

1. INTRODUCTION

The ozone National Ambient Air Quality Standards (NAAQS) contain the phrase "expected number of days per calendar year." [1] This differs from the previous NAAQS for photochemical oxidants which simply state a particular concentration "not to be exceeded more than once per year." [2] The data analysis procedures to be used in computing the expected number are specified in Appendix H to the ozone standard. The purpose of this document is to amplify the discussions contained in Appendix H dealing with compliance assessment and to indicate the data analysis procedures necessary to determine appropriate design values for use in developing control strategies. Where possible, the approaches discussed here are conceptually similar to the procedures presented in the earlier "Guideline for Interpreting Air Quality Data With Respect to the Standards" (OAQPS 1.2-008, revised February, 1977). [3] However, the form of the ozone standards necessitates certain modifications in two general areas: (1) accounting for less than complete sampling and (2) incorporating data from more than one year.

Although the interpretation of the proposed standards may initially appear complicated, the basic principle is relatively straightforward. In general, the average number of days per year above the level of the standard must be less than or equal to 1. In its simplest form, the number of exceedances each year would be recorded and then averaged over the past three years to determine if this average is less than or equal to 1. Most of the complications that arise are consequences of accounting for incomplete sampling or changes in emissions.

Throughout the following discussion certain points are assumed that are consistent with previous guidance [3] but should be reiterated here for completeness. The terms hour and day (daily) are interpreted respectively as clock hour and calendar day. Air quality data are examined on a site by site basis and each individual site must meet the standard. In general, data from several different sites are not combined or averaged when performing these analyses. These points are

discussed in more detail elsewhere. [3]

This document is organized so that the remainder of this introductory section presents the background of the problem, terminology, and certain basic premises that were used in developing this guidance. This is followed by a section which examines methods for determining appropriate design values. The final section discusses approaches that might be employed in cases without ambient monitoring data. This last section is brief and fairly general, because it treats an aspect of the problem which would be expected to rapidly evolve once these new forms of the NAAQS become established. In several parts of this document the material is developed in a conversational format in order to highlight certain points.

1.1. Background

The previous National Ambient Air Quality Standard (NAAQS) for oxidant stated that no more than one hourly value per year should exceed 160 micrograms per cubic meter (.08ppm). [2] With this type of standard, the second highest value for the year becomes the decision-making value. If it is above 160 micrograms per cubic meter then the standard was exceeded. This would initially appear to be an ideal type of standard. The wording is simple and the interpretation is obvious-or is it? Suppose the second highest value for the year is less than 160 micrograms per cubic meter and the question asked is, "Does this site meet the standard?" An experienced air pollution analyst would almost automatically first ask, "How many observations were there?" This response reflects the obvious fact that the second highest measured value can depend upon how many measurements were made in the year. Carried to the absurd, if only one measurement is made for the year, it is impossible to exceed this type of standard. Obviously, this extreme case could be remedied by requiring some minimum number of measurements per year. However, the basic point is that the probability of detecting a violation would still be expected to increase as the number of samples increased from the specified minimum to the maximum possible number of observations per year. Therefore, the present wording of this type of standard inherently penalizes an area that performs

more than the minimum acceptable amount of monitoring. Furthermore, the specification of a minimum data completeness criterion still does not solve the problem of what to do with those data sets that fail to meet this criterion.

A second problem with the current wording of the standard is not as obvious but becomes more apparent when considering what is involved in maintaining the standard year after year. For example, suppose an area meets the standard in the sense that only one value for the year is above 160 micrograms per cubic meter. Because of the variability associated with air quality data, the fact that one value is above the standard level means that there is a chance that two values could be above this standard level the next year even though there is no change in emissions. In other words, any area with emissions and meteorology that can produce one oxidant value above the standard has a definite risk of sometime having at least two such values occurring in the same year and thereby violating the standard. This situation may be viewed as analogous to the "10 year flood" and "100 year flood" concepts used in hydrology; i.e., high values may occur in the future but the likelihood of such events is relatively low. However, with respect to air pollution any rare violation poses distinct practical problems. From a control agency viewpoint, the question arises as to what should be done about such a violation if it is highly unlikely to reoccur in the next few years. If the decision is made to ignore such a violation then the obvious implication is that the standard can occasionally be ignored. This is not only undesirable but produces a state of ambiguity that must be resolved to intelligently assess the risk of violating the standard. In other words, some quantification is needed to describe what it means to maintain the standard year after year in view of the variation associated with air quality data. The wording of the ozone standard is intended to alleviate these problems.

1.2. Terminology

The term 'daily maximum value' refers to the maximum hourly ozone value for a day. As defined in Appendix H, a valid daily maximum means that at least

75% of the hourly values from 9:01 A.M. to 9:00 P.M. (LST) were measured or at least one hourly value exceeded the level of the standard. This criterion is intended to reflect adequate monitoring of the daylight hours while allowing time for routine instrument maintenance. The criterion also ensures that high hourly values are not omitted merely because too few values were measured. It should be noted that this is intended as a minimal criterion for completeness and not as a recommended monitoring schedule.

A final point worth noting concerns terminology. The term "exceedance" is used throughout this document to describe a daily maximum ozone measurement that is above the level of the standard. Therefore the phrase "expected number of exceedances" is equivalent to "the expected number of daily maximum ozone values above the level of the standard."

1.3. Basic Premises

By its very nature, the existence of a guideline document implies several things: (1) that there is a problem, (2) that a solution is provided, and (3) that there were several alternatives considered in reaching the solution. Obviously, if there is no problem then the guideline is of limited value, and if there were not some alternative solutions then the guidance is perhaps superfluous or at best educational. The third point indicates that the "best" alternative, in some sense, was selected. With this in mind, it is useful to briefly discuss some of the key points that were considered in judging the various options. The purpose of this section is to briefly indicate the criteria used in developing this particular guideline.

The most obvious criterion is simplicity. This simplicity extends to several aspects of the problem. When someone asks if a particular area meets the standard they expect either a "yes" or "no" as the answer or even an occasional "I don't know". Secondly, this simplicity should extend to the reason why the standard was met or violated. If a panel of experts is required to debate the probability that an area is in compliance then the general public may rightly feel confused about just what is being done to protect their health. Also,

the more clear-cut the status of an area is (and the reasons why) the more likely it is that all groups involved can concentrate on the real problem of maintaining clean air rather than arguing over minor side issues.

While simplicity is desirable, if the problem is complex the solution cannot be oversimplified. In other words, the goal is to develop a solution that is simple, and yet not simple-minded. In order to do this, the approach taken in this document is to recognize that there are two questions involved in determining compliance: (1) was the standard violated? and (2) if so, by how much? The first question is the simpler of the two in that a "yes/no" answer is expected. The second question implies both a quantification and a determination of what to do about it. Therefore, it seems reasonable to have a more complicated procedure for determining the second answer.

In addition to the trade-offs between simplicity and complexity another problem is to allow a certain amount of flexibility without being vague. There are several reasons for allowing some degree of flexibility. Not only do available resources vary from one area to another but the complexity of the air pollution problems vary. An area with no pollution problem should not be required to do an extensive analysis just because that level of detail is needed someplace else. Conversely, an area with sufficient resources to perform a detailed analysis of their pollution problem to develop an optimum control strategy should not be constrained from doing so simply because it is not warranted elsewhere. Furthermore, a certain degree of flexibility is essential to allow for modified monitoring schedules that are used to make the best use of available resources.

In addition to these points concerning simplicity and flexibility, certain other considerations are of course involved. In particular, the methodology employed cannot merely ignore high values for a particular year simply because they are unlikely to reoccur. The purpose of the standard is to protect against high values in a manner consistent with the likelihood of their occurrence.

A final point is that the proposed interpretation

should involve a framework that could eventually be extended to other pollutants, if necessary, and easily modified in the future as our knowledge and understanding of air pollution increases.

It should be noted that no specific mention is made of measurement error in the following discussions. While it would be naive to assume that measurement errors do not occur, at the present time it is difficult to allow for measurement errors in a manner that is not tantamount to re-defining the level of the standard. Obviously there is no question that data values known to be grossly in error should be corrected or eliminated. In fact the use of multiple years of data for the ozone standards should facilitate this process. The more serious practical problem is with the level of uncertainty associated with every individual measurement. The viewpoint taken here is that these inherent accuracy limitations are accounted for in the choice of the level of the standard and that equitable risk from one area to another is assured by use of the reference (or an equivalent) ambient monitoring method and adherence to a required minimum quality assurance program. It should be noted that the stated level of the standard is taken as defining the number of significant figures to be used in comparisons with the standard. For example, a standard level of .12 ppm means that measurements are to be rounded to two decimal places (.005 rounds up), and, therefore, .125 ppm is the smallest concentration value in excess of the level of the standard.

2. ASSESSING COMPLIANCE

This section examines the ozone standard with particular attention given to the evaluation of compliance. This is done in several steps. The first is a discussion of the term "expected number." Once this is defined it is possible to consider the interpretation when applied to several years of data or to less than complete sampling data. An example calculation is included at the end of this section to summarize and illustrate the major points.

2.1. Interpretation of "Expected Number"

The wording of the ozone standard states that the "expected number of days per calendar year" must be "equal to or less than 1." The statistical term "expected number" is basically an arithmetic average. Perhaps the simplest way to explain the intent of this wording is to give an example of what it would mean for an area to be in compliance with this type of standard. Suppose an area has relatively constant emissions year after year and its monitoring station records an ozone value for every day of the year. At the end of each year the number of daily values above the level of the standard is determined and this is averaged with the results of previous years. As long as this arithmetic average remains "less than or equal to 1" the area is in compliance. As far as rounding conventions are concerned, it suffices to carry one decimal place when computing the average. For example, the average of the three numbers 1,1,2 is 1.3 which is greater than 1.

Two features in this example warrant additional discussion to clearly define how this proposal would be implemented. The example assumes that a daily ozone measurement is available for each day of the year so that the number of exceedances for the year is known. On a practical basis this is highly unlikely and, therefore, it will be necessary to estimate this quantity. This is discussed in section 2.2. In the example it is also assumed that several years of data are available and there is relatively little change in

emissions. This is discussed in more detail in section 2.3.

The key point in the example is that as data from additional years are incorporated into the average this expected number of exceedances per year should stabilize. If unusual meteorology contributes to a high number of exceedances for a particular year then this will be averaged out by the values for other "normal" years. It should be noted that these high values would, therefore, not be ignored but rather their relative contribution to the overall average is in proportion to the likelihood of their occurrence. This use of the average may be contrasted with an approach based upon the median. If the median were used then the year with the greatest number of exceedances could be ignored and there would be no guarantee of protection against their periodic reoccurrence.

2.2. Estimating Exceedances for a Year

As discussed above, it is highly unlikely that an ozone measurement will be available for each day of the year. Therefore, it will be necessary to estimate the number of exceedances in a year. The formula to be used for this estimation is contained in Appendix H of the ozone standard. The purpose of this section is to present the same basic formula but to expand upon the rationale for choosing this approach and to provide illustrations of certain points.

Throughout this discussion the term "missing value" is used in the general sense to describe all days that do not have an associated ozone measurement. It is recognized that in certain cases a so-called "missing value" occurs because the sampling schedule did not require a measurement for that particular day. Such missing values, which can be viewed as "scheduled missing values," may be the result of planned instrument maintenance or, for ozone, may be a consequence of a seasonal monitoring program. In order to estimate the number of exceedances in a particular year it is necessary to account for the possible effect of missing values. Obviously, allowance for missing values can only result in an estimated number of exceedances at least as large as the observed number. From a practi-

cal viewpoint, this means that any site that is in violation of the standard based upon the observed number of exceedances will not change status after this adjustment. Thus, in a sense, this adjustment for missing values is required to demonstrate attainment, but may not be necessary to establish non-attainment.

In estimating the number of exceedances in cases with missing data, certain practical considerations are appropriate. In some areas, cold weather during the winter makes it very unlikely that high ozone values would occur. Therefore it is possible to discontinue ozone monitoring in some localities for limited time periods with little risk of incorrectly assessing the status of the area. As indicated in Appendix H, the proposed monitoring regulations (CFR58) would permit the appropriate Regional Administrator to waive any ozone monitoring requirements during certain times of the year. Although data for such a time period would be technically missing, the estimation formula is structured in terms of the required number of monitoring days and therefore these missing days would not affect the computations.

Another point is that even though a daily ozone value is missing, other data might indicate whether or not the missing value would have been likely to exceed the standard level. There are numerous ways additional information such as solar radiation, temperature, or other pollutants could be used but the final result should be relatively easy to implement and not create an additional burden. An analysis of 258 site-years of ozone/oxidant data from the highest sites in the 90 largest Air Quality Control Regions showed that only 1% of the time did the high value for a day exceed .12 ppm if the adjacent daily values were less than .09 ppm. With this in mind the following exclusion criterion may be used for ozone:

A missing daily ozone value may be assumed to be less than the level of the standard if the daily maxima on both the preceding day and the following day do not exceed 75% of the level of the standard.

It should be noted that to invoke this exclusion criterion data must be available from both adjacent days. Thus it does not apply to consecutive missing

daily values. Having defined the set of missing values that may be assumed to be less than the standard it is possible to present the computations required to adjust for missing data.

Let z denote the number of missing values that may be assumed to be less than the standard. Then the following formula shall be used to estimate the number of exceedances for the year:

$$e = v + (v/n) * (N - n - z) \quad (1)$$

(* indicates multiplication)

Where N = the number of required monitoring days in the year

n = the number of valid daily maxima

v = the number of measured daily values above the level of the standard

z = the number of days assumed to be less than the standard level, and

e = the estimated number of exceedances for the year.

This estimated number of exceedances shall be rounded to one decimal place (fractional parts equal to .05 round up).

Note that N is always equal to the number of days in the year unless a monitoring waiver has been granted by the appropriate Regional Administrator.

The above equation may be interpreted intuitively in the following manner. The estimated number of exceedances is equal to the observed number plus an increment that accounts for incomplete sampling. There were $(N - n)$ missing daily values for the year, but a certain number of these, namely z , were assumed to be below the standard. Therefore, $(N - n - z)$ missing values are considered to be potential exceedances. The fraction of measured values that were above the level of

the standard was v/n and it is assumed that the same fraction of these candidate missing values would also exceed the level of the standard.

The estimation procedures presented are computationally simple. Some data processing complications result when missing data are screened to ensure a representative data base, but on a practical basis this effort is only required for sites that are marginal with respect to compliance. Because the exclusion criterion for missing values does not differentiate between scheduled and non-scheduled missing values it is possible to develop a computerized system to perform the necessary calculations without requiring additional information on why each particular value was missing. In principle, if allowance is made for missing values that are relatively certain to be less than the standard then it would seem reasonable to also account for missing values that are relatively certain to be above the standard. Although this is a possibility, it will probably not be necessary initially because such a situation would, of necessity, have at least two values greater than the standard level. Therefore, it is quite likely that this would be an unnecessary complication in that it would not affect the assessment of compliance.

One feature of these estimation procedures should be noted. If an area does not record any values above the standard, then the estimated number of exceedances for the year is zero. An obvious consequence of this is that any area that does not record a value above the standard level will be in compliance. In most cases this confidence is warranted. However, at least some qualification is necessary to indicate that it is possible that the existing monitoring data can be deemed inadequate for use with these estimation formulas. In general, data sets that are 75% complete for the peak pollution potential seasons will be deemed adequate. Although the general 75% completeness rule has been traditionally used as an air quality validity criterion the key point is to ensure reasonably complete monitoring of those time periods with high pollution potential. An additional word of caution is probably required at this point concerning attainment status determinations based upon limited data. If a particular area has very limited data and shows no exceedances of the standard it must be recognized that a more intense

monitoring program could possibly result in a determination of non-attainment. Therefore, if it is critical to immediately determine the status of a particular area and the ambient data base is not very complete, the design value computations presented in section 3 may be employed as a guide to assess potential problems. The point is, that as the monitoring data base increases, the additional data may indicate non-attainment. Therefore some caution should be used when viewing attainment status designations based upon incomplete data.

2.3. Extension to Multiple Years

As discussed earlier, the major change in the ozone standard is the use of the term "expected number" rather than just "the number." The rationale for this modification is to allow events to be weighted by the probability of their occurrence. Up to this point, only the estimation of the number of exceedances for a single year has been discussed. This section discusses the extension to multiple years.

Ideally, the expected number of exceedances for a site would be compared by knowing the probability that the site would record 0,1,2,3,... exceedances in a year. Then each possible outcome could be weighted according to its likelihood of occurrence, and the appropriate expected value or average could be computed. In practice, this type of situation will not exist because ambient data will only be available for a limited number of years.

A period of three successive years is recommended as the basis for determining attainment for two reasons. First, increasing the number of years increases the stability of the resulting average number of exceedances. Stated differently, as more years are used, there is a greater chance of minimizing the effects of an extreme year caused by unusual weather conditions. The second factor is that extending the number of successive years too far increases the risk of averaging data during a period in which a real shift in emissions and air quality has occurred. This would penalize areas showing recent improvement and similarly reward areas which are experiencing deteriorating ozone

air quality. Three years is thought by EPA to represent a proper balance between these two considerations. This specification of a three year time period for compliance assessment also provides a firm basis for purposes of decision-making. While additional flexibility is possible for developing design values for control strategy purposes, a more definitive framework seems essential when judging compliance to eliminate possible ambiguity and to clearly identify the basis for the decision.

Consequently, the expected number of exceedances per year at a site should be computed by averaging the estimated number of exceedances for each year of data during the past three calendar years. In other words, if the estimated number of exceedances has been computed for 1974, 1975, and 1976, then the expected number of exceedances is estimated by averaging those three numbers. If this estimate is greater than 1, then the standard has been exceeded at this site. As previously mentioned, it suffices to carry one decimal place when computing this average. This averaging rule requires the use of all ozone data collected at that site during the past three calendar years. If no data are available for a particular year then the average is computed on the basis of the remaining years. If in the previous example no data were available for 1974, then the average of the estimated number of exceedances for 1975 and 1976 would be used. In other words, the general rule is to use data from the most recent three years if available, but a single season of monitoring data may still suffice to establish non-attainment. Thus, this three year criterion does not mean that non-attainment decisions must be delayed until three years of data are available. It should be noted that to establish attainment by a particular date, allowance will be permitted for emission reductions that are known to have occurred.

One point worth commenting on is the possibility that the very first year is "unusual." While this could occur, in the case of ozone most urbanized areas already have existing data bases so that some measure of the normal number of exceedances per year is available. Furthermore the nature of the ozone problem makes it unlikely that areas currently well above the standard would suddenly come into compliance. Therefore, as these areas approach the standard addi-

tional years of data would be available to determine the expected number of exceedances for a year.

2.4. Example Calculation

In order to illustrate the key points that have been discussed in this section it is convenient to consider the following example for ozone.

Suppose a site has the following data history for 1978-1980:

1978: 365 daily values; 3 days above the standard level.

1979: 285 daily values; 2 days above the standard level; 21 missing days satisfying the exclusion criterion.

1980: 287 daily values; 1 day above the standard level; 7 missing days satisfying the exclusion criterion.

Suppose further that in 1980 measurements were not taken during the months of January and February (a total of 60 days for a leap year) because the cold weather minimizes any chance of recording exceedances and a monitoring waiver had been granted by the appropriate Regional Administrator.

Because the three year average number of exceedances is clearly greater than 1, there is no computation required to determine that this site is not in compliance. However, the expected number of exceedances may still be computed using equation 1 for purposes of illustration.

For 1978, there were no missing daily values and

therefore there is no need to use the estimated exceedances formula. The number of exceedances for 1978 is 3.

For 1979, equation 1 applies and the estimated number of exceedances is:

$$2 + (2/285) * (365 - 285 - 21) =$$

$$2 + 0.4 = 2.4$$

For 1980, the same estimation formula is used but due to the monitoring waiver for January and February the number of required monitoring days is 306 and therefore the estimated number of exceedances is:

$$1 + (1/287) * (306 - 287 - 7) =$$

$$1 + (1/287) * (12) = 1.0$$

Averaging these three numbers (3, 2.4, and 1.0) gives 2.1 as the estimated expected number of exceedances per year and completes the required calculations.

3. ESTIMATING DESIGN VALUES

The previous section addressed compliance with the standard. As discussed, it suffices to treat questions concerning compliance as requiring a "yes/no" type answer. This approach facilitates the use of relatively simple computational formulas. It also makes it unnecessary to define the type of statistical distribution that describes the behavior of air quality data. The advantage of not invoking a particular statistical distribution is that the key issue of whether or not the standard is exceeded is not obscured by which particular distribution best describes the data. However, once it is established that an area exceeds the standard, the next logical question is more quantitative and requires an estimate of by how much the standard was exceeded. This is done by first examining the definition of a design value for an "expected exceedances" standard and then discussing various procedures that may be used to estimate a design value. A variety of approaches are considered such as fitting a statistical distribution, the use of conditional probabilities, graphical estimation, and even a table look-up procedure. In a sense each of these approaches should be viewed as a means to an end, i.e., meeting the applicable air quality standard. As long as this final goal is kept in mind any of these approaches are satisfactory. As with the previous section discussing compliance, this section concludes with example calculations illustrating the more important points.

3.1. Discussion of Design Values

In order to determine the amount by which the standard is exceeded it is necessary to discuss the interpretation of a design value for the proposed standard. Conceptually the design value for a particular site is the value that should be reduced to the standard level thereby ensuring that the site will meet the standard. With the wording of the ozone standard the appropriate design value is the concentration with expected number of exceedances equal to 1. Although this describes the design value in words it is useful

to introduce certain notations to precisely define this quantity.

Let $P(x \leq c)$ denote the probability that an observation x is less than or equal to concentration c . This is also denoted as $F(c)$.

Let e denote the number of exceedances of the standard level in the year, e.g., in the case of ozone this would be the number of daily values above .12 ppm. Then the expected value of e denoted as $E(e)$ may be written as:

$$E(e) = P(x > .12) * 365 = [1 - F(.12)] * 365$$

For a site to be in compliance the expected number of exceedances per year $E(e)$, must be less than or equal to 1. From the above equation it follows that this is equivalent to saying that the probability of an exceedance must be less than or equal to $1/365$.

As indicated, the appropriate design value is that concentration which is expected to be exceeded once per year. Alternatively, the design value is chosen so that the probability of exceeding this concentration is $1/365$. If an equation is known for $F(c)$ then the design value may be obtained by setting $1-F(c)$ equal to $1/365$ and solving for c . If a graph of $F(c)$ is known then the design value may be determined graphically by choosing the concentration value that corresponds to a frequency of exceedance of $1/365$. Obviously in practice the distribution $F(c)$ is not really known. What is known is a set of air quality measurements that may be approximated by a statistical distribution to determine a design value as discussed in the following section.

3.2. The Use of Statistical Distributions

The use of a statistical distribution to approximately describe the behavior of air quality data is certainly not new. The initial work by Larsen [4] with the log-normal distribution demonstrated how this type

of statistical approximation could be used. The proposed form of the ozone standard provides a framework for the use of statistical distributions to assess the probability that the standard will be met. An important point in dealing with air pollution problems is that the main area of interest is the high values. The National Ambient Air Quality Standards are intended to limit exposure to high concentrations. This has a direct impact on how statistical distributions are chosen to describe the data. [5] If the intended application is to approximate the data in the upper concentration ranges then obviously it must be required that any statistical distribution selected for this purpose has to fit the data in these higher concentration ranges. Initially this would appear to be an obvious truism but, in many cases, a particular distribution may "reasonably approximate" the data in the sense that it fits fairly well for the middle 80% of the values. This may be satisfactory for some applications but if the top 10% of the data is the range of interest it may be inappropriate.

Over the years various statistical distributions have been suggested for possible use in describing air quality data. Example applications include the two-parameter lognormal[4], the three-parameter lognormal[6], the Weibull[5,7], and the exponential distribution[5,8]. Despite certain theoretical reservations concerning factors such as interdependence of successive values these approaches have been proven over time to be useful tools in air quality data analysis. The appropriate choice of a distribution is useful in determining the design value. Viewed in perspective, however, the selection of the appropriate statistical distribution is a secondary objective -- the primary objective is to determine the appropriate design value. In other words, the question of interest is "what concentration has an expected number of exceedances per year equal to 1?" and not "which distribution perfectly describes the data?" Therefore, it is not necessary to require that any particular distribution be used. All that is necessary is to indicate the characteristics that must be considered in determining what is meant by a "reasonable fit". In fact it will be seen later that a design value may be selected without even knowing which particular distribution best describes the data.

There are certain points that are implicit in the above discussion which are worth commenting upon. One possible approach in developing this type of guidance is to specify a particular distribution to be used in determining a design value. This approach is not taken here for a variety of reasons. There is no guarantee that one family of distributions would be adequate to describe ozone levels for all areas of the country, for all weather conditions, etc. It may well be that different distributions are needed for different areas. Secondly, as control programs take effect and pollution levels are reduced the so-called "best" distribution may change. Another point that should be emphasized involves the distinction between determining compliance and determining a design value. Suppose, for example, that a statistical distribution is selected and adequately describes all but the highest five values each year. However, these five values are always above the standard and consequently the number of exceedances per year is always five. Such a site is not in compliance even if the design value predicted from the approximating distribution is below the standard level. In such a case the expected number of exceedances per year is 5 (with complete sampling) and therefore the site is in violation. The design value is an aid in determining the general reduction required, but in some cases it may be necessary to further refine the estimate because of inadequate fit for the high values.

3.3. Methodologies

The purpose of this section is to present some acceptable approaches to determine an appropriate design value, i.e., the concentration with expected number of exceedances per year equal to 1. As discussed, this may be alternatively viewed as determining the concentration that will be exceeded 1 time out of 365.

Throughout this discussion it is important to recognize that the number of measurements must be treated properly. In particular, missing values that are known to be less than the standard level should be accounted for so that they do not incorrectly affect the empirical frequency distribution. For example, if an area does not monitor ozone in December, January, and February, because no values even approaching the stan-

standard level have ever been reported in these months then these observations should not be considered missing but should be assigned some value less than the standard. The exact choice of the value is arbitrary and is not really important because the primary purpose is to fit the upper tail of the distribution.

In discussing the various acceptable approaches several different cases are presented. This is intended to illustrate the general principles that should be applied in determining the design value. Throughout these discussions it is generally assumed that more than one year of data is available. The difficulty with using a single year of data is that any effect due to year to year variations in meteorology is obviously not accounted for. Therefore, any results based upon only one year of data should be viewed as a guide that may be subject to revision.

(1) Fitting One Statistical Distribution to Several Years of Data

One of the simplest cases is when several years of fairly complete data are available during a time of relatively constant emissions. In this situation the data can be plotted to determine an empirical frequency distribution. For example, all data for a site from a 3-5 year period could be ranked from smallest to largest and the empirical frequency distribution plotted on semi-log paper. This type of plot emphasizes the behavior of the upper tail of the data as shown in Figure 1. A discussion of this plotting is contained elsewhere. [5] Figure 2 illustrates how different types of distributions would appear on such a plot. The data may also be plotted on other types of graph paper, such as log-normal or Weibull. The ideal situation is when the data points lie approximately on a straight line. The next step is to choose a statistical distribution that approximately describes the data and to fit the distribution to the data. This may be done by least squares, maximum likelihood estimation, or any method that gives a reasonable fit to the top 10% of the data. An obvious question is "what constitutes a reasonable fit?" This can be judged visually by plotting the fitted distribution on the same graph as the data points. Because of the intended use of the distribution the degree of approximation for the top

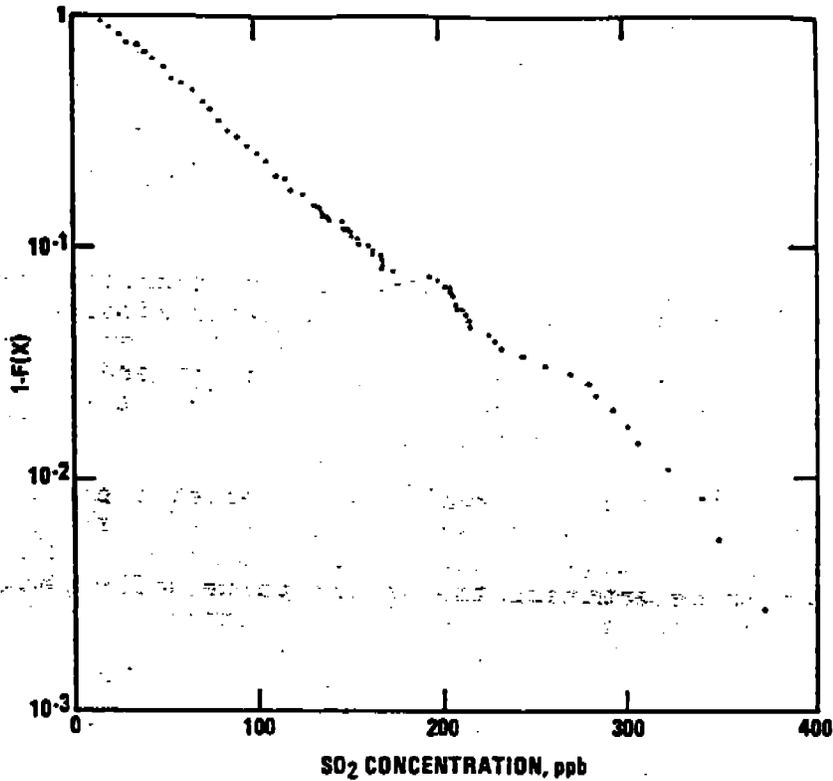


Figure 1. Sulfur dioxide measurements for 1968 (24-hour) at CAMP station in Philadelphia, Pa., plotted on semi-log paper.

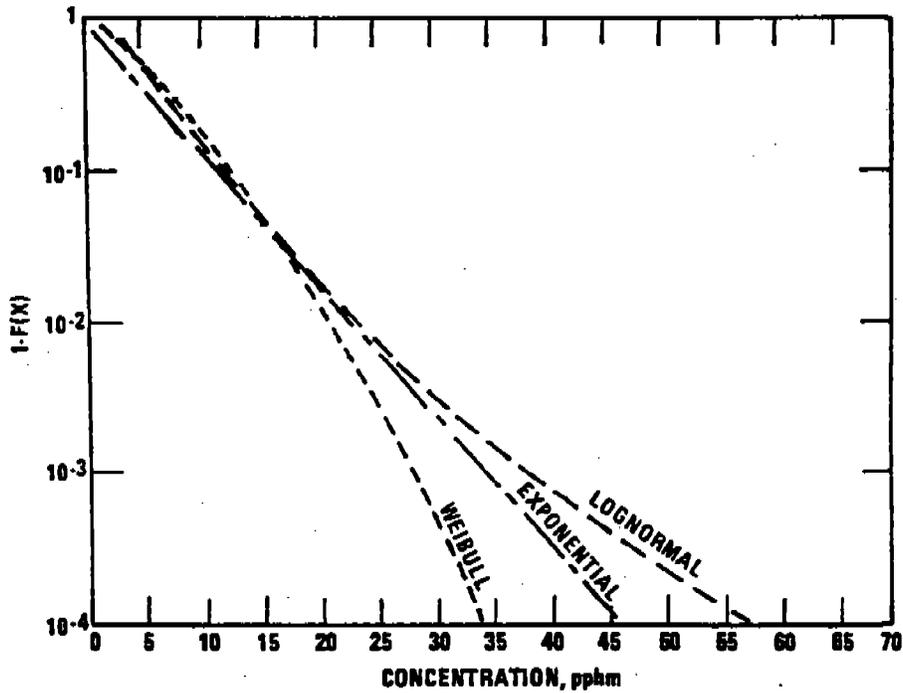


Figure 2. Examples of lognormal, exponential, and Weibull distributions plotted on semi-log paper. A Weibull distribution may also curve upward for certain parameter values.

10%, 5%, 1% and even .5% of the data must be examined. The most obvious check is to examine departures of the actual data points from the fitted distribution. As a general rule there should be no obvious pattern to the lack of fit in terms of under- or over-prediction, or trend. For example, if the fitted distribution underestimates all of the last eight data points by more than 5%, then it must be established that the fitted distribution is reasonable. Such an argument might involve showing that the majority of these data points all occurred in the same period and that the meteorology for these particular days was extremely unusual. The claim that this meteorology was unusual would also have to be substantiated by examining historical meteorological data. It should be noted that this extra effort is not routinely required and would only be necessary when the fit appears inadequate. The design value corresponds to a frequency of $1/365$ and in some cases the empirical frequency distribution function will be plotted in this range. In such cases, the fitted distribution should be consistent with the empirical distribution in this range. This can be examined graphically by locating the concentration on the empirical frequency distribution function corresponding to a frequency of $1/365$. By construction, there will be measured data points on either side of this value. The two measured concentrations below this value and the two measured concentrations above this value will be used as a constraint in fitting a distribution. If the fitted distribution results in a design value that differs by more than 5% from all four of these measured concentrations, some explanation should be presented indicating the reasons for this discrepancy. It should be noted that in some cases there may be only one, rather than two, measured values on the empirical frequency distribution with frequencies less than $1/365$. In these cases the upper constraint would consist of one rather than two data points.

(2) Using the Empirical Frequency Distribution of Several Years of Data (Graphical Estimation)

It should be noted that if several years of fairly complete data are available it is not necessary to even fit a statistical distribution. The concentration value corresponding to a frequency of $1/365$ may be read directly off the graph of the empirical distribution

Table 1.

TABULAR ESTIMATION OF DESIGN VALUE

Number of Daily Values	Rank of Upper Bound	Rank of Lower Bound	Data Point Used for Design Value
365 to 729	1	2	highest value
730 to 1094	2	3	second highest
1095 to 1459	3	4	third highest
1460 to 1824	4	5	fourth highest
1825 to 2189	5	6	fifth highest

function and used as the design value.

If the data records are not sufficiently complete then the empirical distribution function will not be plotted for the 1/365 frequency and it will be necessary to fit a distribution to estimate the design value. However, whenever sufficient data are available, this technique provides a convenient means of graphically estimating the design value.

(3) Table Look-up

An obvious point that can initially be overlooked in the discussion of these techniques is that the final choice of a design value is primarily influenced by the few highest values in the data set. With this in mind, it is possible to construct a simple table look-up procedure to determine a design value. Again, it is important to treat the number of values properly to ensure that the data adequately reflects all portions of the year.

To use this tabular approach it is only necessary to know the total number of daily values, and then determine a few of the highest data values. For example, if there are 1,017 daily values then the ranks of the lower and upper bounds obtained from Table 1 are 3 and 2. This means that an appropriate design value would be between the third-highest and second-highest observed values. In using this table the higher of the two concentrations may be used as the design value. Therefore in this particular case, it suffices to know the three highest measured values during the time period.

This look-up procedure is basically a tabular technique for determining what point on the empirical frequency distribution corresponds to a frequency of 1/365. By construction, the table look-up procedure overestimates the design value. For instance, in the example with 1,017 values an acceptable design value would lie closer to the lower bound. This could be handled by interpolation between the second and third highest values. However, rather than introduce interpolation formulas it would be simpler to merely use the previously discussed graphical procedure.

For the cases that are 75% complete but still have less than 365 days the maximum observed concentration may be used as a tentative design value as long as the data set was 75% complete during the peak times of the year. In this case it must be recognized that the design value is quite likely to require future revision. In principle, if statistical independence applied, this maximum observed concentration would equal or exceed the 1/365 concentration about half the time. However, the failure to adequately account for yearly variations in meteorology makes any estimate based on a single year of data very tentative.

(4) Fitting a Separate Distribution for Each Year of Data (Conditional Probability Approach)

The previous method required grouping data from several years into a single frequency distribution. In some cases data processing constraints may make this cumbersome. Therefore, an alternate approach may be used that allows each year to be treated individually. In considering this alternate approach it is useful to briefly indicate the underlying framework. This particular approach uses conditional probabilities and in most cases it would probably be more convenient to use one of the previous methods. However, the underlying framework of this method has sufficient flexibility to warrant its inclusion.

Suppose that the air quality data at a particular site may be approximated by some statistical distribution $F(x|\theta)$, where θ denotes the fitted parameters. Suppose further that the values of the fitted parameters differ from year to year, but that the data may still be approximated by the same type of distribution. Intuitively this would mean that while the same type of distribution describes each year of data, the values of the parameters would change from year to year reflecting the prevailing meteorology for the year. In theory it could be possible to define a set of meteorological classes, say $m(i)$, so that the distribution function of the air quality data could be defined for each one of these meteorological classes. Then for each meteorological class, $m(i)$, there would be an associated air quality distribution function denoted as $F(x|m(i))$, the distribution function for x given the meteorological class $m(i)$. Using the standard rules of

conditional probability the distribution function $F(x)$ may be written as:

$$F(x) = \sum_i \{F(x|m(i))\} P[m(i)]$$

where $P[m(i)]$ is the probability of meteorological class $m(i)$ occurring.

Continuing this approach the expected number of exceedances may be written as:

$$E(e) = \sum_i P[x > s | m(i)] * P[m(i)]$$

where s denotes the standard level.

Initially the above framework may seem to be too theoretical to have much practical use. However, it will be seen in Section 4 that this approach may afford a convenient means of determining the expected number of exceedances per year when limited historical data is available. For the present discussion it suffices to indicate how this approach may be used when ambient data sets are available.

Suppose that five years of ambient measurements are available. An approximating statistical distribution may be determined as discussed previously for each year, denoted as $F_i(x)$. This would be analogous to the $F(x|m(i))$ in the above discussion. Then the distribution function of $F(x)$ may be written as:

$$F(x) = \sum_{i=1}^5 F_i(x) * 1/5$$

where F_i is analogous to $F[x|m(i)]$ and $P[m(i)]$ is assumed to be $1/5$. The design value may then be determined by setting $1-F(d) = 1/365$ and solving for d , the design value. This is equivalent to determining the concentration d so that:

$$\sum_{i=1}^5 [1-F_i(d)] * 1/5 = 1/365.$$

In general it may not be possible to explicitly solve this equation for d , but the answer may be obtained iteratively by first guessing an appropriate design value.

The use of this equation can perhaps best be illustrated by a simple example with two years of data. Suppose the data for each year may be approximated by an exponential distribution although the parameter is different for the two years. In particular let

$$F_1(x) = 1 - \text{EXP}(-43.4x) \quad \text{and} \\ F_2(x) = 1 - \text{EXP}(-37.6x).$$

Using the previous equation, the design value (d) must be determined so that

$$\frac{1}{2} \text{EXP}(-43.4d) + \frac{1}{2} \text{EXP}(-37.6d) = \frac{1}{365} \quad \text{or} \\ 365 * \{ \frac{1}{2} \text{EXP}(-43.4d) + \frac{1}{2} \text{EXP}(-37.6d) \} = 1.$$

If .15 is used as an initial guess for d this equation gives a value of .92 rather than 1. If .145 is used the resulting value is 1.12 indicating that the design value is between .145 and .15. Guessing .148 gives a value of .99, i.e.

$$365 \{ \frac{1}{2} \text{EXP}(-43.4 * .148) + \frac{1}{2} \text{EXP}(-37.6 * .148) \} = \\ .99$$

This is sufficiently close to 1 and is a reasonable stopping place in determining the design value.

3.4. Quick Test for Design Values

All of the approaches in the previous section have one thing in common; namely, their purpose. Each technique is intended to select an appropriate design value, i.e., a concentration with expected number of

yearly exceedances equal to 1. With this in mind a quick check may be made to determine how reasonable the selected design value is. This may be done by counting the number of observed daily values that exceed the selected design value and computing the average number of exceedances per year. For example, if the selected design value was exceeded 4 times in 3 years, then the average number of exceedances per year is 1.3. Ideally, this average should be less than or equal to 1, but for a variety of reasons somewhat higher values may occur. However, if this average is greater than 2.0 the design value is questionable. In such cases the design value should either be changed or, if not changed, careful examination should be performed to substantiate this choice of a design value.

3.5. Discussion of Data Requirements

The use of the previous approaches presupposes the existence of an adequate data base. Both approaches were presented in the context of having several years of ambient data. In many practical cases the available data base may not be so extensive. Although these statistical approaches may be used with less data, some caution is still required to ensure a minimally acceptable data set. In general, statistical procedures permit inferences to be made from limited data sets. Nevertheless, the initial data set must be representative. For example, if no data is available from the peak season, then any extrapolations would require more than merely statistical procedures. Therefore, the input data sets should be at least 50% complete for the peak season with no systematic pattern of missing potential peak hours. This 50% completeness criterion should be viewed in the context of the type of monitoring performed. A continuous monitor that fails to produce data sets meeting this criteria has in effect a down-time of more than 50%. With such a high percentage of down-time for the instrument even the recorded values should be viewed with caution.

In employing approaches that group data from all years into one frequency distribution, it should be verified that all years have approximately the same pattern of missing values. Furthermore, if the number of measurements during the oxidant season differs by

more than 20% from one year to another, then the conditional probability approach should be used. The reason for this constraint is to ensure that variations in sample sizes do not result in disproportionate weighting of data from different years.

Another point of concern is how many years of data should be used. Intuitively it would be reasonable to use as many years of data as possible as long as emissions have not changed "appreciably". Obviously this suggests that some guidance be provided on what percent change in emissions is permissible. To some degree any such specification is arbitrary. However, the more relevant point is that the specified percentage be reasonable. The reason for a cut-off is to ensure that the impact of increased emissions is not masked by the use of air quality data occurring prior to these emission increases. If an area is in violation of the standard, then emission changes should be expected as control programs take effect. Also, the design value serves as a guide to achieving the standard and is, in a sense, merely the means to an end rather than an end in itself. Therefore, no more than a 20% variation between the lowest and highest years is recommended. It should be noted that a total variation of 20% may translate into a + or - 10% variation around the average.

