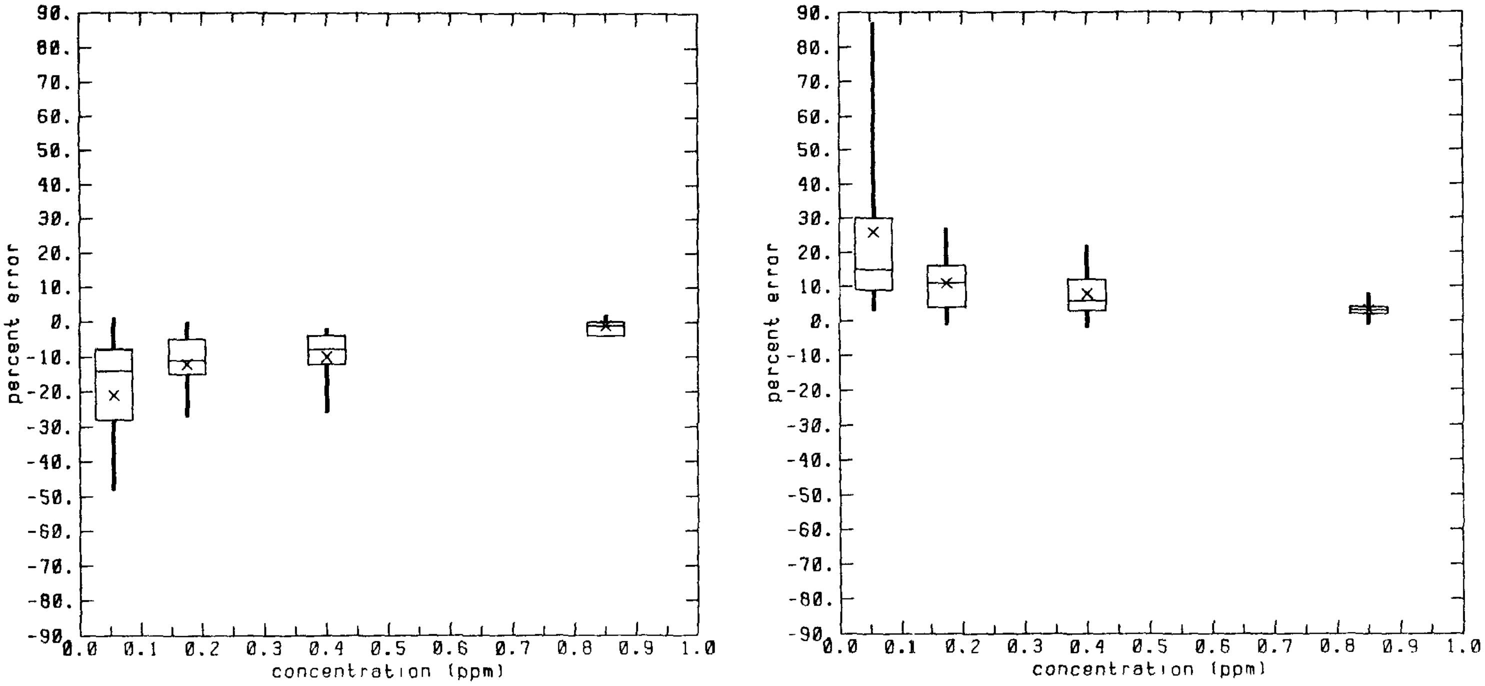
(d) accuracy - upper prob. limit

FIGURE 4. Distribution of carbon monoxide precision and accuracy (percentage error, automated analyzer) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

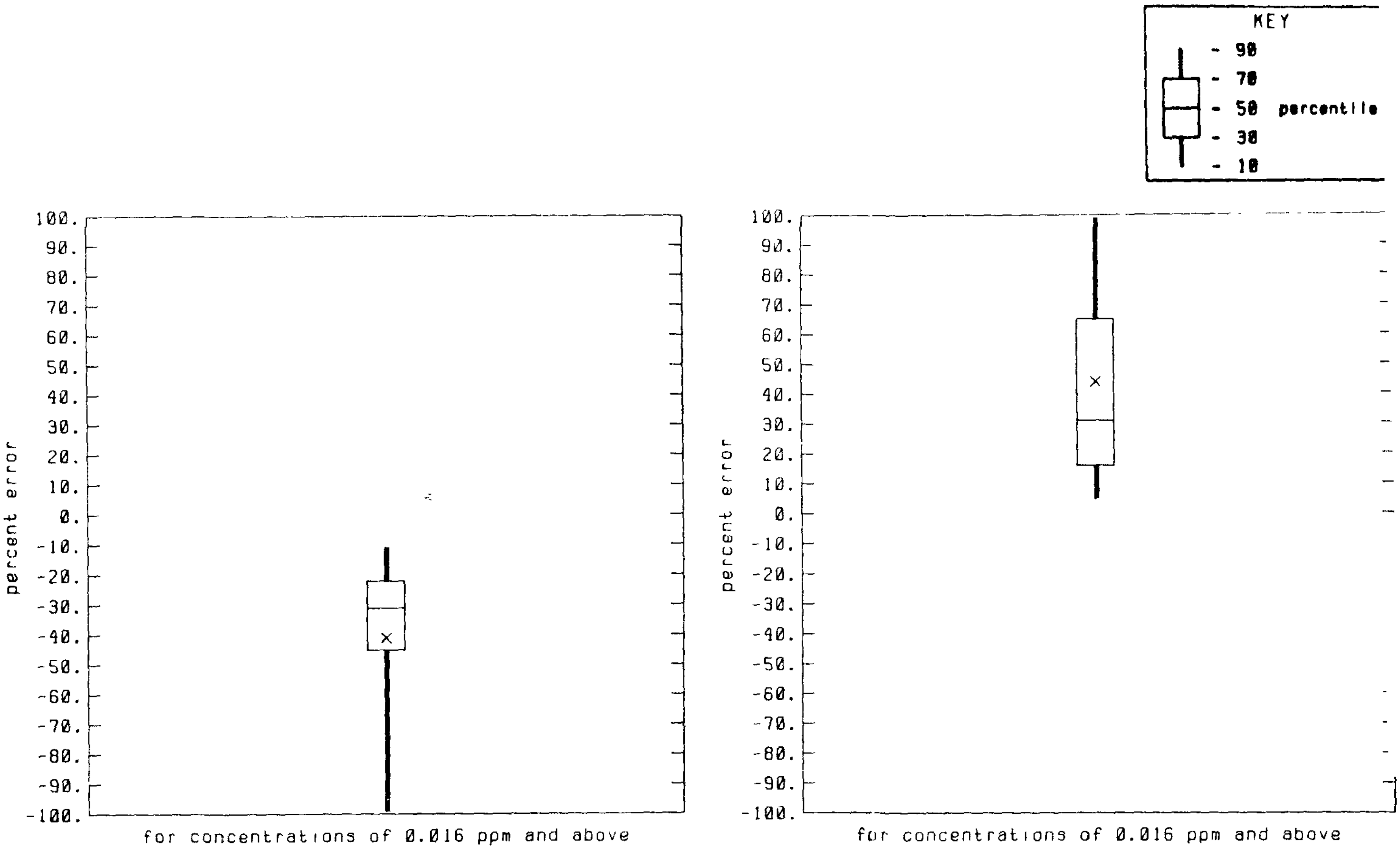
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