If emissions have increased by more than 20% then additional years should not be incorporated unless the air quality values can be adjusted for the change in emissions. For cases in which emissions have decreased by more than 20% the earlier data may be used after adjustment or used without change knowing that the design value will consequently be conservative. Although this document does not discuss methods for performing this adjustment, it is useful to mention the basic principle involved. The selection of a design value inherently implies the existence of an acceptable model for taking an air quality value and determining the emission reduction required to reduce this value to the standard. In principle, then, this same model may be used in reverse to take the emission change known to have occurred and use the model to scale the previous data sets. Attempting to adjust older historical data may initially seem to be an unnecessary complication but the more data that can be used to estimate the design value the more likely it is that a proper design

value is selected. Because considerable effort could be expended in revising a control strategy this additional effort may be warranted.

3.6. Example Design Value Computations

As in the previous discussion of compliance assessment, it is convenient to conclude this section with examples illustrating the main point involved in applying these various techniques. For purposes of illustration all four techniques are used on the same data set. Figures 3, 4, and 5 display semi-log plots of daily ozone values for 1974, 1975 and 1976 at a sample site. These data are plotted using previously discussed conventions. [5] The horizontal axis is concentration (in ppm) and the vertical axis is the fraction of values exceeding this concentration. A horizontal dotted line is shown at a frequency of 1/365 and the dotted line represents a Weibull distribution approximating the data. This particular fit was done by "eye-balling" the data, but suffices for the purposes of illustration. Figure 6 is a similar plot for all three years of data grouped together. The high and second high values for the three years are: (.13 and .12), (.16 and .16), and (.15 and .14).

Method 1: Fitting a single distribution to data from all three years.

The Weibull distribution plotted in Figure 6 for the three years of data is described by the equation:

$$F(x) = 1 - \text{EXP}[-(x/.0609)^{2.011}].$$

Setting $F(x) = 1 - 1/365$ and solving for x gives .147 which is the design value because it corresponds to a frequency of exceedance of 1/365. Using this quick check, there are three values above .147 so the average number of yearly exceedances is 1.

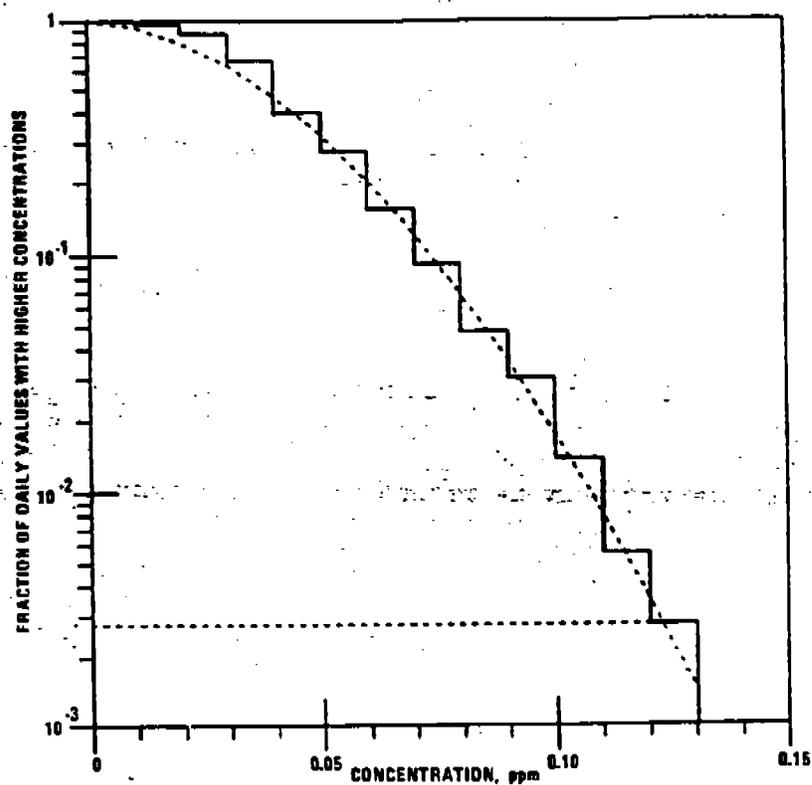


Figure 3. Semi-log plot of daily maximum ozone for 1975 (365 daily values).

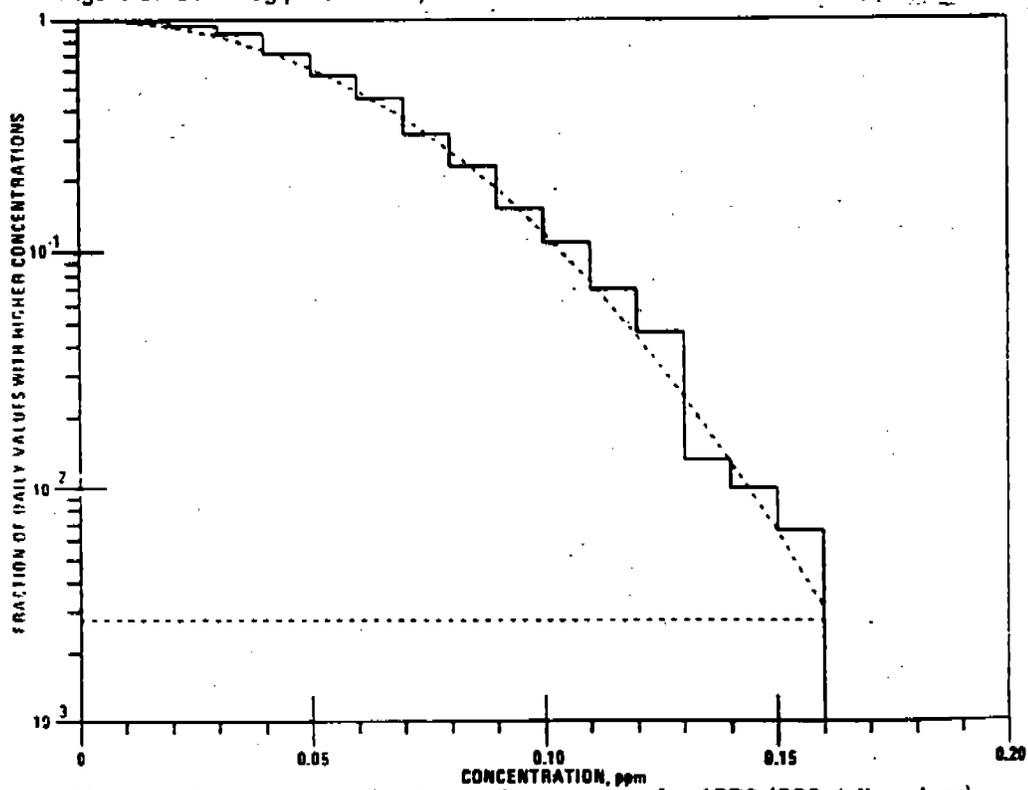


Figure 4. Semi-log plot of daily maximum ozone for 1976 (303 daily values).

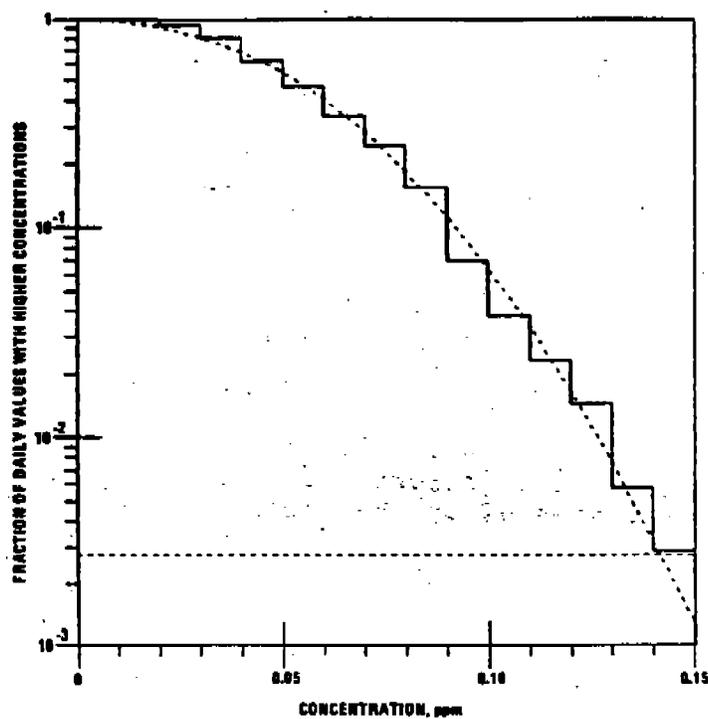


Figure 5. Semi-log plot of daily maximum ozone for 1977 (349 daily values).

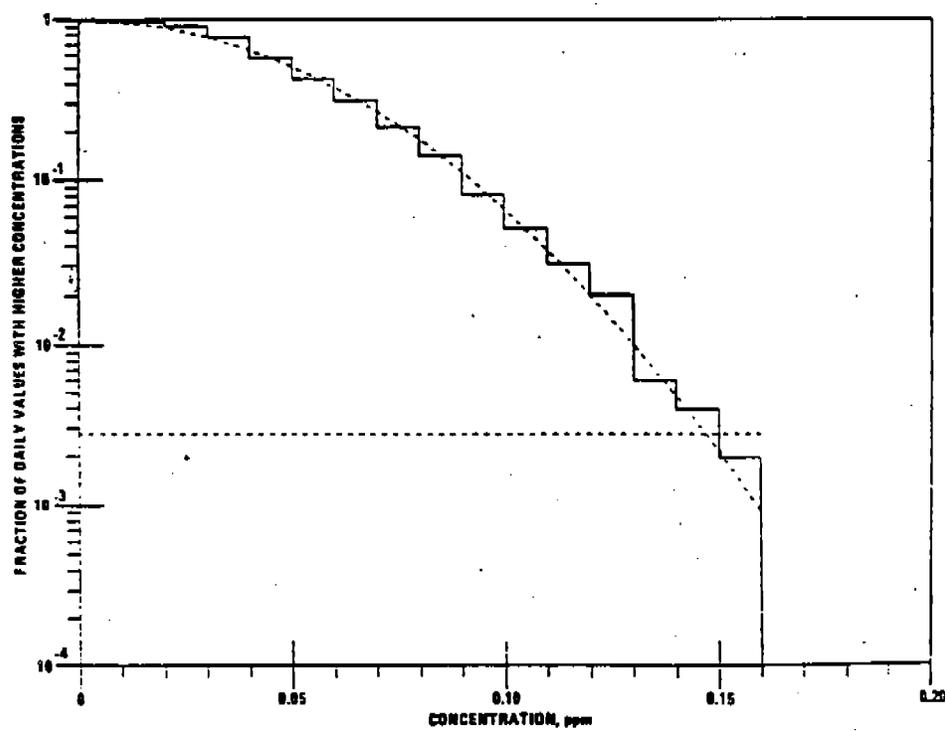


Figure 6. Semi-log plot of daily maximum ozone for three years: 1975, 1976, 1977 (1,017 daily values).

Method 2: Graphical estimation

Referring to Figure 6 it may be seen that the empirical frequency distribution function crosses the line plotted at 1/365 at a concentration of .15 and, therefore, this is the design value selected by this method.

Using the quick check there are only two data values above .15 and, therefore, the average number of yearly exceedances of the design value is .67 which is acceptable.

Method 3: Table look-up

A total of 1,017 data values were recorded during the three year period. Using Table 1, this method says that the second highest value may be used as the design value. Therefore this method yields .16 as the design value. The quick check gives 0 as the average number of yearly exceedances of the design value although there are two values exactly equal to this estimated design value. As indicated earlier, this procedure is somewhat conservative in that it tends to overestimate the design value.

Method 4: Conditional probabilities

Separate two parameter Weibull distributions were fitted to each yearly data set as shown in the graphs. Using the form of equation 5 gives the equation:

$$\begin{aligned} 1/365 = & 1/3 \text{ EXP}\{-(d/.0467)^{1.835}\} + \\ & 1/3 \text{ EXP}\{-(d/.0705)^{2.139}\} + \\ & 1/3 \text{ EXP}\{-(d/.0629)^{2.180}\} \end{aligned}$$

Solving for d (by successive guesses) gives .15 as the design value. Using the quick check gives two values above the design value and therefore an average yearly exceedance rate of 2/3.

4. APPLICATIONS WITH LIMITED AMBIENT DATA

Virtually all of this discussion has focused upon the use of ambient data. Historically, air quality models have been quite useful in providing estimates of air quality levels in the absence of ambient data. The proposed wording of the standard does not preclude the use of such models. As models that provide frequency distributions of air quality are developed their use with the proposed standard will be convenient.

Another potential means of estimating air quality data involves the use of conditional probabilities. While the use of conditional probabilities was discussed earlier in terms of combining different years of data, a more promising use of this technique would involve the construction of historical air quality data sets from relatively short monitoring studies. Very limited ambient data or air quality models may be used to develop frequency distributions for certain types of days or meteorological conditions. Then past historical meteorological data may be used to determine the frequency of occurrence associated with these meteorological conditions. This information may then be combined using conditional probabilities to obtain a general air quality distribution. This particular approach could even be expanded to allow for changes in emissions.

No matter what approach is chosen the two quantities of interest are: (1) the expected number of exceedances per year and (2) the design value, i.e., that concentration with expected number of yearly exceedances equal to 1. However, these modelling and conditional probability constructions may make it possible to assess the risk of violating the standard in the future based upon limited historical data.

5. REFERENCES

1. 40CFR50.9
2. Fed. Reg., 36(84):8186(April 30, 1971)
3. "Guidelines for Interpretation of Air Quality Standards," Office of Air Quality Planning and Standards Publ. 1.2-008 U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, February, 1977.
4. Larsen, R.I. A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards. U.S. Environmental Protection Agency Research Triangle Park, North Carolina Publication Number AP-89, 1971.
5. Curran, T.C. and N.H. Frank. Assessing the Validity of the Lognormal Model When Predicting Maximum Air Pollutant Concentrations. Paper No. 75-51.3, 68th Annual Meeting of the Air Pollution Control Association, Boston, Massachusetts, 1975.
6. Mage, D.T. and W.R. Ott An Improved Statistical Model for Analyzing Air Pollution Concentration Data. Paper No. 75-51.4, 68th Annual Meeting of the Air Pollution Control Association, Boston, Massachusetts, 1975.
7. Johnson, T. A Comparison of the Two-Parameter Weibull and Lognormal Distributions Fitted to Ambient Ozone Data, Quality Assurance in Air Pollution Measurement Conference, New Orleans, Louisiana, March, 1979.
8. Breiman, L. et al. Statistical Analysis and Interpretation of Peak Air Pollution Measurements. Technology Service Corporation, Santa Monica, California. 1978.

TECHNICAL REPORT DATA (Please read Instructions on the reverse before completing)		
1. REPORT NO. EPA 450/4-79-003	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Guideline for the Interpretation of Ozone Air Quality Standards	5. REPORT DATE January, 1979	6. PERFORMING ORGANIZATION CODE
	8. PERFORMING ORGANIZATION REPORT NO.	
7. AUTHOR(S) Thomas C. Curran, Ph.D	10. PROGRAM ELEMENT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air, Noise and Radiation Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711	11. CONTRACT/GRANT NO.	
	13. TYPE OF REPORT AND PERIOD COVERED	
12. SPONSORING AGENCY NAME AND ADDRESS	14. SPONSORING AGENCY CODE	
	15. SUPPLEMENTARY NOTES Special mention should be made of the contributions of William M. Cox, Thomas B. Feagans, William F. Hunt, Jr. and Sherry L. Olson	
16. ABSTRACT This document discusses the interpretation of the National Ambient Air Quality Standards (NAAQS) for ozone that were promulgated by the U.S. Environmental Protection Agency in 1979. These standards differ from previous NAAQS in that attainment decisions are based upon the expected number of days per year above the level of the standard. The data analysis implications of this statistical formulation of an air quality standard are presented for both compliance assessment and design value estimation purposes. Example calculations are included.		
17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Standards Design Values Ozone		
18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 37
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

United States
Environmental Protection
Agency

Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park NC 27711

Official Business
Penalty for Private Use
\$300

Publication No EPA-450/4-79-003

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335



If your address is incorrect, please change on the above label,
tear off, and return to the above address
if you do not desire to continue receiving this technical report
series. CHECK HERE : tear off label, and return it to the
above address



APPENDIX D

**QUESTIONS AND ANSWERS ON THE
PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)
NETWORK BASED ON THE APRIL 27-29, 1993
TELECONFERENCE WORKSHOP**



TABLE OF CONTENTS

Section	Page
INTRODUCTION	1
OVERVIEW	2
NETWORK DESIGN AND SITING	5
SAMPLING AND ANALYSIS	10
QUALITY ASSURANCE	27
MODELING AND METEOROLOGICAL MONITORING	33
DATA ANALYSIS	40
AIRS AND PAMS	43

INTRODUCTION

The following questions and answers were compiled primarily from the Photochemical Assessment Monitoring Stations (PAMS) Teleconference Workshop held April 27-29, 1993. Supplemental questions and answers have been added in this document to address broader PAMS issues and provide an overview of the regulations. The questions and answers have been organized into the following categories: (1) Overview; (2) Network Design and Siting; (3) Sampling and Analysis; (4) Quality Assurance; (5) Modeling and Meteorological Monitoring; (6) Data Analysis; and (7) AIRS and PAMS.

OVERVIEW

Question:

What are the PAMS program objectives?

Answer:

The PAMS program objectives, or data uses, include the following: National Ambient Air Quality Standards (NAAQS) attainment and control strategies; State Implementation Plan (SIP) control strategy evaluation; emissions tracking; exposure assessment; and support for urban airshed modeling.

Question:

Who is affected by the 40 CFR Part 58 PAMS regulations?

Answer:

The regulations directly affect those air pollution control agencies with designated serious, severe, or extreme ozone nonattainment areas. For the first time, States are required to collect data, not only to determine compliance with the NAAQS but also to provide fundamental data to aid in assessing the ozone problem.

Question:

What is the difference between standard and alternate network plans?

Answer:

The Part 58 PAMS regulations allow for two types of network plans: standard network plans conform directly to the criteria for a network description as described in Section 58.41 and Appendices A and D of the regulations, including all of the elements listed; alternate network plans include one or more of the acceptable alternative network elements, but otherwise comply with the criteria for a standard network.

Question:

What alternative elements are allowed under the alternative element provisions of the regulations?

Answer:

The PAMS regulations contain provisions for alternative network elements in five areas: (1) sites (number and arrangement); (2) methodology (sampling and analysis methods); (3) monitoring season (months with the highest ozone); (4) sampling frequency; and (5) meteorology (establishing wind directions for siting). States submitting plans containing one or more of these alternative elements must state that the submittal is an alternative PAMS network design. In order to be accepted, a network plan containing alternative elements must demonstrate fulfillment of the PAMS monitoring and program objectives.

Question:

What are the basic elements that must be included in a network plan?

Answer:

To be considered complete, a network plan must include the following elements, in conformance with the criteria outlined in 40 CFR Part 58: (1) network overview, (2) site identification, (3) sampling and analysis methods, (4) monitoring period, (5) sampling frequency, (5) meteorological monitoring, (6) network implementation schedule, and (7) quality assurance. Alternate network plans must also include the following documentation: (1) narrative explanation of the alternative element(s); (2) justification of the alternative element(s); and (3) demonstration of comparability.

Question:

Who will review and approve network design plans?

Answer:

Network plans are submitted first to the EPA Regional Office for preliminary review. The plans are then forwarded to EPA's Monitoring and Reports Branch, Technical Support Division, Research Triangle Park, NC, where they are reviewed by the PAMS Network Review Committee, which will forward the plan along with its recommendations to EPA Headquarters management for final approval.

Question:

Will States be able to meet in person with EPA's Office of Air Quality Planning and Standards (OAQPS) and Regional staff to explain in detail an alternative regional plan?

Answer:

The monitoring program is envisioned as a three-way partnership between State, Regional Office, and OAQPS staff, and communication and coordination between States and EPA staff are encouraged in establishing alternative plans. Because of travel restrictions, however, conference calls may be the best vehicle for such communication. Alternatively, States are welcome to visit OAQPS staff in RTP, NC to discuss alternative plans in person.

Question:

Where does the SIP get submitted, and what should it say?

Answer:

The SIP revision is submitted to the Regional Office, which then prepares the rulemaking. EPA anticipates that the SIP revision covering the PAMS provisions will be a relatively small part of the total SIP, basically, a commitment to design and install the network. Though the revision is not regulatory in nature, it does have to go to public hearing, as all SIP revisions do. EPA's Air Quality Management Division in conjunction with the Technical Support Division has drafted suggested language that will be helpful to States in developing their SIPs.

Question:

Does an alternative plan based on a regional effort need to reference sites to specific Metropolitan Statistical Areas/Consolidated Metropolitan Statistical Areas (MSAs/CMSAs) or can the sites be referenced to the region as a whole?

Answer:

For purposes of strategy development, if an area does have a regional network (for instance, the northeast United States), such areas can use those monitors to develop strategies which could be implemented region-wide. It is still important, however, that each site be keyed to a particular MSA/CMSA. EPA would encourage even regional sites to be keyed to one or more MSAs and not just to the region.

NETWORK DESIGN AND SITING

Question:

How many and what type sites are required?

Answer:

A maximum of five PAMS sites is required in an affected ozone nonattainment area, depending on the population of the MSA/CMSA. For the larger areas, EPA has determined that the minimum network that will provide data sufficient to satisfy the PAMS monitoring objectives should consist of five sites: (1) Site No. 1 - upwind and background characterization site; (2) Site No. 2 - maximum representative ozone precursor emissions impact site; (3) a second Site No. 2 in the second most prominent morning wind direction; (4) Site No. 3 - maximum ozone concentration site; and (5) Site No. 4 - extreme downwind monitoring site. The recommended order of implementation is Site No. 2, No. 3, No. 1, No. 4, and last, the secondary No. 2.

Question:

What if a State does not want to use the recommended phase-in schedule?

Answer:

The regulation requires that five sites be established in five years, with Site No. 2 required as the first site to be established. But the phase-in schedule for years 2 through 5 can be in any order chosen by the State, allowing for a great deal of flexibility. For a particular area, once Site No. 2 is in place the first year, as long as the one site per year requirement is met, the choice of sites will be up to the particular State or local air pollution control agency. Plans containing alternative numbers and types of sites would be considered alternative plans and would have to be submitted in accordance with the requirements in EPA's guidance on PAMS network plan and approval.

Question:

Does the rule provide for alternative phase-in schedules longer than 5 years?

Answer:

No, it does not. The network must be totally implemented by 1998. States that started phase-in in 1993 get an extra year.

Question:

At the Region IV Air Monitoring Workshop, it was recommended that monitoring be conducted at a background site. Is there a difference between Site No. 1 and the background site referred to at the workshop?

Answer:

Site No. 1 is supposed to be the upwind background site; typically, it will be located near the upwind edge of the photochemical modeling domain. That is the only requirement for a background site for PAMS.

Question:

How close should Site No. 2 be to the central business district for major point sources?

Answer:

The regulation states that Site No. 2 should be located immediately downwind of the area of maximum precursor emissions. In an urban area, precursor emissions are expected to come, in large part, from the central business district. In general, Site No. 2 should be close enough to the central business district for major point sources to record higher concentrations and get more sensitive and precise information but not so close to a particular emission source that maximum ground level precursor concentration would be expected. The site should be representative of the area's emissions, but should not be unduly influenced by any particular emissions source.

Question:

What is the rationale for Site No. 2, Type "B" sampling frequency (eight 3-hour samples every day during the monitoring period and one additional 24-hour sample every sixth day year-round)? What will these data be used for?

Answer:

Site No. 2, as stated in the regulation, is to be located representative of the MSA's downwind VOC emissions, to capture the "maximum precursor impact." Finding a site which is appropriate and not unduly influenced by any particular source of emissions may be very difficult. Therefore, there is going to have to be a great deal of leeway in looking at the particular arc in which Site No. 2 is located. Generally though, Site No. 2 should be located in that arc in the morning wind direction, downwind of the MSA, such that it is not unduly influenced by any particular source of emissions.

Data from Site No. 2 will be used for (1) development and evaluation of imminent and future control strategies, (2) corroboration of NO_x and VOC emission inventories, (3) augmentation of reasonable further progress (RFP) tracking, (4) verification of photochemical grid model performance, (5) characterization of ozone and toxic air pollutant exposures, (6) development of pollutant trends, particularly toxic air pollutants and annual ambient speciated VOC trends to compare with trends in annual VOC emission estimates, and (7) determination of attainment with the NAAQS for NO₂ and ozone. The additional once every sixth day sampling is required for quality control purposes and for determining annual averages of speciated VOC for air toxics assessments.

Question:

Should Site No. 3 be the current ozone design value site?

Answer:

Site No. 3 should correspond to the maximum ozone site for the MSA/CMSA which is located downwind. Site No. 3 may or may not be collocated with the ozone design value site for a particular MSA/CMSA. In some cases, the design value site may be upwind of the MSA itself and be influenced totally by long-range transport of ozone. Further,

an existing site downwind, measuring the highest ozone levels in the area, may not be the ideal location for Site No. 3. This determination will need to be made on a case-by-case basis.

Question:

Regarding siting guidance, what does "undue source influence" mean?

Answer:

Criteria for dealing with undue influence from sources are covered in 40 CFR Part 58, Appendix E. With regard to spacing from roadways, a minimum separation distance must be maintained between roadways and PAMS monitoring sites, for example, to minimize NO interference on ozone monitoring and minimize the influence from mobile sources. Sites No. 1, No. 2, and No. 4, in particular, should avoid NO_x interference from nearby roadways. Generally, Site No. 2 should be placed at a location which is representative of all the emissions of the area and not just indicate the signature of a particular source. In terms of spatial scale of representativeness, it should be a neighborhood scale rather than a micro or middle scale.

Question:

For submitting the network design plans, where can wind roses be obtained if they cannot be produced by a given agency?

Answer:

Ideally, local/nearby meteorological information is used to develop wind roses. If current, local information is not available, the wind roses produced by Headquarters can be used; these can be obtained from Regional Offices. Two sets of roses were prepared, one for ozone conducive days and the other for high ozone days, according to the following criteria: for both sets of days the most recent 5- or 10-year data set for June, July and August were used; ozone conducive criteria were used in which the temperature is greater than 85°F, the 7 to 10 a.m. wind speeds are ≤10 knots, the 1 to 4 p.m. wind speeds are ≤14 knots, and the 1 to 4 p.m. relative humidity is ≤60%; and for high ozone days in which the criteria ozone concentration is ≥0.10 ppm.

The weakness in the high ozone day information is that it presumes that the current ozone sites are located correctly. EPA has been encouraged by the fact that for most MSAs, the wind roses for ozone conducive days correlate well with the wind roses for high ozone days. In any case, the Agency feels that using either set of roses, the sites would be located at least in the same quadrant, and most of the time probably within a 30° arc.

Question:

When discussing the site guidance criteria for using the wind data on high ozone days, or on those days which exhibit the potential for producing high ozone levels (high ozone conducive days) as in Site No. 1, which wind rose should be used? There are two represented for each time period, categorized under the headings "conductive days" and "observed highs."

Answer:

If the current ozone site is believed to be properly located, the wind rose based on observed highs would probably be more appropriate. Otherwise, consideration should be given to both.

Question:

Are AIRS Graphics printouts acceptable for emissions?

Answer:

EPA would prefer emission density maps in combination with AIRS Graphics printouts (or equivalent) depicting the locations of the largest point emitters, if they can be obtained. Your Regional modeler may be able to provide further assistance.

Question:

Regarding emission source information, what is the smallest point source for which information is needed?

Answer:

For SIP inventory purposes, the VOC point source cutoff definition for VOC sources is 10 tons per year. EPA is requesting the same cutoff for PAMS network plans emissions information.

Question:

Can episode sampling be used at Site No. 2?

Answer:

The rule allows for episodic sampling at Site Nos. 1, 3, and 4, but does not speak to it as an allowable alternative for Site No. 2. The Agency's philosophy for criteria pollutants is that around-the-clock sampling is required in order to capture the rare event. This same philosophy of capturing the rare event applies to Site No. 2--as "an insurance policy," continuous sampling at Site No. 2 is desired. However, the Agency could consider plans which propose less than complete or 24-hour per day sampling at Site No. 2, in those situations where it could be demonstrated that data collected on an episodic basis or collected at selected hours of the day are sufficient. Even if an episodic plan were to be approved at Site No. 2, however, it would still be important to do additional intermittent sampling to provide information on the concentration on nonepisode days, as it is equally important to understand what is happening on the days of lower photochemical reactivity as on the days that produce the highest ozone.

Question:

What data must be submitted to support a change to the required June, July, August monitoring season?

Answer:

The intent of the regulation was to require at least three months of intensive sampling. In most States, June, July, and August incorporate the periods when peak ozone values

are likely to occur. Historical ozone data could be submitted to demonstrate that a different three consecutive months (for example, July, August, and September) would better serve the PAMS program. EPA encourages States to extend the PAMS monitoring period whenever feasible to include the entire ozone season or perhaps the entire calendar year. Again, plans containing alternate monitoring seasons would be considered alternate network plans and would have to be submitted in accordance with the requirements specified in EPA's guidance on PAMS network plan and approval.

SAMPLING AND ANALYSIS

Question:

Should particulate filters be used on the auto gas chromatograph (GC) system? If so, how should they be configured and of what materials should they be constructed?

Answer:

Particulate filters should be used on the GC system. Most canisters use a stainless steel 10 micron filter which removes particles that would otherwise get into the canisters. However, if particulate filters are used, a maintenance program which includes periodic checking of the filter is necessary.

Question:

What is the maximum allowable inlet line length for various auto GC systems?

Answer:

In general, there is no prescribed maximum allowable inlet line length. The concept is that as gases are entering the system, they contact surfaces. The smaller the surface, the less of a potential problem. Therefore, the rule-of-thumb is to minimize the surface contact area. Silica material seems to be a good inert surface. If the tubing is coated with the silica material to make it inert, then the larger surface may be acceptable, but rule-of-thumb is to minimize surface areas. Further information may be found in 40 CFR Part 58, Appendix E.

Question:

What is the shelf-life of an ambient air sample in a Summa[®] polished canister (without significant hydrocarbon chemical reactions and alterations)? What is the shelf-life of a calibration cylinder (*e.g.*, 56 compound super-blend)?

Answer:

Generally, tests under typical conditions for ambient air samples collected in canisters indicate a shelf-life of 14 to 30 days and probably longer (with the exception of α - and β -pinene, which have not been tested). However, ambient canister samples should be analyzed as soon as practicable after collection to ensure that losses are minimized.

Calibration or retention time standards in high pressure cylinders containing the 56-compound mixture (with the exception of α - and β -pinene) are generally stable for at least 6 months to a year. However, problems with losses of olefinic compounds such as 2-methyl-1-pentene and isoprene have been observed.

Question:

What is the recommended frequency for the analysis of (a) the propane standard, and (b) the qualitative multi-component retention time standard?

Answer:

The frequency of calibration and analysis of the retention time standards will be left to the judgement of the analyst and will be dependent on the stability of the system. However, at least initially, the retention time standard should be analyzed daily. Further guidance on this issue is provided in the *Technical Assistance Document for Sampling and Analysis of Ozone Precursors* (TAD), Section 2.2.6 (EPA-600/8-91-215, October 1991).

Question:

Is EPA guidance available for the sampling and analysis of ozone precursors?

Answer:

Guidance is provided in the TAD. The Agency will be updating this manual in the near future.

Question:

Given the following background information for Baton Rouge:

- (1) It is a "serious" area
- (2) It is Type "B" for sampling frequency requirements
- (3) It has a January to December "ozone season"
- (4) It has a population between 500,000 and 1,000,000; frequency type is "B" or "E"
- (5) Sampling frequency requirement "B" is daily part of the year/every sixth day year-round
- (6) Multiple-canister sampling (8, 3-hour samples) is to be run daily during June, July, and August; and every sixth day per year, year-round

Does the Baton Rouge area's daily VOC sampling schedule run only from June through August or will it run year-round to coincide with the ozone season?

Answer:

The ozone monitoring should be for the entire ozone season as every other ozone monitor in the network is operated. The precursor monitoring, which includes the oxides of nitrogen, the VOC and the carbonyls (except for any year-round component), would be for June, July and August only. That presumes that Baton Rouge chooses June, July and August for its monitoring season. The rule does allow for any MSA to choose a different monitoring season if it captures the peak ozone days for that particular area. Assuming June, July and August did encompass the peak ozone days, Baton Rouge would only be required to operate the VOC and other precursor monitors during that time period (except for the year-round component).

In addition, although only 3 months of precursor monitoring are required, State or local agencies can extend that season to more than 3 months if they believe that those additional months are critical to understanding the ozone problem in their area. However, areas of the country with longer ozone seasons (*i.e.*, 12 months) typically have the highest ozone concentrations during the warmest months of the year, which usually are 3 to 6 months of that annual period.

Question:

Why is it necessary to sample around-the-clock? Is it necessary to capture the diurnal pattern whether by eight 3-hour samples per day or by the use of a continuous instrument to collect hourly samples?

Answer:

Data collected "around-the-clock" will be useful for quality assurance, for establishing trends, for evaluating control strategies, for photochemical model diagnostics, for confirming emissions inventories, and for toxics assessments. Twenty-four hour a day sampling refers not only to eight 3-hour samples a day, but also to the year-round 24-hour canister component.

One of the real advantages of the PAMS network is that it provides much more data to compare with emission inventories. It is important that the PAMS network shows data from around-the-clock, because the inventories are around-the-clock representations, especially for the VOC, where much of the emissions come from evaporation around-the-clock.

The PAMS program and the ozone program in general are concerned with rare events. Continuous sampling is preferable to try to capture the event that occurs just once or twice a year. In terms of trying to identify the impact of certain emission changes, it may be important to understand what changes actually occurred to the underlying diurnal pattern. Will the diurnal pattern change when fuels are changed, for example? Will there be a shift in the concentration observed at night? In previously collected data, higher concentrations were recorded at night, when photochemical activity was at its lowest. Continuous sampling provides additional sensitivity to follow data for determining trends. Without continuous data, looking at a selected period of time during the night might mean sampling during the wrong period of time. Some of the sites in Atlanta had very stable patterns during the early morning hours; for example, 2:00 a.m. was particularly high. Sampling only at that time and not continuously during the night might result in an unrepresentative nighttime value. Thus, it is important to sample continuously throughout these higher nighttime periods to arrive at a representative nighttime value.

Further, sampling in the evening would provide additional information on mobile source emissions. Ozone planning has focused historically on morning emissions. Continuous sampling would probably corroborate better the evening rush-hour emissions for mobile sources.

In the past, the EPA has been criticized, in general, for not collecting enough data; the National Science Academy's report addressed this issue. In the 1980s, data were basically collected from 6 to 9 a.m. at a very limited number of sites. With such a limited schedule, it was not possible to see what happened in the afternoon with the biogenic factor, or with evaporative emissions. Since this is a long-term monitoring program, it only makes sense to start off with as robust a database as possible in order to track changes in the atmosphere over time, to answer questions which may arise in the future.

In addition, when reviewing ozone data, the data cycle may not be the same from day to day, particularly at monitoring sites in areas with varying transport and stagnation types. Transport may result in ozone peaks in the early morning or late afternoon. When conditions are stagnant, the ozone peak may be more persistent and lingering. Additionally, weekday emissions data differ from weekend data. Therefore, two fixed 3-hour sampling periods may miss some of the data needed to evaluate these situations.

To summarize, continuous sampling is seen as "an insurance policy" to collect data over the course of the entire day in order to capture the diurnal pattern and to be able to answer the many different types of questions that could arise. In fact, in the ozone nonattainment areas designated severe and extreme, between 1994 and 1995, fuels are going to be reformulated and the atmosphere is going to change when this is implemented. Continuous sampling will provide a picture of the diurnal patterns and atmospheric constituents in those cities in 1994 and how they have changed in 1995.

Question:

Can sampling aloft be substituted for ground level monitoring of ozone and ozone precursors?

Answer:

To the extent that States can assist in the model evaluation process, EPA would certainly encourage the collection of air quality data aloft. However, collecting air quality data aloft must be balanced against some of the primary objectives of the PAMS program which include tracking the progress of control programs and trends in emissions. If the basic components of the PAMS program would not be jeopardized by such air monitoring aloft, EPA would be open to complementing ground monitoring with this aloft monitoring. However, questions remain regarding this issue, and the Agency would consider such requests on a case-by-case basis.

Question:

Were there any interferences in the UV open path system such as weather conditions, rain, etc.?

Answer:

The UV open path system may be vulnerable to dense fog conditions which can act as optical obstructions in reducing the light transmission below the critical level necessary for measuring gaseous pollutant concentrations. During these periods, however, the OPSIS system is designed to flag the data as invalid. The ozone concentrations coming from the UV open path system correlate very well with the ozone concentrations at a fixed monitoring site. Since this is a photometric measurement, it is believed that those measurements are very appropriate for ozone. Measurements of NO₂ and SO₂ have also been made. An advantage of the system for NO₂ is that the measurements are direct spectroscopic ones and not "difference-derived" as with the chemiluminescence instruments. At the time of the Atlanta study, the measurements for hydrocarbons, particularly benzene, toluene and xylene, were just emerging and the study found some problems with the deconvolution software used by the differential optical absorption

spectrometer to separate the interfering species from the species to be measured. The company making the system used in Atlanta, OPSIS, is currently working to improve its internal and data collection software, and while there are hopeful signs for future use, for the moment, OPSIS is limited to those compounds that will absorb in the UV region of the spectrum.

Question:

What are some suggestions about CO₂ management? Any problems, solutions, or expectations?

Answer:

CO₂ is probably more of a problem in mass spectrometry work than in the case of hydrocarbon analysis using the flame ionization detector (FID). When using narrow internal diameter (ID) columns a problem could occur due to CO₂ plugging the column. In such cases, water removal is important and should be done. Whether or not there are ways of taking CO₂ out without taking out the VOC compounds remains to be seen. Selective removal of particular compounds may affect the VOC. Therefore, it might be better not to remove the CO₂.

Question:

Why don't you use a Nafion Dryer to eliminate water in the preconcentration direct flame ionization detection (PDFID) method?

Answer:

About 10 years ago when the PDFID method for estimating the total NMOC was developed, the Nafion Dryer had not been tested adequately to be sure that it passed NMOC without unacceptable losses. At the same time, correcting for water using the operational baseline technique seemed to work quite well. The method was put into service at that point. The additional development work to test the performance of the system with the Nafion Dryer was never carried out.

Question:

Define high and low VOC to NO_x ratios.

Answer:

A high VOC to NO_x ratio would be greater than 16-20 to 1 and a low VOC to NO_x ratio would be about 5 to 1. Most cities fall within the range of 20 to 1 to 5 to 1.

Question:

How can canisters be checked for contamination via NMOC analysis when VOC sensitivity is 0.3 ppmC while with PAMS we are frequently looking at ambient concentrations less than 1 ppb?

Answer:

The 0.2 or 0.3 ppmC number that is given for the detection limit is really based on variability in background response from the canisters. The instrumental measurement

capabilities are as much as an order of magnitude better. Contamination normally involves several compounds so that there are several compounds included in total NMOC. The PDFID method serves as an excellent screening tool to ensure that canisters are cleaned properly. It is recommended that an occasional blank analysis be conducted with the full GC system to make sure there is no single compound contamination that constitutes a major contamination.

Question:

Can a surrogate for speciated VOC be used?

Answer:

The rule would allow for the proposal of a surrogate for speciated VOC, but the burden-of-proof would be on the State to show that it can still provide enough information to meet a set of balanced objectives. Currently, the Agency would consider surrogates for speciated VOC at Site Nos. 1, 3, and 4, but feels strongly that continuous speciated VOC at Site No. 2 is necessary.

Question:

In hindsight, regarding the Atlanta study, were hourly averages adequate for the study's data analysis needs?

Answer:

The current automated GC systems require one hour to complete sample preconcentration and analysis procedures. Consequently, sample frequency cannot be any greater than one sample per hour. Hourly averages were adequate for the study's data analysis needs. The regulations require a minimum of 3-hour sampling. The samples analyzed for the 1990 Atlanta Study were integrated over a 35-minute period with the assumption that this period was representative of the one-hour average. It was thought that a period shorter than 35 minutes might not be representative of an hour average.

Question:

What is meant by internal reference peaks in a gas chromatogram?

Answer:

Internal reference peaks are usually 3-4 gas chromatograph peaks used as retention time and/or response factor references in processing the GC data. The peaks correspond to individual compounds that are added to the sample during analysis or that are usually present in ambient air (such as benzene, toluene, and the xylenes). If the retention times of the internal standards shift, then adjustments to the expected retention times of all other target compounds are made during processing to ensure correct identification. Similarly, if the internal reference peaks are used as response factor references, they must be compounds that are added to the system during sample collection at known amounts. Changes in system response can be identified by comparing the response of the internal standard to the response determined during calibration. The use of internal standards allows for the adjustment of the analytical system for each analysis.

Question:

We have received a canister mixture standard from a supplier of standards with certified concentrations for propane and benzene. We saw nonlinear quantitative response between propane and benzene (*i.e.*, area versus ppbC). Is this likely to be caused by a collection bias? The supplier is using a Chrompack FID measurement system or some other method. How can this nonlinearity be adjusted when determining concentrations?

Answer:

A similar per carbon response has been seen in investigations comparing response factors of nonmethane hydrocarbons, aromatics, paraffins and olefins. If a response is not within 5 percent, there must be something wrong with the system. There have been some reports that a dry mix in the canister does not store well, but propane and benzene usually store well in canisters with dry atmospheres; therefore, the problem could be the result of a leak in the system, in the preconcentration, or some other part.

Also, some collection efficiency factors to consider when an adsorbent column is used for sampling are trapping efficiencies and transfer of the sample to the columns. These factors can affect the area count for carbon sensitivity as well as the linearity of the response.

Question:

We have experienced large differences in hourly total NMOC values delivered by collocated GC systems. The difference occurs because one system uses a serial column arrangement while the other uses parallel columns. Differences have exceeded 100 percent and only occur on ambient air. Calibration standards are generally within 10 percent. How can this situation best be addressed?

Answer:

These differences are associated with how samples are being introduced into the system. In this case, the different types of collection media (*i.e.*, moisture in the sample versus a standard mix in the dry atmosphere) may be affecting trapping efficiency or collection efficiencies. Certainly the mixture in the atmosphere is more complicated than a calibration standard and that may account for part of the problem. Compare the internal compositions to see where the differences occur and try to reinvestigate the system. These systems have all been evaluated and compared very well. The fact that they are not comparing well suggests that there is a systematic problem (*i.e.*, leaks in the system or problems in the collection aspect of the system) that has to be evaluated.

In general, there is no conceptual reason why a series application versus a parallel application would result in differences that large. Discuss those problems with the vendor and review all the aspects of the system to see where the problem lies.

Question:

How many National Institute for Standards and Technology (NIST)-traceable standards should be employed when determining detection levels of automated GC systems for the list of over 50 targeted compounds?

Answer:

The FID detector provides constant response for all compounds on a per carbon basis requiring just one standard reference method (SRM) for detector response calibration. Detection limits may be slightly different for each GC peak and can be determined with the retention time standards. In some automated GC systems with dual FID serial and parallel columns, propane will be used to calibrate one of those columns and benzene will be used to calibrate the other FID. Since benzene SRMs are no longer available from NIST, a certified benzene standard obtained from a cylinder gas manufacturer will be required for calibration.

Question:

If a compound on the current targeted list of compounds is not found, can it be removed from the list? If yes, at what detection level must this be demonstrated?

Answer:

More guidance on this may be provided as the Agency defines how to ascertain detection limits. Certainly, compounds should not be indiscriminately removed from the list that might play a role in the total estimate, in the chemistry, or in receptor modeling; on the other hand, compounds which are seldom, if ever, detected should not be retained on the target list. In addition, a number of compounds on the target lists, mostly the olefin compounds, will be in the atmosphere at low concentrations. They usually will be at higher concentrations in the morning; during the afternoon period they may be below detectable limits. All of the compounds on the target list should be noticed, with the possible exception of the natural hydrocarbons in an urban mix, at some of the sampling periods, but not necessarily all of them.

Question:

For how many compounds should the States determine detection levels (40 CFR Part 136 Appendix B)? How many standards do States need to use?

Answer:

Detection limit is not deemed to be a critical parameter for this application because most areas of concern will have reasonably high ambient air concentrations of VOC precursors (particularly the ones on the target list). No requirements to determine definitive detection limits (via 40 CFR Part 136 Appendix B) for all the listed species are planned but it would be prudent to make this determination on at least one representative light VOC species (*e.g.*, propane or butane) and at least one heavy VOC species (*e.g.*, toluene or xylene).

Question:

The use of parallel analytical columns may result in unacceptable signal loss. How do you compensate for this to maintain the required level of response?

Answer:

If the sample is split or if only a portion of the sample is used, signal response is reduced. However, current automated GCs that use a splitter do have adequate sensitivity to

monitor ambient air levels of ozone precursors down to concentrations of 0.5 ppb. Additional sensitivity may be obtained by increasing the sample size during collection on the primary trap provided breakthrough of target compounds does not occur and provided unacceptable accumulations of water vapor or carbon dioxide do not occur.

Question:

Are procedures in place to allow for zero span gas challenge procedures using the field sampling manifold systems?

Answer:

No. However, zero challenges are very important and the issue of whether or not they are challenged through the manifold or challenged with zero canisters is going to be discussed and addressed in the next version of the TAD. Zero samples allow the potential for artifacts in concentrator traps within the whole system to be addressed.

Question:

How should the States calculate total NMOC? How many compounds should be included? Should all measurable peaks be included?

Answer:

Total NMOC is generally considered as the sum of all the peaks in the chromatogram in ppbC excluding methane. There is concern that some NMOC peaks are removed with the water management system (e.g., Nafion, etc.). Consequently, true NMOC may not be obtained by the sum of all GC peaks.

Question:

Can estimates be given for costs for procurement, operation and maintenance of the various PAMS network configurations being discussed?

Answer:

Some cost estimates made by OAQPS are included in the Preamble to the proposal and promulgation of the PAMS regulations. Cost estimates are also addressed in the EPA report, *Guidance for Estimating Ambient Air Monitoring Costs for Criteria Pollutants and Selected Air Toxic Pollutants*, EPA-454/R-93-042, October 1993.

Question:

Can you comment on the cost benefits of purchasing carbonyl cartridges versus making them?

Answer:

Currently, the commercially available dinitrophenylhydrazine (DNPH) silica gel coated cartridges cost about \$10.00 each; uncoated blank cartridges cost about \$2.00 each. The cost of coating, quality assurance, etc. involved in cartridge preparation must be considered, however. EPA did prepare cartridges as demonstrated in the April 1993 PAMS workshop video presentation, but now finds it more cost-effective to purchase them. Agencies wishing to use the DNPH-coated C18 cartridges will have to make them

since they are not commercially available. There may, however, be private contract labs willing to prepare them. It is important that they can guarantee a specified background level suitable to the application.

Question:

Current annual estimated costs for carbonyl sampling and analysis are substantial. What new technologies are EPA or other sister Federal Agencies such as the National Oceanic and Atmospheric Administration (NOAA) pursuing to automate carbonyl sampling and analysis and bring down State costs? Can you comment on alternative technologies?

Answer:

Although there are no commercially available automated technologies for sampling and analysis of speciated carbonyls, there are several methods that have been used to sample just for formaldehyde, for example. There are some possible alternatives for derivatization. Certain perfluoro compounds might be used to make an oxime, for instance, which could then be analyzed by GC/ECD. That would probably provide slightly cheaper analytical costs, but sampling would still involve some kind of trapping on a cartridge. Using ECD might provide the sensitivity needed to compensate for the difference in the amount of sample going on a column. For liquid chromatography (LC), up to 25 microliters of sample are commonly injected. Less than one microliter of sample would likely be used for GC analysis; there are a lot of tradeoffs to be considered.

A real-time formaldehyde analyzer was used in the Atlanta Ozone Precursor Study in 1990. It uses a diffusion scrubber to collect formaldehyde. Ambient air is sampled through a tube along the walls of which water is flowing. The formaldehyde diffuses to the wall and goes into solution in the water. The water is then separated from the air and chemicals are added so that a new compound is formed by chemical reaction. This derivatized compound is sensed with a fluorescence detector. The system is very sensitive, detecting ambient background concentrations of formaldehyde in the sub-ppbV range. Interference testing indicated no significant interference. The disadvantage of the system is that it measures only formaldehyde.

For continuous carbonyl monitoring there is a reference in the literature to a procedure where DNPH reagent solution and air flow through a glass coil scrubber. The reacted reagent is then collected and analyzed by HPLC. This could be automated by using sequential collection of sample and an auto injector. The method is only good for soluble carbonyl compounds having solubilities similar to or greater than formaldehyde (see *Environmental Science & Technology*, Vol. 27, No. 4, 1993, pp. 749-756). The disadvantage is that liquid reagents and HPLC are worked with in the field, which could contaminate other analyses (e.g., VOC).

Question:

Which hydrophobic adsorbents are now being tested?

Answer:

Several companies make hydrophobic adsorbents including Supelco with their Carboxin series. The Carboxin adsorbents are hydrophobic and therefore reduce the amount of water vapor remaining after sampling. EPA has used the Carboxins in place of the Carbosieve S-III adsorbent, which is typically the last and most retentive adsorbent in a multisorbent trap. The breakthrough volume for water vapor is reduced using the Carboxins. A neutral gas purge is used to eliminate additional water vapor from the multisorbent. Additional information on multisorbents is presented as "Evaluation of a Sorbent-Based Preconcentrator for Analysis of VOCs in Air Using Gas Chromatography-Atomic Emission Detection" in the *Proceedings of the 1992 U.S. EPA/A&WMA International Symposium on Measurement of Toxic and Related Air Pollutants*.

Question:

Do any of the continuous GC/FID systems have an automatic shut-off for hydrogen during a flame out? If not, what do you recommend to prevent explosions at field sites?

Answer:

The instrument manufacturers have addressed the safety problems with the use of hydrogen. Vendors should be contacted to determine whether or not their systems have automatic shut-off valves.

Question:

Since FID detection is not enough to confidently identify ambient air pollutants, why wasn't mass spectrometry included in the federal regulation? If it is going to be a future revision, when will this take place?

Answer:

EPA believes that the FID with modern analytical GC columns and associated hardware and software is the most appropriate procedure to qualitatively identify and quantitatively analyze the target species for the purposes delineated in the PAMS regulations and detailed in the TAD.

Mass spectrometry is not recommended for primary monitoring for this purpose, and it is not likely that it will be recommended in the future. Mass spectrometry does play an important role in quality assurance/quality control (QA/QC) and in verifying and identifying unknowns.

Question:

How well should PDFID (total concentrations) correlate with speciation concentrations (taking into account that some compounds are not high enough in concentration for some FIDs to detect) assuming good QA/QC?

Answer:

Generally, PDFID estimates of total NMOC should agree with the GC/FID sum of peaks estimates within 15 percent. However, areas with significant concentrations of polar, water soluble, and substituted species may not agree as well. The correlation with a total measurement by photoionization detection (PID) would probably not be as good because of the response variability of the PID to different compounds.

Question:

Will the TAD provide specific criteria for States to decide if PDFID will be an acceptable substitute for speciated analysis?

Answer:

Decisions about the acceptability of plans is addressed in the regulations for submitting alternate plans to EPA. Specific criteria will probably not be included in the TAD since alternative plans will be considered and approved on a case-by-case basis.

Question:

If the only equipment currently available to an agency to analyze ozone precursors is an Entech System interfaced to a Hewlett Packard GC with a mass spectrometer detector (MSD), would the MS data be acceptable for participation in the PAMS program for the summer of 1993?

Answer:

The use of MSDs is not encouraged because of problems in calibrating individual species and difficulties in estimating the concentrations of unidentified species (and resultant difficulties in estimating the total NMOC). However, data for a specific set of compounds collected by MSD this summer would probably not be refused. States proposing this kind of system as part of an alternative plan should contact Entech to determine the cost of putting an FID detector on that system.

Question:

What degree of accuracy is expected or required for the 50 compounds monitored by the automated GC procedure? Will it be necessary to routinely examine every chromatogram to verify and identify the compounds using the automated GC procedure?

Answer:

EPA is currently reviewing this issue and hopes to provide more definitive guidance in the next version of the TAD. For automated GC applications it will not be practical to routinely examine every chromatogram. Users will have to rely on emerging software techniques to process chromatographs that are now examined and validated manually. (Initially, as many chromatograms as practical or possible should be examined manually.)

Question:

How are data between different instruments having dissimilar detection limits for varying compounds compared?

Answer:

Comparisons are appropriate if each of the instruments is measuring species concentrations well above the detection limit. Comparison of results for species at or near detection is not advisable.

Question:

Why is it necessary to monitor for C₂ and C₃ compounds?

Answer:

This issue was addressed when the 1990 Atlanta study was designed. Users of the data felt that the database would be incomplete without this information because the C₂ compounds have too much potential for contributing a significant amount to the total VOC. Also, some of the C₂ compounds are reactive.

The principal interest in monitoring the C₂ and C₃ compounds is to provide source fingerprints. Acetylene is an excellent indicator for an exhaust component from mobile sources. In addition, ethylene and propene are reactive compounds and important in the photochemistry process.

Question:

How does EPA plan to address interferences in ozone measurement methodology such as moisture in the chemiluminescence method and benzene and its derivatives in the UV method?

Answer:

Some reports about interferences with the UV photometry technique have been based on comparing UV photometry with the chemiluminescence technology. Substantial studies have been conducted to ascertain whether or not moisture could be causing those differences, but so far no definitive information has been found to indicate that moisture is a serious problem in terms of the UV measurement. There is always the potential for any hydrocarbon compound that is a strong UV absorber (usually aromatic type compounds) that is not properly compensated for in the ozone scrubber in the UV technique to be an interferant. It is very difficult to quantitate what those interferences are because those studies can only be done with known compounds like benzene, naphthalene, and toluene. There is always the possibility that some higher boiling compound that has absorption characteristics in the same portion of the spectrum as ozone will cause an interference. Currently, these are not creating major interferences, but the Agency does have an ongoing program to look at this issue within the limits of the

available resources. Contact the AREAL Equivalency and Methods Program at (919) 541-2622 for further information.

Question:

Could you explain the differences in the units of measurement between parts per billion carbon (ppbC) and parts per billion volume (ppbV)?

Answer:

Both units are concentration measurements used particularly for hydrocarbon compounds. Parts per billion carbon (ppbC) represent concentration in terms of carbon atoms in the compound. Parts per billion volume (ppbV) represent compound concentration. For example, a 1 ppbV hexane concentration would convert to a 6 ppbC concentration since there are 6 carbon atoms in the hexane molecule. The FID response is reasonably constant over the whole spectrum of PAMS compounds.

Question:

Since CO plays a role in ozone formation and will likely be included in ozone model evaluation, what type of CO instrument(s) does EPA suggest the States use at the different PAMS sites?

Answer:

States are encouraged but not required to make CO measurements at PAMS sites. EPA has not developed definitive guidance for low level CO measurements for this purpose. States that choose to make this measurement should consult with the research community involved in low level CO measurements and follow their suggestions.

Question:

Can CO monitoring be part of the PAMS network?

Answer:

CO monitoring is not currently required; however, many data analysis studies involving CO show that CO correlates extremely well with some of the VOC species, in particular, for mobile sources. CO information can be very useful, particularly to photochemical modelers, in identifying to what extent mobile sources are contributing to the total VOC and may be unduly influencing a monitoring site. A CO monitor with a more sensitive range than the CO monitors used for determining compliance with the CO standards should be used. Such monitors have been used in several research studies for this purpose, and interested State and local agencies would be encouraged to look into these.

Question:

What factors should be considered for using ozone scrubbers for carbonyl sampling? Commercially available cartridges have a copper grid to eliminate ozone interference. Isn't this required for lab-prepared dinitrophenylhydrazine (DNPH) cartridges?

Answer:

Commercially available cartridges (DNPH-coated silica gel) do not incorporate a copper grid to eliminate ozone interference. Both commercially or lab-prepared cartridges require some form of ozone scrubber or denuder. One example of a denuder that worked successfully for EPA has a coiled 3' length of 1/4" copper tubing treated with a solution of potassium iodide; it had a lifetime of 80 hours for 700 ppb ozone at 2 liters/minute. The carbonyls required to be monitored for PAMS showed no losses from use of the denuder. Other types of scrubbers are possible, but would need to be validated.

While DNPH C18 type cartridges appear to be more immune to ozone interference than DNPH-coated silica gel cartridges, there is evidence of degradation products that appear during HPLC chromatography. Thus, use of the denuder for either DNPH-coated silica gel or DNPH-coated C18 cartridges is recommended.

Question:

Is a heater needed for an ozone scrubber for carbonyl sampling?

Answer:

Yes, using a heater is recommended.

Question:

Is once every sixth day, 24-hour sampling also required for carbonyls?

Answer:

The regulations state that carbonyl sampling frequency must match the chosen speciated VOC frequency. That means that at each Site No. 2, a 24-hour sample for VOC and also a 24-hour sample for carbonyls should be collected concurrently with the 3-hour samples.

Question:

What time (daylight or standard) should be used for VOC and carbonyl sampling?

Answer:

As with the criteria pollutants, local time is used for sampling. Data should be reported in accordance with the AIRS guidance indicating local standard time.

Question:

Is the instrumentation associated with monitoring nitrogen compounds adequate to characterize simple and slightly complex atmospheric chemistry and to provide useful information for evaluating and validating models in both urban and rural areas?

Answer:

Actually, current chemiluminescence analyzers for oxides of nitrogen (NO_y) only measure NO accurately. The NO_x channel measures NO, NO_2 , and PAN quantitatively and other gas phase nitrogen oxides such as nitric acid less quantitatively. In the early stages of the ambient air photooxidation process, the NO_x results consist mainly of NO and NO_2 . As the photooxidation process proceeds, NO_2 is further oxidized to PAN and nitric acid. For model evaluation and validation, better information for the NO_y is needed. Joe Sickles (AREAL, 919-541-2446) is the contact person for additional information on this issue.

Question:

Does NO_x include NO_2 ? How does solar radiation correlate with ozone or hydrocarbons?

Answer:

NO_x in its strictest sense is $\text{NO} + \text{NO}_2$. Solar radiation is required to produce photochemical ozone; consequently, there is a correlation between these two components. There is no correlation between hydrocarbons and solar radiation.

Question:

Please elaborate on NO_x measurements, carbonyl issues, and CO measurements?

Answer:

In promulgating the PAMS regulation, EPA considered using emerging technology to look at more definitive NO_y species and was faced with deciding whether or not to require more definitive species measurements or to continue to use the chemiluminescence reference method technologies that State and local agencies have used for NO_2 measurements.

Over the past several years, the research community interested in background measurements has been very concerned about measuring all NO_y including nitric acid, peroxyacetyl nitrate (PAN) and other oxides of nitrogen. Although research techniques have been developed, they have not become routine. Consequently, no techniques for measuring these additional oxides of nitrogen have been included in the 1991 version of the TAD. When improved technology for measuring the nitrogen oxide compounds becomes available, the TAD will be revised. A range problem exists because there are high NO_x concentrations in the morning compared to very low NO_x concentrations in the afternoon. Vendors of chemiluminescence instruments will be encouraged to provide automatic range changes to address this issue.

Consideration is being given to relocate the converter on the NO_x chemiluminescence analyzer to measure NO_y . This technique will also be included in the revised TAD. In addition, GC techniques for measuring PAN will be addressed. Although these measurements will not be required, State and local agencies are encouraged to work with the research community to make such NO_x and NO_y measurements.

For carbonyls, the regulation requires that the carbonyl measurement schedule be the same as the VOC schedule so that modelers can make sense of the data; unfortunately, little monitoring has been done with sequential carbonyl samplers. Therefore, there is a lot of encouragement to, and a reasonable effort by, the manufacturing community to design samplers that can take 3-hour sequential samples around-the-clock. These samplers should be on the market by early 1994.

Question:

Can an open path instrument be used in lieu of GC or canister sampling?

Answer:

Open path technology is just emerging and does not currently measure all of the compounds to be measured for PAMS. While open path technology will continue to be evaluated, it will not apply to PAMS at this time.

QUALITY ASSURANCE

Question:

How will proficiency cylinders be made available for testing in 1993?

Answer:

The cylinders will be shipped to a contact person in each agency as identified by OAQPS. EPA will have a contract established with a national carrier to ship cylinders to and from the contacts, at no cost to the agencies.

Question:

How can one obtain a copy of the PAMS northeast quality assurance plan?

Answer:

Copies are available by calling Avi Teitz, EPA Region II, at (908) 906-6160 or faxing your request to (908) 321-6788.

Question:

How does one obtain the calibration and retention time standards?

Answer:

State or local agencies can obtain calibration and retention time standards from their EPA Regional Office. Regional Offices can contact Geri Dorosz-Stargardt, OAQPS, at (919) 541-5492, who will coordinate with AREAL to get calibration retention time standards.

Question:

Who pays for the calibration and retention time standards?

Answer:

Arrangements have been made by EPA to cover the cost for 1994 by withholding \$105 grant funds. In the future, grant dollars will likely be set aside for this purpose.

Question:

If we already have retention time standards, how many components should standards contain, and which compounds should have certified concentrations?

Answer:

The calibration standards EPA is supplying are going to be certified for propane and another compound, most likely benzene. The mixtures themselves, as ordered from the vendor, were certified to be within $\pm 10\%$ of the values stated on the cylinders. All 25 of these mixtures will be analyzed by EPA and these values will be used to provide the

average value for each compound in the mixture plus a standard deviation for each compound.

Question:

Some EPA regional laboratories use SRM gases for their ambient air monitoring programs, including certifying tanks for use in regional performance audit programs and certifying State standards, usually certified reference materials (CRMs), to assure stability and repeatability. What is EPA doing to make SRM gases, especially for the NO, NO₂, and NO_x monitoring, more readily available since there is a lengthy certification process for each cylinder and demand for these cylinders is likely to increase?

Answer:

EPA's Office of Research and Development (ORD) is concerned about the availability of standards, and has instituted three new programs in the last year to make high quality standards readily available.

(1) The first is a quality assurance program for the suppliers of protocol gases. The results of these checks on the certification accuracy and documentation completeness of certified protocol gases obtained from the suppliers of these gases are available on the AMTIC bulletin board system (BBS). For instructions on accessing this information on the AMTIC BBS, contact Ed Hanks at (919) 541-5475.

(2) EPA is also working with NIST to improve the availability of NO SRMs. Two new programs have been started at NIST to supplement the SRM program. Copies of papers presented at the EPA and Air & Waste Management Association (A&WMA) Conference in Durham describing these programs are available by calling Bill Mitchell at (919) 541-2769.

(3) Finally, the NO certification accuracy of 8 vendors for a 50 ppm NO cylinder was checked in January 1993. All 8 vendors were able to get within ± 2 percent of the certified value that is specified for protocol gases. EPA hopes to make high quality gases available through the protocol gas program. By revising the guidance (procedures for establishing traceability of gas mixtures to NIST SRMs), EPA hopes to make it simpler and easier for the vendors to provide these gases, which should be more readily available, more accurate, and less expensive than SRM gases. (Note: This guidance was issued in revised form in October 1993. Copies were sent to all suppliers of protocol gases.)

Question:

What concentration ranges of SRMs and CRMs are available for propane and benzene?

Answer:

A 3 ppm concentration level is used for propane and a 0.2 ppm concentration level is used for benzene; each of them is adequate.

Question:

If methane can be detected, should it be reported or ignored? If this information is important for modeling purposes, should some subset of the PAMS sites monitor methane on a routine basis?

Answer:

Although methane has a rather high concentration (the background level is about 1.6 ppm), the hydroxyl radical (OH) reaction with methane is slow (about 1,000 to 10,000 times slower than most VOC). That being the case, very little ozone is produced in those systems when NO_x is added. Although it is important when talking about tropospheric ozone (that is, background ozone), in general, methane is not considered because it contributes very little to ozone formation in urban situations; therefore, EPA has not been concerned with monitoring it.

Question:

Where can part per billion level certified VOC standards be purchased for calibrating automated GCs, and at what cost?

Answer:

NIST sells an SRM containing about 18 compounds, 6 to 8 of which are PAMS compounds that are also toxic organics. The standard sells for about \$11,000. It is certified to within 10 percent, and concentrations are about 5 ppbV. No specific NIST SRM is currently available for the PAMS hydrocarbon mixture.

Scott Specialty Gases and Alpha Gas have also made high quality PAMS mixtures. The retention time standards that EPA is supplying to agencies were bought from Scott. Mantech is going to certify these mixtures for propane and for a second compound using NIST SRMs; that second compound may be benzene or toluene. Certified mixtures are available from several suppliers including Scott and Alpha Gas. Perhaps the retention time standards along with the certification that could be given for the values on the standards, and the proficiency sample testing results, will provide adequate information.

Calibrated standards can be purchased from Scott Specialty Gases for \$5,000 to \$7,000, depending on the desired certification. However, the desired certification may not necessarily agree with what is being used as a reference for PAMS, and that would have

to be taken into account. The particular mixture purchased would have to be somehow referenced back to the standard being used for PAMS. That is an important consideration when buying calibration standards "on the outside."

Question:

Will VOC gas mixtures need to be diluted when added to canisters? What concentration will the tanks contain? Will EPA have a proficiency program in 1993?

Answer:

All compounds in the retention time standard cylinders will be at 30 ppbC concentration and will not require dilution. A proficiency program was begun in 1993. EPA has a new gas transfer system that allows stock gases to be put into smaller cylinders and pressurized to the pressure needed to obtain a specified volume. Stability tests have been started to make sure that the PAMS compounds are stable in the compressed gas cylinders.

Question:

Will the VOC performance audit gases be humidified by an external system?

Answer:

Note that these are proficiency samples, not audit samples. To answer the question directly, these mixtures will not be humidified initially, because the effect of humidity on a mixture that might be pressurized to 1000 psi is unknown. However, the possible effect is to be studied.

Question:

Based on past experience, what level of comparability do you expect to see for VOC and carbonyls (a) within a monitoring organization, and (b) between monitoring organizations?

Answer:

It has been EPA's experience that at low concentration levels, monitoring organizations can disagree by more than a factor of two. At concentration levels that can be measured quantitatively, comparability improves to 10 to 25 percent. It is generally the case that agreement between monitoring groups within an organization is better than that between organizations.

Question:

In the past, where has the variability among organizations been most likely to occur?

Answer:

The differences among organizations have generally been at the analytical level. Great differences were not found when different organizations conducted the sampling but sent

the samples to the same laboratory. This is probably because the organizations are already proficient in the technique of setting timers, doing automated sampling, and other tasks associated with sampling.

Question:

What will EPA be doing to quality assure the performance of those commercial laboratories performing analyses for States?

Answer:

For some EPA Regions (such as Regions I, II, and III) this is hypothetical, but other Regions may have different plans or experiences with the use of commercial laboratories. If commercial laboratories get more involved, EPA will expand and support regional efforts to the States to enable them to perform adequate quality assurance oversight, whether this involves performance evaluations, monitor collocations, etc. EPA will work with the States to ensure that they have the capacity to do the proper quality assurance oversight.

Question:

For carbonyl proficiency studies, will AREAL use tubes supplied by each agency?

Answer:

Yes. The tubes are to be prepared by each agency and sent to AREAL. For proficiency testing, representative tubes (*i.e.*, tubes that represent the cleanup and extraction procedures that the agency would use) have to be provided. Tubes provided from AREAL's own inventory would not necessarily reflect the agency's proficiency at recovering aldehydes.

The details still need to be worked out. EPA Regional Offices have been contacted and are aware that some procedures will have to be developed for making these tubes available to AREAL to spike on a routine basis. Only a limited number of agencies are expected to start sampling for aldehydes on a regular basis in the first few months of summer. The majority of agencies contacted will not conduct carbonyl sampling before the summer of 1994, giving AREAL time to develop these materials.

Question:

What about the effects of different flow rates used by the agencies?

Answer:

If an agency uses a different flow rate than the standard, it should show up at some point in the proficiency samples. In general, proficiency samples do not have to be checked for flow because they are going to be recovered as an analytical sample. The details still need to be worked out.

Question:

During previous National Performance Audit Program (NPAP) audits conducted against our standard reference photometer (NIST SRP) for ozone, changes have been observed in the ozone output from the TECO 165 of as much as 38 percent. Does the new TECO 175 have the capability to monitor line voltage, which seems to be the major concern?

Answer:

The TECO 175 will not have the capability to monitor line voltage. The first version of the TECO 165, which was pilot tested in 1990-91 and first used in 1992, had some problems with circuit boards that were not adequately stabilized, and some breaks in solder. EPA has not seen this 30 percent difference in its own laboratory. Generally, results are repeatable within ± 2 percent on a daily basis. (EPA will check into that 30 percent difference to see what caused it.) AREAL keeps a record of every problem and how it was solved, along with a logbook of equipment maintenance. EPA has adjusted its certification procedures as it has found problems. The 175 has essentially the same circuitry as the 165 now does, and EPA is putting it through acceptance testing.

MODELING AND METEOROLOGICAL MONITORING

Question:

The PAMS regulation requires intensive monitoring at one site, starting in the summer of 1994. This will provide some limited data by the end of 1994; the PAMS data will increase in future years. Since modeling for the 1994 nonattainment plans must be completed in late 1993 or early 1994, how will the PAMS data help air pollution control agencies make control measure evaluations and decisions, and perform attainment demonstrations for the 1994 nonattainment plans?

Answer:

The modeling must be completed by November 1994. Obviously, the PAMS data are not going to be on-line to assist in that modeling process for either the model inputs or for evaluating model performance for the base case. However, the PAMS data that come on-line from 1994 throughout the next several years will be useful for tracking model performance over time for the future. Certain assumptions about control strategies and the PAMS data will be used to track how well the model predicts future events. In short, the PAMS data at this time will not complement the upcoming modeling; however, the PAMS data will be very useful for future interim modeling.

Question:

When using the Urban Airshed Model (UAM) to predict future ozone concentrations, is the worst case or average used for the weather input? How is the prediction of the weather made for a given time period? What weather parameters are used (*i.e.*, temperature, humidity, etc.)?

Answer:

An underlying assumption in the regulatory modeling approach is that historical meteorological episodes will repeat themselves in the future. When applying the model to future years, such as projections to the year 1999 or 2005, the same meteorological inputs (from actual meteorological data) in the base case are used, adjusting emissions and boundary conditions to reflect, as much as possible, the future year scenario. These meteorological fields are usually obtained from National Weather Service data and include 3-dimensional wind fields, wind speed and wind direction, temperature fields, mixing heights, atmospheric pressure, relative humidity, and some other variables.

EPA guidance requires that the most severe ozone episodes from the last several years of data available, roughly the late 1980s and early 1990s, be considered for the modeling process. The following factors are generally considered when selecting episodes to model: the severity of the ozone episode in terms of maximum ozone, the persistence of ozone during the period of interest, and the likelihood that the episode meteorology will recur.

Question:

How important are actual NO_y measurements for the UAM and other models? Is some confirmatory monitoring necessary or are default values for NO_y available for the model?

Answer:

NO_y data are useful in drawing inferences about the types of control strategies that might be beneficial, and in determining whether an area is NO_x or hydrocarbon limited. To a certain extent, the model is capable of adding up the number of the oxidized nitrogen species and determining roughly what the NO_y simulated values would be since NO_y is an accumulation of many of the oxidized nitrogen species (*e.g.*, nitric acid, PAN, and NO_x). Since some of the emerging ambient techniques (*e.g.*, incremental emission rate algorithms, smog production algorithms, "Airtrak mechanism," etc.) rely heavily on nitrogen measurements, it becomes important to be able to separate NO_y and NO when using these ambient measurements. NO_y is useful in the overall context of model application because it represents a cumulative group of species that can indicate model performance.

Question:

Given the different UAM data needs for areas with special conditions (for example, the Great Lake environments), how will EPA handle deviations from the basic PAMS program to meet these varied special needs? For example, for the Lake Michigan region, modelers are requesting ozone measurements aloft; will EPA consider a reduction in ground level measurements for VOC so that the available funds can be spent differently? For States and regions which have already collected databases for modeling and have been developing models appropriate for special regions (such as the Lake Michigan Ozone Study), would a reduced VOC sampling program be adequate?

Answer:

It is important to be able to account for what occurs vertically in the model process and the whole atmospheric chemistry process. When considering mass balances for the overall volume of the model, a lot is happening vertically for which little information exists and for which more information is needed. For alternative plans, there are certain minimum requirements which must be met with respect to surface monitoring for a number of purposes beyond modeling. In addition to modeling, PAMS data are crucial for tracking emission trends and the success of control implementation programs. The ability of the PAMS programs to accomplish these objectives must not be jeopardized by tradeoffs for modeling purposes.

Question:

How can the Chemical Mass Balance (CMB) be used since VOC react in the atmosphere over time, creating secondary products?

Answer:

The fitting species must be restricted to relatively stable species whose reaction rates are slow (*i.e.*, species which do not transform appreciably in 10 hours or so, or a large fraction of a full day), a small subset of the VOC that have been targeted.

Question:

The CMB type of receptor modeling seems to require a lot of ambient data. Will there be enough data generated by a PAMS station to be able to use the CMB model approach?

Answer:

There are two aspects to how the data are used. If the source profiles are already available, then the CMB approach can be used for a single sample and provide an estimate of what sources are contributing to the measured VOC. However, large quantities of data are required to extract source profiles from the ambient data. Several hundred individual measurements are estimated to be required to perform this data-intensive, multivariate procedure. If one is willing to use profiles compiled by others (and more accurate profiles are likely to be obtained as the PAMS network goes on), then data requirements become small. Only in the initial stages, while trying to construct these reliable profiles, are large amounts of data necessary.

Question:

What has to be done to adapt the CMB-7 program for receptor modeling of VOC data instead of aerosol data?

Answer:

The CMB-7 program was originally used for aerosol data, and all the documentation references this application, but it is perfectly adaptable to VOC simply by changing what is specified in the input. No changes to the internal workings of the program are necessary.

Question:

Would it be wise to conduct source receptor analyses periodically to see how the inventory is changing over time as the control program reduces ozone precursors over time? Should source receptor analyses be conducted before and after the fuel reformulation program?

Answer:

Yes to both of those questions. The PAMS network will accumulate data over several years to track the relative contributions of the source categories that can be quantified over time.

Question:

What about receptor modeling for sources other than those that are vehicle-related (such as tailpipe emissions and gasoline evaporation)?

Answer:

Vehicle-related sources probably represent the majority of the VOC in the atmosphere in any urban center. There are other sources that can be quantified such as industrial solvent sources or leakage of natural gas in areas where natural gas is used. Biogenic emissions is another source which many feel is important. There has been lots of discussion in the past few years suggesting that the biogenic contribution of VOC has been underestimated in comparison to anthropogenic sources. The difficulty in quantifying the biogenic contribution by the CMB approach is that stable VOC must be included in a given source to make the CMB procedure reliable. Practically all species that would be connected with a biogenic source (*e.g.*, isoprene and α - and β -pinene) are very rapidly reacting species. Thus, there is no acceptable way of treating biogenic emissions through the CMB approach. Work is in progress to assess the biogenic contribution by using carbon-14 dating techniques.

Question:

Urban receptor modeling has previously used data for hydrocarbons and halogenated species to quantify urban sources. Will the hydrocarbon species measured at PAMS sites be sufficient to quantify urban sources?

Answer:

With receptor models, sites should be located all over the city, with definitive speciation available anywhere there is likely to be a source to be quantified. The receptor modeling technique is currently being applied to ambient VOC species with the intent of apportioning the sources of VOC among the various sources in the city. In addition, receptor modeling is being combined with a "hybrid" dispersion model to estimate emission rates from a given source and then to compare rate estimates directly with emission inventory information. EPA is very excited about this application of the speciated data.

Question:

Where can one obtain the most recent copy of the photochemical grid model domain for the areas to be included in a given network design?

Answer:

Ellen Baldrige of the Source Receptor Analysis Branch is responsible for tracking all of the UAM applications and recording all the domain coordinates throughout the country; she can be contacted at (919) 541-5684.

Question:

Is on-site meteorological monitoring necessary if nearby National Weather Service (NWS) data are available?

Answer:

The PAMS regulations require that surface monitoring be representative of the PAMS site itself, and that upper air monitoring be representative of the MSA being monitored. If NWS data are complete and provide one of those representativeness options then those data may be satisfactory for either a PAMS surface monitoring site or for the upper air station for the MSA. EPA will consider each proposal on a case-by-case basis to ensure that NWS data are representative.

Question:

Do the meteorological data need to be collected at the monitoring site itself?

Answer:

According to the regulation, meteorological data must be collected with the monitoring data. However, it depends on whether it is a big urban area or a small urban area, as well as on the complexity of the area. Where the distance between the monitor Site No. 1 and Site No. 4 is within 100 miles and the terrain is not complex, the difference in meteorological measurements is very small. In such situations, one might be able to use the local weather service meteorological data. On the other hand, if there is complex terrain or blocking by physical obstructions, collocated monitoring would be necessary in order to accurately depict the meteorological data at the monitoring sites.

Question:

For No. 2 sites, why can't mini-Sodar systems be used instead of the 10-meter tower? Good wind speed and wind direction data in the range of 10 to 200 meters can be collected with these Sodar systems.

Answer:

The No. 2 sites are typically located immediately downwind of downtown areas or other areas of maximum VOC concentrations. Siting a Sodar downtown causes problems with noise interference from cars and planes. There is no problem with using a Sodar if it is sited properly to eliminate a lot of the noise. If a Sodar is located on top of a building, however, it will be several tens of meters above ground level. In addition, Sodar and Rass systems emit irritating sounds and, thus, cannot be sited in residential areas.

Question:

Is a mini-Sodar system less expensive than a regular Sodar system?

Answer:

A mini-Sodar system typically costs \$12,000 compared to a regular Sodar which costs \$50,000 to \$100,000. The problem with mini-Sodar systems is that they only go up to about 200 meters while the mixing height can vary from near ground level to 2 kilometers. The mini-Sodar provides very good wind structure near the ground and is valuable for calculating maximum concentrations which typically occur when the boundary layers are near the surface. However, some data will be missed using the mini-Sodar alone. Thus, both systems should be purchased, using the mini-Sodar to get the lower winds and the regular Sodar or Rass system to get the upper winds.

Question:

How many low level and upper level meteorological stations are required for a typical PAMS area?

Answer:

A 10-meter meteorological tower at every PAMS station and a minimum of one upper air radar sodar profiler in every city is recommended.

Question:

Why are temperature measurements indicated at the 2 and 10 meter levels of the 10-meter meteorological tower?

Answer:

The two height requirement was included because that information is needed for the model. The configuration of 2 and 10 meters gives a lot of information for calculating mixing heights using equations instead of using a Sodar or Rass system and will permit checks that the Sodar or Rass system is working properly. Boundary layer conditions (*i.e.*, temperature, relative humidity) at the surface and at the mixing height are needed for the model.

Question:

Is temperature accuracy 0.1 or 0.01°C?

Answer:

With the delta T approach, the best temperature accuracy that can be expected with a 10-meter tower is about 0.2°C. EPA guidance is being updated to include this and other new technology.

Question:

What time (daylight or standard) should be used for meteorological data?

Answer:

For VOC, carbonyl, and criteria pollutant sampling, local time should be used in developing wind roses and summarizing other meteorological data. Data should, however, be reported to AIRS in local standard time.

Question:

In volume IV of the *Quality Assurance Handbook for Air Pollution Measurement Systems*, the problems of siting meteorological towers in urban environments are not addressed. In the future updated version of this quality assurance handbook, will EPA address the urban meteorological No. 2 sites?

Answer:

EPA is in the process of gathering information on meteorological equipment and what must be done regarding quality assurance. Volume IV deals mainly with the installation and calibration of meteorological towers located for rural monitoring networks. Obviously, siting a meteorological tower in an urban area is more complicated. Volume IV will be revised to address the PAMS meteorological situation and the problems of siting meteorological towers in urban environments.

Question:

Has the 915 megahertz wavelength been included by the FCC?

Answer:

The 915 megahertz wavelength has been cleared by the FCC. Efforts are being made to get several more frequencies cleared.

Question:

Why are temperatures measured at 2 meters?

Answer:

They are needed to determine "delta," which is the temperature difference between 2 and 10 meters which is used to infer stability near the surface. That has been used to aid in processing the Pasquill stability curve, estimating which one to use along with the solar radiation measurements. As the solar technology advances, we are hoping to eliminate that sort of instrumentation completely if we can measure the mixing height accurately.

DATA ANALYSIS

Question:

A day of the week versus ozone dependence has been noted in our data. Are there other researchers or studies with similar results?

Answer:

In the 1970s, analyses were done using data from Los Angeles which compared weekends to weekdays, and higher ozone concentrations were noted on Sundays in some locations.

This type of analysis will be possible with PAMS data to provide insight into the potential benefits of VOC versus NO_x control strategies, for example, by looking at ozone and NO_x levels on the weekends versus weekdays.

In some of the air quality trends analysis work involving meteorology, a variable has been included to account for weekend versus weekday differences. Very distinct patterns can be seen in terms of the weekend effect, depending on the geographic area when looking at a number of urban areas. There is no question that such an indicator would be used in future analysis involving PAMS data, and perhaps even in looking at the national ozone network, which is in place and has a large database.

There have been some studies where monitoring was only conducted on the weekdays as an economy measure. As soon as one considers a day-of-the-week effect or weekend/weekday differences, monitoring must occur every day of the week.

Question:

What is the biggest problem in trends analysis?

Answer:

In terms of ozone, the biggest problem in trends analysis is clearly the confounding effect of meteorology. For example, east of the Mississippi between 1987 and 1988, ozone levels in many areas increased an average of 10 percent, although emissions did not actually change that much. One of the challenges in trends analysis is how to remove, or at least reduce, the effect of meteorology on ozone levels. Some of the work that EPA has done looks promising, in terms of attempting to remove the effect of meteorology. Another possibility is that precursors, particularly in early morning hours or times when there is greater stability, are not going to be as influenced by meteorology as ozone levels. Therefore, PAMS data may be used to gain more insight into trends, and to help eliminate or at least qualitatively eliminate some of the effects of meteorology.

Question:

Why was the use of specific techniques for data analysis not required?