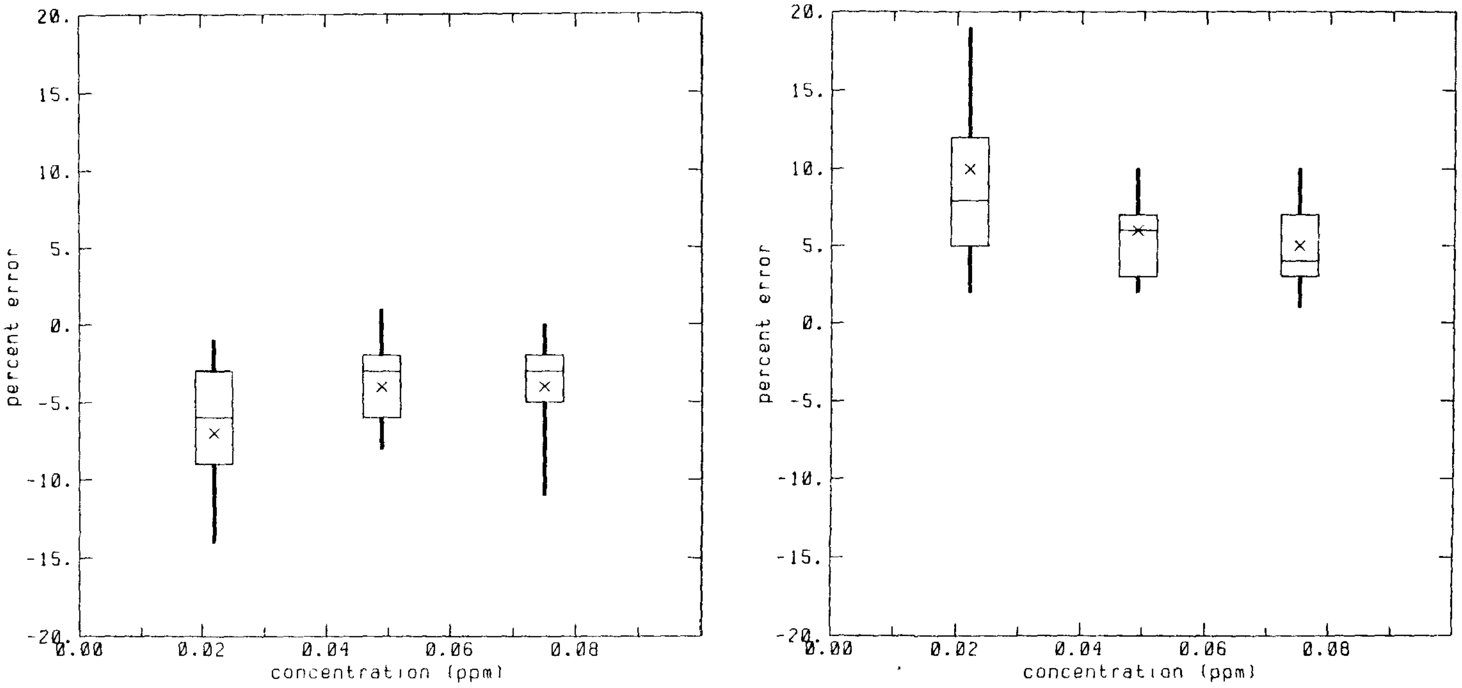
(d) accuracy - upper prob. limit

FIGURE 5. Distribution of nitrogen dioxide precision and accuracy (percentage error, automated analyzer) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

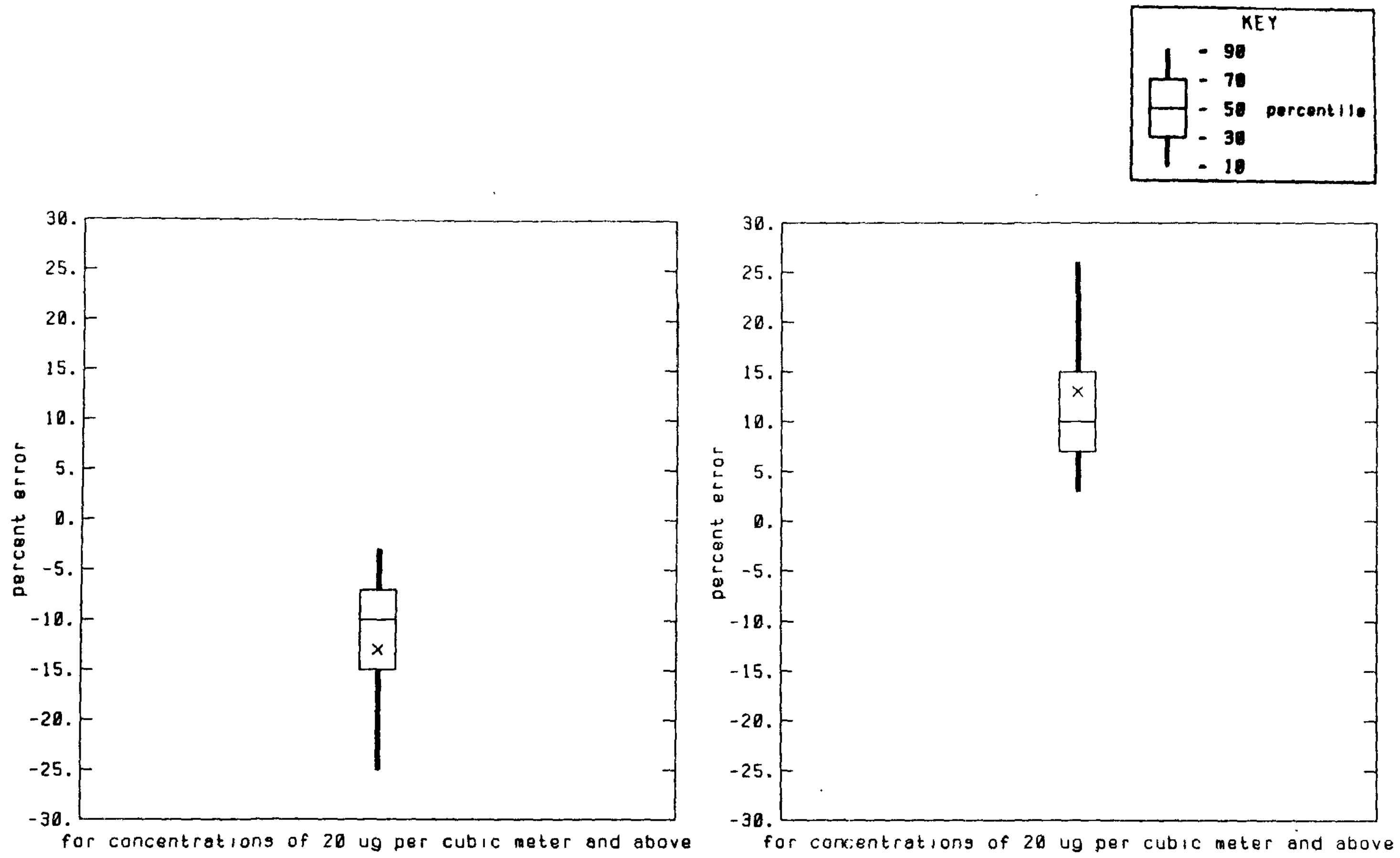
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

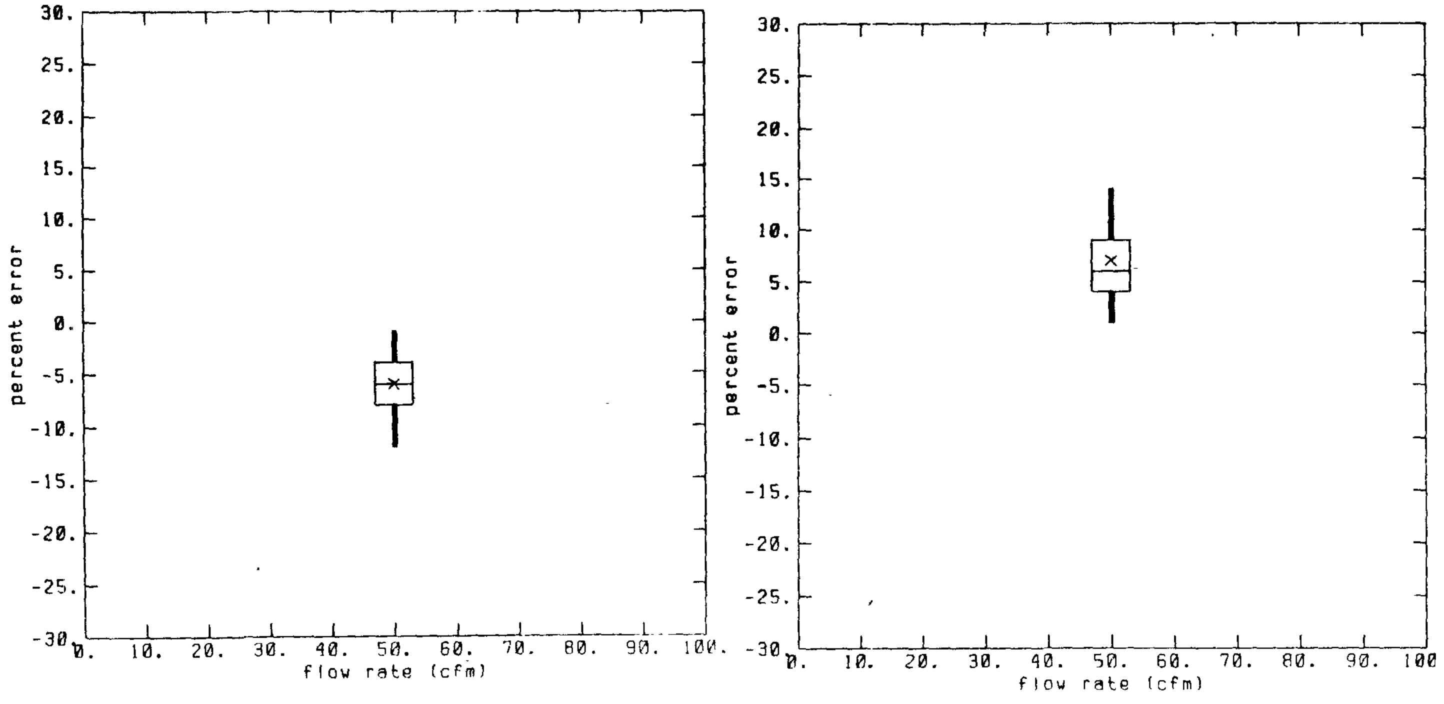
(d) accuracy - upper prob. limit

FIGURE 6. Distribution of nitrogen dioxide precision and accuracy (percentage error, manual method) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