Answer:

A prescribed approach might drive analysis efforts to the lowest common denominator. The PAMS network data are going to be a veritable gold mine of information. The data must be analyzed with the best and most sophisticated tools available to get the most out of the data. The hope is that by not requiring specific techniques, creativity will be encouraged and innovative approaches will be used. Obviously, a minimum or standardized set of analyses may evolve over time, but for right now, the current approach seems to be most reasonable.

Question:

Can standard statistical approaches, such as regression analysis, be used?

Answer:

Standard statistical techniques would be acceptable in some cases. Exploratory techniques provide more insight into the data and help to get more out of the data initially. The problem with linear regression is that it assumes a linear dependence on the independent variables which may not be appropriate for complex photochemical relationships. There is no consistent linear trend in ozone data over time, particularly in the 1980s; it is a mix of good and bad years. For the EPA trends report, a classic statistical approach, more like general linear models, is used in which a year effect term is fit into the trend display as a better way of determining trends.

Question:

What statistics should be considered for determining VOC trends?

Answer:

The morning traffic peak (6:00 a.m. to 9:00 a.m.), on high ozone days, as well as other days, should be considered for determining VOC trends.

Question:

How should trends be adjusted for meteorology?

Answer:

Work has been done involving adjusting ozone for meteorological influences. The techniques, which have been documented and are available to interested agencies, could be adapted and applied to adjusting trends in VOC and VOC species. It is not clear whether the same success rate achieved with ozone can be achieved for VOC. Obviously, there will not be enough data for 2 to 6 years to make meaningful adjustments to annual trends; nevertheless, this is a worthwhile option to consider. By using some of the

exploratory data analysis techniques that have been talked about, the basic relationships between meteorology and some of these VOC species can begin to be investigated, with the idea that those relationships could be used to make the adjustments in the VOC trends, giving a more precise, less biased estimate of those trends.

Question:

Please describe the SAS package used in the demonstration. In particular, what is required to run it and where is it available?

Answer:

The SAS package, **Insight**, runs on a variety of platforms, including Avion and General workstations, and some SPARC workstations. It is also available on a PC platform with a minimum number of megabytes in size. The EPA has a contract with the SAS Institute to acquire SAS products. To acquire software through that contract, contact Ron Scarborough at (919) 541-1369. For more specific information about SAS products, contact the SAS Institute in Cary, NC at (919) 677-8000.

Question:

Exploratory data analysis can provide insight into the data. How long does it take to learn the exploratory data analysis methods that SAS **Insight** offers? Are there any other software packages that could be used besides SAS **Insight**?

Answer:

Based on personal experience, it took about 1-1½ months to become reasonably proficient at using that database and package. It is a very easy interface to use and a very easy tool with which to become proficient fairly quickly.

Other software packages could also be used for these analyses. One possibility would be **S-Plus**, manufactured by Stat-Sci in Seattle, Washington. This package has many of the features that SAS **Insight** has; however, **S-Plus** is more of a programming language and the learning curve for that package would be somewhat higher. **S-Plus** and other similar packages offer the same kind of functionality available with **Insight**, and certainly could also be considered.

AIRS AND PAMS

Question:

Describe the hardware and software requirements necessary to access AIRS Graphics via a PC-based system, and the status of the AIRS Graphics access for direct AIRS users. Will separate screening files be required for loading the PAMS data onto NCC AIRS?

Answer:

To access AIRS Graphics, a graphics terminal and graphics interpretation card are needed on your PC. You can then call via modem to the NCC mainframe. In order to access AIRS Graphics, a valid time sharing option (TSO) NCC user ID is needed.

The easiest and most popular way to access AIRS is to sign on through TSO. At the TSO ready prompt from the NCC mainframe, type in AIRSG (one word) to log directly into AIRS Graphics. Another way to log into AIRS Graphics is by typing the command AIRSX at the NCC main menu. A third way to access AIRS Graphics is directly through the AIRS main menu screen.

Separate files are not needed to submit PAMS data into the AIRS Air Quality Subsystem (AQS). The PAMS data can be entered into AIRS just like any other data. Regions may, but are not required to, build new screen files specifically to handle PAMS data. To set up a new screen file, contact Gary Wilder, NADB, at (919) 541-5447.

Question:

Is it possible to download an AIRS Graphic file using the phone line and modem? If so, how?

Answer:

It is possible to download any TSO file through a modem and telephone line. Contact Tom Link, NADB, at (919) 541-5456 for specifics on downloading AIRS files.

Question:

Is the AIRS Graphics package available as separate software for use on a PC? If yes, how can it be obtained? Is it available through EPA's BBS?

Answer:

There is not a PC-version of AIRS Graphics. A software program called AIRS Executive is available, however. AIRS Executive is a managerial tool that houses canned data and prints a variety of fixed preset reports (for example, top 30 source emitters for point sources). AIRS Executive is geared more towards point source data, although it does contain some ambient data. For more information, contact Tom Link, NADB, at

(919) 541-5456. [AIRS Executive, along with current data files, may be downloaded from the AIRS BBS, which is part of the OAQPS Technology Transfer Network (TTN).]

Question:

In AIRS Graphics, is there any way to alter the AIRS Graphics, line charts or maps?

Answer:

The line graphs in AIRS Graphics are generated from the raw data listing the AMP 350 work files. The only way to alter AIRS Graphics is to edit what is going into AIRS Graphics (*i.e.*, the TSO data set where the work files for the AMP 350 reside). AIRS Graphics can be exported as metafiles or printed directly at the NCC; manipulation of the graphs, maps, or charts once they have been generated in AIRS Graphics is not possible.

Question:

What types of AIRS reports and AIRS Graphics in AQS are projected to be available in the future for PAMS related data?

Answer:

AIRS has two types of PAMS specific reports: the AMP 225, which is the PAMS network report, and the PAMS raw data summary report, which is currently under development. User input is requested with regard to future types of batch reports both in AIRS Graphics and in AQS. If you have any suggestions on what kinds of AIRS Graphics or AQS would be useful, please contact Jonathan Miller at (919) 541-3330.

Question:

Does AIRS have a method code for a 6-hour sampling period for carbonyls or should the 3-hour method code be used and two identical values be reported?

Answer:

AIRS has the ability to generate new method codes at any time it is deemed appropriate. In this situation, the best thing to do would be to use a separate (new) method code to indicate a 6-hour sampling period to differentiate that from two consecutive 3-hour time periods.

Question:

If the intermittent sampling is collected on local time at one of the PAMS sites, is it appropriate to report that data to AIRS on local standard time?

Answer:

Yes, the time frame used in AIRS is local standard time.

Question:

Since the AIRS reporting format includes parts per billion per unit, can VOC data be submitted as parts per billion volume (ppbV)?

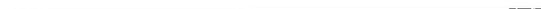
Answer:

Currently, data submitted in ppbV would be accepted; however, it is not the preferred format. It is recommended that data be submitted in parts per billion carbon (ppbC). There is currently discussion as to whether AIRS should have an edit check to screen out data not reported in ppbC.

EPA-454/B-93/051
Appendix E
Revision No. 0
Date: March 1994
Page E-1

APPENDIX E

**UPDATED ESTIMATED CANCER INCIDENCE
FOR SELECTED TOXIC AIR POLLUTANTS**



Updated Estimated Cancer Incidence For Selected
Toxic Air Pollutants Based on Ambient Air Pollution Data

Robert B. Faoro, Thomas C. Curran and
William F. Hunt, Jr.

U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Technical Support Division
Monitoring and Reports Branch
Research Triangle Park, North Carolina 27711

August 1989

Acknowledgment

The authors would like to acknowledge the technical support they received from Alison Pollack and Belle Hudischewskyj of Systems Applications Inc., J. J. Wind of American Management Systems, John Bachmann, Larry Cupitt, Fred Dimmick, Tom Lahre, and Joe Padgett of EPA and finally Helen Hinton of EPA for the typing and retyping of this report.

UPDATED ESTIMATED CANCER INCIDENCE FOR SELECTED TOXIC
AIR POLLUTANTS BASED ON AMBIENT AIR POLLUTION DATA

1. INTRODUCTION

In 1985 a major study assessed the cancer risks from selected air toxics in the United States.¹ The use of ambient air toxic data to determine these risks was a major portion of the overall air toxic assessment.² This report is an update to the 1985 study and it estimates individual cancer risk and number of cancer cases or incidence for three major classes of air toxics: the volatile organic compounds (VOC), trace metals, and benzo(a)pyrene (BaP), the last belonging to the large class of pollutants called the products of incomplete combustion (PIC). The VOC data have been obtained from either the updated National Ambient Volatile Organic Compound Data Base³ or the Interim Data Base for State and Local Air Toxic Volatile Organic Chemical Measurements⁴ The trace metal data were obtained from the National Aerometric Data Bank's new Aerometric Information Retrieval System⁵ (AIRS) while the benzo(a)pyrene data came from U.S. Environmental Protection Agency's (EPA) Atmospheric Research and Exposure Assessment Laboratory⁶ (AREAL).

This report is organized basically into three sections: estimated national cancer incidence for trace metals and BaP; estimated national incidence for VOC; and lifetime additive and highest observed individual risks. Cancer incidence are determined with unit risk values currently used by EPA in analyses of cancer risks associated with air toxic pollutants.⁷ Table 1 presents the 28 pollutants which are thought to be present in the ambient air in sufficient quantities to pose a cancer risk to the general population. Also included are the current risk values and those used in the previous study. Of the 15 pollutants considered in both studies, ten had

changes in their unit risk values. Beryllium showed the largest difference for these pollutants with the unit risk value increasing from 4.0×10^{-4} to 2.4×10^{-3} a six-fold increase. However, 1,3 butadiene, which was not considered in the previous study because ambient data was not available; shows the largest difference in unit risk values changing from 4.6×10^{-7} to a current value of 2.8×10^{-4} .

The number of estimated cancer cases or incidence is found by applying a factor which represents the chance of contracting cancer if an individual is exposed to a concentration of $1 \mu\text{g}/\text{m}^3$ of a toxic pollutant for 70 years (lifetime). This factor is called the unit risk. Generally, the unit risk value represents the probability of cancer cases, not deaths. However, since the epidemiological studies that generated the potency number for PIC (products of incomplete combustion) are based on lung cancer mortality, the PIC estimates used in this study imply lung cancer deaths. The potency factors or unit risk values represent plausible upper bounds -- i.e. they are unlikely to be higher, and could be substantially lower. As will be seen later the estimation of incidence for all pollutants will be the product of three numbers: 1) the unit risk, 2) an estimate of exposure usually an average of annual averages across some geographical area, and 3) the exposed population of the geographical area. The size of the geographical area for which incidence are estimated will vary depending upon the number of estimates of exposures represented by the available ambient data. In this study, incidence for the trace metals are estimated on a county basis while for the VOCs, because of the much smaller data base, incidence estimates could only be determined for the urban and non-urban segments of the National population.

In the 1985 study, national incidence derived from ambient data were estimated for 16 pollutants, while highest observed individual lifetime risks were calculated for 21 pollutants. Also the additive lifetime individual risks were estimated by summing together lifetime individual risks for metals, BaP, PIC and VOC. These additive lifetime risks were estimated at two monitoring locations, generally those with the highest pollutant levels, in each of four metropolitan areas. Similar types of analysis will be shown in this updated study, which addresses all of the pollutants shown in Table 1; except as noted there.

2. OBJECTIVE

The objective of this report is to utilize available ambient monitoring data for air toxics to present estimates of: national cancer incidence; additive individual lifetime risks in metropolitan areas, where possible; and highest observed individual lifetime risks for as many pollutants as possible.

3. DEVELOPING NATIONAL INCIDENCE ESTIMATES FOR TRACE METALS, BENZO(A)PYRENE, AND VOLATILE ORGANIC COMPOUNDS

The following discusses how National estimates of incidence using ambient data for selected trace metals BaP, and the VOCs are developed. Five trace metals are considered: arsenic, beryllium, cadmium, chromium, and nickel. The ambient data available for these pollutants pose a problem when national estimates are to be developed. The available ambient data is always inadequate for the purpose of defining true population exposure especially that portion of the population receiving the highest dose. The aim here is to derive reasonable estimates of typical exposures in terms of long-term averages. The number of monitoring sites and their geographic coverage for

the trace metals make it more feasible to attempt estimations for the trace metals than for volatile organic compounds. However, a major problem with the trace metal data is that ambient chromium and nickel concentrations reflect the total of all particulate species, while only specific species like chromium +6 and nickel subsulfide are thought to be carcinogenic. The available ambient data for volatile organic compounds are typically the results of short term special studies in selected areas. In contrast hi-vol filters from the old National Air Surveillance Network (NASN) going back to the early 1960s were routinely analyzed for certain metals. This original network and the continued operation of some of these sites over the years provide a data base that reflects year-round monitoring efforts and minimizes the effect of seasonality on the estimates of annual averages.

For the most part, these NASN sites were located in the center city business area. In developing these national estimates, two different geographical extrapolations are made. The first assumes that monitoring data from a specific site or sites are representative of concentrations over as broad a geographical area, as a county. The second involves estimating the average concentrations for those counties with no monitoring data. Although obviously legitimate concerns may be raised about both of these steps, this discussion attempts not to assess the potential error in estimates resulting from these extrapolations but merely to provide some perspective on the assumptions.

Beryllium and nickel are often associated with fuel combustion emissions, primarily from coal.⁸ Cadmium and chromium are more closely associated with industrial uses, such as making steel or other alloys or

fabricating them into end products.⁸ Arsenic emissions are associated with industry (e.g. primary copper smelters) and also with pesticide use.⁹ BaP emissions are primarily associated with the emissions from coke ovens.¹⁰ In recent years, wood burning has become a major source of BaP in some areas, but a national data base is not available to measure this source. With these emission sources involved, it is possible that a center city site could either over- or underestimate long term average exposure for a county.

3.1 METHODOLOGY FOR TRACE METALS AND BaP

The methodology used in developing these national estimates is discussed in terms of the various steps involved: data base selection, estimated county averages, and estimation of concentrations for counties without data.

Ambient air quality data from AIRS was used for the five trace metals, while the BaP data came from AREAL. For the trace metals, all annual averages with at least 20 daily values from 1985 to 1986 were used, because they represent the latest and best estimates of ambient concentrations. The BaP data used were from 1986 and 1987 since earlier data (1982-85) which were to be used were found to have a positive bias because of some unknown contamination. Annual averages were used if there were a minimum of twenty 24-hour samples. 1986 and 1987 BaP levels were higher (1.0 ng/m^3 vs. 0.3 ng/m^3) than those reported in 1977-80 but significantly lower than 1981-82 levels. The 1985 study on BaP and PIC incidences used data from the 1977-82 period.

For the trace metals, the valid annual averages for each site were averaged for all available years (1985-86). Then the average of all sites in a county was computed to determine a county wide air quality value. As

discussed earlier, this temporal and spatial average estimate is assumed to represent the average for the county. The methodology used for BaP was similar to that used for the trace metals but because of the relative sparseness of the BaP data a larger geographic area than counties was used.

Two different approaches were used to extrapolate to counties without data in order to compute national estimates. The approach used for the metals and that used for BaP differ because of the sparseness of the available BaP data and the apparent BaP network emphasis on eastern industrial areas.

The approach used to estimate county average concentrations for the trace metals also differs slightly from that used in the 1985 study. The earlier study used available ambient data to extrapolate to those counties without data. Because of observed differences in ambient levels for some of the trace metals, the data from the counties with data were categorized in one of four ways. The counties with data were categorized as being from either "smelter" or "non-smelter", "Texas", or "non-Texas" counties. This resulted in four categories of county averages from which composite averages were computed. Those counties without data were classified by the same scheme and the appropriate average from those counties with data was assumed to apply. As a refinement this study used estimated county trace metal emissions categories for those counties with data to extrapolate to the counties without ambient data. It is assumed that the relationship between ambient trace metal concentrations and emissions in those counties with ambient monitoring results is the same for the counties without ambient data. All annual averages satisfying the minimum data completeness criteria stated above were categorized into six emission strength classes based on the estimated county

emissions. The composite average concentration was then computed for each of the emission classes. For counties without ambient data, the composite average for the emission class corresponding to the estimated county emissions was then used to represent average trace metal concentrations.

In summary, the estimate of the county trace metal average was obtained from either monitored data, if available, or from the averages based on the estimated trace metal emissions for the counties not having ambient monitoring results. These average county concentration estimates were then used with the unit risk and county population figures to estimate cancer incidence. After either the observed or estimated average concentration was assigned to each county, the incidence was computed for each county by multiplying the average ambient concentration by the unit risk and population, and then dividing by 70 years in order to present the incidence on an annual basis. The national incidence estimate was obtained by summing over all counties in the country. County emission estimates for the trace metals were obtained by applying speciation factors to total emissions (area + point sources) of particulates from the most recent (1985) National Emission Data System (NEDS) summary.^{11,12} The speciation factors used here also represent the latest estimates.¹³

Special efforts were made to extrapolate BaP exposures for the entire country. In this study, BaP is considered not only as a carcinogen but also as a surrogate for a wide variety of air pollutants, produced by incomplete combustion of fossil fuels. The national data base for BaP is much less extensive than for the metals, and most of the network is concentrated in eastern industrial areas. Seventy-seven site-years of data from 35 counties, having at least twenty observations in 1986 or 1987 are included in this analysis, and 23 of the site-years were from sites west of the Mississippi

River. Fortunately, the BaP sites represent many of the largest urban areas in the country, e.g. New York City, Los Angeles, and Chicago.

To avoid assuming that this data base is representative of the nation, and to avoid the other extreme of assuming that there is no BaP problem in areas without data, a compromise approach was developed to attempt to make the best use of the limited available data. The basic approach was to divide the nation into broad geographical areas patterned after the U.S. Census Division and Regions. Because BaP levels would likely be higher in colder climates, some of these areas were further subdivided into the 11 areas shown in Figure 1. This was also done for convenience to make use of census data for these 11 regions. Within each, urban and rural populations were determined, as well as urban and rural BaP annual averages for 1986, which are also shown in Figure 1.

Ten of the 11 regions had BaP data in the urban areas. Region III (Florida) had no BaP data, so the urban area BaP average for the adjacent Region II is used to represent Florida.

Current BaP data were not available for any nonurban site. Consequently, nonurban BaP averages from the earlier study are used. The reader should consult the earlier study for details on how the nonurban averages were obtained.

Once these air quality values were determined, the incidence was determined for each of the 11 geographical areas, for both urban and nonurban segments of the population, and then the total incidence computed as the sum of the individual area incidence.

3.2 Methodology for the Volatile Organic Compounds

Because of the sparsity of available VOC data, only a limited number of metropolitan areas had air pollution data which satisfied the completeness criteria of any site having a minimum of 5 observations in one quarter and at least 10 observations for the year. The VOC data used in this analysis represents primarily the years 1985-1987; however, in a few cases earlier data (1980-83) was used. The California VOC data generally is from 1986 and 1987. Other criteria requiring more complete data essentially limited the data available for analysis to the California sites and thereby it would have been difficult to extrapolate these data to the entire nation. It is recognized that this criteria could include sites with an imbalanced representation of samples throughout the year and could result in biased annual averages where the data exhibit a seasonal pattern. This criterion is used to maximize the number of valid sites, thence the geographic coverage of the available VOC data. It is consistent with the approach used in the previous study.

The urban areas with VOC data satisfying all the criteria varied from four areas for styrene to 43 areas for benzene. Table 2 shows the urban areas represented for each of the VOCs with data. Several pollutants having unit risk values did not have any data on which to make an assessment. These pollutants include: acetaldehyde; acrylonitrile; asbestos; epichlorodhydrin; ethylene oxide; hexachlorobenzene; propylene oxide; and 2,3,7,8-tetrachlorodibenzo-p-dioxin. Metropolitan area population figures were used to calculate a population-weighted VOC grand mean concentration across the metropolitan areas represented for each pollutant (Table 3). The VOC grand

mean concentrations are assumed to be the "best" available estimate of urban area VOC concentrations.

The same simple formula used in the earlier study was used to calculate the cancer incidence for the VOC:

$$\text{Cancer Incidence Per Million Population} = r \cdot \left(\frac{\text{VOC}_{\text{UA}} \cdot \text{pop}_{\text{UA}}}{70} + \frac{\text{VOC}_{\text{NUA}} \cdot \text{pop}_{\text{NUA}}}{240} \right)$$

where r = unit risk value

VOC_{UA} = estimated VOC grand mean concentration for urban areas from Table 3.

pop UA = urban area U.S. population (185 million).

VOC_{NUA} = estimated VOC grand mean concentration for nonurban areas from Table 3.

pop NUA = nonurban area population of the U.S. (55 million).

70 = the number of years in a lifetime.

240 = the number of millions of people in the U.S. (used so that the rate can also be expressed as the incidence per million population)

A slight modification in the calculations was made for the following chemicals involving a large number of California areas so that the California data would not be used to characterize non-California: benzene, carbon tetrachloride, chloroform, ethylene dibromide, methylene chloride, tetrachloroethylene, and trichloroethylene. For each of these pollutants, a total of 15 urban California areas are involved. Separate incidences were computed for California and for the remainder of the country, then they were

added together to get the urban contribution, which was then added to the nonurban incidences to derive the incidence total for the nation.

The urban, nonurban and total population estimate of the United States are estimates for 1986 and are taken from the Statistical Abstract of the United States, 1988.¹⁴ The estimated VOC urban and nonurban area grand mean concentrations are shown in Table 3. The nonurban area means are calculated for all remote and rural sites in Reference 3. Of the 13 VOC areas in Table 3, all had urban area means, and 10 had nonurban area means. For the three VOCs for which there are no nonurban data (formaldehyde, tetrachloroethylene and vinylidene chloride) nonurban averages were obtained from Reference 15.

4. ESTIMATION OF NATIONAL INCIDENCE FOR TRACE METALS, BENZO(A)PYRENE, AND THE VOLATILE ORGANIC COMPOUNDS

The national estimates of incidence for the five trace metals and BaP are shown in Table 4. These rates assume that values less than the minimum detectable limit are equal to 1/2 of the minimum detectable limit, which is a fairly standard practice in air pollution data analysis.¹⁶ A factor of 0.4 was used to adjust the total chromium (Cr) incidences to Cr+6.¹⁷ This factor represents the average of hexavalent to total chromium concentrations estimated from modeling done in five U.S. cities. In subsequent tables, only the estimated chromium +6 incidence are shown. No such factor was available for nickel. The unit risk factor for nickel, 4.8×10^{-4} , shown in the table represents nickel subsulfide. However, because there are no known emissions of nickel subsulfide in the county; the incidence from nickel subsulfide is assumed to be zero. Table 4 also indicates both the extent of coverage of the ambient data (the number of counties with data) and the relative sparseness of

the BaP data. One additional point that should be made concerning BaP is that most of these sites are located to reflect industrial sources of BaP. The current concern with respect to the effect of wood stoves on BaP emissions suggests the existing data base is quite limited, in that monitors generally are not situated in areas with wood smoke problems. Table 5 provides the pollutant specific incidence for the VOCs having both some ambient monitoring data and unit risk values. Some discussion of these incidence will follow in the next two sections.

4.1 National Incidence Totals

National incidence are summarized in Table 6 for all 20 air toxic pollutants considered. The national incidence for trace metals, BaP and PIC and number of incidence per million population are based on the number of incidence from Table 4. Chromium +6 is shown here because it is the species associated with cancer risk. The formaldehyde data are primarily taken from a recent 1987-88 study done in 17 urban areas.¹⁸ The incidence rates for the 10 VOCs were estimated using the formula given in Section 3.2 above. The total incidence for all 20 pollutants was 1924, or approximately 8.0 per million people. Eight pollutants account for over 90 percent of the risk: PIC, formaldehyde, 1,3 butadiene, benzene, chloroform, chromium +6, arsenic, and ethylene dibromide. As discussed below, some caution is necessary in interpreting these results, particularly for 1,3 butadiene.

4.2 Comparison of Previous and Current Cancer Incidence Studies

In the 1985 study, 1562 excess cancer cases, or 6.8 cases per million people, were reported based on a U.S. population estimate of 230 million. This figure represented 16 pollutants, however, the unit risk values for 10 of

these pollutants have since changed. Correcting the earlier incidence figures by using the new unit risk values increases the total incidence rates from 1562 to 1686 cases, or 7.3 per million population. This compares with approximately the same number of cases (1597) and rate per million (6.7) for the current assessment for the pollutants in common. Table 7 compares the incidence in the old and new studies, using the same unit risk numbers. It is indeed quite unexpected that the totals are so close, owing to the many sizeable differences for certain pollutants for example benzene or chloroform. One pollutant, methyl chloride, which accounted for only one incidence, was included in the earlier study but not in the current one because it no longer is on the list of pollutants with unit risk factors. So, for the pollutants in common between the two studies there really is no significant difference in the number of excess cancer cases estimated.

However, as was shown above, the current study estimates 1924 excess cancer cases per year. The main differences between this figure and the 1597 cases based on 16 pollutants are the incidence attributed to 1,3 butadiene (244). In the case of 1,3 butadiene, urban concentration estimates are based solely on 12 urban areas situated in northern California representing such urban areas as: San Francisco, San Jose, and Sacramento. These are the only 1,3 butadiene data representing 24-hour sampling that were available. Using 1,3 butadiene from 20 urban areas which measured 6 to 9 a.m. average concentrations at one monitoring site in the area, the incidence would be much higher (1055). Since 1,3 butadiene is emitted by automobiles, the 6 to 9 a.m. average undoubtedly would overestimate a long term average based on all hours in the day. For example, 6-9 a.m. carbon monoxide concentrations are on the

average 30 percent times higher than levels representing an entire day. Adjusting the 1,3 butadiene in the 20 cities by this factor would result in an incidence of about 800 -- or over three times the estimate using the California data. In the case of vinylidene chloride, the 10 excess case figure is based on ten urban areas. Data from eight of these areas came from a study done in 1980 by Singh et. al.¹⁹ The two other areas included are Sacramento, CA and Charleston (Institute) WV. Two New Jersey areas (Camden and Newark) were excluded from this analysis because their vinylidene chloride levels were more than an order of magnitude higher than the other results. Although there is significant concern about the accuracy of all of the national estimates, it is clear that for 1,3 butadiene and vinylidene chloride, the concern is even greater. In the assessment of ethylene dibromide, a very high annual average of $2.12 \mu\text{g}/\text{m}^3$ was not used because it was more than an order of magnitude larger than the next highest average available. The next largest average was $0.2 \mu\text{g}/\text{m}^3$, while most of the averages were less than $0.1 \mu\text{g}/\text{m}^3$.

5. INDIVIDUAL LIFETIME RISKS

Individual lifetime risks are examined in two ways, as additive individual lifetime risks and as the highest observed individual lifetime risks. Additive multipollutant individual lifetime risks are defined as the sum of lifetime individual risks for metals, BaP, VOC and PIC at a monitoring site within a city where a battery of air toxic pollutants is being monitored. These are summarized in Table 8 for four metropolitan areas, Baton Rouge, Boston, Chicago, and Los Angeles. For the most part, the data shown represent the year given alongside the city name; for the cases footnoted, data from

other years were used. The added individual risks are influenced by the number of pollutants for which there are available data at the given monitoring locations. Note that 1,3 butadiene is not included for any of these cities. Boston had the fewest number of pollutants represented, 11, out of the 20 pollutants investigated. Given the limitations in the available data, it can be seen from Table 8 that additive individual risks on the order of 10^{-4} are not uncommon.

Highest observed individual lifetime risks are calculated for 20 pollutants. The calculations are made by using the simple formula:

$$\begin{array}{l} \text{Highest} \\ \text{Observed} \\ \text{Individual} \\ \text{Lifetime Risk} \end{array} = \begin{array}{l} \text{Highest arithmetic} \\ \text{mean concentration} \\ \text{observed} \end{array} \times \begin{array}{l} \text{Unit} \\ \text{Risk} \end{array}$$

The air pollution data base varies considerably. Table 9 gives the highest observed individual risks for the trace metals and benzo(a)pyrene, including PIC. This risk, based on monitoring data, represents the highest observed risk in the nation. Since monitoring data generally would be expected to underestimate the "true" maximum, these results should be viewed as approximations. Also, generally speaking, the larger the number of sites represented, the better the chances are of hitting the "true" maximum. In this light, the data base for BaP (44 site years) should not provide as good an approximation as the more nearly complete trace metal data. The maximum individual risks range from a low of 1.7×10^{-5} for beryllium to a high of 8.4×10^{-3} for PIC. Arsenic has the next highest risk of 3.9×10^{-4} .

Table 10 gives the highest observed individual lifetime risks for the VOC pollutants studied. Once again, the number of site years of data varies widely, with benzene having the most data (108 site years) and styrene the

least (6 site years). The highest observed individual lifetime risks range from a low of 1.8×10^{-6} for styrene to a high of 3.0×10^{-4} for formaldehyde. Several of the VOC have risks in the 1×10^{-4} to 9.9×10^{-4} range. These include chloroform (2.1×10^{-4}) benzene (1.7×10^{-4}), 1,3 butadiene (1.3×10^{-4}) ethylene dichloride (1.1×10^{-4}), and formaldehyde (3.0×10^{-4}).

6. SUMMARY

The reader is cautioned, when interpreting this information, that the national cancer incidence are based on very spotty VOC and BaP air quality data, as well as on uncertain unit risk factors. In the opinion of the authors of this report, eventually some measure of imprecision in the unit risk rates should be introduced to provide upper and lower bounds to the national cancer incidence rates. It may also be appropriate to view these estimates as only one approach, and to consider the results in the context of estimates obtained from alternative methods.

When interpreting the combined national incidence rate for all 20 pollutants, the reader should keep in mind that all the individual incidence rates are added together, under the assumption that their combined effects are additive. People can be exposed to not one but several of these pollutants simultaneously, and there could be synergistic effects associated with these pollutants which could increase or decrease the national incidence rates.

More and better monitoring data are needed to provide better estimates of the rates of true national cancer incidence due to air toxic pollution. This should be coupled with some measure of uncertainty for the unit risks.

REFERENCES

1. Elaine Haemisegger, et al., The Air Toxics Problem in the United States: An Analysis of Cancer Risks for Selected Pollutants, EPA-450/1-85-001, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1985.
2. William F. Hunt, Jr., et al., Estimated Cancer Incidence Rates for Selected Toxic Air Pollutants Using Ambient Air Pollution Data, Unpublished Report, April 1985.
3. J. J. Shah and E. K. Heyerdahl, National Ambient Volatile Organic Compounds (VOC's) Data Base Update, U. S. Environmental Protection Agency, Atmospheric Sciences Research Laboratory, Research Triangle Park, NC, February 1988.
4. A. Pollack, Systems Applications, Inc., Updated Report on the Interim Data Base for State and Local Air Toxic Volatile Organic Chemical Measurements. Prepared for Robert B. Faoro, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, August 1988.
5. Aerometric Information Retrieval System, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1988.
6. J. Bumgarner, Atmospheric Research and Exposure Assessment Laboratory, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1988.
7. F. S. Hauchman, Memorandum on Air Toxics Unit Risk Estimates, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1988.
8. R. B. Faoro and T. B. McMullen, National Trends in Trace Metals in Ambient Air, 1965-1974, EPA-450/1-77-003, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1977.
9. B. E. Suta, Human Exposures to Atmospheric Arsenic, SRI International, Prepared for A. P. Carlin and J. D. Cirvello, U. S. Environmental Protection Agency, Offices of Research and Development and Air Quality Planning and Standards, September 1978.
10. R. B. Faoro, and J. A. Manning, Trends in Benzo(a)Pyrene, 1966-77 Journal of the Air Pollution Control Association Volume 31, No. 1, January 1981.
11. J. J. Wind, "Gateway to EPA Program Systems," American Management Systems, October 1987.

12. Aerometric Information Retrieval System - National Emissions Data Systems National Emissions Summary (1985), U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, August 1987.
13. Air Emissions Species Manual - Volume II Particulate Matter Species Profiles, EPA-450/2-88-036, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1988.
14. Statistical Abstract of the United States, 1988, National Data Book and Guide to Sources, U. S. Department of Commerce, Bureau of the Census, Washington, DC, December 1987.
15. Personal Communication, William Lonneman, U. S. Environmental Protection Agency to Robert B. Faoro, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1984.
16. Guidelines for the Evaluation of Air Quality Data, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, Publication No. OAQPS 1.2-015, February 1974.
17. Personal communication, Tom Lahr, U. S. Environmental Protection Agency to Robert Faoro, U. S. Environmental Protection Agency, October 1, 1988.
18. R. A. McAllister, et al., 1988 Nonmethane Organic Compound Monitoring Program Volume II: Urban Air Toxics Monitoring Program, EPA-450/4-89-005, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC 27711.
19. H. B. Singh, et al., Measurements of Hazardous Organic Chemicals in the Ambient Atmosphere, EPA-600/53-83-002, U. S. Environmental Protection Agency, Research Triangle Park, NC 27711.

TABLE 1

POLLUTANTS CONSIDERED IN UPDATED AIR TOXIC ASSESSMENT
WITH THE OLD AND CURRENT UNIT RISK VALUES.

POLLUTANT	PREVIOUSLY USED UNIT RISK ESTIMATES ($\mu\text{g}/\text{m}^3$)-1	CURRENT UNIT RISK ESTIMATE ($\mu\text{g}/\text{m}^3$)-1
Acetaldehyde ^a	Not available	2.2×10^{-6}
Acrylonitrile ^a	Same as current value	6.8×10^{-5}
Arsenic ^b	Same as current value	4.3×10^{-3}
Asbestos ^a	Not available	2.3×10^{-1} (fibers/ml)
Benzene ^b	6.9×10^{-6}	8.3×10^{-6}
Benzo[a]pyrene (BaP) ^b	3.3×10^{-3}	1.7×10^{-3}
Beryllium ^b	4.0×10^{-4}	2.4×10^{-3}
1,3-butadiene ^c	4.6×10^{-7}	2.8×10^{-4}
Cadmium ^b	2.3×10^{-3}	1.8×10^{-3}
Carbon tetrachloride ^b	Same as current value	1.5×10^{-5}
Chloroform ^b	1.0×10^{-5}	2.3×10^{-5}
Chromium (VI) ^b	Same as current value	1.2×10^{-2}
Ethylene dichloride ^b	Same as current value	2.6×10^{-5}
Epichlorohydrin ^a	2.2×10^{-7}	1.2×10^{-6}
Ethylene dibromide ^c	5.1×10^{-4}	2.2×10^{-4}
Ethylene oxide ^a	3.6×10^{-4}	1.0×10^{-4}
Formaldehyde ^b	6.1×10^{-6}	1.3×10^{-5}
Hexachlorobenzene (HBC) ^a	Not available	4.9×10^{-4}
Methylene chloride ^b	1.8×10^{-7}	4.7×10^{-7}
Nickel - Subsulfide ^c	3.3×10^{-4}	4.8×10^{-4}
Products Incomplete Combustion (PIC) ^b	Same as current value	4.2×10^{-1}
Propylene oxide ^a	1.2×10^{-4}	3.7×10^{-6}
Styrene ^c	2.9×10^{-7}	5.7×10^{-7}
2,3,7,8-tetrachlorodibenzo-p-dioxin ^a	Not available	3.3×10^{-5} (pg/m^3)-1
Tetrachloroethylene ^b	1.7×10^{-6}	5.8×10^{-7}
Trichloroethylene ^b	4.1×10^{-6}	1.7×10^{-6}
Vinyl chloride ^c	2.6×10^{-6}	4.1×10^{-6}
Vinylidene chloride ^b	4.2×10^{-5}	5.0×10^{-5}

^a These pollutants did not have data and were not included in the study.

^b These pollutants were included in previous assessment. Methylene chloride considered in earlier study was omitted from this study because it was not on the current list of pollutants with unit risk values.

^c These pollutants were not considered in the previous study.

TABLE 7 URBAN AREAS WITH VOC DATA

URBAN AREA	NOV	NOV	COL	CHLOR	EDC	ED9	FORM	NO	STYR	PERC	TCE	VC	VOC
IRVINGHAM													
MOENIT													
ROGERSFIELD													
DIXCROD													
RENOVT													
RESNO													
IS ANGELES-LONG BEACH													
ERCED													
DRESD													
VLAND													
IRAND-VENTURA													
ICHAND													
VERSIDE-SAN BERNARDINO													
CRAMENTO													
R DIEGO													
W FRANCISCO													
W JOSE													
WTA SARASOTA													
TOCKTON													
VILLEJO-WPA													
WYDER													
WNINGTON													
WSONVILLE													
WMI													
WANTA													
WILCAGO													
WST ST LOUIS													
WTHAMMOLIS													
WUISVILLE													
WTON ROUGE													
WKE CHARLES													
WSTON													
WLTIMORE													
WTRURO													
WTRUIT													
WRSING													
WOLAND													
WRT HURON													
WVAS CITY													
W LOUIS													
WV LAS													
WVBER													
WVARK													
WV YORK CITY													
WVLOTTE													
WVON													
WVVELAND													
WVRLAND													
WVDELPHIA													
WVATTANOOGA													
WVAMONT													
WVUTE													
WVLLAS													
WV PASO													
WVAT NORTH													
WVOSTON													
WVIAS CITY													
WVRLINGTON													
WVCHAND													
WVLESTON(INSTITUTE)													
TOTALS	12	21	21	22	13	19	19	21	26	26	23	7	10

NOTE: THIS TABLE IS BASED ON THE DATA FROM THE AIR QUALITY MONITORING SYSTEMS OPERATING IN THESE CITIES FROM 1970 TO 1974.

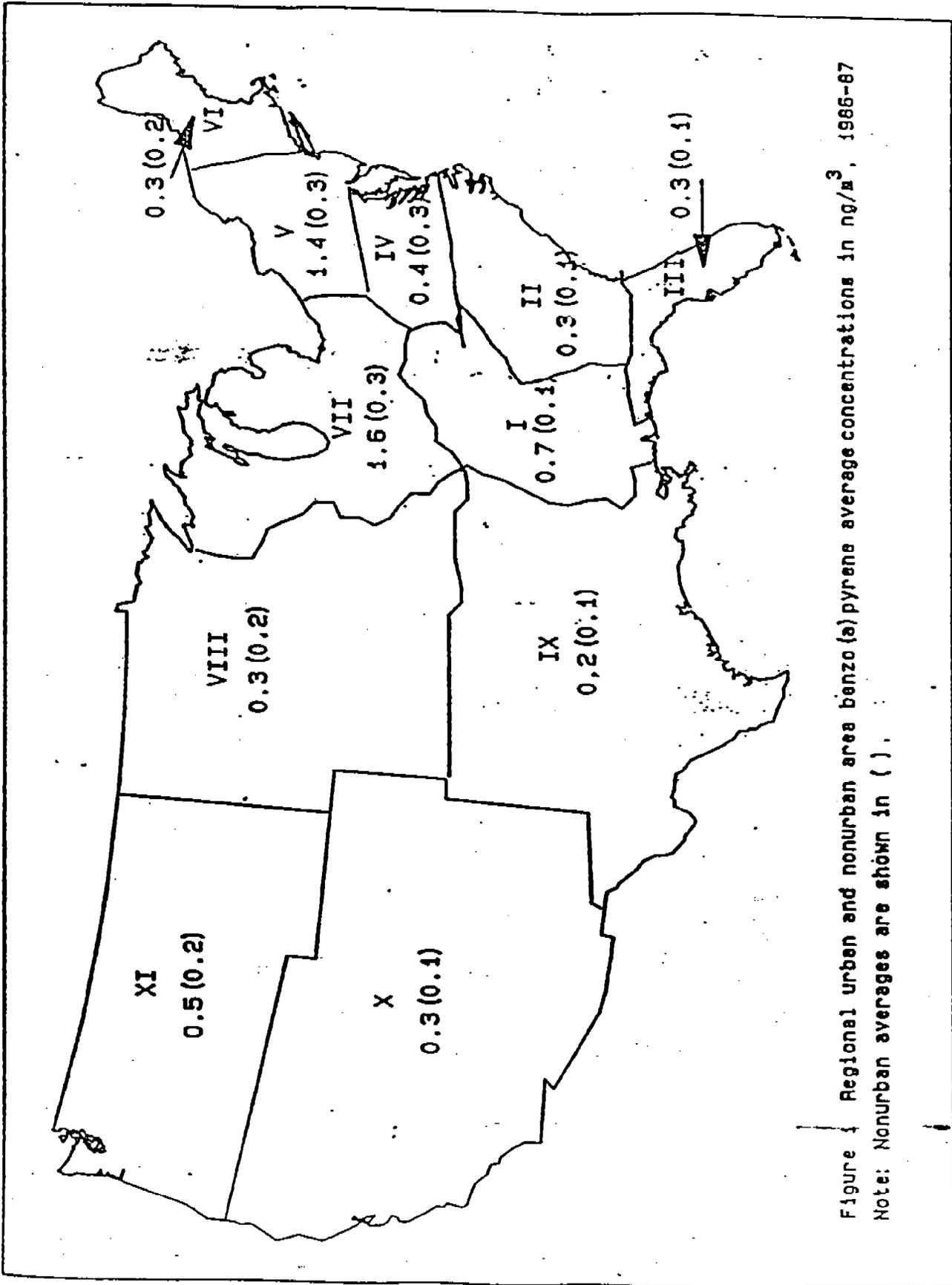


Figure 1 Regional urban and nonurban area benzo(a)pyrene average concentrations in ng/m³, 1985-87
 Note: Nonurban averages are shown in ().

TABLE 3 NATIONAL URBAN AND NONURBAN VOC AVERAGES

POLLUTANT	URBAN AVERAGE UG/M3	NONURBAN AVERAGE UG/M3
BENZENE	8.07	0.6
1,3 BUTADIENE	0.30	0.1
CARBON TETRACHLORIDE	0.79	0.4
CHLOROFORM	1.86	0.1
ETHYLENE DIBROMIDE	0.10	0.05
ETHYLENE DICHLORIDE	0.59	0.2
FORMALDEHYDE	3.16	1.5a.
METHYLENE CHLORIDE	3.97	0.2
STYRENE	1.02	0.08
TETRACHLOROETHYLENE	3.83	0.3a.
TRICHLOROETHYLENE	1.50	0.2
VINYL CHLORIDE	1.15	0.0
VINYLDENE CHLORIDE	0.07	0.02a.

a. NONURBAN DATA WAS UNAVAILABLE. ESTIMATES WERE OBTAINED FROM REFERENCE 15.

TABLE 4. ESTIMATED INCIDENCE FOR THE TRACE METALS AND BAP

POLLUTANT	COUNTIES WITH DATA	POPULATION OF COUNTIES (MILLIONS)	UNIT RISK	INCIDENCE	INCIDENCE PER MILLION
ARSENIC	163	91	4.3E-3	68	0.28
BERYLLIUM	161	91	2.4E-3	1	<0.01
CADMIUM	164	91	1.8E-3	10	0.04
CHROMIUM	158	89	1.2E-2	283	1.18
CHROMIUM+6	158	89	1.2E-2	1134	0.47
NICKEL (SUBSULFIDE)	161	91	4.8E-4	0b.	0.00
BAP	35	47	1.7E-3	4	0.02
PDCc.	35	47	4.2E-1	872	3.63

- a. FACTOR(0.4) WAS USED TO ESTIMATE CR+6 FROM TOTAL CR.
- b. ASSUMED TO BE ZERO BECAUSE THERE ARE NO EMISSIONS OF NICKEL SUBSULFIDE IN U.S.
- c. IN THIS STUDY, BAP IS BEING USED NOT ONLY AS A SPECIFIC CARCINOGEN, BUT ALSO AS AN INDICATOR OF AIR POLLUTION, PARTICULARLY INCOMPLETE COMBUSTION

MA 31

TABLE 5 ESTIMATED INCIDENCE FOR VOC POLLUTANTS

POLLUTANT	NO. OF AREAS WITH DATA	COMBINED POP. OF AREAS WITH DATA-MILLIONS	UNIT RISK	INCIDENCE	INCIDENCE PER MILLION
BENZENE	43	63	8.3E-06	181	0.75
1,3 BUTADIENE	12	3	2.8E-04	244a	1.02
CARBON TETRACHLORIDE	24	41	1.5E-05	36	0.15
CHLOROFORM	22	35	2.3E-05	115	0.48
ETHYLENE DIBROMIDE	19	32	2.2E-04	68	0.28
ETHYLENE DICHLORIDE	13	26	2.6E-05	45	0.19
FORMALDEHYDE	19	31	1.3E-05	124	0.52
METHYLENE CHLORIDE	21	32	4.7E-07	5	0.02
STYRENE	4	6	5.7E-07	2	0.01
TETRACHLOROETHYLENE	26	53	5.8E-07	6	0.03
TRICHLOROETHYLENE	25	44	1.7E-06	7	0.03
VINYL CHLORIDE	7	7	4.1E-06	13	0.05
VINYLDENE CHLORIDE	10	29	5.0E-05	10	0.04

a. BASED ON RECENTLY COLLECTED DATA FROM THE CALIFORNIA AIR RESOURCES BOARD

TABLE 6 NATIONAL INCIDENCE FOR POLLUTANTS WITH UNIT RISK NUMBERS

POLLUTANT	NO. OF AREAS WITH DATA	COMBINED POP. OF AREAS WITH DATA-MILLIONS	UNIT RISK	INCIDENCE FOR NATION	INCIDENCE PER MILLION
ARSENIC	163	91	4.3E-03	68	0.28
BENZENE	43	63	8.3E-06	181	0.75
BENZO(A)PYRENE	35	47	1.7E-03	4	0.02
PTC	35	47	4.2E-01	872	3.63
BERYLLIUM	161	91	2.4E-03	1	<0.01
1,3 BUTADIENE	12	3	2.8E-04	244a.	1.02
CADMIUM	164	91	1.8E-03	10	0.04
CARBON TETRACHLORIDE	24	41	1.5E-05	36	0.15
CHLOROFORM	22	35	2.3E-05	115	0.48
CHROMIUM +6	158	89	1.2E-02	113b.	0.47
ETHYLENE DIBROMIDE	19	32	2.2E-04	68	0.28
ETHYLENE DICHLORIDE	13	26	2.6E-05	45	0.19
FORMALDEHYDE	19	31	1.3E-05	124	0.52
METHYLENE CHLORIDE	21	32	4.7E-07	5	0.02
NICKEL(SUBSULFIDE)	161	91	4.8E-04	0	0.00
STYRENE	4	6	5.7E-07	2	0.01
TETRACHLOROETHYLENE	26	53	5.8E-07	6	0.03
TRICHLOROETHYLENE	25	44	1.7E-06	7	0.03
VINYL CHLORIDE	7	7	4.1E-06	13	0.05
VINYLIDENE CHLORIDE	10	29	5.0E-05	10	0.04
TOTALS				1924	8.02

a. BASED ON RECENTLY COLLECTED DATA FROM THE CALIFORNIA AIR RESOURCES BOARD

b. TOTAL CHROMIUM INCIDENCE ADJUSTED TO CHROMIUM+6 INCIDENCE BY MULTIPLYING BY 0.4

TABLE 7. COMPARISON OF OLD AND NEW ASSESSMENTS OF AIR TOXIC INCIDENCE USING CURRENT UNIT RISK VALUES

POLLUTANT	INCIDENCE FOR NATION	
	OLD	NEW
ARSENIC	60	68
BENZENE	280	181
BENZO(a)PYRENE	3	4
PIC	609	872
BERYLLIUM	3	1
CADMIUM	12	10
CARBON TETRACHLORIDE	43	36
CHLOROFORM	39	115
CHROMIUM +6	97a.	113a.
ETHYLENE DICHLORIDE	41	45
FORMALDEHYDE	407	424
METHYL CHLORIDE	1	- b.
METHYLENE CHLORIDE	2	5
TETRACHLOROETHYLENE	8	6
TRICHLOROETHYLENE	7	7
VINYLIDENE CHLORIDE	74	10
TOTALS	1686	1597

a. TOTAL CR INCIDENCE ADJUSTED TO CR+6 BY MULTIPLYING BY 0.4

b. UNIT RISK NOT AVAILABLE FOR CURRENT STUDY

TABLE 8. SUMMARY OF ADDITIVE INDIVIDUAL LIFETIME RISKS FOR SELECTED CITIES

POLLUTANT	UNIT RISK	LOS ANGELES (1987)			BATON ROUGE (1986)			BOSTON (1986 D1986)			CHICAGO (1986)		
		HIGHEST ANNUAL MEAN (UG/MS)	IND. RISK	HIGHEST ANNUAL MEAN (UG/MS)	IND. RISK	HIGHEST ANNUAL MEAN (UG/MS)	IND. RISK	HIGHEST ANNUAL MEAN (UG/MS)	IND. RISK	HIGHEST ANNUAL MEAN (UG/MS)	IND. RISK	HIGHEST ANNUAL MEAN (UG/MS)	
BENZENE	4.3E-03	0.007	3.0E-5	0.004	1.7E-5	0.003	1.3E-5	0.010	0.010	4.3E-5	0.010	4.3E-5	
ETHYLENE	8.3E-06	11.15	9.3E-5	8.63	7.2E-5	4.27	3.5E-5	4.45	4.45	3.7E-5	4.45	3.7E-5	
ETHYLENE	1.7E-03	0.30a	5.1E-7	0.20a	3.4E-7	0.46a	7.8E-7	7.13a	7.13a	1.2E-5	7.13a	1.2E-5	
ETHYLENE	4.2E-01	0.30a	1.3E-4	0.20a	8.4E-5	0.46a	1.9E-4	7.13a	7.13a	3.0E-3	7.13a	3.0E-3	
ETHYLENE	2.4E-03	0.00003	7.2E-8	0.00003	7.2E-8	0.00003	7.2E-8	0.00052	0.00052	1.2E-6	0.00052	1.2E-6	
BUTADIENE	2.8E-04	-	-	-	-	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	1.8E-03	0.002	3.6E-6	0.001	1.8E-6	0.001	1.8E-6	0.003	0.003	5.4E-6	0.003	5.4E-6	
1,1-DICHLOROETHYLENE	1.5E-05	0.67	1.0E-5	0.04	6.0E-7	-	-	-	0.000	-	-	-	
1,1-DICHLOROETHYLENE	2.3E-05	0.44	1.0E-5	1.08	2.5E-5	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	1.2E-02	0.004	4.8E-5	0.002	2.4E-5	0.002	2.4E-5	0.006	0.006	7.2E-5	0.006	7.2E-5	
1,1-DICHLOROETHYLENE	2.2E-04	0.05	1.1E-5	-	-	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	2.6E-05	0.40	1.0E-5	4.19	1.1E-4	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	1.3E-05	23.30b	3.0E-4	2.66	3.8E-5	2.59	3.4E-5	3.24	3.24	4.2E-5	3.24	4.2E-5	
1,1-DICHLOROETHYLENE	4.7E-07	5.94	2.8E-6	0.48	2.3E-7	-	-	5.77c	5.77c	2.7E-6	5.77c	2.7E-6	
1,1-DICHLOROETHYLENE	4.8E-04	0.000	0.0E-0	0.000	0.0E-0	0.000	0.0E-0	0.000	0.000	0.0E-0	0.000	0.0E-0	
1,1-DICHLOROETHYLENE	5.7E-07	-	-	-	-	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	5.8E-07	6.94	4.0E-6	0.50	2.9E-7	1.64	1.1E-6	1.64	1.64	1.2E-6	1.64	1.2E-6	
1,1-DICHLOROETHYLENE	1.7E-06	1.54	2.6E-6	0.03	5.1E-8	1.53c	2.6E-6	2.20	2.20	3.7E-6	2.20	3.7E-6	
1,1-DICHLOROETHYLENE	4.1E-06	-	-	1.28	5.2E-6	-	-	-	-	-	-	-	
1,1-DICHLOROETHYLENE	5.0E-05	0.20d	1.0E-6	-	-	-	-	-	-	0.09d	0.09d	4.5E-6	
TOTALS			6.6E-4		3.8E-4		3.0E-4		3.0E-4		3.0E-4	3.2E-3	

ANDRANS/MS
ATA REPRESENTS RIVERSIDE, CA, IN 1980
985 DATA
ATA REPRESENTS SAMPLES COLLECTED IN 1980

TABLE 9. SUMMARY OF HIGHEST OBSERVED INDIVIDUAL LIFETIME RISKS FOR TRACE METALS AND BAP

POLLUTANT	NO. OF SITE-YEARS	UNIT RISK	HIGHEST ANNUAL MEAN (UG/KG)	MAXIMUM IND. RISK
ARSENIC	347	4.3E-3	0.091	3.9E-4
BERYLLIUM	399	2.4E-3	0.007	1.7E-5
CADMIUM	416	1.8E-3	0.186	3.3E-4
CHROMIUM+6	356	1.2E-2	0.031a	3.7E-4a
NICKEL	400	4.8E-4	0.000	0.0E-0
BAP	4477	3.3E-3	0.020	6.6E-5
PIC	4477	4.2E-1	0.020	8.4E-3

a. FACTOR(0.4) WAS USED TO ESTIMATE CR+6 FROM TOTAL CR

TABLE 10. SUMMARY OF HIGHEST OBSERVED INDIVIDUAL LIFETIME RISKS FOR VOC'S

POLLUTANT	NO. OF SITE-YEARS	UNIT RISK	HIGHEST ANNUAL MEAN (UG/MS)	MAXIMUM IND. RISK
BENZENE	108	8.3E-6	19.95	1.7E-4
1,3 BUTADIENE	12	2.8E-4	0.46	1.3E-4
CARBON TETRACHLORIDE	71	1.5E-5	3.48	5.2E-5
CHLOROFORM	73	2.3E-5	9.30	2.1E-4
ETHYLENE DIBROMIDE	49	2.2E-4	0.36	7.9E-5
ETHYLENE DICHLORIDE	26	2.6E-5	4.19	1.1E-4
FORMALDEHYDE	37	1.3E-5	23.30	3.0E-4
METHYLENE CHLORIDE	67	4.7E-7	20.43	9.6E-6
STYRENE	6	5.7E-7	3.19	1.8E-6
TETRACHLOROETHYLENE	61	5.8E-7	20.69	1.2E-5
TRICHLOROETHYLENE	59	1.7E-6	6.60	1.2E-5
VINYL CHLORIDE	13	4.1E-6	2.44	1.0E-5
VINYLDENE CHLORIDE	37	5.0E-5	0.34	1.7E-5



EPA-454/B-93/051
Appendix F
Revision No. 0
Date: March 1994
Page F-1

APPENDIX F

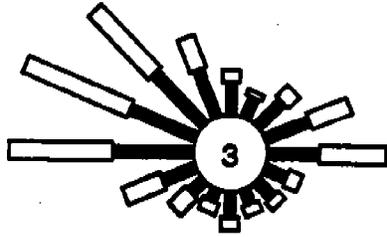
SAMPLE WIND ROSES FOR THE PAMS PROGRAM



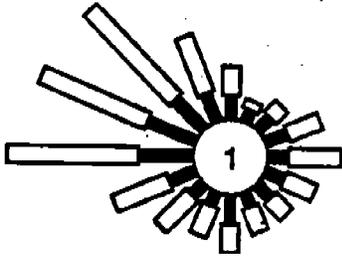
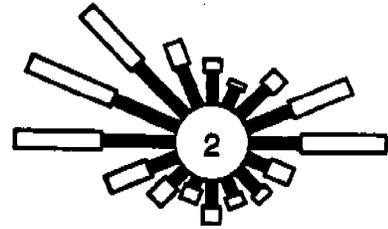
conductive days

Atlanta GA
10 years

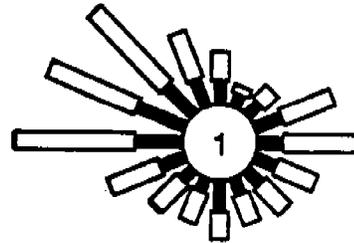
observed highs



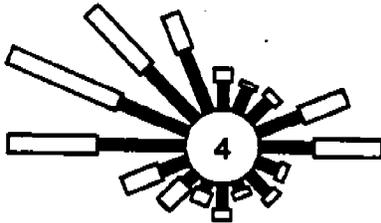
AM



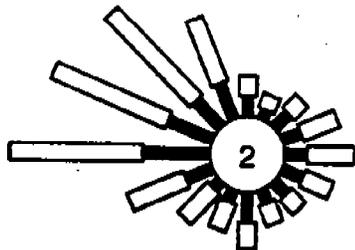
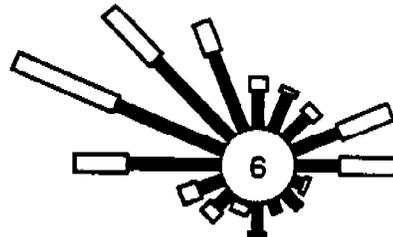
PM



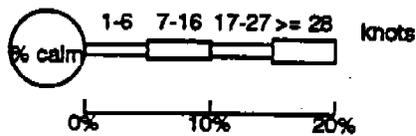
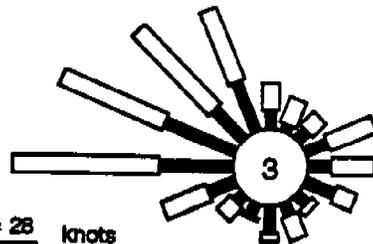
5 years



AM



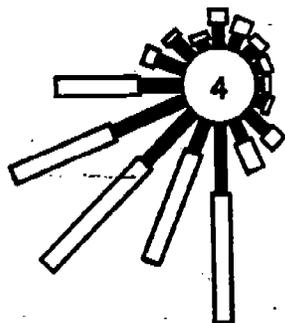
PM



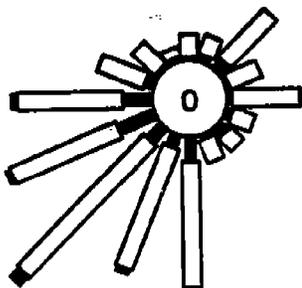
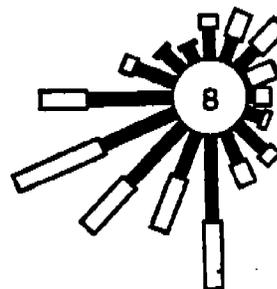
conductive days

Chicago IL
10 years

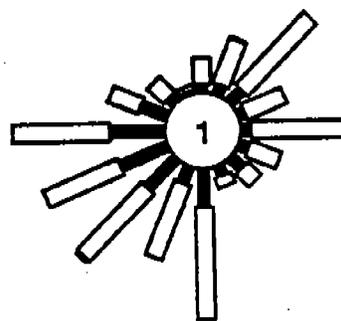
observed highs



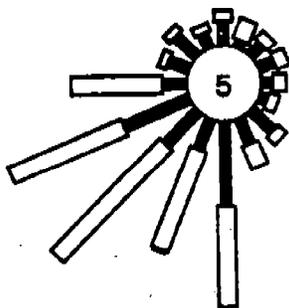
AM



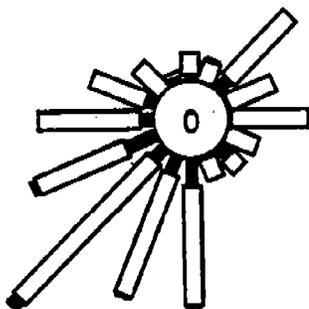
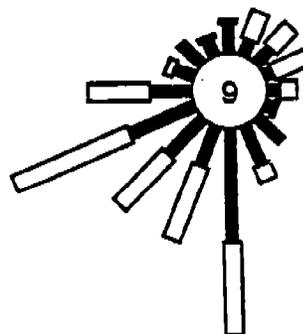
PM



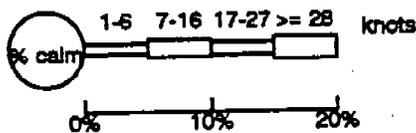
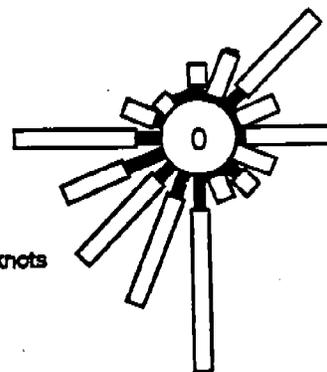
5 years



AM



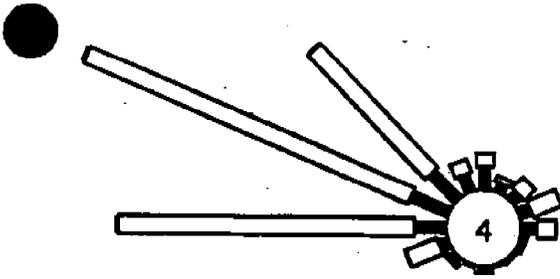
PM



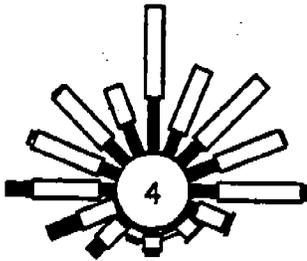
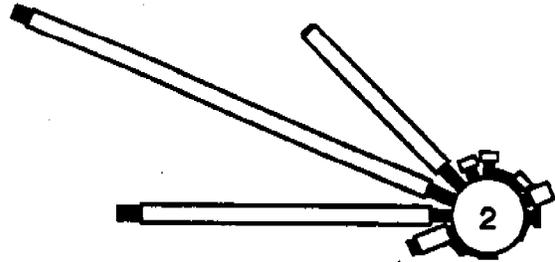
conductive days

SE Desert (Daggett)
10 years

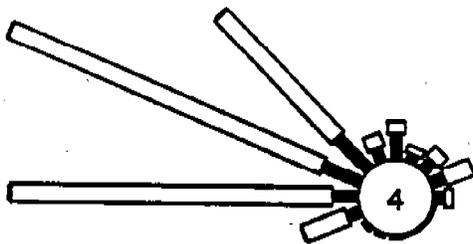
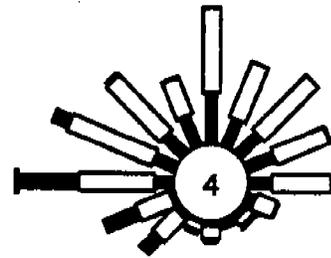
observed highs



AM

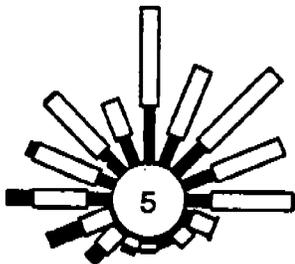
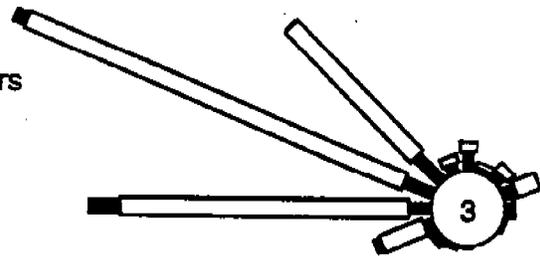


PM

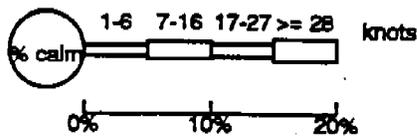
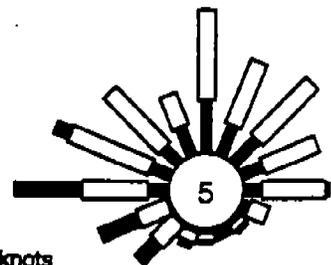


5 years

AM



PM

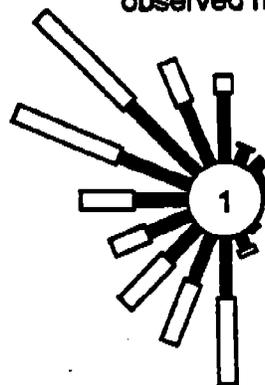
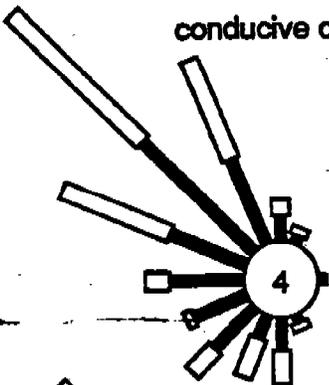


San Diego CA
10 years

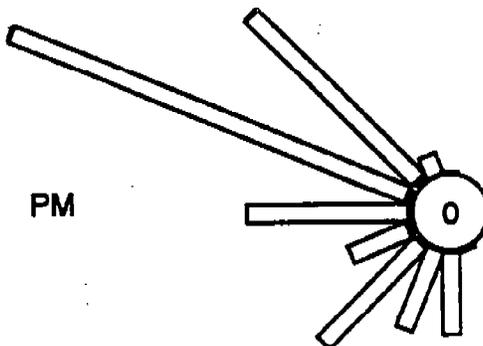
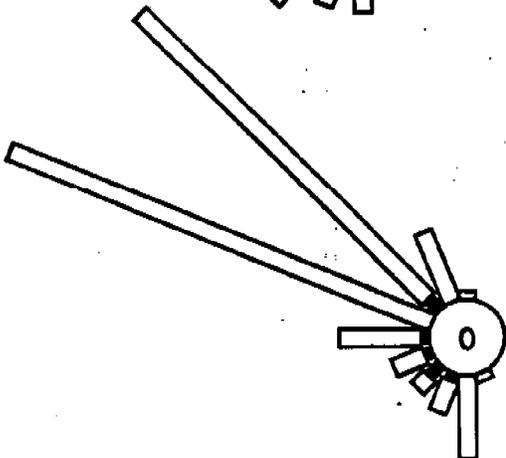
conductive days

observed highs

AM

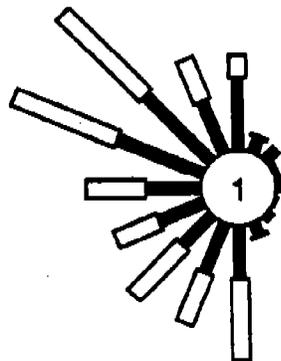
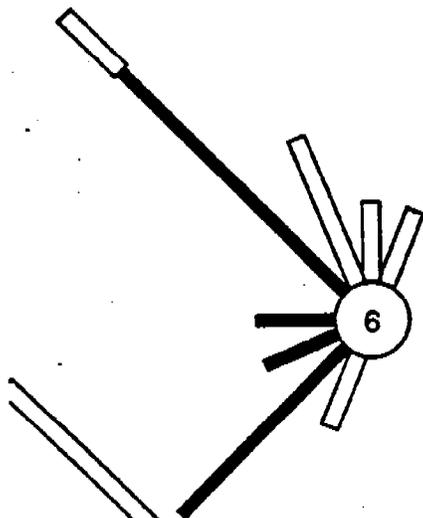


PM

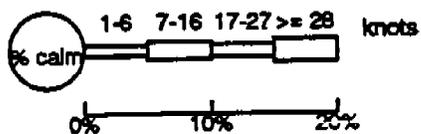
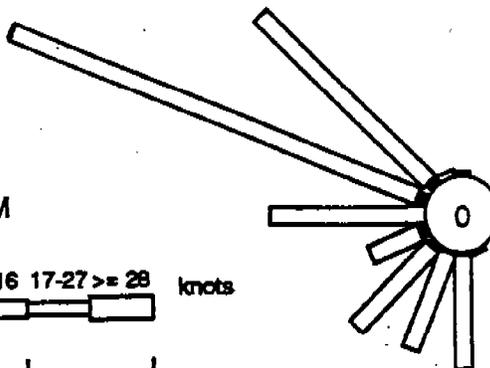
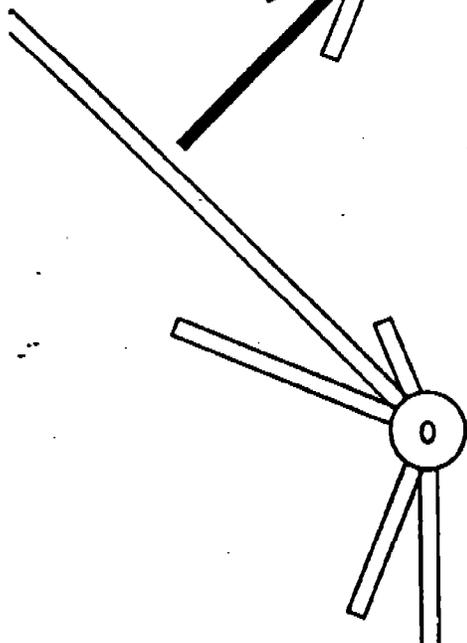


5 years

AM



PM



conductive days

Washington DC

observed highs

10 years

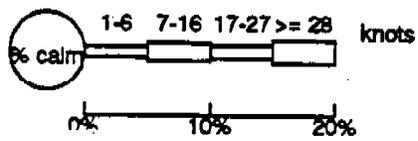
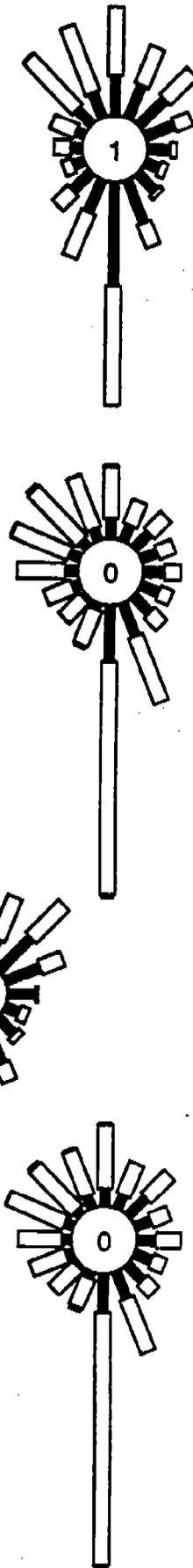
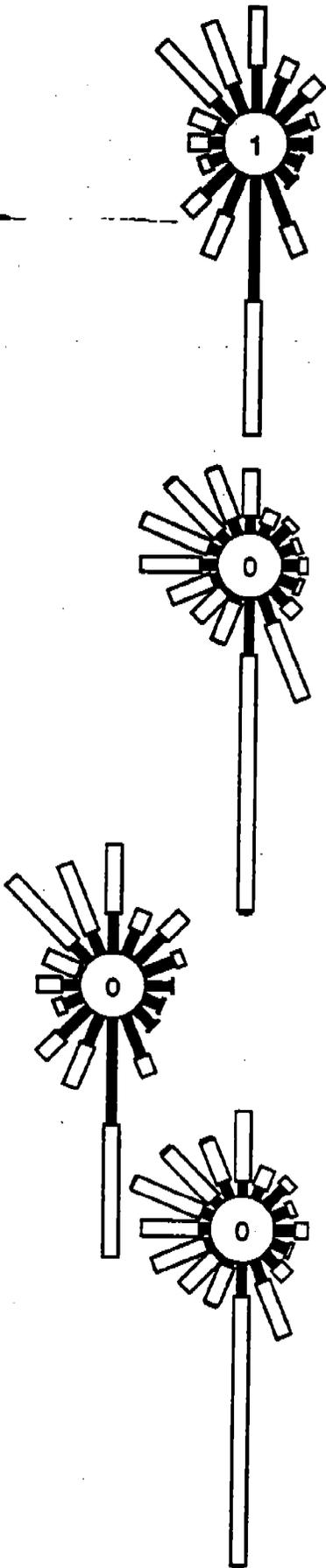
AM

PM

5 years

AM

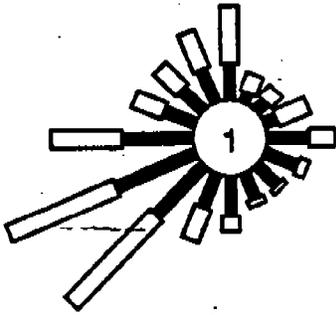
PM



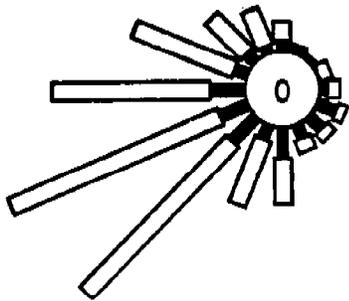
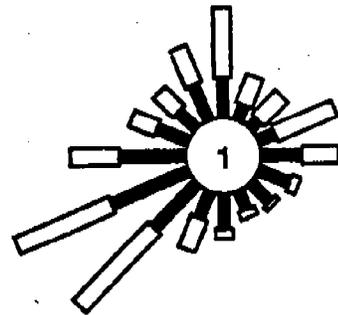
conductive days

Philadelphia PA
10 years

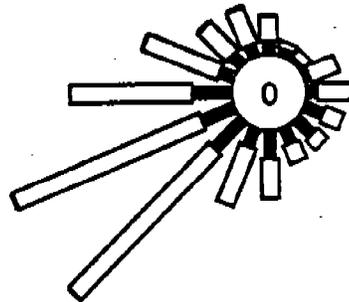
observed highs



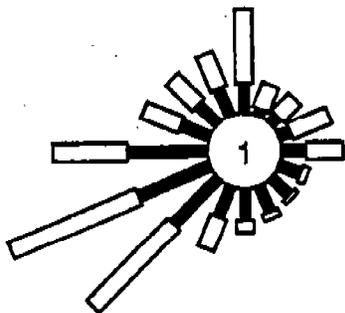
AM



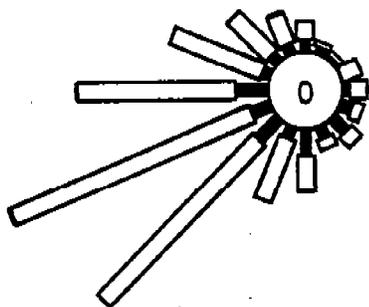
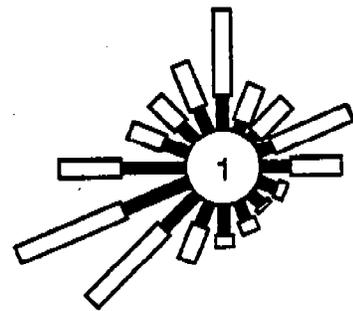
PM



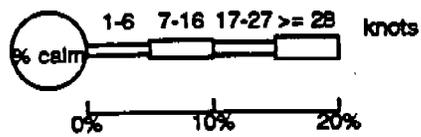
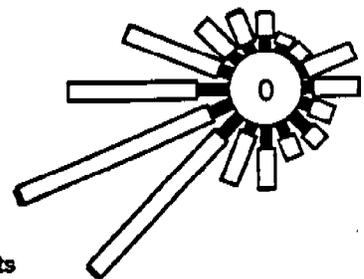
5 years



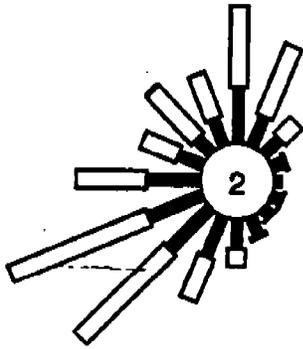
AM



PM

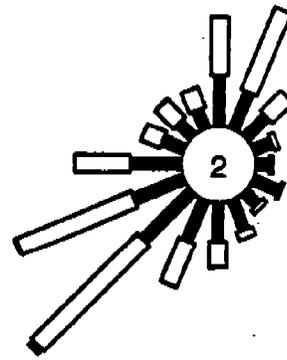


conductive days

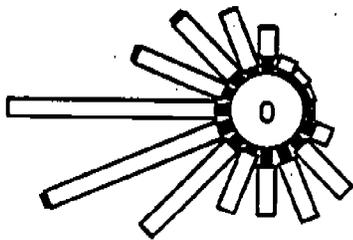


New York, NY
10 years

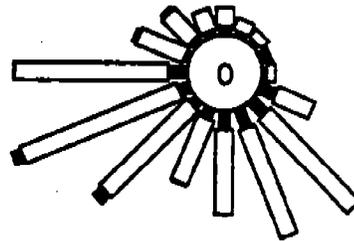
observed highs



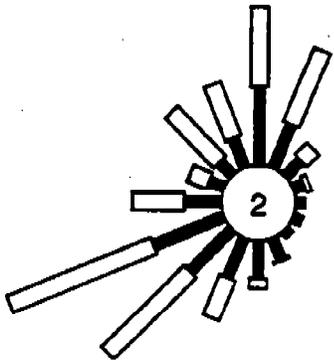
AM



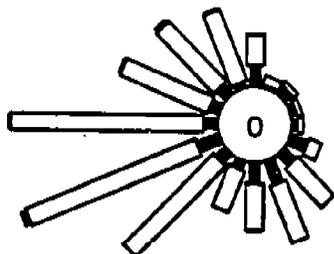
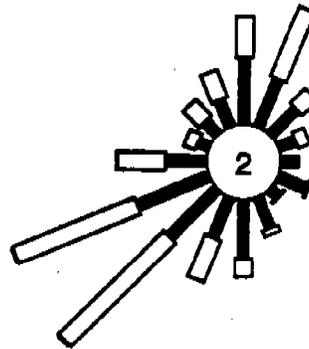
PM



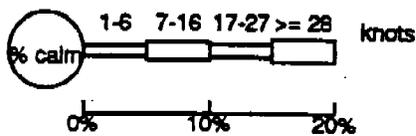
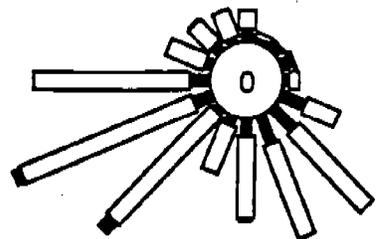
5 years



AM



PM

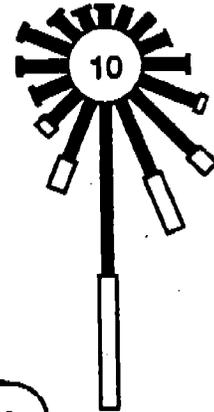
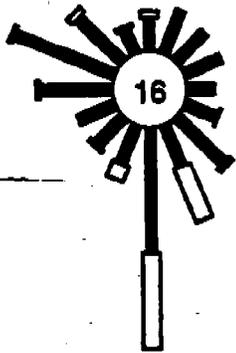


conductive days

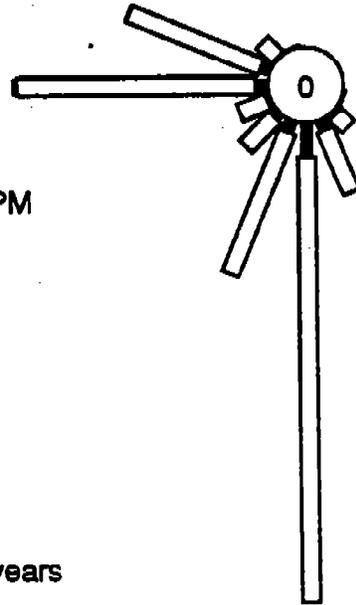
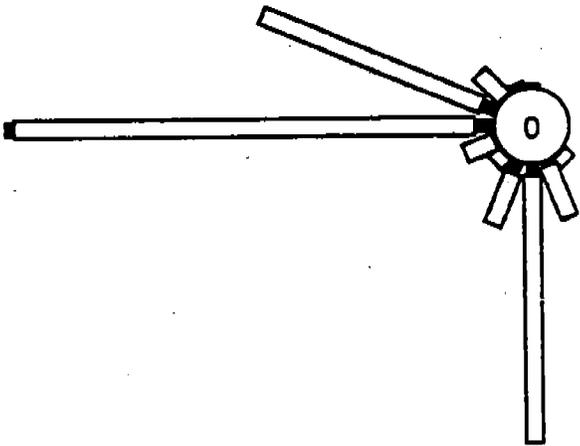
Los Angeles CA
10 years

observed highs

AM

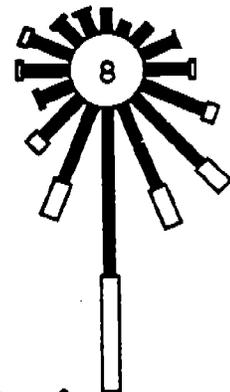
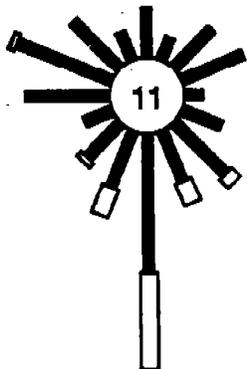


PM

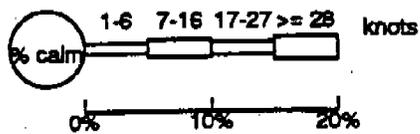
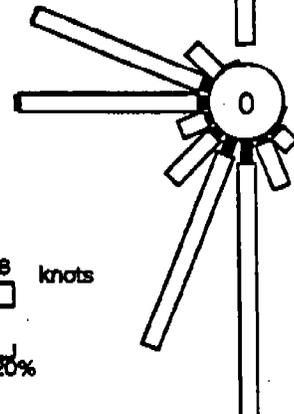
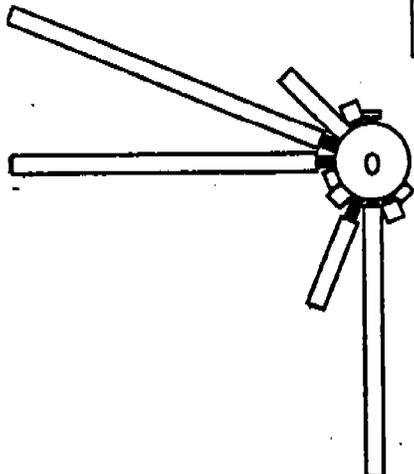


5 years

AM



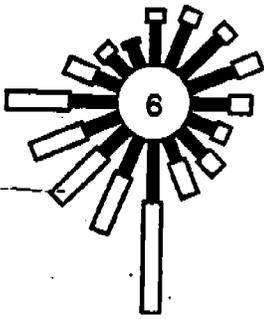
PM



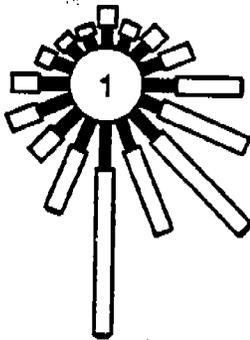
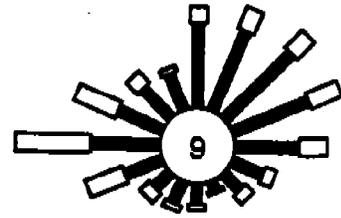
conductive days

Houston TX
10 years

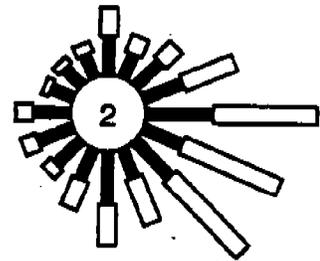
observed highs



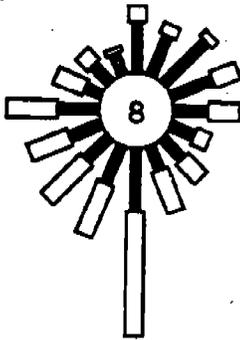
AM



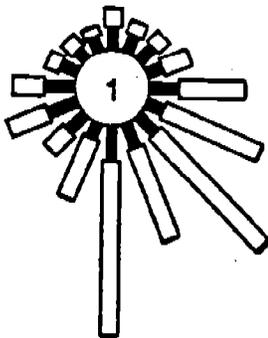
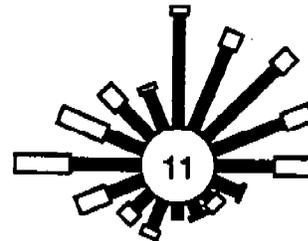
PM