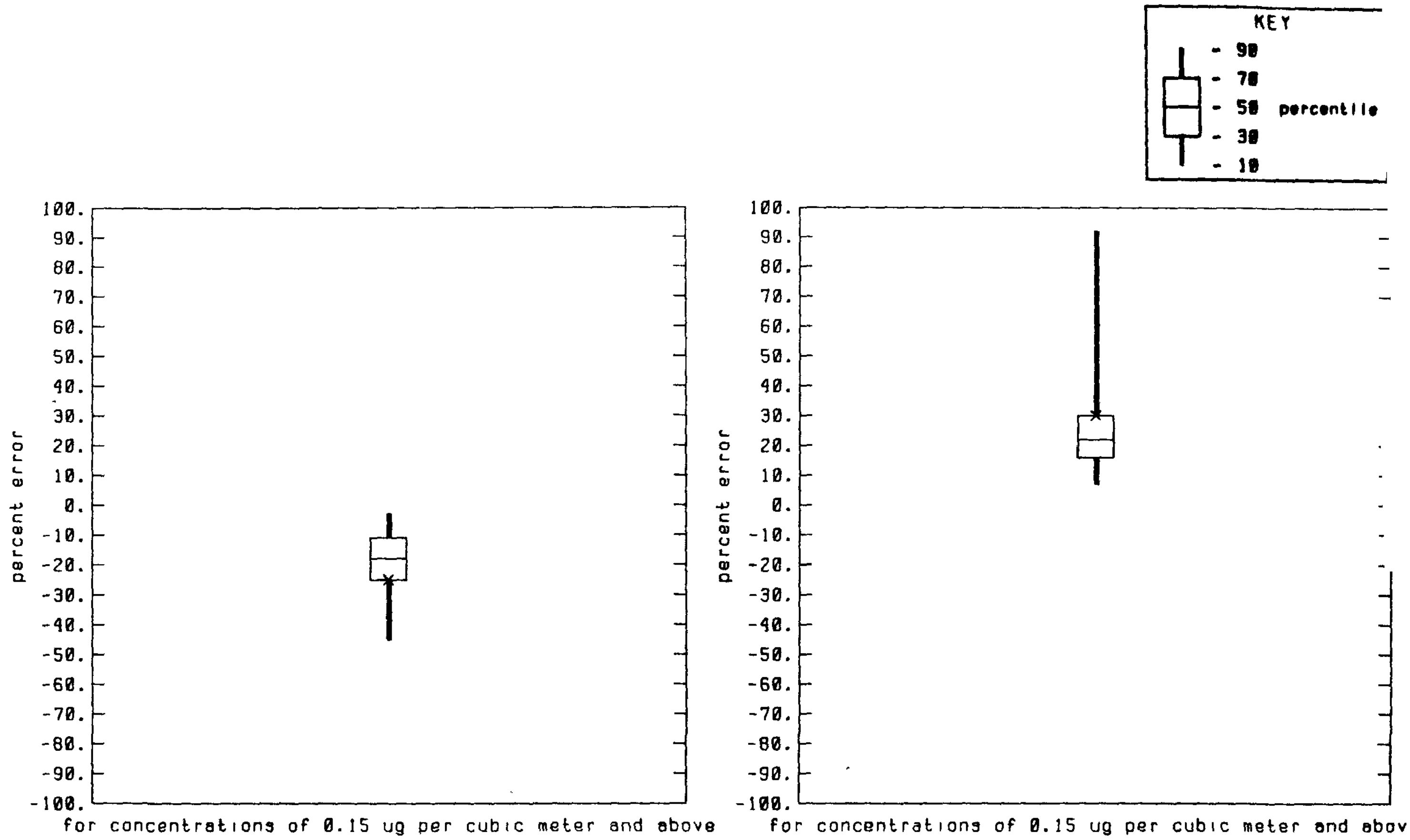
(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

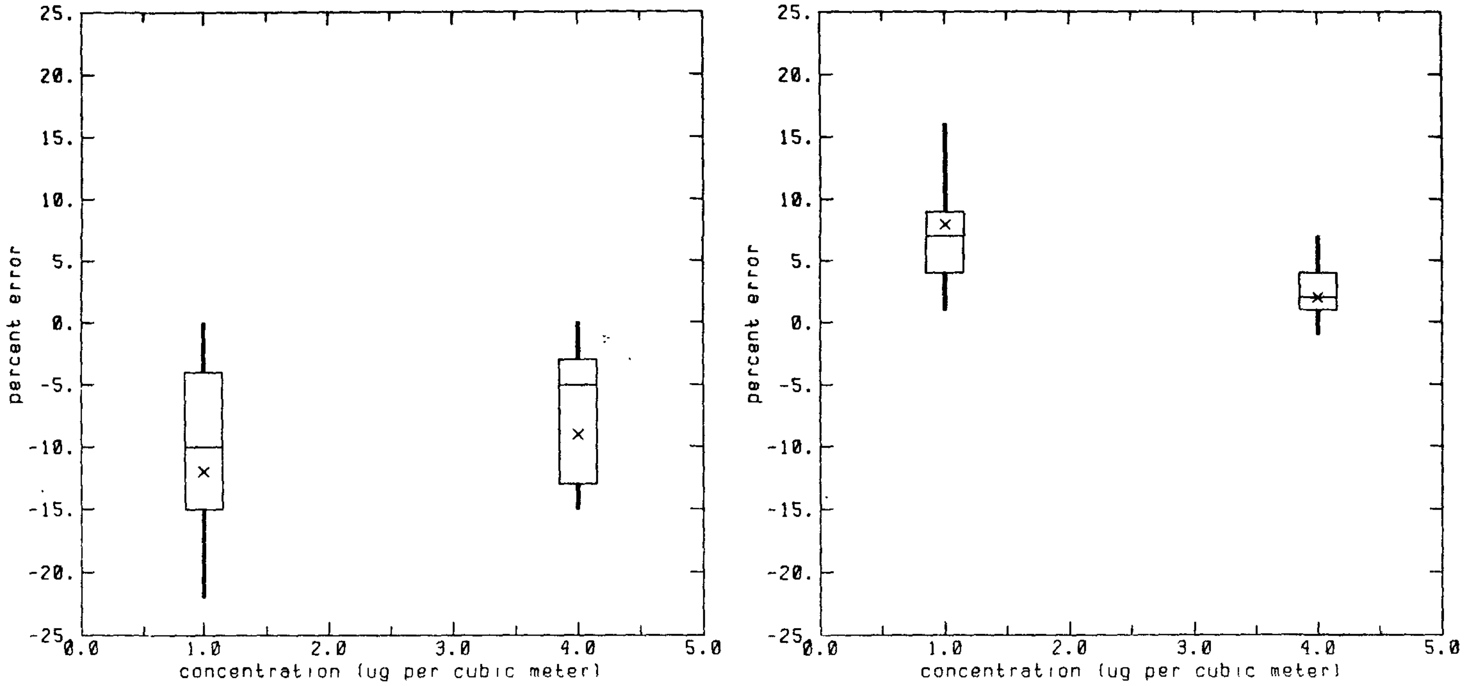
(d) accuracy - upper prob. limit

FIGURE 7. Distribution of total suspended particulate precision and accuracy (percenta error, manual method) attained by reporting organizations, 1981.