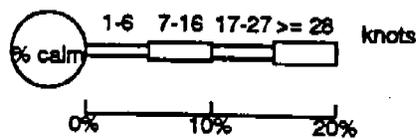
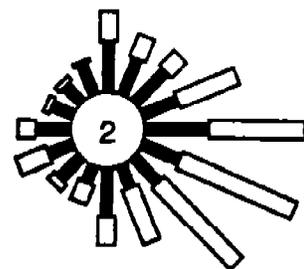
5 years



AM



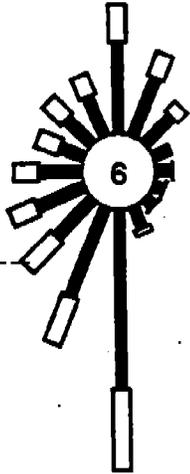
PM



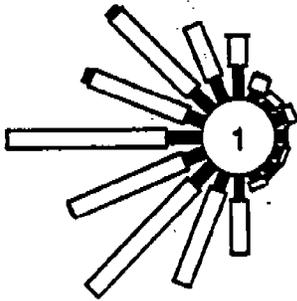
conductive days

Hartford CT
10 years

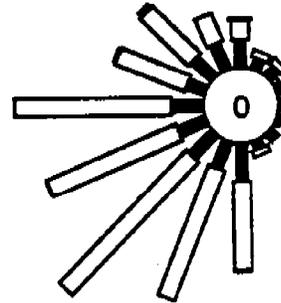
observed highs



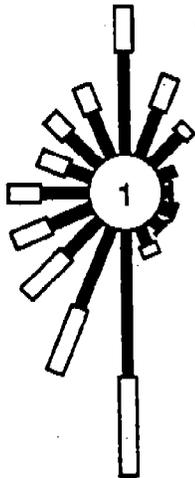
AM



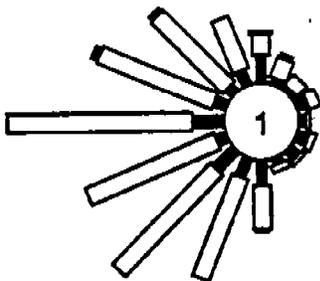
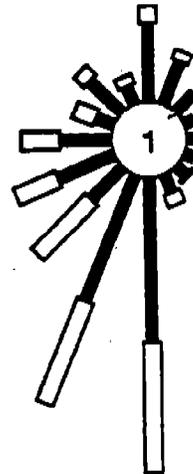
PM



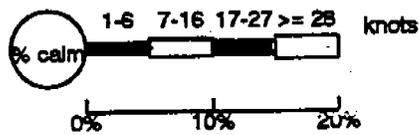
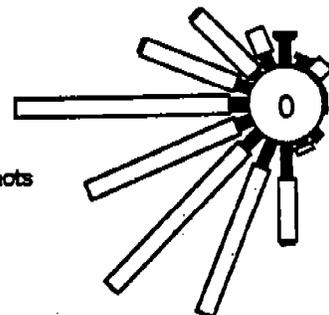
5 years



AM



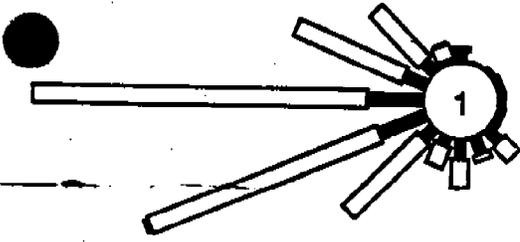
PM



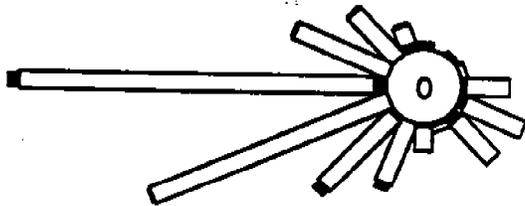
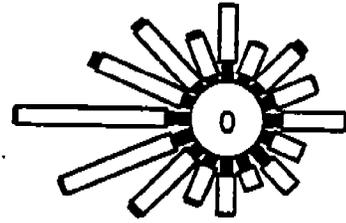
conductive days

Boston MA
10 years

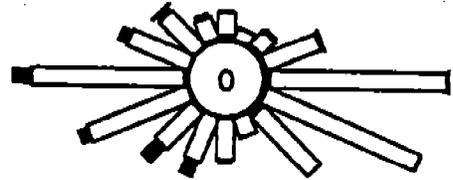
observed highs



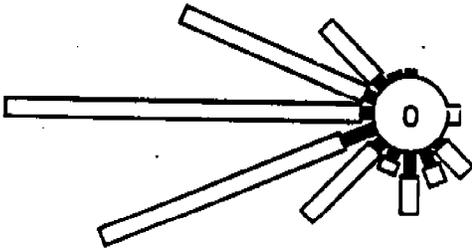
AM



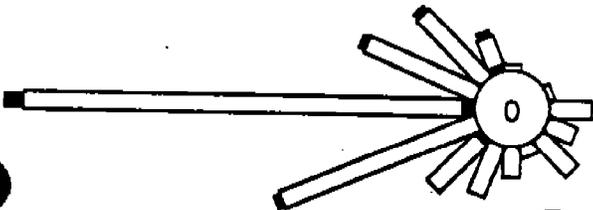
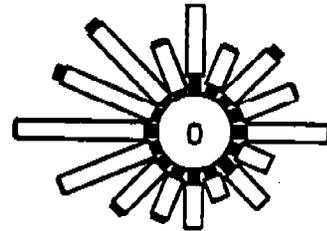
PM



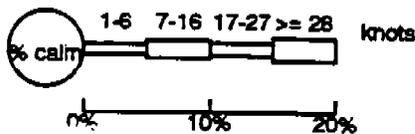
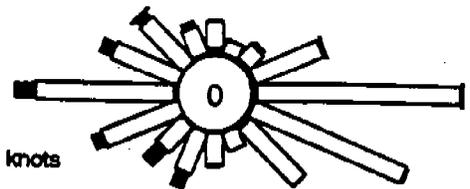
5 years



AM



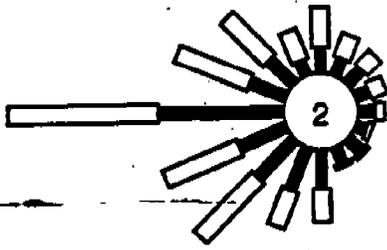
PM



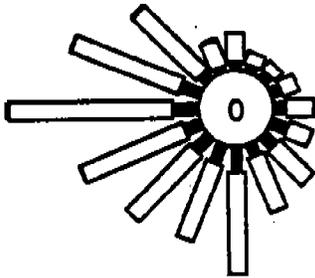
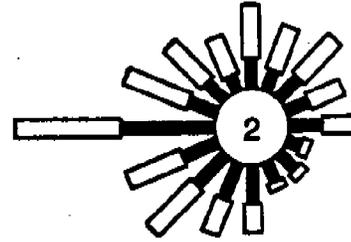
conductive days

Baltimore MD
10 years

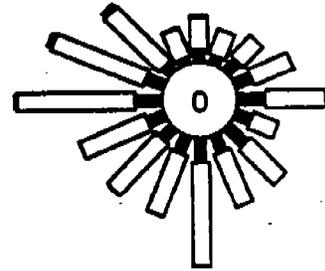
observed highs



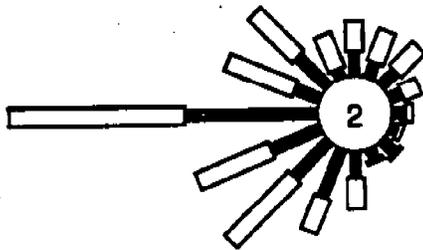
AM



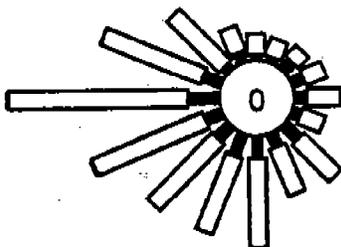
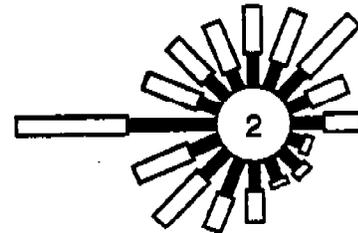
PM



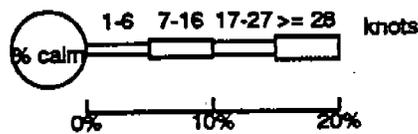
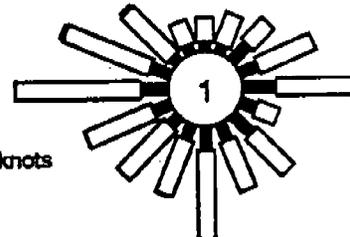
5 years



AM



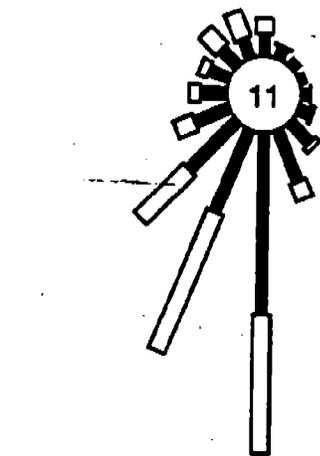
PM



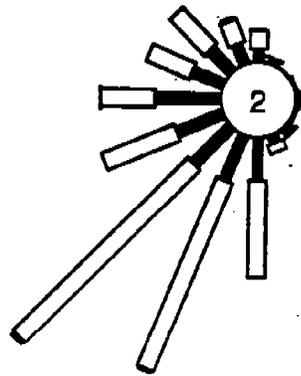
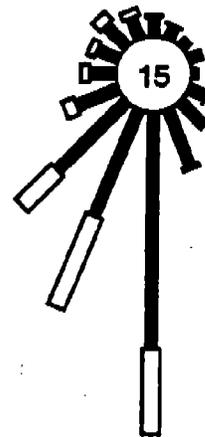
conductive days

Sacramento CA
10 years

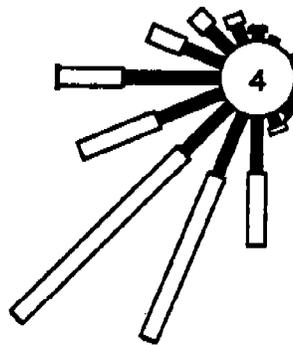
observed highs



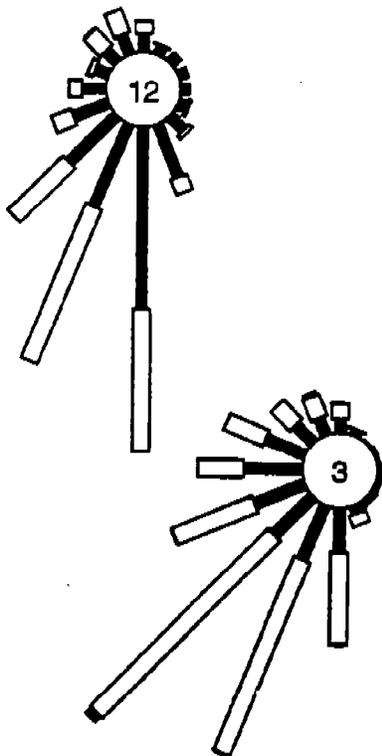
AM



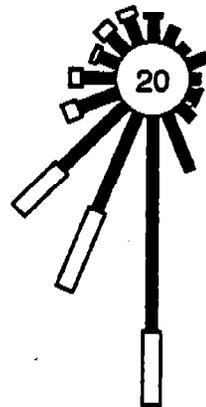
PM



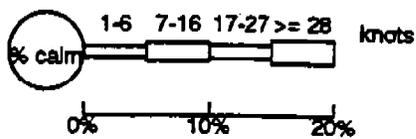
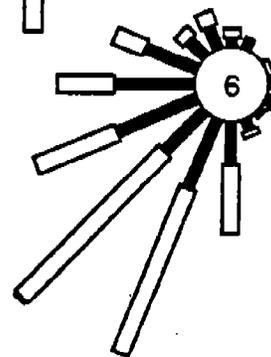
5 years



AM



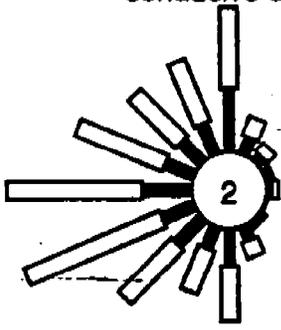
PM



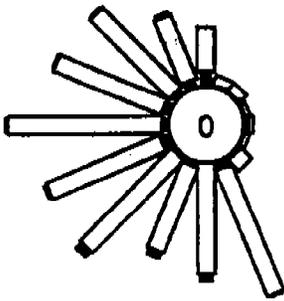
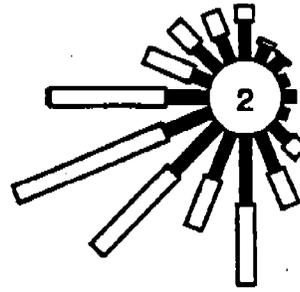
conductive days

Providence RI
10 years

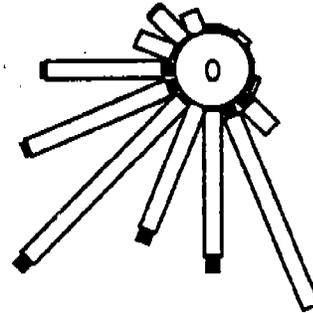
observed highs



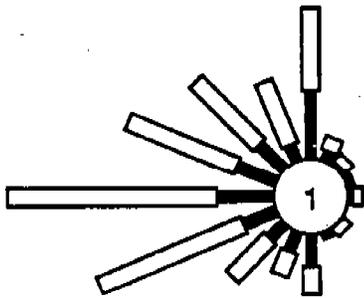
AM



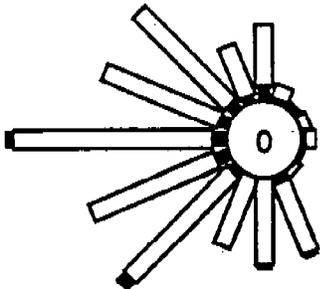
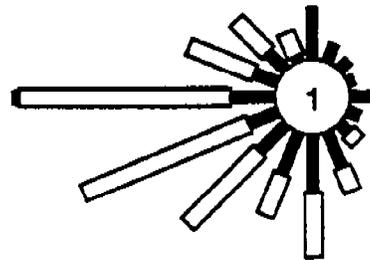
PM



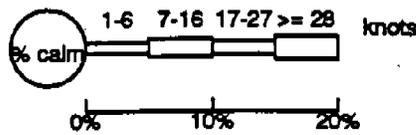
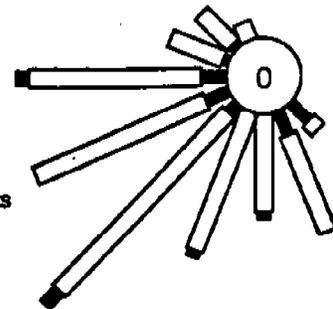
5 years



AM



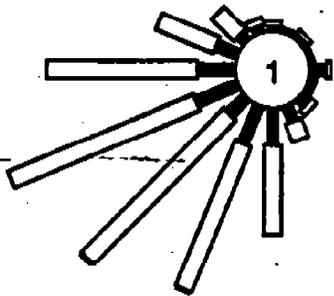
PM



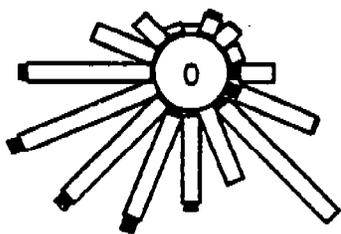
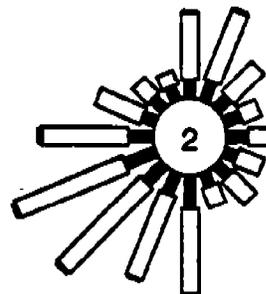
conductive days

Milwaukee WI
10 years

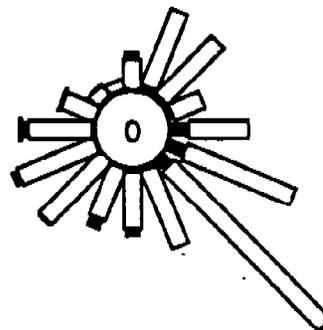
observed highs



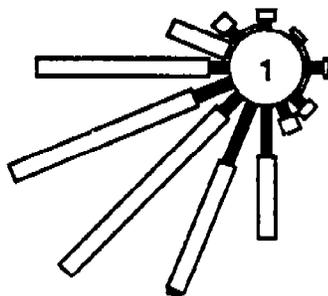
AM



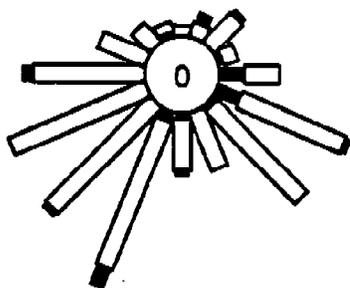
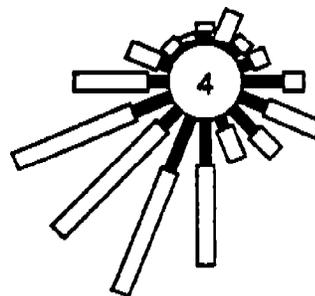
PM



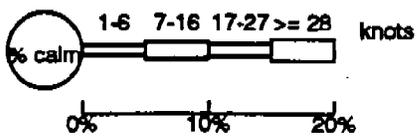
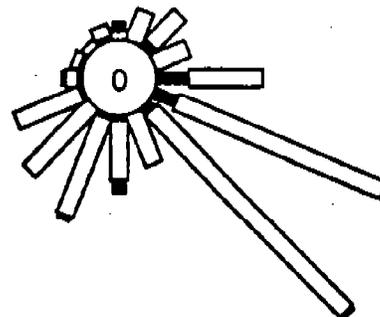
5 years



AM



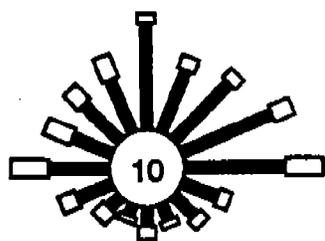
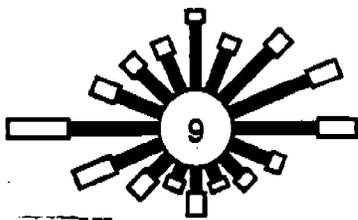
PM



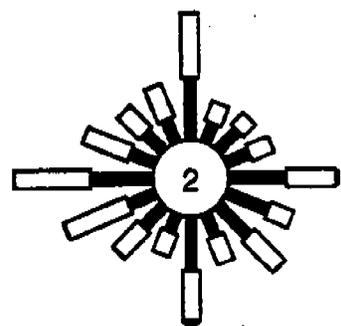
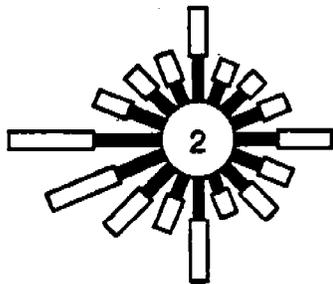
conductive days

Baton Rouge LA
10 years

observed highs

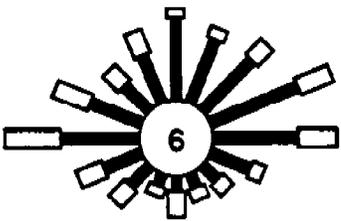


AM

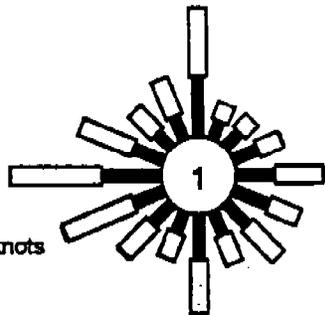
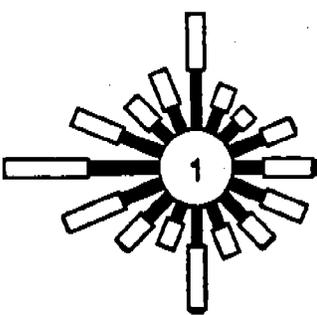


PM

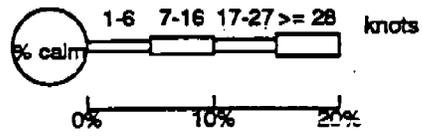
5 years



AM



PM

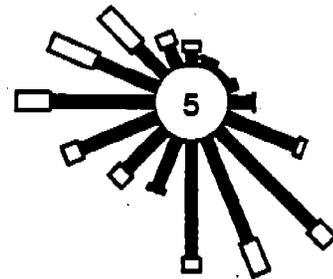
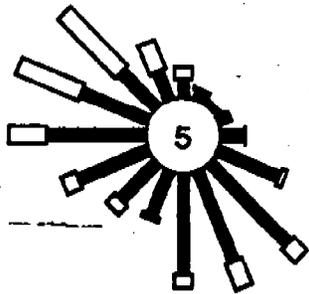


conductive days

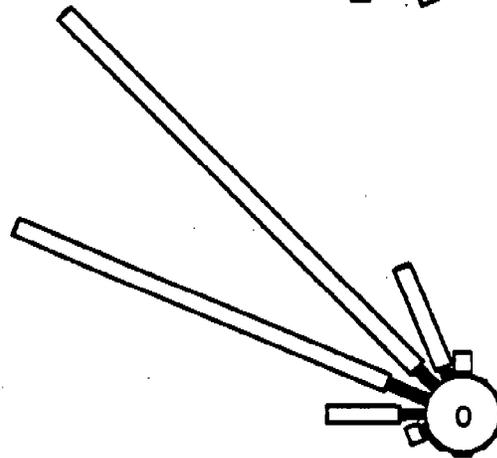
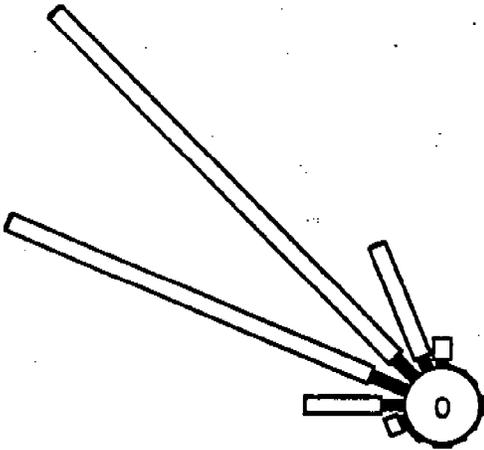
San Joaquin (Bakersfield)
10 years

observed highs

AM

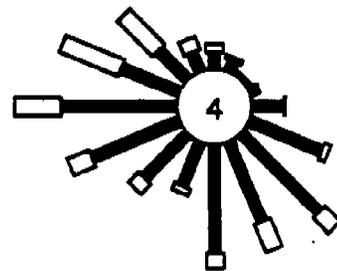
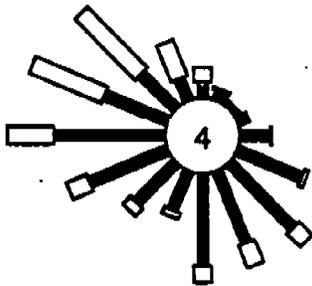


PM

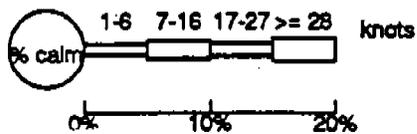
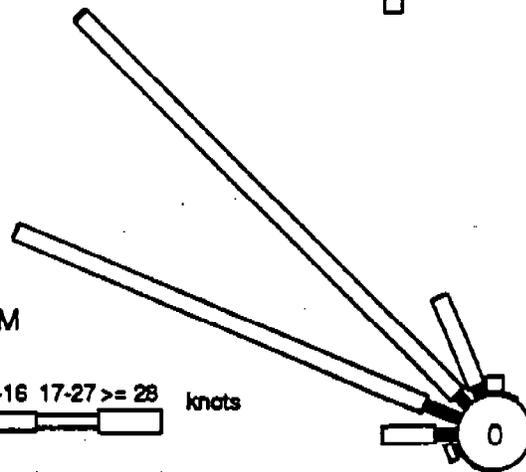
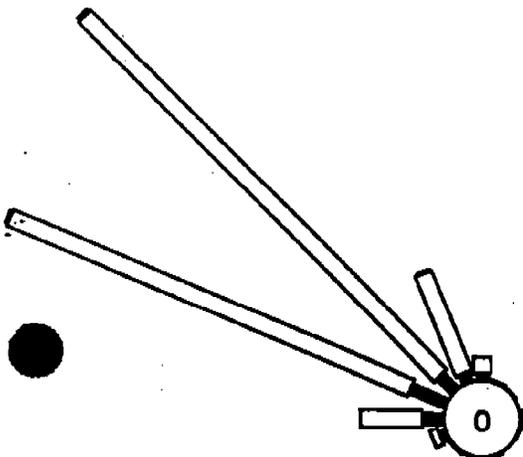


5 years

AM



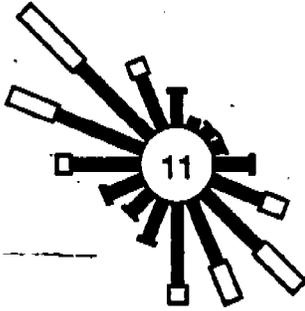
PM



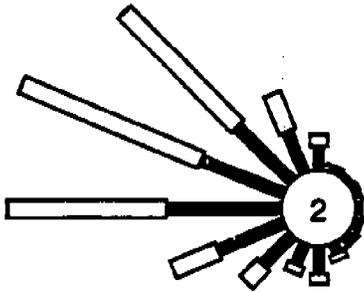
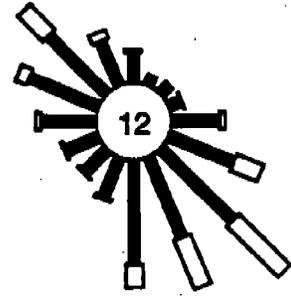
conductive days

San Joaquin (Fresno)
10 years

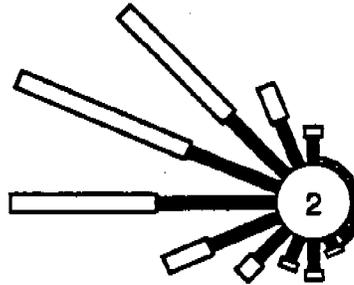
observed highs



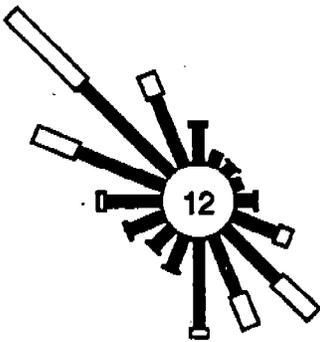
AM



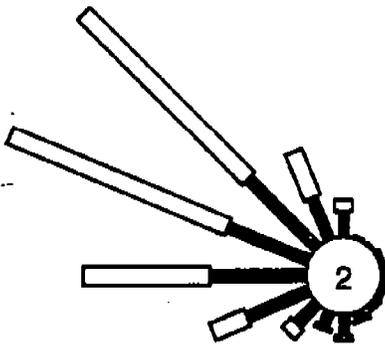
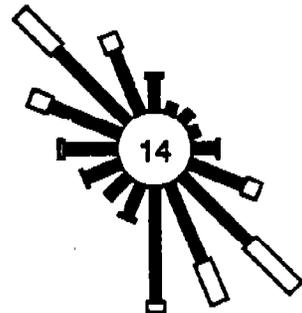
PM



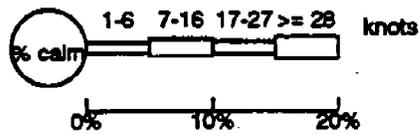
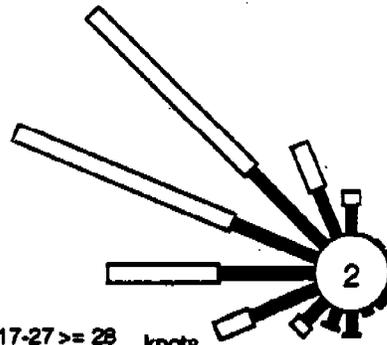
5 years



AM



PM

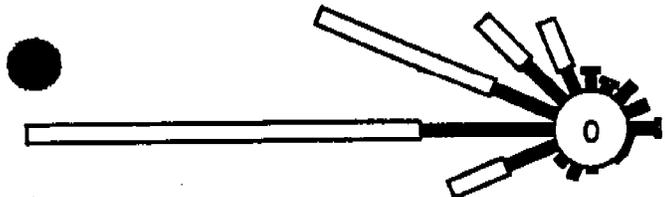


conductive days

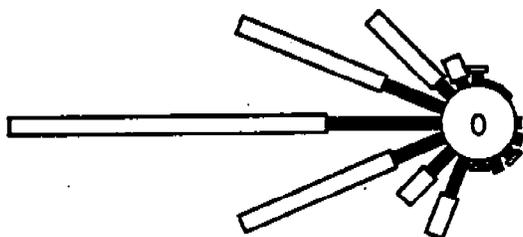
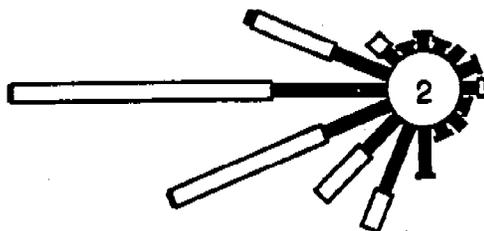
Springfield (Worcester met data)

observed highs

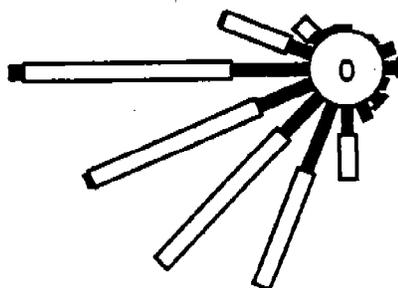
10 years



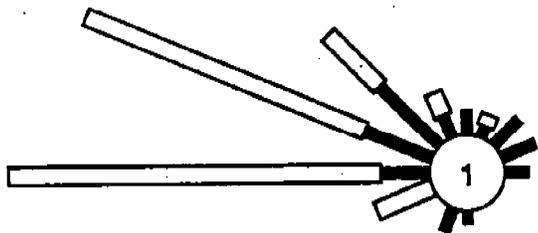
AM



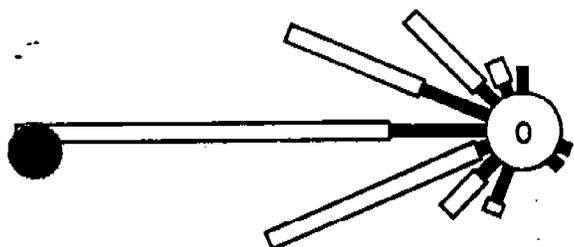
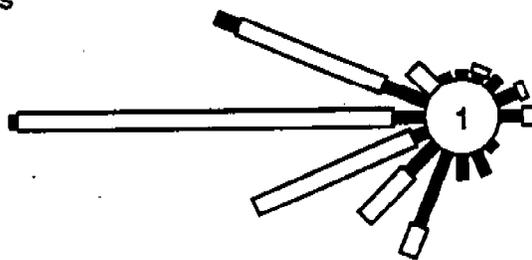
PM



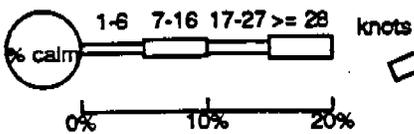
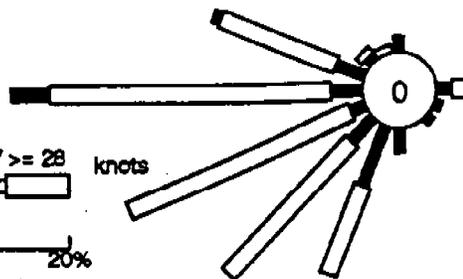
5 years



AM



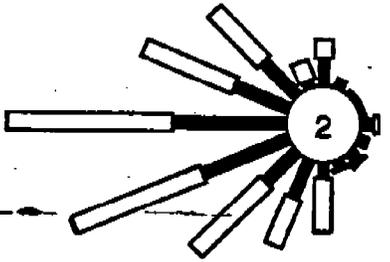
PM



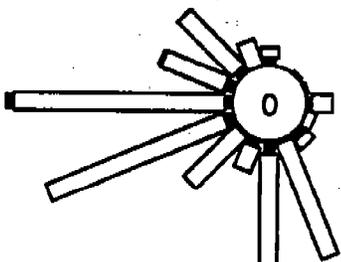
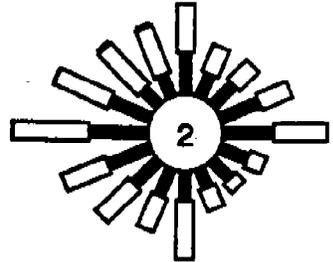
conductive days Portsmouth with Portland Met data

observed highs

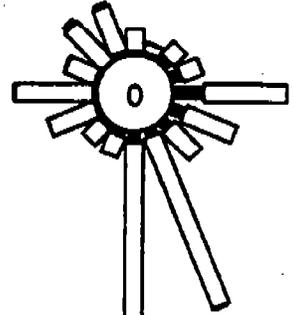
10 years



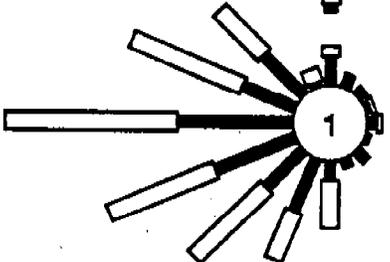
AM



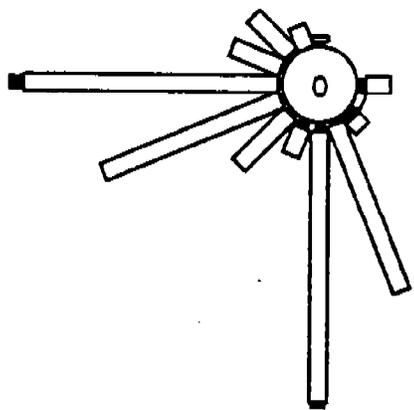
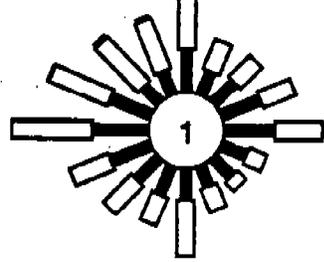
PM



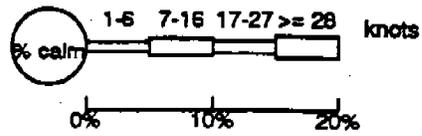
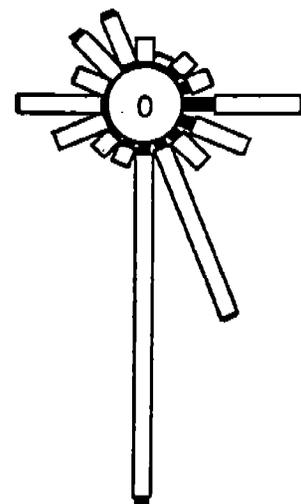
5 years



AM



PM

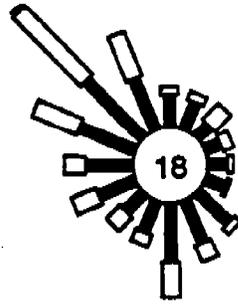
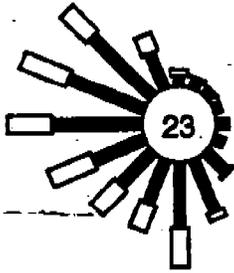


conductive days Portsmouth with Concord Met data

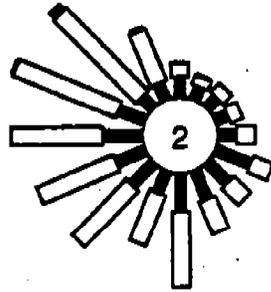
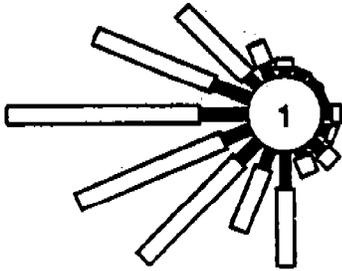
observed highs

10 years

AM

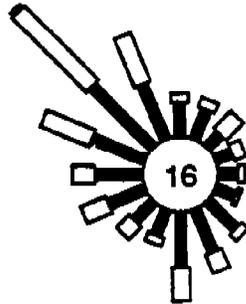
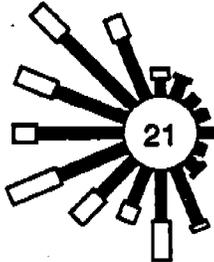


PM

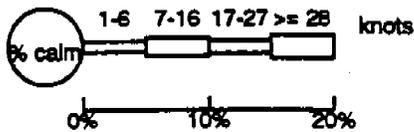
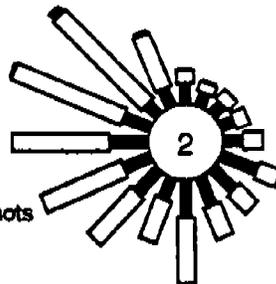
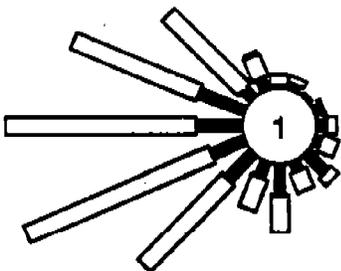


5 years

AM



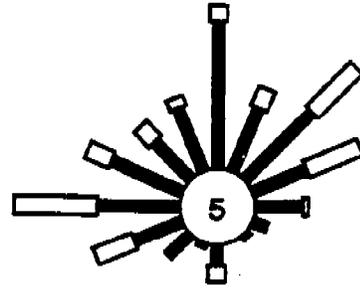
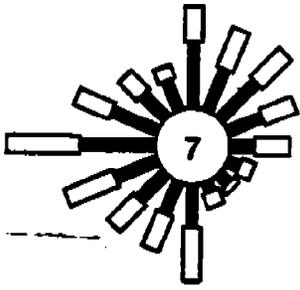
PM



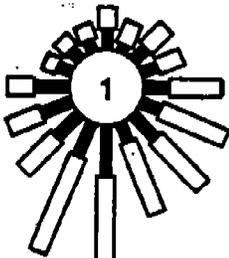
conductive days

Beaumont-Port Arthur TX
10 years

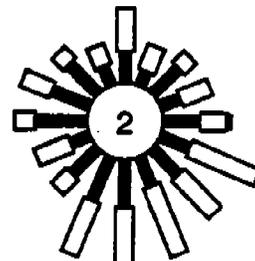
observed highs



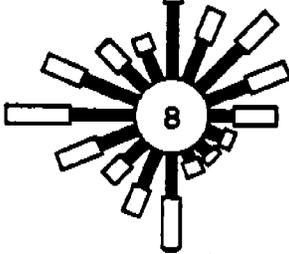
AM



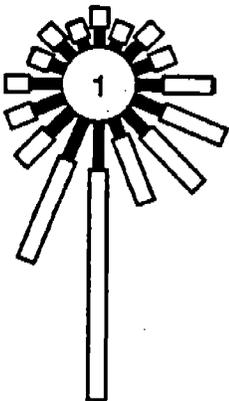
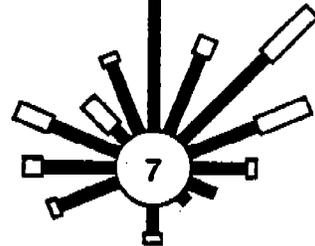
PM



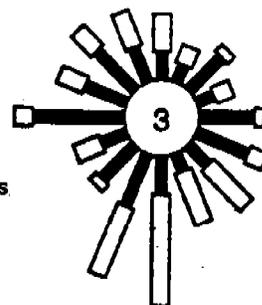
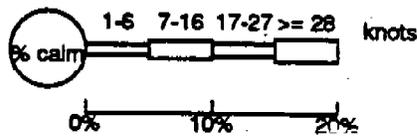
5 years



AM



PM

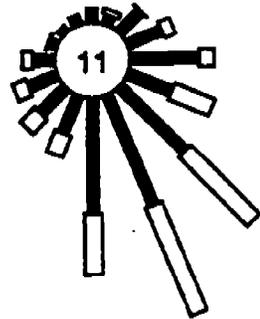
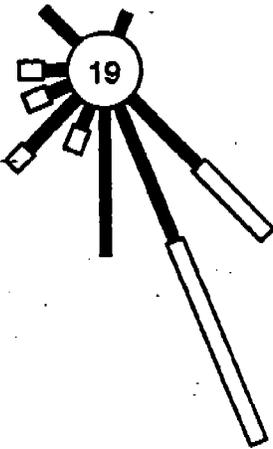


conductive days

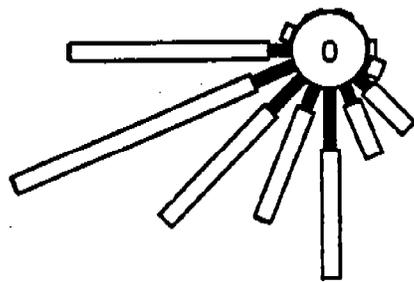
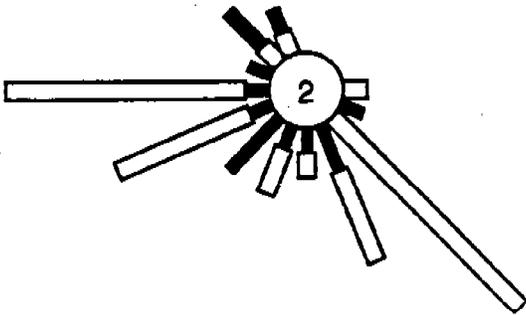
Ventura (Santa Barbara)
10 years

observed highs

AM

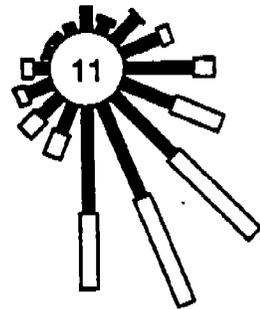
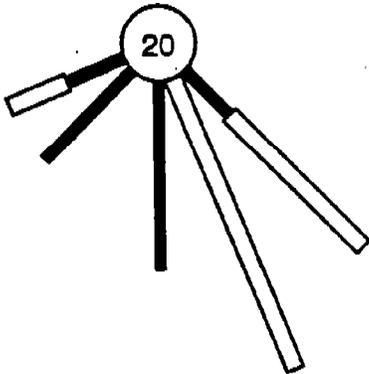


PM

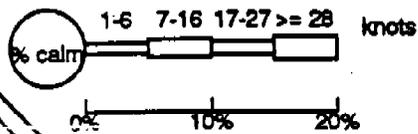
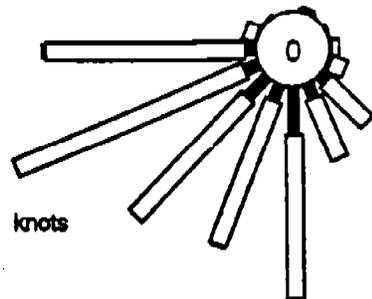
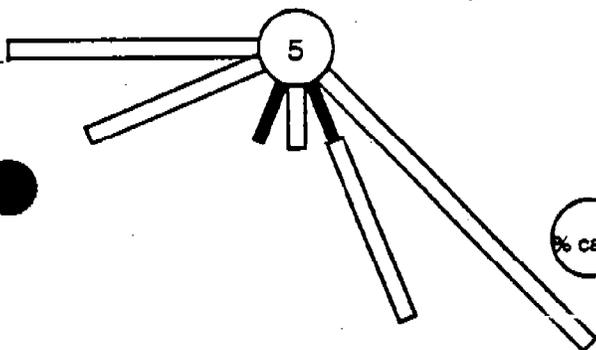


5 years

AM



PM

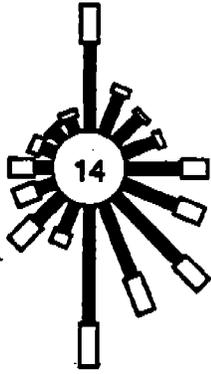


conductive days

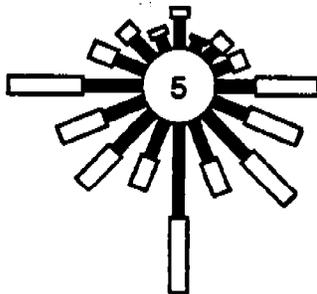
El Paso, TX

observed highs

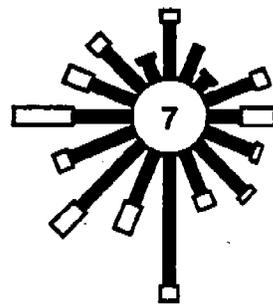
10 years



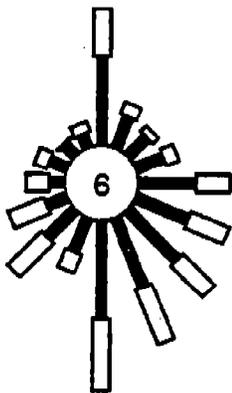
AM



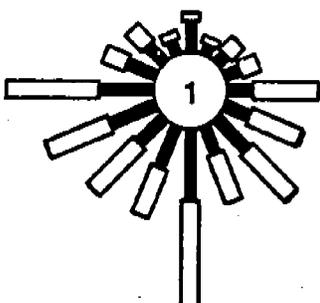
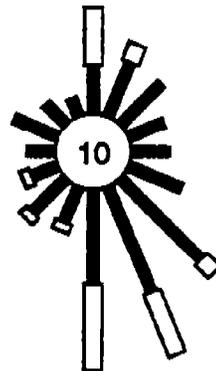
PM



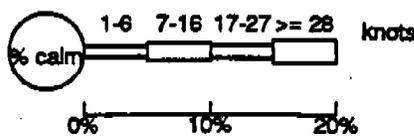
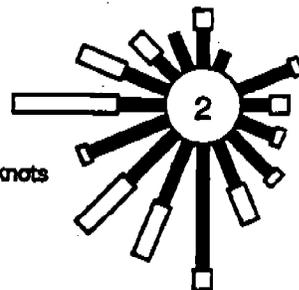
5 years



AM



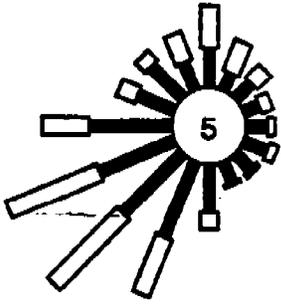
PM



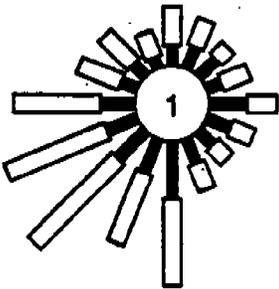
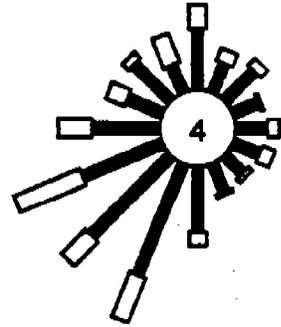
conductive days

Raleigh-Durham NC
10 years

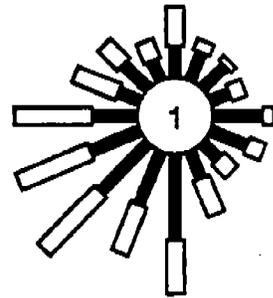
observed highs



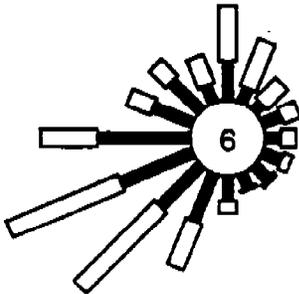
AM



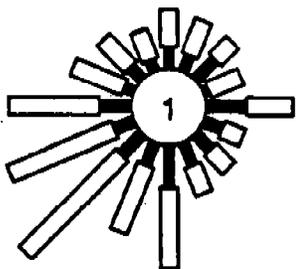
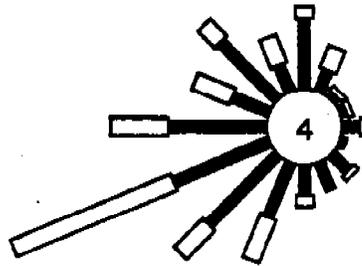
PM



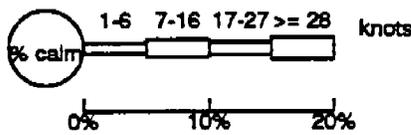
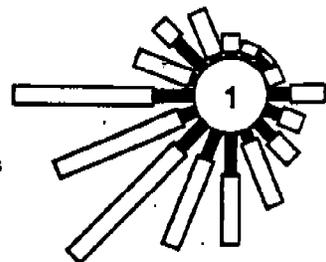
5 years



AM



PM

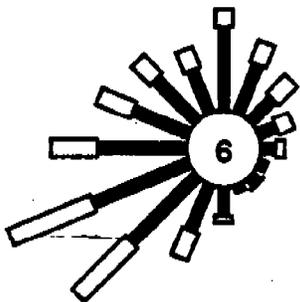


conductive days

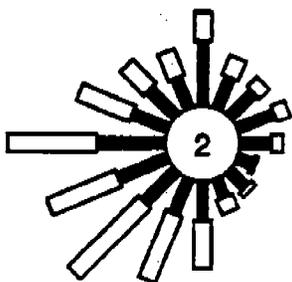
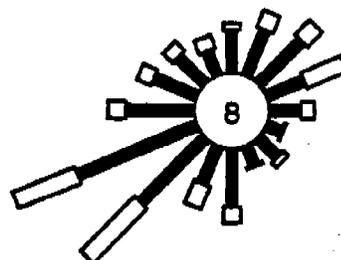
Greensboro-Winston-Salem

observed highs

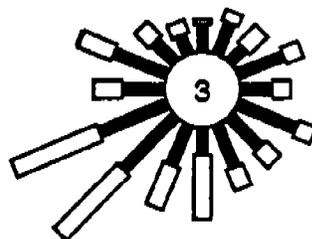
10 years



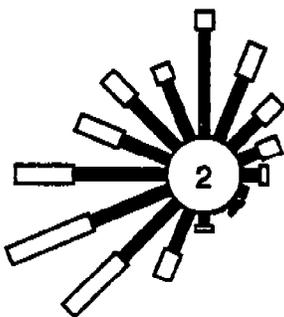
AM



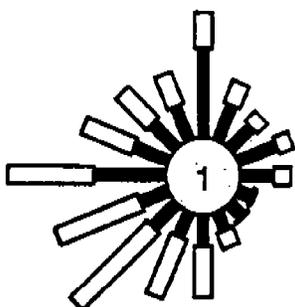
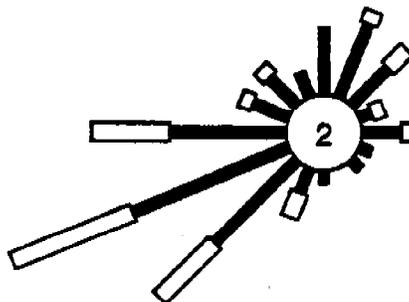
PM



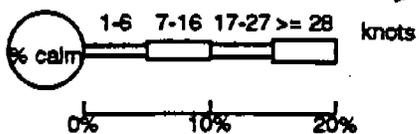
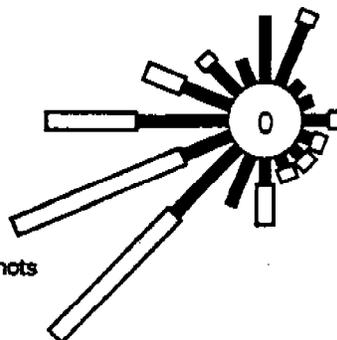
5 years



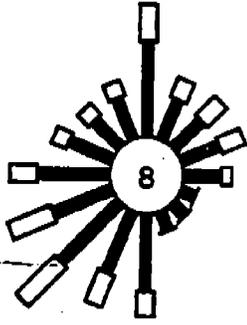
AM



PM



conductive days

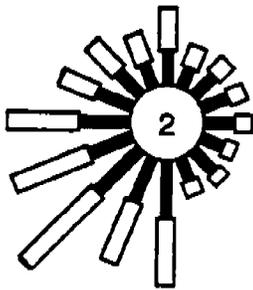
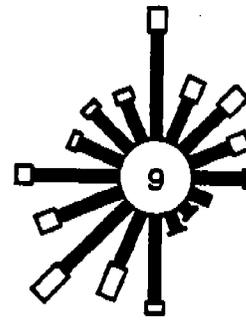


Charlotte NC

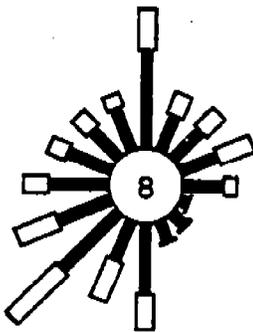
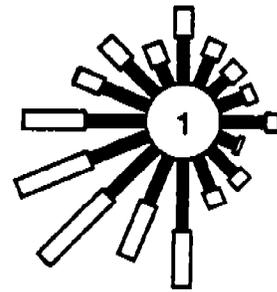
10 years

AM

observed highs

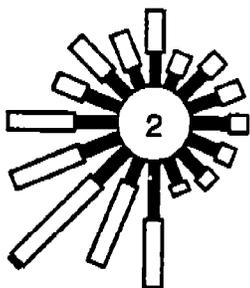
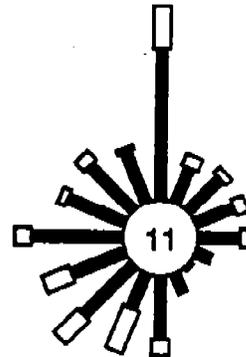


PM

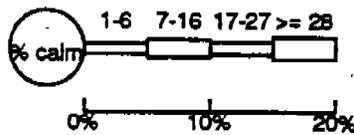
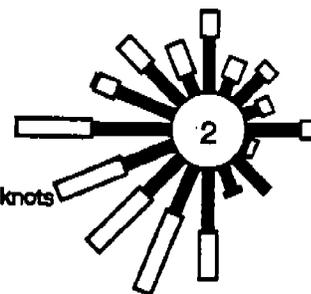


5 years

AM



PM





EPA-454/B-93/051
Appendix G
Revision No. 0
Date: March 1994
Page G-1

APPENDIX G
OUTPUTS FROM THE SCREEN MODEL



*** SCREEN2 MODEL RUN ***
*** VERSION DATED 92245 ***

POINT SOURCE EFFECT ON URBAN PAMS SITE

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = POINT
EMISSION RATE (G/S) = 1.00000
STACK HEIGHT (M) = 12.0000
STK INSIDE DIAM (M) = .5000
STK EXIT VELOCITY (M/S) = 10.0000
STK GAS EXIT TEMP (K) = 298.0000
AMBIENT AIR TEMP (K) = 298.0000
RECEPTOR HEIGHT (M) = 2.0000
URBAN/RURAL OPTION = URBAN
BUILDING HEIGHT (M) = 10.0000
MIN HORIZ BLDG DIM (M) = 50.0000
MAX HORIZ BLDG DIM (M) = 100.0000

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = 6.250 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
50.	822.6	3	1.0	1.0	320.0	15.88	10.89	10.00	SS
100.	610.6	4	1.0	1.0	320.0	17.89	15.69	13.79	SS
200.	378.8	6	1.5	1.6	10000.0	15.13	21.17	14.03	SS
300.	282.9	6	1.0	1.1	10000.0	20.70	31.18	19.93	SS
400.	208.4	6	1.0	1.1	10000.0	20.70	40.85	25.30	SS
500.	156.9	6	1.0	1.1	10000.0	20.70	50.21	30.24	SS
600.	122.2	6	1.0	1.1	10000.0	20.70	59.27	34.82	SS
700.	98.32	6	1.0	1.1	10000.0	20.70	68.06	39.11	SS
800.	81.21	6	1.0	1.1	10000.0	20.70	76.59	43.15	SS
900.	68.54	6	1.0	1.1	10000.0	20.70	84.89	46.97	SS
1000.	58.89	6	1.0	1.1	10000.0	20.70	92.97	50.60	SS
1100.	51.35	6	1.0	1.1	10000.0	20.70	100.83	54.06	SS
1200.	45.34	6	1.0	1.1	10000.0	20.70	108.50	57.37	SS
1300.	40.45	6	1.0	1.1	10000.0	20.70	115.99	60.55	SS
1400.	36.43	6	1.0	1.1	10000.0	20.70	123.30	63.61	SS
1500.	33.06	6	1.0	1.1	10000.0	20.70	130.44	66.56	SS
1600.	30.20	6	1.0	1.1	10000.0	20.70	137.43	69.42	SS
1700.	27.76	6	1.0	1.1	10000.0	20.70	144.27	72.18	SS
1800.	25.66	6	1.0	1.1	10000.0	20.70	150.97	74.86	SS
1900.	23.82	6	1.0	1.1	10000.0	20.70	157.54	77.47	SS
2000.	22.21	6	1.0	1.1	10000.0	20.70	163.98	80.00	SS
2100.	20.79	6	1.0	1.1	10000.0	20.70	170.30	82.47	SS
2200.	19.52	6	1.0	1.1	10000.0	20.70	176.50	84.87	SS
2300.	18.39	6	1.0	1.1	10000.0	20.70	182.59	87.22	SS
2400.	17.38	6	1.0	1.1	10000.0	20.70	188.57	89.52	SS
2500.	16.46	6	1.0	1.1	10000.0	20.70	194.45	91.77	SS
2600.	15.63	6	1.0	1.1	10000.0	20.70	200.24	93.96	SS
2700.	14.87	6	1.0	1.1	10000.0	20.70	205.93	96.12	SS
2800.	14.18	6	1.0	1.1	10000.0	20.70	211.54	98.23	SS
2900.	13.55	6	1.0	1.1	10000.0	20.70	217.05	100.30	SS

02/23/94
14:14:23

*** SCREEN2 MODEL RUN ***
*** VERSION DATED 92245 ***

POINT SOURCE EFFECT ON RURAL PAMS SITE

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = POINT
EMISSION RATE (G/S) = 1.00000
STACK HEIGHT (M) = 12.0000
STK INSIDE DIAM (M) = .5000
STK EXIT VELOCITY (M/S) = 10.0000
STK GAS EXIT TEMP (K) = 298.0000
AMBIENT AIR TEMP (K) = 298.0000
RECEPTOR HEIGHT (M) = 2.0000
URBAN/RURAL OPTION = RURAL
BUILDING HEIGHT (M) = 10.0000
MIN HORIZ BLDG DIM (M) = 50.0000
MAX HORIZ BLDG DIM (M) = 100.0000

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = 6.250 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWAS
50.	976.5	6	3.0	3.3	10000.0	12.23	2.14	5.74	SS
100.	1058.	6	2.5	2.8	10000.0	12.45	4.07	7.75	SS
200.	694.2	6	2.0	2.2	10000.0	13.00	7.73	8.39	SS
300.	546.2	6	2.0	2.2	10000.0	13.00	11.23	9.68	SS
400.	452.9	6	1.5	1.7	10000.0	14.71	14.64	9.96	SS
500.	396.3	6	1.5	1.7	10000.0	14.71	17.97	10.77	SS
600.	355.8	6	1.5	1.7	10000.0	14.71	21.24	11.84	SS
700.	318.5	6	1.5	1.7	10000.0	14.71	24.46	12.85	SS
800.	285.7	6	1.5	1.7	10000.0	14.71	27.63	13.83	SS
900.	257.3	6	1.5	1.7	10000.0	14.71	30.78	14.47	SS
1000.	233.1	6	1.5	1.7	10000.0	14.71	33.88	15.32	SS
1100.	212.2	6	1.5	1.7	10000.0	14.71	36.96	16.14	SS
1200.	200.7	6	1.0	1.1	10000.0	20.37	40.01	15.97	SS
1300.	191.4	6	1.0	1.1	10000.0	20.37	43.04	16.77	SS
1400.	182.1	6	1.0	1.1	10000.0	20.37	46.05	17.56	SS
1500.	173.0	6	1.0	1.1	10000.0	20.37	49.03	18.32	SS
1600.	164.2	6	1.0	1.1	10000.0	20.37	51.99	19.06	SS
1700.	155.9	6	1.0	1.1	10000.0	20.37	54.94	19.79	SS
1800.	148.1	6	1.0	1.1	10000.0	20.37	57.87	20.50	SS
1900.	140.8	6	1.0	1.1	10000.0	20.37	60.78	21.20	SS
2000.	134.1	6	1.0	1.1	10000.0	20.37	63.68	21.63	SS
2100.	127.8	6	1.0	1.1	10000.0	20.37	66.56	22.21	SS
2200.	122.0	6	1.0	1.1	10000.0	20.37	69.42	22.78	SS
2300.	116.5	6	1.0	1.1	10000.0	20.37	72.28	23.34	SS
2400.	111.4	6	1.0	1.1	10000.0	20.37	75.12	23.89	SS
2500.	106.7	6	1.0	1.1	10000.0	20.37	77.95	24.42	SS
2600.	102.3	6	1.0	1.1	10000.0	20.37	80.76	24.95	SS
2700.	98.13	6	1.0	1.1	10000.0	20.37	83.57	25.47	SS
2800.	94.25	6	1.0	1.1	10000.0	20.37	86.36	25.98	SS
2900.	90.61	6	1.0	1.1	10000.0	20.37	89.15	26.48	SS

3000. 12.97 6 1.0 1.1 10000.0 20.70 222.49 102.34 SS
 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 50. M:
 50. 822.6 3 1.0 1.0 320.0 15.88 10.89 10.00 SS

WASH= MEANS NO CALC MADE (CONC = 0.0)
 WASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*** CAVITY CALCULATION - 1 ***	*** CAVITY CALCULATION - 2 ***
CONC (UG/M**3) = .0000	CONC (UG/M**3) = .0000
CRIT WS @10M (M/S) = 99.99	CRIT WS @10M (M/S) = 99.99
CRIT WS @ HS (M/S) = 99.99	CRIT WS @ HS (M/S) = 99.99
DILUTION WS (M/S) = 99.99	DILUTION WS (M/S) = 99.99
CAVITY HT (M) = 10.02	CAVITY HT (M) = 10.00
CAVITY LENGTH (M) = 50.00	CAVITY LENGTH (M) = 38.89
ALONGWIND DIM (M) = 50.00	ALONGWIND DIM (M) = 100.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S. CONC SET = 0.0

 *** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
----- SIMPLE TERRAIN	822.6	50.	0.

 REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

02/24/94
15:30:23

*** SCREEN2 MODEL RUN ***
*** VERSION DATED 92245 ***

AREA SOURCE EFFECT ON RURAL PAMS SITE

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = AREA
EMISSION RATE (G/(S-M**2)) = .400000E-03
SOURCE HEIGHT (M) = 12.0000
LENGTH OF SIDE (M) = 50.0000
RECEPTOR HEIGHT (M) = 2.0000
URBAN/RURAL OPTION = RURAL

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = .000 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
50.	690.1	1	1.0	1.0	320.0	12.00	6.80	10.20	NO
100.	668.8	2	1.0	1.0	320.0	12.00	14.24	12.74	NO
200.	629.0	4	1.0	1.0	320.0	12.00	13.53	9.30	NO
300.	582.7	5	1.0	1.1	10000.0	12.00	15.43	9.17	NO
400.	555.0	5	1.0	1.1	10000.0	12.00	20.58	11.26	NO
500.	523.5	6	1.0	1.1	10000.0	12.00	17.03	8.68	NO
600.	523.6	6	1.0	1.1	10000.0	12.00	20.32	9.96	NO
700.	495.7	6	1.0	1.1	10000.0	12.00	23.55	11.16	NO
800.	457.8	6	1.0	1.1	10000.0	12.00	26.74	12.20	NO
900.	418.9	6	1.0	1.1	10000.0	12.00	29.89	13.20	NO
1000.	382.1	6	1.0	1.1	10000.0	12.00	33.01	14.14	NO
1100.	349.0	6	1.0	1.1	10000.0	12.00	36.10	15.00	NO
1200.	319.4	6	1.0	1.1	10000.0	12.00	39.16	15.84	NO
1300.	293.1	6	1.0	1.1	10000.0	12.00	42.19	16.64	NO
1400.	269.7	6	1.0	1.1	10000.0	12.00	45.20	17.43	NO
1500.	249.0	6	1.0	1.1	10000.0	12.00	48.19	18.20	NO
1600.	230.6	6	1.0	1.1	10000.0	12.00	51.16	18.94	NO
1700.	214.1	6	1.0	1.1	10000.0	12.00	54.11	19.67	NO
1800.	199.4	6	1.0	1.1	10000.0	12.00	57.04	20.39	NO
1900.	186.2	6	1.0	1.1	10000.0	12.00	59.96	21.09	NO
2000.	174.4	6	1.0	1.1	10000.0	12.00	62.86	21.76	NO
2100.	164.2	6	1.0	1.1	10000.0	12.00	65.75	22.34	NO
2200.	154.9	6	1.0	1.1	10000.0	12.00	68.62	22.90	NO
2300.	146.5	6	1.0	1.1	10000.0	12.00	71.47	23.46	NO
2400.	138.7	6	1.0	1.1	10000.0	12.00	74.32	24.01	NO
2500.	131.7	6	1.0	1.1	10000.0	12.00	77.15	24.54	NO
2600.	125.2	6	1.0	1.1	10000.0	12.00	79.97	25.07	NO
2700.	119.2	6	1.0	1.1	10000.0	12.00	82.78	25.58	NO
2800.	113.7	6	1.0	1.1	10000.0	12.00	85.58	26.09	NO
2900.	108.6	6	1.0	1.1	10000.0	12.00	88.36	26.59	NO
3000.	103.9	6	1.0	1.1	10000.0	12.00	91.14	27.07	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 50. M:

59. 703.2 1 1.0 1.0 320.0 12.00 9.57 11.54 NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	703.2	59.	0.

** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

02/24/94
15:33:02

*** SCREEN2 MODEL RUN ***
*** VERSION DATED 92245 ***

AREA SOURCE EFFECT ON URBAN PAMS SITE

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = AREA
EMISSION RATE (G/(S-M**2)) = .400000E-03
SOURCE HEIGHT (M) = 12.0000
LENGTH OF SIDE (M) = 50.0000
RECEPTOR HEIGHT (M) = 2.0000
URBAN/RURAL OPTION = URBAN

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = .000 M**4/S**2.

*** FULL METEOROLOGY ***

*** SCREEN AUTOMATED DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
50.	667.8	3	1.0	1.0	320.0	12.00	4.77	14.36	NO
100.	621.0	5	1.0	1.1	10000.0	12.00	7.79	8.96	NO
200.	561.6	5	1.0	1.1	10000.0	12.00	18.28	15.37	NO
300.	365.2	5	1.0	1.1	10000.0	12.00	28.39	21.14	NO
400.	246.5	5	1.0	1.1	10000.0	12.00	38.16	26.41	NO
500.	177.4	5	1.0	1.1	10000.0	12.00	47.60	31.26	NO
600.	134.6	5	1.0	1.1	10000.0	12.00	56.74	35.78	NO
700.	106.3	5	1.0	1.1	10000.0	12.00	65.61	40.01	NO
800.	86.75	5	1.0	1.1	10000.0	12.00	74.21	44.00	NO
900.	72.55	5	1.0	1.1	10000.0	12.00	82.57	47.77	NO
1000.	61.90	5	1.0	1.1	10000.0	12.00	90.71	51.36	NO
1100.	53.67	5	1.0	1.1	10000.0	12.00	98.63	54.79	NO
1200.	47.18	5	1.0	1.1	10000.0	12.00	106.36	58.07	NO
1300.	41.94	5	1.0	1.1	10000.0	12.00	113.89	61.23	NO
1400.	37.65	5	1.0	1.1	10000.0	12.00	121.25	64.26	NO
1500.	34.08	5	1.0	1.1	10000.0	12.00	128.44	67.19	NO
1600.	31.07	5	1.0	1.1	10000.0	12.00	135.48	70.03	NO
1700.	28.50	5	1.0	1.1	10000.0	12.00	142.36	72.77	NO
1800.	26.29	5	1.0	1.1	10000.0	12.00	149.10	75.44	NO
1900.	24.37	5	1.0	1.1	10000.0	12.00	155.70	78.02	NO
2000.	22.70	5	1.0	1.1	10000.0	12.00	162.17	80.54	NO
2100.	21.22	5	1.0	1.1	10000.0	12.00	168.53	83.00	NO
2200.	19.90	5	1.0	1.1	10000.0	12.00	174.76	85.39	NO
2300.	18.73	5	1.0	1.1	10000.0	12.00	180.88	87.73	NO
2400.	17.68	5	1.0	1.1	10000.0	12.00	186.89	90.01	NO
2500.	16.74	5	1.0	1.1	10000.0	12.00	192.80	92.25	NO
2600.	15.88	5	1.0	1.1	10000.0	12.00	198.62	94.44	NO
2700.	15.10	5	1.0	1.1	10000.0	12.00	204.34	96.58	NO
2800.	14.39	5	1.0	1.1	10000.0	12.00	209.96	98.69	NO
2900.	13.74	5	1.0	1.1	10000.0	12.00	215.50	100.75	NO
3000.	13.14	5	1.0	1.1	10000.0	12.00	220.96	102.77	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 50. M:
64. 683.0 4 1.0 1.0 320.0 12.00 5.84 12.00 NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

3000. 87.20 6 1.0 1.1 10000.0 20.37 91.92 26.98 SS
 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 50. M:
 100. 1058. 6 2.5 2.8 10000.0 12.45 4.07 7.75 SS

DWASH= MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** SCREEN DISCRETE DISTANCES ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
-------------	-------------------	------	---------------	---------------	---------------	-----------------	----------------	----------------	-------

DWASH= MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*** CAVITY CALCULATION - 1 ***	*** CAVITY CALCULATION - 2 ***
CONC (UG/M**3) = .0000	CONC (UG/M**3) = .0000
CRIT WS @10M (M/S) = 99.99	CRIT WS @10M (M/S) = 99.99
CRIT WS @ HS (M/S) = 99.99	CRIT WS @ HS (M/S) = 99.99
DILUTION WS (M/S) = 99.99	DILUTION WS (M/S) = 99.99
CAVITY HT (M) = 10.02	CAVITY HT (M) = 10.00
CAVITY LENGTH (M) = 50.00	CAVITY LENGTH (M) = 38.89
ALONGWIND DIM (M) = 50.00	ALONGWIND DIM (M) = 100.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S. CONC SET = 0.0

 *** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	1058.	100.	0.

 ** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

*** SUMMARY OF SCREEN MODEL RESULTS ***

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	683.0	64.	0.

** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **

APPENDIX H

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS





U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Atmospheric Research and Exposure
Assessment Laboratory
Methods Research & Development Division (MD-77)
Research Triangle Park, North Carolina 27711
919 541-2622 or 919 541-4599
FTS 629-2622 or FTS 629-4599

* * * * *
* Previous Revision: February 8, 1993
* * * * *
* New Designations:
* * * * *
* Advanced Pollution Instrumentation, Inc
* Model 300 Gas Filter Correlation CO Analyzer
* * * * *

Issue Date: November 12, 1993

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

These methods for measuring ambient concentrations of specified air pollutants have been designated as "reference methods" or "equivalent methods" in accordance with Title 40, Part 53 of the Code of Federal Regulations (40 CFR Part 53). Subject to any limitations (e.g., operating range) specified in the applicable designation, each method is acceptable for use in state or local air quality surveillance systems under 40 CFR Part 58 unless the applicable designation is subsequently canceled. Automated methods are acceptable for use at temperatures between 20°C and 30°C and line voltages between 105 and 125 volts unless wider limits are specified in the method description.

Prospective users of the methods listed should note (1) that each method must be used in strict accordance with the operation or instruction manual and with applicable quality assurance procedures, and (2) that modification of a method by its vendor or user may cause the pertinent designation to be inapplicable to the method as modified. (See Section 2.8 of Appendix C, 40 CFR Part 58 for approval of modifications to any of these methods by users.)

Further information concerning particular designations may be found in the *Federal Register* notice cited for each method or by writing to the Atmospheric Research & Exposure Assessment Laboratory, Methods Research & Development Division (MD-77), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Technical information concerning the methods should be obtained by writing to the "source" listed for each method. New analyzers or PM₁₀ samplers sold as reference or equivalent methods must carry a label or sticker identifying them as designated methods. For analyzers or PM₁₀ samplers sold prior to the designation, the model number does not necessarily identify an analyzer or sampler as a designated method. Consult the manufacturer or seller to determine if a previously sold analyzer or sampler can be considered a designated method, or if it can be upgraded to designation status. Analyzer users who experience operational or other difficulties with a designated analyzer or sampler and are unable to resolve the problem directly with the instrument manufacturer may contact EPA (preferably in writing) at the above address for assistance.

This list will be revised as necessary to reflect any new designations or any cancellation of a designation currently in effect. The most current revision of the list will be available for inspection at EPA's Regional Offices, and copies may be obtained by writing to the Atmospheric Research & Exposure Assessment Laboratory at the address specified above.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR OR AUTO EQUIV.		FED. REGISTER NOTICE	
			VOL.	PAGE	VOL.	PAGE
*****	Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)	<u>PARTICULATE MATTER - TSP</u> 40 CFR Part 50, Appendix B	Manual Ref.	47 48	54912 17355	12/06/82 04/22/83
*****	Reference Method for the Determination of Particulate Matter as PM ₁₀ in the Atmosphere	<u>PARTICULATE MATTER - PM₁₀</u> 40 CFR Part 50, Appendix J	Manual Ref.	52 52	24664 29467	07/01/87 08/07/87
IFPS-1087-062	"Wedding & Associates' PM ₁₀ Critical Flow High-Volume Sampler," consisting of the following components: Wedding PM ₁₀ Inlet Wedding & Associates' Critical Flow Device Wedding & Associates' Anodized Aluminum Shelter 115, 220 or 240 VAC Motor Blower Assembly Mechanical Timer Or Optional Digital Timer Elapsed Time Indicator Filter Cartridge/Cassette	Wedding & Associates, Inc. P.O. Box 1756 Fort Collins, CO 80522	Manual Ref.	52	37366	10/06/87
IFPS-1287-063	"Sierra-Andersen or General Metal Works Model I200 PM ₁₀ High-Volume Air Sampler System," consisting of a Sierra-Andersen or General Metal Works Model I200 PM ₁₀ Size-Selective Inlet and any of the high-volume air samplers identified as SAUV-10H, SAUV-11H, GMW-IP-10, GMW-IP-10-70, GMW-IP-10-801, or GMW-IP-10-8000, which include the following components: Anodized aluminum high-volume shelter with either acrylonitrile butadiene styrene plastic filter holder and motor/blower housing or stainless steel filter holder and phenolic plastic motor/blower housing; 0.6 hp motor/blower; pressure transducer flow recorder; either an electronic mass flow controller or a volumetric flow controller; either a digital timer/programmer, seven-day mechanical timer, six-day timer/programmer, or solid-state timer/programmer; elapsed time indicator; and filter cartridge.	Andersen Samplers, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336 or General Metal Works, Inc. 145 South Miami Cleveland, OH 45002	Manual Ref.	52 53	45684 1062	12/01/87 01/15/88

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE	
			OR AUTO EQUIV.	VOL. PAGE

IDENTIFICATION

PARTICULATE MATTER - PM₁₀ (Continued)

RFPS-1287-064	"Sierra-Andersen or General Metal Works Model 321-B PM ₁₀ High-Volume Air Sampler System," consisting of a Sierra-Andersen or General Metal Works Model 321-B PM ₁₀ Size-Selective Inlet and any of the high-volume air samplers identified as SAUV-10H, SAUV-11H, GMW-IP-10, GMW-IP-10-70, GMW-IP-10-801, or GMW-IP-10-8000,	Andersen Samplers, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336 or General Metal Works, Inc. 145 South Miami Clevel, OH 45002	52 53	45684 1062	12/01/87 01/15/88
---------------	---	--	----------	---------------	----------------------

which include the following components:

Anodized aluminum high-volume shelter with either acrylonitrile butadiene styrene plastic filter holder and motor/blower housing or stainless steel filter holder and phenolic plastic motor/blower housing; 0.6 hp motor/blower; pressure transducer flow recorder; either an electronic mass flow controller or a volumetric flow controller; either a digital timer/programmer, seven-day mechanical timer, six-day timer/programmer, or solid-state timer/programmer; elapsed time indicator; and filter cartridge.

RFPS-1287-065	"Sierra-Andersen or General Metal Works Model 321-C PM ₁₀ High-Volume Air Sampler System," consisting of a Sierra-Andersen or General Metal Works Model 321-C PM ₁₀ Size-Selective Inlet and any of the high-volume air samplers identified as SAUV-10H, SAUV-11H, GMW-IP-10, GMW-IP-10-70, GMW-IP-10-801, or GMW-IP-10-8000,	Andersen Samplers, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336 or General Metal Works, Inc. 145 South Miami Clevel, OH 45002	52 53	45684 1062	12/01/87 01/15/88
---------------	---	--	----------	---------------	----------------------

which include the following components:

Anodized aluminum high-volume shelter with either acrylonitrile butadiene styrene plastic filter holder and motor/blower housing or stainless steel filter holder and phenolic plastic motor/blower housing; 0.6 hp motor/blower; pressure transducer flow recorder; either an electronic mass flow controller or a volumetric flow controller; either a digital timer/programmer, seven-day mechanical timer, six-day timer/programmer, or solid-state timer/programmer; elapsed time indicator; and filter cartridge.

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO EQUIV.	FED. REGISTER VOL.	NOTICE PAGE
--------------------	----------------	--------	-----------------------	--------------------	-------------

PARTICULATE MATTER - PM₁₀ (Continued)

RFPS-0389-071	"Oregon DEQ Medium Volume PM ₁₀ Sampler"	State of Oregon Department of Environmental Quality Air Quality Division 811 S.W. Sixth Avenue Portland, OR 97204	Manual Ref.	54	12273 03/24/89
---------------	---	---	-------------	----	----------------

NOTE: This method is not now commercially available.

RFPS-0789-073	"Sierra-Andersen Models SA241 and SA241M or General Metal Works Models G241 and G241M PM ₁₀ Dichotomous Samplers," consisting of the following components: Sampling Module with SA246b or G246b 10 µm inlet, 2.5 µm virtual impactor assembly, 37 mm coarse and fine particulate filter holders, and tripod mount; Control Module with diaphragm vacuum pump, rotameters and vacuum gauges, pressure switch timer/programmer or 7-day skip timer, and elapsed time indicator;	Andersen Samplers, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336 or General Metal Works, Inc. 145 South Miami Clevles, OH 45002	Manual Ref.	54	31247 07/27/89
---------------	--	---	-------------	----	----------------

EQPM-0990-076	"Andersen Instruments Model FH62I-N PM ₁₀ Beta Attenuation Monitor," consisting of the following components: FH101 Vacuum Pump Assembly FH102 Accessory Kit FH107 Roof Flange Kit FH125 Zero and Span PM ₁₀ Mass Foil Calibration Kit FH62I Beta Attenuation 19-inch Control Module SA246b PM ₁₀ Inlet. (16.7 liter/min) operated for 24-hour average measurements, with a glass fiber filter tape, an automatic filter advance after each 24-hour sample period, and with or without either of the following options: FH0PI Indoor Cabinet FH0P2 Outdoor Shelter Assembly	Andersen Instruments, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336 Andersen Instruments, Auto Equiv. 55 38387 09/18/90	Auto Equiv.	55	38387 09/18/90
---------------	--	---	-------------	----	----------------

DESIGNATION
NUMBER

IDENTIFICATION

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

SOURCE

PARTICULATE MATTER - PM₁₀ (Continued)

EQPM-1090-079	"Rupprecht & Patashnick TEOM Series 1400 and Series 1400a PM-10 Monitors," consisting of the following components: TEOM Sensor Unit TEOM Control Unit Flow Splitter Teflon-Coated Glass Fiber Filter Cartridges Rupprecht & Patashnick PM-10 Inlet (part number 57-00596) or Sierra-Andersen Model 246b PM-10 Inlet (16.7 liter/min) operated for 24-hour average measurements, with the total mass averaging time set at 300 seconds, the gate time set at 2 seconds, and with or without any of the following options: Tripod Outdoor Enclosure Automatic Cartridge Collection Unit (Series 1400a only)	Rupprecht & Patashnick Company, Inc. 8 Corporate Circle Albany, NY 12203	Auto	Equiv.	55	43406	10/29/90
EQPM-0391-081	"Wedding & Associates' PM ₁₀ Beta Gauge Automated Particle Sampler," consisting of the following components: Particle Sampling Module PM ₁₀ Inlet (18.9 liter/min) Inlet Tube and Support Ring Vacuum Pump (115 VAC/60 Hz or 220-240 VAC/50 Hz) operated for 24-hour average measurements with glass fiber filter tape.	Wedding & Associates, Inc. P.O. Box 1756 Fort Collins, CO 80522	Auto	Equiv.	56	9216	03/05/91

February 8, 1993 LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS Page 6

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE		DATE
			OR AUTO EQUIV.	VOL. PAGE	
*****	Reference Method for the Determination of Sulfur Dioxide in the Atmosphere (Pararosaniline Method)	SULFUR DIOXIDE 40 CFR Part 50, Appendix A	Manual Ref.	47 54899 48 17355	12/06/82 04/22/83
EQS-0775-001	"Pararosaniline Method for the Determination of Sulfur Dioxide in the Atmosphere-Technicon I Automated Analysis System"	Atmospheric Research & Exposure Assessment Laboratory Department E (MD-77) U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv.	40 34024	08/13/75
EQS-0775-002	"Pararosaniline Method for the Determination of Sulfur Dioxide in the Atmosphere-Technicon II Automated Analysis System"	Atmospheric Research & Exposure Assessment Laboratory Department E (MD-77) U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv	40 34024	08/13/75
EQSA-1275-005	"Lear Siegler Model SM1000 SO ₂ Ambient Monitor," operated on the 0-0.5 ppm range, at a wavelength of 299.5 nm, with the "slow" (300 second) response time, with or without any of the following options: SM-1 Internal Zero/Span SM-2 Span Timer Card SM-3 0-0.1 Volt Output SM-4 0-5 Volt Output SM-5 Alternate Sample Pump SM-6 Outdoor Enclosure	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto Equiv.	41 3893 41 32946 42 13044 45 1147	01/27/76 08/06/76 03/08/77 01/04/80

DESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR FED. REGISTER NOTICE OR AUTO EQUIV. VOL. PAGE DATE

SULFUR DIOXIDE (Continued)

EQSA-1275-006 "Moloy Model SA185-2A Sulfur Dioxide Analyzer," operated on the 0-0.5 ppm range, with or without any of the following options:
 S-1 Linearized Output
 S-2 Modified Recorder Output
 S-5 Teflon-Coated Block
 S-6A Reignite Timer Circuit
 S-7 Press To Read
 S-11A Manual Zero And Span
 S-11B Automatic Zero And Span
 S-13 Status Lights
 S-14 Output Booster Amplifier
 S-14B Line Transmitter Board
 or operated on the 0-1.0 ppm range with either option S-36 or options S-1 and S-24, with or without any of the other options.