(a) precision - lower prob. limit

(b) precision - upper prob. limit



(c) accuracy - lower prob. limit

(d) accuracy - upper prob. limit

FIGURE 8. Distribution of lead precision and accuracy (percentage error, manual method) attained by reporting organizations, 1981.

ISSUE 2

Issue. What P&A data, and what data quality, are necessary for trends or attainment determinations?

Recommendation: At a minimum, an estimate of the average and standard deviation of instrument-specific precision checks are needed to support the accuracy of attainment determinations. Provided the measurement error for an instrument is within a range of ±20 percent, measurement imprecision is not currently believed to adversely influence attainment determinations. In contrast, the currently available 95 percent probable error range for reporting organizations may be adequate for trends determination, and acceptable measurement error may here be as much as 100%.

It is recommended that organization-wide measurement error, reflected by the upper and lower 95 percent probability limits for precision and accuracy, be held within the range of ± 25 percent for automated analyzers. Additionally, it is recommended that NAAQS attainment be determined directly from recorded ambient concentrations, without adjustment for measurement error. These recommendations are subject to review by the Standing Air Monitoring Work Group (SAMWG).

Discussion: In a simulation study, Curran, Stiegerwald, and Burton (1981) show that measurement imprecision of 20 percent or less may cause measured annual second-highest concentrations to be biased upward by as much as 5 percent, while more robust air quality indicators used in trends determinations are more resistant to measurement error (seasonal averages were shown to be practically unaffected by as much as 100 percent measurement imprecision). Moreover, instrument-specific information is needed to interpret concentration extremes relevant to short-term standards, whereas trends are typically averaged over monitors in a region, so that instrument-specific information may not be necessary.

Thus, the overriding requirements for both the type of P&A data and the quality of ambient data are for attainment determinations. We note that reporting organizations are currently required to maintain instrument-specific P&A records for three years, and they are encouraged to keep permanent instrument-specific records. As discussed in Issue 1, holding measurement error of automated analyzers to ± 25 percent is an attainable goal.

There has been considerable discussion of whether and how to use P&A data in determining NAAQS attainment. One possibility, for example, would be to construct 95 percent confidence limits for the actual annual ambient concentration, and to judge at site to be in attainment of the annual standard unless the entire confidence interval lay above the annual NAAQS concentration. The confidence interval would be computed as

$$C \left(1 + \frac{U + L}{2} \pm \frac{U - L}{2\sqrt{n}}\right)$$

where C is the computed annual average concentration, U and L are the upper and lower 95 percent probability limits based on precision checks, and n is the number of terms used to compute the annual average concentration. The interpretation of this interval as a 95 percent probability interval is based on the assumption that the annual average is approximately normally distributed, an assumption that can be justified without assuming that individual measurement errors are normally distributed. In the case of short-term standards, however, it is essential that the distribution of individual measurement errors be known, at least approximately, in order for us to determine the appropriate use of P&A data in the assessment of short-term NAAQS attainment.

An additional difficulty in using P&A data in NAAQS attainment determinations is that such policies may result inadvertently either in more lenient determinations for the reporting organizations having the largest measurement errors, or in unjustly stringent determinations for all reporting organizations. If, however, no P&A adjustment is made in assessing attainment, reporting organizations have a natural incentive, in addition to explicit requirements, for maintaining data reliability, for, as Curran, Steigerwald, and Burton (1981) show, measurement imprecision tends to result in the highest measured concentrations being higher than the actual ambient concentration.

As pointed out in the 1983 EPA document <u>Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40CFR58, Appendices A and B</u>, the precision checks and accuracy audits conducted by reporting organizations serve as one component of the quality assurance programs. At a local level, P&A data enable reporting organizations to identify aspects of their quality assurance programs that may need strengthening. The P&A data also enable the EPA to determine the steps that may need to be taken to improve the quality of ambient data, such as additional research on measurement procedures, increased quality control for certain types of measurements, or technical assistance to some areas of the country needing improved quality control. The checks and audits have not been designed, however, to yield data directly applicable to the determination of the attainment of ambient standards. For this purpose appropriate averaging times, spatial representativeness, and other components of error or variation would have to be considered.

ISSUE 3

Issue. How should P&A data be used for (1) quality assurance and (2) reported statistics?

Recommendation: The primary purpose for the P&A program is to assist in the quality control of concentration measurements. The program enables reporting organizations to identify occurrences of unacceptably large measurement errors (e.g., more than 25 percent for automated analyzers) and to tighten up quality control procedures as necessary. Additionally, the P&A data roughly indicate the reliability of the data that are used for the analysis of trends or alternative regulatory policies. The P&A data are not, and should not be, used to alter concentration values stored in the NADB, but the NADB maintains special reader comment files where changes in measurement procedures may be reported.

Discussion: The precision and accuracy (P&A) activities supplement the quality control (QC) activities of reporting organizations. The P&A and QC components comprise the quality assurance (QA) program. As part of the quality control activities, instruments are regularly calibrated to minimize measurement error. The P&A phase of the program serves to inform all concerned as to the data quality being achieved.

Additionally, the user of ambient concentration data stored in the NADB has access to the corresponding P&A data maintained by the EMSL, so that informed judgments may be made as to the reliability of ambient air quality data. Note however that the P&A activities are not designed for this additional purpose: P&A data describe only a portion of the measurement error associated with ambient air quality data.

ISSUE 4

Issue. Are presently prescribed P&A check frequencies adequate to assess data quality?

Recommendation: The current practice of conducting precision checks once every two weeks and accuracy audits once per year appears to be adequate. Note that reporting organizations having fewer than four analyzers for a given pollutant are required to audit a randomly selected analyzer each calendar quarter (so that each analyzer is audited once or more per year).

Discussion: There are essentially two considerations in deciding how frequently to conduct the precision checks and accuracy audits, namely, cost and quality assurance. The frequency of precision checks necessary to assure data quality has been determined by the Environmental Monitoring Systems Laboratory (EMSL) to be once every two weeks, based on knowledge of instrument drift (how rapidly an instrument goes out of calibration) and other factors. The frequency of the more costly accuracy audits have similarly been determined to be once per year per instrument (and a minimum of one audit per quarter) based on both cost and quality assurance considerations.

ISSUE 6

Issue. How should P&A measurements be used to screen out anomalous data values, e.g., gross measurement errors?

Recommendation: Current EPA screening procedures appear to be an adequate safeguard against gross outliers. P&A data at the reporting organization level can be used to screen out groups of values that resulted from unacceptably imprecise or inaccurate instruments.

Discussion: Methods for the detection of gross outliers and other data anomalies are presented in the 1978 EPA guideline document Screening Procedures for Ambient Air Quality Data. These automated procedures are most valuable, but may fail to detect biased, yet self-consistent, measurements that could be checked at the reporting organization level. In flagging suspect measurements, measurement error should be kept in mind. If a monitored concentration is suspiciously low or high, but the P&A data show that the anomaly may be an instance of extreme measurement error, the question turns from the validity of a single reported concentration to the validity of a set of reported concentrations that were subject to large measurement error. If, on the other hand, the monitored concentration cannot be explained by measurement error, based on P&A data, the value may be excluded from future calculations, the grounds for exclusion being a probable error in something other than the measurement process, e.g., a data transcription error.

Consider, for example, three colocated instruments whose precision checks reveal that the instrument-specific averages agree, but that one instrument is much more variable than the other two. An implausibly large concentration from the two less variable instruments would suggest that a transcription or keypunch error may have occurred, whereas the same concentration from the highly variable instrument might be in the realm of measurement error. Thus in the case of a highly variable instrument, it may be more appropriate to question the validity of the set of readings from that instrument, rather than to focus on a single high value. Under current practice, comments about data reliability are recorded in reader comment files maintained by the EMSL.

Finally, it should be emphasized that the primary purpose of the precision checks and data audits is not to assess the validity of ambient measurements, but to assess and guide quality control procedures.

ISSUE 6

Issue. *Should measurements be corrected in accordance with the P&A* results before being reported?

Recommendation: Measurements should never to be corrected on the basis of P&A data.

Discussion: In principle NADB data should agree with data from the state from which they were obtained. As an illustration, the EPA and the State of California agreed in revising recorded ozone concentrations downward and in not revising nitrogen dioxide concentrations. In both instances, the state noted biases in the calibration procedure for ozone and nitrogen dioxide monitoring instruments; however, the state revised only the ozone concentrations (since records permitted a precise estimate of calibration bias) and not the nitrogen dioxide concentrations.

If an instrument were subject only to a constant systematic bias and not to imprecision, then the detection and quantification of this bias would allow us to obtain actual concentrations, uncontaminated by measurement error, by making a bias correction. Under these circumstances it would seem that P&A results need not be reported once appropriate bias corrections were made. Realistically, however, an instrument is subject to some imprecision, as well as bias, and the estimation of an appropriate bias correction is itself subject to error. So we may infer the likely range of the actual concentration corresponding to a measurement only if we know the likely range of measurement error. Since P&A results roughly indicate the level of measurement error, they need to be available even if state or local agencies make bias corrections.

ISSUE 7

Issue. Which of the following P&A data should be required of reporting organizations and stored in the EPA computer file?

1. Raw data for each instrument
2. Number of measurements, average, standard deviation; for each instrument
3. The currently reported 95 percent probability limits for each reporting organization

Recommendation: *Current practice (the third option) may* be adequate, provided that each reporting organization is comprised of a homogeneous set of monitors such that the pooled P&A results provide reliable estimates for each monitor.

Discussion: Note that the average ($\bar{x}$) and standard deviation (s) for a reporting organization may be calculated from the upper and lower 95 percent probability limits (U and L), and vice-versa, i.e.,

$$U = \bar{x} + 1.96\ s$$

$$L = \bar{x} - 1.96\ s$$

so that

$$\bar{x} = (U + L)/2$$

and

$$s = (U - L)/3.92 \quad .$$

Thus the choice of (U, L) versus ($\bar{x}$, s) is not a major issue. Some preference may be given to the ($\bar{x}$, s) format because the interpretation of U and L as 95 percent probability limits follows from the possibly unwarranted assumption that measurement error is normally distributed.

What is at issue is the availability of instrument-specific P&A results, so that, for example, more informed attainment determinations pertaining to a specific monitor may be made. Currently, reporting organizations are required to maintain instrument-specific P&A results for three years, and they are encouraged to maintain permanent records.

The current organization-wide reporting may be sufficient provided that there are no large differences between instrument-specific P&A results within a reporting organization. It is possible, for example, for there to be substantial systematic measurement errors (biases) for several instruments within a reporting organization, but that these biases cancel out in the calculation of organization-wide measurement bias. Such inhomogeneity would inflate the organization-wide standard deviation, thereby making the attainment of the ±25 percent P&A goal difficult. This situation could lead to an erroneous interpretation of concentrations recorded by a specific instrument.

Thus, current practice demands a degree of homogeneity among the instruments within a reporting organization. The alternative is to require instrument-specific P&A reporting (the second option).

ISSUE 8

Issue. Where should P&A results be reported?

Recommendation: P&A summary statistics currently reside in files maintained by the Environmental Monitoring Systems Laboratory (EMSL), as appropriate. In EPA documents concerning monitored concentration data, the average and standard deviation of the percentage errors obtained from precision checks could be reported parenthetically if, in the judgment of the data user, measurement error were pertinent to the discussion and adequately described by the P&A results.

Discussion: One possibility under consideration is to automatically supply P&A results and the reader comment files to those people requesting ambient concentration data. This would allow the greatest flexibility in the treatment of measurement error when interpreting calculations based on monitored concentrations.

ISSUE 9

Issue. What criteria can be used to determine the cost effectiveness of generating P&A information?

Recommendation: The benefit of quality assurance programs (which include the collection of P&A information used to guide quality control activities) is greatest for those sites in potential nonattainment of NAAQS. Considering possible economic consequences to an urban area due to an erroneous determination of NAAQS nonattainment based on faulty data, the benefit of reliable data may be on the order of tens to hundreds of millions of dollars, whereas the cost is on the order of thousands to tens of thousands of dollars.

Discussion: A detailed formulation of the marginal cost and benefit of a quality assurance program as a function of expected levels of ambient concentration and potential consequences of NAAQS nonattainment is beyond the scope of the present report. Nevertheless, it is clear from the work of Curran, Steigerwald, and Burton (1981) that those sites near the NAAQS limit deserve the most quality assurance (including P&A) effort, if limited funding requires that some sites be given more attention than others. At such sites, each additional increment of imprecision leads to an increased chance that the area would be decreed to be not in attainment when in fact it is.

ISSUE 10

Issue. What are the components of measurement error or measurement variation? Which of these components are reflected in the P&A data?

Discussion: To a limited extent the P&A data describe measurement error, but they do not describe spatial and temporal variation in actual air pollutant concentrations. Presumably, the latter factors comprise most of the variation in concentration measurements, but further investigation would be needed to verify and quantify this. The P&A data do not account for errors in sample collection, i.e., "scrubbing" by sampling lines and leaks in sampling lines.

The P&A data can be used to gauge measurement error for a single instrument and to gauge the variation of instrument accuracy within a reporting organization. The P&A data do not reflect the spatial representativeness of a site measurement, nor do they indicate temporal variation in concentration levels at a site. Also the P&A data do not reflect sample collection and sample handling errors. These errors are caused by adsorption and absorption of acid gases on sample tube walls and sample tube contaminants; they may also be caused by irreversible chemical reactions of reactive gases on sample tube walls and sample tube contaminants.

Measurement error and concentration variation can be distinguished, for example, in the components of variation about an annual average concentration representing a large region, obtained by averaging the calculated annual averages at several monitors. Variation of individual concentration measurements about this spatial-temporal average are accounted for, to some extent, by measurement error. The spatial and temporal variation of actual concentrations probably account for most of this variation, however. Sample collection and sample handling errors can be estimated by challenging instruments through the sampling line rather than bypassing the sampling line.

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16. ABSTRACT

This reports represents the efforts of the Work Group on the Utilization of Precision and Accuracy (P&A) data, which was formed to determine how P&A data should be utilized relative to the EPA regulatory decision-making process. The report discusses ten issues concerning the utilization of P&A data and summarizes the calculations specified in 40 CFR 58 Appendix A, "Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)." P&A data is reported by the National Aerometric Data Bank (NADB), along with the associated air quality. The P&A data bank is maintained by the Environmental Monitoring Systems Laboratory (EMSL) and contains the P&A data reported by the States to the EPA Regional offices and EMSL.

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