Columbia Scientific Industries
 11950 Jollyville Road
 Austin, TX 78759

S-18 Rack Mount Conversion
 S-18A Rack Mount Conversion
 S-21 Front Panel Digital Volt Meter
 S-22 Remote Zero/Span Control Control And Status (Timer)
 S-22A Remote Zero/Span Control
 S-23 Automatic Zero Adjust
 S-23A Automatic/Manual Zero Adjust

S-24 Dual Range Linearized Output
 S-33 Remote Range Control And Status (Signals)
 S-34 Remote Control
 S-35 Front Panel Digital Meter With BCD Output
 S-36 Dual Range Log-Linear Output
 S-38 Sampling Mode Status

Auto Equip. 41 3893 01/27/76
 43 38088 08/25/78

EQSA-0276-009 "Thermo Electron Model 43 Pulsed Fluorescent SO₂ Analyzer," equipped with an aromatic hydrocarbon cutter and operated on a range of either 0-0.5 or 0-1.0 ppm, with or without any of the following options:
 001 Rack Mounting For Standard 19 Inch Relay Rack
 002 Automatic Actuation Of Zero And Span Solenoid Valves
 003 Type S Flash Lamp Power Supply
 004 Low Flow

Thermo Environmental Instruments, Inc.
 8 West Forge Parkway
 Franklin, MA 02038

Auto Equip. 41 8531 02/27/76
 41 15363 04/12/76
 42 20490 04/20/77
 44 21861 04/12/79
 45 2700 01/14/80
 45 32419 05/16/80

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

DESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR OR AUTO EQUIV. VOL. PAGE NOTICE DATE

EQSA-0676-010 "Philips PW9755 SO₂ Analyzer," consisting of the following components:
 PW9755/02 SO₂ Monitor with:
 PW9741/00 SO₂ Source
 PW9721/00 Filter Set SO₂
 PW9711/00 Electrolyte SO₂
 PW9750/00 Supply Cabinet
 PW9750/10 Supply Unit/Coulometric
 Either PW9731/00 Sampler or PW9731/20 Dust Filter (or vendor-approved alternate particulate filter); operated with a 0-0.5 ppm range and with a reference voltage setting of 760 millivolts; with or without any of the following options:
 PW9750/30 Frame For MTT
 PW9750/41 Control Clock 60 Hz

SULFUR DIOXIDE (Continued)
 Philips Electronic Instruments, Inc.
 85 McKee Drive
 Mahwah, NJ 07430
 Auto Equip. 41 26252 06/25/76
 41 46019 10/19/76
 42 28571 06/03/77
 PW9752/00 Air Sampler Manifold
 PW9754/00 Air Distributor
 PW9753/00 Mounting Rack For Accessories

EQSA-0876-011 "Philips PW9700 SO₂ Analyzer," consisting of the following components:
 PW9710/00 Chemical Unit with:
 PW9711/00 Electrolyte SO₂
 PW9721/00 Filter Set SO₂
 PW9740/00 SO₂ Source
 PW9720/00 Electrical Unit
 PW9730/00 Sampler Unit (or vendor-approved alternate particulate filter); operated with a 0-0.5 ppm range and with a reference voltage of 760 millivolts.

EQSA-0876-013 "Monitor Labs Model 8450 Sulfur Monitor," operated on a range of either 0-0.5 or 0-1.0 ppm, with a 5 second time constant, a model 8740 hydrogen sulfide scrubber in the sample line, with or without any of the following options:
 BP Bipolar Signal Processor
 CLO Current Loop Output
 DO Status Remote Interface
 Lear Siegler Measurement Controls Corporation
 74 Inverness Drive East
 Englewood, CO 80112-5189
 Auto Equip. 41 36245 08/27/76
 44 33476 06/11/79
 IZS Internal Zero/Span Module
 TF TFE Sample Particulate Filter
 V Zero/Span Valves
 VT Zero/Span Valves And Timer

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

February 8, 1993

ESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR OR AUTO EQUIV. VOL. PAGE NOTICE DATE

SULFUR DIOXIDE (Continued)

QSA-0877-024 "ASARCO Model 500 Sulfur Dioxide Monitor," operated on a 0-0.5 ppm range; or "ASARCO Model 600 Sulfur Dioxide Monitor," operated on a 0-1.0 ppm range. (Both models are identical except the range.) ASARCO Incorporated 3422 South 700 West Salt Lake City, UT 84119 Auto Equiv. 42 44 44264 67522 09/02/77 11/26/79

NOTE: This method is not now commercially available.

QSA-0678-029 "Beckman Model 953 Fluorescent Ambient SO₂ Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with a time constant setting of 2, 2.5, or 3 minutes, a 5 to 10 micron membrane filter element installed in the rear-panel filter assembly, with or without any of the following options:
 a. Remote Operation Kit, Catalog No. 641984
 b. Digital Panel Meter, Catalog No. 641710
 c. Rack Mount Kit, Catalog No. 641709
 d. Panel Mount Kit, Catalog No. 641708 Beckman Instruments, Inc. Process Instruments Division 2500 Harbor Boulevard Fullerton, CA 92634 Auto Equiv. 43 35995 08/14/78

QSA-1078-030 "Bendix Model 8303 Sulfur Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with a Teflon filter installed on the sample inlet of the H₂S scrubber assembly. Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901 Auto Equiv. 43 50733 10/31/78

DESIGNATION
NUMBER

IDENTIFICATION

SOURCE
OR AUTO EQUIV. VOL. PAGEMANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

EQSA-1078-032 "Moloy Model SA285E Sulfur Dioxide Analyzer," operated on the following ranges and time constant switch positions:

Columbia Scientific Industries
11950 Jollyville Road
Austin, TX 78759

Auto Equip. 43 50733

10/31/78

Range, ppb Time Constant Setting

0-50* 1 or 10
0-100* 1 or 10
0-500 off, 1 or 10
0-1000 off, 1 or 10

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

The analyzer may be operated at temperatures between 10°C and 40°C and at line voltages between 105 and 130 volts, with or without any of the following options:

S-5 Teflon Coated Block S-30 Auto Reignite
S-14B Line Transmitter Board S-32 Remote Range Control And Status
S-18 Rack Mount Conversion S-35 Front Panel Digital Meter With BCD Output
S-18A Rack Mount Conversion S-37 Temperature Status Lights
S-21 Front Panel Digital Meter S-38 Sampling Mode Status
S-22 Remote Zero/Span Control
And Status (Timer)
S-22A Remote Zero/Span ControlEQSA-0779-039 "Monitor Labs Model 8850 Fluorescent SO₂ Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with an internal time constant setting of 55 seconds, a TFE sample filter installed on the sample inlet line, with or without any of the following options:Lear Siegler Measurement Controls Corporation
74 Inverness Drive East
Englewood, CO 80112-5189

Auto Equip. 44 44616

07/30/79

03A Rack 013 Recorder Output Options
03B Slides 014 DAS Output Options
05A Valves Zero/Span 017 Low Flow Option
06A IZS Internal Zero/Span Source 010 Status Output W/Connector 018 Kicker

<u>DESIGNATION NUMBER</u>	<u>IDENTIFICATION</u>	<u>SOURCE</u>	<u>MANUAL OR AUTO EQUIV.</u>	<u>FED. REGISTER VOL.</u>	<u>NOTICE PAGE</u>	<u>DATE</u>
---------------------------	-----------------------	---------------	------------------------------	---------------------------	--------------------	-------------

SULFUR DIOXIDE (Continued)

EQSA-0580-046	"Meloy Model SA 700 Fluorescence Sulfur Dioxide Analyzer," operated on the 0-250 ppb*, the 0-500 ppm, or the 0-1000 ppb range with a time constant switch position of either 2 or 3. The analyzer may be operated at temperatures between 20°C and 30°C and at line voltages between 105 and 130 volts, with or without any of the following options: FS-1 Current Output FS-2 Rack Mount Conversion FS-2A Rack Mount Conversion	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	45	31488	05/13/80
	FS-2B Rack Mount Conversion		Auto/Manual Zero/Span With Status			
	FS-3 Front Panel Mounted Digital Meter		Remote/Manual Zero/Span With Status			
			FS-7 Auto Zero Adjust			

*NOTE: Users should be aware that designation of this analyzer for operation on a range less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of this lower range does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

EQSA-1280-049	"Lear Siegler Model AM2020 Ambient SO ₂ Monitor," operated on a range of either 0-0.5 or 0-1.0 ppm, at a wavelength of 299.5 nm, with a 5 minute integration period, over any 10°C temperature range between 20°C and 45°C, with or without the automatic zero and span correction feature.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	45	79574	12/01/80
			Equiv.	46	9997	01/30/81

DESIGNATION
NUMBER

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

IDENTIFICATION

SOURCE

SULFUR DIOXIDE (Continued)

EQSA-0486-060	"Thermo Environmental Instruments, Inc. Model 43A or 43B Pulsed Fluorescence SO ₂ Analyzer," operated on the 0-0.1 ppm*, the 0-0.2 ppm*, the 0-0.5 ppm, or the 0-1.0 ppm range, with either a high or a low time constant setting (Model 43A) and with or without any of the following options: 001 Teflon Particulate Filter 002 19" Rack Mounting Configuration 003 Internal Zero/Span Valves 004 High Flow Rate (1 LPM) 005 Current Output	Auto	51	12390	04/10/86
		Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038			

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

EQSA-1086-061	"Dasibi Model 4108 U.V. Fluorescence SO ₂ Analyzer," operated with a range of 0-100 ppb*, 0-200 ppb*, 0-500 ppb, or 0-1000 ppb, with a Teflon-coated particulate filter and continuous hydrocarbon removal system, with or without any of the following options: a. Rack Mounting Brackets And Slides	Auto	51	32244	09/10/86
		Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101			

b. RS-232-C Interface c. Temperature Correction

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

EQSA-0390-075	"Monitor Labs Model 8850S SO ₂ Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm.	Auto	55	5264	02/14/90
		Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189			

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE			
			OR AUTO	EQUIV.	VOL.	PAGE DATE

SULFUR DIOXIDE (Continued)

EQSA-0990-077	"Advanced Pollution Instrumentation, Inc. Model 100 Fluorescent SO ₂ Analyzer," operated on the 0-0.1 ppm*, the 0-0.2 ppm*, the 0-0.5 ppm, or the 0-1.0 ppm range with a 5-micron TFE filter element installed in the rear-panel filter assembly, either a user- or vendor-supplied vacuum pump capable of providing 20 inches of mercury vacuum at 2.5 L/min, with or without any of the following options: Internal Zero/Span Pump Pack Rack Mount With Slides RS-232 Interface Status Output TFE Zero/Span Valves Zero Air Scrubber	Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Equiv.	55	38149	09/17/90
---------------	--	--	------	--------	----	-------	----------

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

EQSA-0292-084	"Environnement S.A. Model AF21M Sulfur Dioxide Analyzer," operated on a range of 0-0.5 ppm with a response time coefficient setting of 01, a Teflon filter installed in the rear-panel filter assembly, and with or without any of the following options: Rack Mount/Slides	Environnement S.A. 111, bd Robespierre 78300 Poissy, France	Auto	Equiv.	57	5444	02/14/92
---------------	--	---	------	--------	----	------	----------

DESIGNATION
NUMBER

IDENTIFICATION

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

SOURCE

SULFUR DIOXIDE (Continued)

EQSA-0193-092	"Lear Sieglar Measurement Controls Corporation Model ML9850 Sulfur Dioxide Analyzer," operated on any full scale range between 0-0.050 ppm* and 0-1.0 ppm, with auto-ranging enabled or disabled, at any temperature in the range of 15°C to 35°C, with a five-micron Teflon filter element installed in the filter assembly behind the secondary panel, the service switch on the secondary panel set to the In position; with the following menu choices selected: Background: Not Disabled; Calibration: Manual or Timed; Diagnostic Mode: Operate; Filter Type: Kalman; Pres/Temp/Flow Comp: On; Span Comp: Disabled; with the 50-pin I/O board installed on the rear panel configured at any of the following output range settings: Voltage, 0.1 V, 1 V, 5 V, 10 V; Current, 0-20 mA, 2-20 mA, 4-20 mA; and with or without any of the following options: Valve Assembly for External Zero/Span (EVS) Rack Mount Assembly Internal Floppy Disk Drive.	Lear Sieglar Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	58	6964	02/03/93
---------------	--	--	------	--------	----	------	----------

*NOTE: Users should be aware that designation of this analyzer for operation on any full scale range less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of any full scale range lower than the 0-0.5 ppm range does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER OR AUTO EQUIV.		NOTICE DATE
			VOL.	PAGE	
RFOA-1075-003	"Moloy Model OA325-2R Ozone Analyzer," operated with a scale range of 0-0.5 ppm, with or without any of the following options: 0-4 Output Booster Amplifier 0-18 Rack Mount Conversion 0-18A Rack Mount Conversion	<u>OZONE</u> Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	40	54856	11/26/75
RFOA-1075-004	"Moloy Model OA350-2R Ozone Analyzer," operated with a scale range of 0-0.5 ppm, with or without any of the following options: 0-2 Automatic Zero And Span 0-3 Remote Control Zero And Span 0-4 Output Booster Amplifier 0-18 Rack Mount Conversion 0-18A Rack Mount Conversion	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	40	54856	11/26/75
RFOA-0176-007	Bendix or Combustion Engineering Model 8002 Ozone Analyzer, operated on the 0-0.5 ppm range, with a 40 second time constant, with or without any of the following options: A Rack Mounting With Chassis Slides B Rack Mounting Without Chassis Slides C Zero And Span Timer D Ethylene/CO ₂ Blend Reactant Gas	Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901	41 45	5145 18474	02/04/76 03/21/80
RFOA-1076-014	"MEC Model 1100-1 Ozone Meter,"	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	41	46647	10/22/76
RFOA-1076-015	"MEC Model 1100-2 Ozone Meter,"				
RFOA-1076-016	"MEC Model 1100-3 Ozone Meter," operated on a 0-0.5 ppm range, with or without any of the following options: 0011 Rack Mounting Ears 0012 Instrument Bail 0016 Chassis Slide Kit				
	0026 Alarm Set Feature 0033 Local-Remote Sample, Zero, Span Kit Blend Feature 0040 Ethylene/CO ₂		42	30235	06/13/77

DESIGNATION NUMBER	IDENTIFICATION	SOURCE			MANUAL OR AUTO	REF. OR EQUIV.	FED. REGISTER VOL. PAGE	NOTICE DATE
RFOA-1176-017	"Monitor Labs Model 8410E Ozone Analyzer," operated on a range of 0-0.5 ppm with a time constant setting of 5 seconds, with or without any of the following options: D0 Status Outputs ER Ethylene Regulator Assembly TF TFE Sample Particulate Filter	V TFE Zero/Span Valves VT TFE Zero/Span Valves And Timer	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	41	53684	12/08/76
EQA-0577-019	"Dasibi Model 1003-AH, 1003-PC, or 1003-RS Ozone Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with or without any of the following options: Adjustable Alarm Aluminum Coated Absorption Tubes BCD Digital Output Glass (Pyrex) Absorption Tubes	Integrated Output Rack Mounting Ears And Slides Teflon-based Solenoid Valve	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	Equiv.	42	28571	06/03/77
RFOA-0577-020	"Beckman Model 950A Ozone Analyzer," operated on a range of 0-0.5 ppm and with the "SLOW" (60 second) response time, with or without any of the following options: Internal Ozone Generator Computer Adaptor Kit Pure Ethylene Accessory	Beckman Instruments, Inc. Process Instruments Division 2500 Harbor Boulevard Fullerton, CA 92634	Auto	Ref.	42	28571	06/03/77	Vycor-Jacketed U.V. Source Lamp 0-10 mV, 0-100 mV, 0-1 V, or 0-10 V Analog Output
EQA-0777-023	"Philips PW9771 03 Analyzer," consisting of the following components: PW9771/00 03 Monitor with PW9724/00 Disc.-Set; PW9750/00 Supply Cabinet; PW9750/20 Supply Unit; operated on a range of 0-0.5 ppm, with or without any of the following accessories: PW9732/00 Sampler Line Heater PW9733/00 Sampler	Philips Electronic Instruments, Inc. 85 McKee Drive Mahwah, NJ 07430	Auto	Equiv.	42	38931	08/01/77	42 57156 11/01/77

DESIGNATION
NUMBERIDENTIFICATIONSOURCE

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

OZONE (Continued)

FOA-0279-036	"Columbia Scientific Industries Model 2000 Ozone Meter," when operated on the 0-0.5 ppm range with either AC or battery power: The BCA 952 battery charger/AC adapter M952-0002 (115V) or M952-0003 (230V) is required for AC operation; an internal battery M952-0006 or 12 volt external battery is required for portable non-AC powered operation.	Auto	Ref.	44	10429	02/20/79
		Columbia Scientific Industries 11950 Jollyville Rd. Austin, TX 78759				
FOA-0880-047	"Thermo Electron Model 49 U.V. Photometric Ambient O ₃ Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with or without any of the following options: 49-001 Teflon Particulate Filter 49-002 19 Inch Rack Mountable Configuration 49-100 Internal Ozone Generator For Zero, Precision, And Level 1 Span Checks 49-103 Internal Ozone Generator For Zero, Precision, And Level 1 Span Checks With Remote Activation 49-488 GPIB (General Purpose Interface Bus) IEEE-488	Auto	Equiv.	45	57168	08/27/80
		Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038				
EQA-0881-053	"Monitor Labs Model 8810 Photometric Ozone Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with selectable electronic time constant settings from 20 through 150 seconds, with or without any of the following options: 05 Pressure Compensation 06 Averaging Option 07 Zero/Span Valves 08 Internal Zero/Span (Valve And Ozone Source) 09 Status	Auto	Equiv.	46	52224	10/26/81
		Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189				
EQA-0382-055	"PCI Ozone Corporation Model LC-12 Ozone Analyzer," operated on a range of 0-0.5 ppm.	Auto	Equiv.	47	13572	03/31/82
		PCI Ozone Corporation One Fairfield Crescent West Caldwell, NJ 07006				

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE OR AUTO EQUIV., VOL., PAGE, DATE				
			Auto	Equip.	48	10126	03/10/83
EQA-0383-056	"Dasibi Model 1008-AH, 1008-PC, or 1008-RS Ozone Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with or without any of the following options: Aluminum Coated Absorption Tubes BCD Digital Output Glass (Pyrex) Absorption Tubes Ozone Generator Photometer Flow Restrictor (2 LPM) Rack Mounting Brackets or Slides	Dasibi Environmental Corporation 515 West Colorado St. Glendale, CA 91204-1101	Auto	Equip.	48	10126	03/10/83
EQA-0990-078	"Envionics Series 300 Computerized Ozone Analyzer," operated on the 0-0.5 ppm range, with the following parameters entered into the analyzer's computer system: Absorption Coefficient = 308 ± 4 ; Flush Time = 3; Integration Factor = 1; Offset Adjustment = 0.025 ppm; Ozone Average Time = 4; Signal Average = 0; Temp/Press Correction = 0n; and with or without the RS-232 Serial Data Interface.	RS232 Interface Vycor-Jacketed U.V. Source Lamp Teflon-based Solenoid Valve 4-20 mA, Isolated, or Dual Analog Outputs 20 Second Update Software Envionics, Inc. 165 River Road West Willington, CT 06279	Auto	Equip.	55	38386	09/18/90
EQA-0992-087	"Advanced Pollution Instrumentation, Inc. Model 400 Ozone Analyzer," operated on any full scale range between 0-100 ppb* and 0-1000 ppb, at any temperature in the range of 5°C to 40°C, with the dynamic zero and span adjustment features set to Off, with a 5-micron TFE filter element installed in the rear-panel filter assembly, and with or without any of the following options: Internal Zero/Span (IZS) IZS Reference Adjustment Rack Mount With Slides RS-232 With Status Outputs Zero/Span Valves	Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Equip.	57	44565	09/28/92

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0-500 ppb is based on meeting the same absolute performance specifications required for the 0-500 ppb range. Thus, designation of any range lower than 0-500 ppb does not imply commensurably better performance than that obtained on the 0-500 ppb range.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE			MANUAL REF. OR FED. REGISTER NOTICE OR AUTO EQUIV. VOL. PAGE DATE		

OZONE (Continued)

E00A-0193-091	"Lear Siegler Measurement Controls Corporation Model ML9810 Ozone Analyzer," operated on any full scale range between 0-0.050 ppm* and 0-1.0 ppm, with auto-ranging <i>enabled</i> or <i>disabled</i> , at any temperature in the range of 15°C to 35°C, with a five-micron Teflon filter element installed in the filter assembly behind the secondary panel, the service switch on the secondary panel set to the <i>In</i> position; with the following menu choices selected:	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equip.	58	6964	02/03/93
---------------	---	--	------	--------	----	------	----------

selected:

Calibration: *Manual* or *Timed*; Diagnostic Mode: *Operate*; Filter Type: *Kalman*; Pres/Temp/Flow Comp: *On*;

Span Comp: *Disabled*;

with the 50-pin I/O board installed on the rear panel configured at any of the following output range settings:

Voltage, 0.1 V, 1 V, 5 V, 10 V;

Current, 0-20 mA, 2-20 mA, 4-20 mA;

and with or without any of the following options:

Valve Assembly for External Zero/Span (EVS)

Rack Mount Assembly

Internal Floppy Disk Drive.

*NOTE: Users should be aware that designation of this analyzer for operation on any full scale range less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of any full scale range lower than the 0-0.5 ppm range does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

DESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR FED. REGISTER OR AUTO EQUIV. VOL. PAGE NOTICE DATE

CARBON MONOXIDE

RFCA-0276-008	Bendix or Combustion Engineering Model 8501-5CA Infrared CO Analyzer, operated on the 0-50 ppm range and with a time constant setting between 5 and 16 seconds, with or without any of the following options: A Rack Mounting With Chassis Slides B Rack Mounting Without Chassis Slides	Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901	Auto	Ref. 41	7450	02/18/76
RFCA-0876-012	"Beckman Model 866 Ambient CO Monitoring System," consisting of the following components: Pump/Sample-Handling Module; Gas Control Panel; Model 865-17 Analyzer Unit; Automatic Zero/Span Standardizer; operated with a 0-50 ppm range, a 13 second electronic response time, with or without any of the following options: Current Output Feature	Beckman Instruments, Inc. Process Instruments Division 2500 Harbor Boulevard Fullerton, CA 92634	Auto	Ref. 41	36245	08/27/76
RFCA-0177-018	"LIRA Model 202S Air Quality Carbon Monoxide Analyzer System," consisting of a LIRA Model 202S optical bench (P/N 459839), a regenerative dryer (P/N 464084), and rack-mounted sampling system; operated on a 0-50 ppm range, with the slow response amplifier, with or without any of the following options: Remote Meter Remote Zero And Span Controls	Mine Safety Appliances Company 600 Penn Center Boulevard Pittsburgh, PA 15208	Auto	Ref. 42	5748	01/31/77
RFCA-1278-033	"Horiba Models AQM-10, AQM-11, and AQM12 Ambient CO Monitoring Systems," operated on the 0-50 ppm range, with a response time setting of 15.5 seconds, with or without any of the following options: a AIC-101 Automatic Indication Corrector b VIT-3 Non-Isolated Current Output c ISO-2 and DCS-3 Isolated Current Output	Horiba Instruments, Inc. 17671 Armstrong Avenue Irvine, CA 92714-5727	Auto	Ref. 43	58429	12/14/78

SIGNATURE NUMBER	IDENTIFICATION	SOURCE		MANUAL REF. OR FED. REGISTER NOTICE OR AUTO EQUIV.	
				VOL.	PAGE

CARBON MONOXIDE (Continued)

FCA-0979-041	"Monitor Labs Model 8310 CO Analyzer," operated on the 0-50 ppm range, with a sample inlet filter, with or without any of the following options: 02A Zero/Span Valves 03A Floor Stand 04A Pump (60 Hz) 04B Pump (50 Hz) 05A CO Regulator 06A CO Cylinder	Lear Siegler Measurement Controls Corporation Englewood, CO 80112-5189 74 Inverness Drive East	Auto	44 45	54545 2700	09/20/79 01/14/80
		07A Zero/Span Valve Power Supply 08A Calibration Valves 9A,B,C,D Input Power Transformer				

FCA-1180-048	"Horiba Model APMA-300E Ambient Carbon Monoxide Monitoring System," operated on the 0-20 ppm*, the 0-50 ppm, or the 0-100 ppm range with a time constant switch setting of No. 5. The monitoring system may be operated at temperatures between 10°C and 40°C.	Horiba Instruments, Inc. 17671 Armstrong Avenue Irvine, CA 92714-5727	Auto	45	72774	11/03/80
--------------	--	---	------	----	-------	----------

*NOTE: Users should be aware that designation of this analyzer for operation on a range less than 50 ppm is based on meeting the same absolute performance specifications required for the 0-50 ppm range. Thus, designation of this lower range does not imply commensurably better performance than that obtained on the 0-50 ppm range.

(This method was originally designated as "Horiba Model APMA 300E/300SE Ambient Carbon Monoxide Monitoring System".)

FCA-1280-050	"MASS-CO, Model 1 Carbon Monoxide Analyzer," operated on a range of 0-50 ppm, with automatic zero and span adjustments at time intervals not to exceed 4 hours, with or without the 100 millivolt and 5 volt output options. The method consists of the following components: (1) Infra-2 (Uras 2) Infrared Analyzer Model 5611-200-35, (2) Automatic Calibrator Model 5869-111, (3) Electric Gas Cooler Model 7865-222 or equivalent with prehumidifier, (4) Diaphragm Pump Model 5861-214 or equivalent, (5) Membrane Filter Model 5862-111 or equivalent, (6) Flow Meter Model SK 1171-U or equivalent, (7) Recorder Model Mini Comp DN 1/192 or equivalent	Commonwealth of Massachusetts Department of Environmental Quality Engineering Tewksberry, MA 01876	Auto	45	81650	12/11/80
--------------	---	--	------	----	-------	----------

NOTE: This method is not now commercially available.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE			MANUAL OR AUTO	REF. OR EQUIV.	FED. REGISTER VOL.	PAGE	NOTICE DATE
		CARBON MONOXIDE (Continued)							
RFCA-0381-051	"Dasibi Model 3003 Gas Filter Correlation CO Analyzer," operated on the 0-50 ppm range, with a sample particulate filter installed on the sample inlet line, with or without any of the following options: 3-001 Rack Mount 3-002 Remote Zero And Span 3-003 BCD Digital Output 3-004 4-20 Milliamp Output	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	Ref.	46	20773		04/07/81	
RFCA-0981-054	"Thermo Environmental Instruments Model 48 Gas Filter Correlation Ambient CO Analyzer," operated on the 0-50 ppm range, with a time constant setting of 30 seconds, with or without any of the following options: 48-001 Particulate Filter 48-002 19 Inch Rack Mountable Configuration 48-003 Internal Zero/Span Valves With Remote Activation 48-488 GPIB (General Purpose Interface Bus) IEEE-488 48-010 Internal Zero Air Package	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref.	46	47002		09/23/81	
RFCA-0388-066	"Monitor Labs Model 8830 CO Analyzer," operated on the 0-50 ppm range, with a five micron Teflon filter element installed in the rear-panel filter assembly, with or without any of the following options: 2 Zero/Span Valve Assembly 3 Rack Assembly 4 Slide Assembly 7 230 VAC, 50/60 Hz	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	53	7233		03/07/88	
RFCA-0488-067	"Dasibi Model 3008 Gas Filter Correlation CO Analyzer," operated on the 0-50 ppm range, with a time constant setting of 60 seconds, a particulate filter installed in the analyzer sample inlet line, with or without use of the auto zero or auto zero/span feature, and with or without any of the following options: N-0056-A RS-232-C Interface S-0132-A Rack Mounting Slides Z-0176-S Rack Mounting Brackets	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	Ref.	53	12073		04/12/88	

DESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR OR AUTO EQUIV. VOL. PAGE NOTICE DATE

CARBON MONOXIDE (Continued)

RFCA-0992-088 "Lear Siegler Measurement Controls Corporation Model ML9830 Carbon Monoxide Analyzer," operated on any full scale range between 0-5.0 ppm* and 0-100 ppm, with auto-ranging enabled or disabled, at any temperature in the range of 15°C to 35°C, with a five-micron Teflon filter element installed in the filter assembly behind the secondary panel, the service switch on the secondary panel set to the *In* position, with the following menu choices selected:
 Background: Not Disabled; Calibration: Manual or Timed; Diagnostic Mode: Operate; Filter Type: Kalman; Pres/Temp/Flow Comp: On; Span Comp: Disabled; with the 50-pin I/O board installed on the rear panel configured at any of the following output range settings:
 Voltage, 0.1 V, 1 V, 5 V, 10 V; Current, 0-20 mA, 2-20 mA and 4-20 mA; and with or without any of the following options:
 Internal Floppy Disk Drive Valve Assembly For External Zero/Span (EVS)
 Rack Mount Assembly Valve Assembly For Internal Zero/Span (IZS)

*NOTE: Users should be aware that designation of this analyzer for operation on any full scale range less than 50 ppm is based on meeting the same absolute performance specifications required for the 0-50 ppm range. Thus, designation of any full scale range lower than the 0-50 ppm range does not imply commensurably better performance than that obtained on the 0-50 ppm range.

RFCA-1093-093 "Advanced Pollution Instrumentation, Inc. Model 300 Gas Filter Correlation Carbon Monoxide Analyzer," operated on any full scale range between 0-10 ppm and 0-50 ppm, at any temperature in the range of 15°C to 35°C, with the dynamic zero and span adjustment set to OFF, with a 5-micron TFE filter element installed in the filter assembly, and with or without any of the following options:
 Internal Zero/Span (IZS) Rack Mount With Slides
 RS-232 With Status Outputs Zero/Span Valves

*NOTE: Users should be aware that designation of this analyzer for operation on any full scale range less than 50 ppm is based on meeting the same absolute performance specifications required for the 0-50 ppm range. Thus, designation of any full scale range lower than the 0-50 ppm range does not imply commensurably better performance than that obtained on the 0-50 ppm range.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE		OR AUTO EQUIV.	VOL.	PAGE	DATE
			REF.	OR				
<u>NITROGEN DIOXIDE</u>								
RFNA-0677-021	"Monitor Labs Model 8440E Nitrogen Oxides Analyzer," operated on a 0-0.5 ppm range (position 2 of range switch) with a time constant setting of 20 seconds, with or without any of the following options: TF Sample Particulate Filter With TFE Filter Element V Zero/Span Valves DO Status Outputs R Rack Mount FM Flowmeters	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	42	37434	07/21/77	07/21/77
					42	46575	09/16/77	09/16/77
					46	29986	06/04/81	06/04/81
		018A Ozone Dry Air 018B Ozone Dry Air - No Drierite						
RFNA-0777-022	Bendix or Combustion Engineering Model 8101-C Oxides of Nitrogen Analyzer, operated on a 0-0.5 ppm range with a Teflon sample filter (Bendix P/N 007163) installed on the sample inlet line.	Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901	Auto	Ref.	42	37435	07/21/77	07/21/77
RFNA-0977-025	"CSI Model 1600 Oxides of Nitrogen Analyzer," operated on a 0-0.5 ppm range with a Teflon sample filter (CSI P/N M951-8023) installed on the sample inlet line, with or without any of the following options: 951-0103 Rack Ears 951-0104 Rack Mounting Kit (Ears & Slides) 951-0106 Current Output, 4-20 mA (Non-Insulated) 951-0108 Diagnostic Output Option 951-0111 Recorder Output, 10 V	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Ref.	42	46574	09/16/77	09/16/77
		Remote Zero/Span Sample Control						
		951-0112 Recorder Output, 5 V External Pump (115 V, 60 Hz)						
		951-0114 Molybdenum Converter Assembly (Horizontal)						
		951-0115 Molybdenum Converter Assembly (Vertical)						
		951-0106 Molybdenum Converter Assembly (Vertical)						
		951-0108 Molybdenum Converter Assembly (Vertical)						
		951-0111 Molybdenum Converter Assembly (Vertical)						

NOTE: The vertical molybdenum converter assembly is standard on all new analyzers as of 1-1-87; however, use of any of the other converter assemblies is optional. Also, the above options reflect new CSI part numbers.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER		NOTICE DATE
			OR AUTO EQUIV.	VOL. PAGE	
<u>NITROGEN DIOXIDE (Continued)</u>					
EQN-1277-026	"Sodium Arsenite Method for the Determination of Nitrogen Dioxide in the Atmosphere"	Atmospheric Research & Exposure Assessment Laboratory Department E (MD-77) U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv.	42 62971	12/14/77
EQN-1277-027	"Sodium Arsenite Method for the Determination of Nitrogen Dioxide in the Atmosphere--Technicon II Automated Analysis System"	Atmospheric Research & Exposure Assessment Laboratory Department E (MD-77) U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv.	42 62971	12/14/77
EQN-1277-028	"TGS-ANSA Method for the Determination of Nitrogen Dioxide in the Atmosphere"	Atmospheric Research & Exposure Assessment Laboratory Department E (MD-77) U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv.	42 62971	12/14/77

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

DESIGNATION NUMBER IDENTIFICATION SOURCE MANUAL REF. OR OR AUTO EQUIV. VOL. PAGE REGISTER NOTICE DATE

NITROGEN DIOXIDE (Continued)

RFNA-1078-031 "Meloj Model NA530R Nitrogen Oxides Analyzer," operated on the following ranges and time constant switch positions:

Range, ppm	Time Constant Setting
0-0.1*	4
0-0.25*	3 or 4
0-0.5	2, 3, or 4
0-1.0	2, 3, or 4

Operation of the analyzer requires an external vacuum pump, either Meloy Option N-10 or an equivalent pump capable of maintaining a vacuum of 200 torr (22 inches mercury vacuum) or better at the pump connection at the specified sample and ozone-air flow rates of 1200 and 200 cm³/min, respectively. The analyzer may be operated at temperatures between 10°C and 40°C and at line voltages between 105 and 130 volts, with or without any of the following options:

- N-1A Automatic Zero And Span
- N-2 Vacuum Gauge
- N-4 Digital Panel Meter
- N-6 Remote Control For Zero And Span
- N-6B Remote Zero/Span Control And Status (Pulse)
- N-6C Remote Zero/Span Control And Status (Timer)
- N-9 Manual Zero/Span
- N-10 Vacuum Pump Assembly (See Alternate Requirement Above)
- N-11 Auto Ranging
- N-14B Line Transmitter
- N-18 Rack Mount Conversion
- N-18A Rack Mount Conversion

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

Auto Ref. 43 50733 10/31/78
44 8327 02/09/79

Columbia Scientific Industries
11950 Jollyville Road
Austin, TX 78759

DESIGNATION NUMBER	IDENTIFICATION	SOURCE			MANUAL OR AUTO	REF. OR EQUIV.	FED. REGISTER VOL.	PAGE	NOTICE DATE
		<u>NITROGEN DIOXIDE (Continued)</u>							
RFNA-0179-034	"Beckman Model 952-A NO/NO ₂ /NO _x Analyzer," operated on the 0-0.5 ppm range with the 5-micron Teflon sample filter (Beckman P/N 861072 supplied with the analyzer) installed on the sample inlet line, with or without the Remote Operation Option (Beckman No. 635539).	Beckman Instruments, Inc. Process Instruments Division 2500 Harbor Boulevard Fullerton, CA 92634	Auto	Ref.	44	7806		02/07/79	
RFNA-0179-035	"Thermo Electron Model 14 B/E Chemiluminescent NO/NO ₂ /NO _x Analyzer," operated on the 0-0.5 ppm range, with or without any of the following options: 14-001 Teflon Particulate Filter 14-002 Voltage Divider Card 14-003 Long-Time Signal Integrator	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref.	44	7805	54545	02/07/79 09/20/79	
RFNA-0279-037	"Thermo Electron Model 14 D/E Chemiluminescent NO/NO ₂ /NO _x Analyzer," operated on the 0-0.5 ppm range, with or without any of the following options: 14-001 Teflon Particulate Filter 14-002 Voltage Divider Card	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref.	44	10429		02/20/79	
RFNA-0479-038	"Bendix Model 8101-B Oxides of Nitrogen Analyzer," operated on a 0-0.5 ppm range with a Teflon sample filter installed on the sample inlet line and with the following post-manufacture modifications: 1. Ozone generator and reaction chamber input-output tubing modification per Bendix Service Bulletin 8101B-2; 2. The approved converter material; 3. The revised and EPA-approved operation and service manual. These items are mandatory and must be obtained from Combustion Engineering, Inc. The analyzer may be operated with or without any of the following optional modifications: a. Perma Pure dryer/ambient air modification; b. Valve cycle time modification; c. Zero potentiometer centering modification per Bendix Service Bulletin 8101B-1; d. Reaction chamber vacuum gauge modification.	Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901	Auto	Ref.	44	26792		05/07/79	

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE	
			OR AUTO EQUIV.	VOL. PAGE

NITROGEN DIOXIDE (Continued)

RFNA-0879-040	"Phillips Model PW9762/02 NO/NO ₂ /NO _x Analyzer," consisting of the following components: PW9762/02 Basic Analyzer PW9729/00 Converter Cartridge PW9731/00 Sampler or PW9731/20 Dust Filter; operated on a range of 0-0.5 ppm, with or without any of the following accessories: PW9752/00 Air Sampler Manifold PW9732/00 Sample Line Heater	Auto	Ref. 44	51683	09/04/79
---------------	--	------	---------	-------	----------

Phillips Electronic Instruments, Inc.
85 McKee Drive
Mahwah, NJ 07430

RFNA-0280-042	"Monitor Labs Model 8840 Nitrogen Oxides Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with an internal time constant setting of 60 seconds, a TFE sample filter installed on the sample inlet line, with or without any of the following options: 02 Flowmeter 03A Rack Ears 03B Slides 05A Zero/Span Valves 05B Valve/Relay 06 Status 07A Input Power Transformer 100 VAC, 50/60 Hz 07B Input Power Transformer 220/240 VAC, 50 Hz	Auto	Ref. 45 46	9100 29986	02/11/80 06/04/81
---------------	---	------	---------------	---------------	----------------------

Lear Siegler Measurement Controls Corporation
74 Inverness Drive East
Englewood, CO 80112-5189

08A Pump Pac Assembly With 09A (115 VAC)
08B Pump Pac Assembly With 09B (100 VAC)
08C Pump Pac Assembly With 09C (220/240 VAC)
08D Rack Mount Panel Assembly
09A Pump 115 VAC 50/60 Hz
09B Pump 100 VAC 50/60 Hz
09C Pump 220/240 VAC 50 Hz

011A Recorder Output 1 Volt
011B Recorder Output 100 mV
011C Recorder Output 10 mV
012A DAS Output 1 Volt
012B DAS Output 100 mV
012C DAS Output 10 mV
013A Ozone Dry Air
013B Ozone Dry Air - No Drierite

DESIGNATION
NUMBER

IDENTIFICATION

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

SOURCE

NITROGEN DIOXIDE (Continued)

RFNA-1289-074	"Thermo Environmental Instruments Inc. Model 42 NO/NO ₂ /NO Analyzer," operated on the 0-0.05 ppm*, the 0-0.1 ppm*, the 0-0.2 ppm*, the 0-0.5 ppm, or the 0-1.0 ppm range, with any time average setting from 10 to 300 seconds. The analyzer may be operated at temperatures between 15°C and 35°C and at line voltages between 105 and 125 volts, with or without any of the following options: 42-002 Rack Mounts 42-003 Internal Zero/Span And Sample Valves With Remote Activation 42-004 Sample/Ozone Flowmeters 42-005 4-20 mA Current Output 42-006 Pressure Transducer	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref. 54 50820	12/11/89
		42-007 Ozone Particulate Filter 42-008 RS-232 Interface 42-009 Permeation Dryer			

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

RFNA-0691-082

"Advanced Pollution Instrumentation, Inc. Model 200 Nitrogen Oxides Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm, with a 5-micron TFE filter element installed in the rear-panel filter assembly, with either a user- or vendor-supplied vacuum pump capable of providing 5 inches mercury absolute pressure at 5 slpm, with either a user- or vendor-supplied dry air source capable of providing air at a dew point of 0°C or lower, with the following settings of the adjustable setup variables:
Adaptive Filter = On; Dwell Time = 7 seconds; Dynamic Span = Off; Dynamic Zero = Off; PMT Temperature Set Point = 15°C; Rate of Change(ROC) Threshold = 10%; Reaction Cell Temperature = 50°C; Sample Time = 8 seconds; Normal Filter Size = 12 samples; and with or without any of the following options:
180 Stainless Steel Valves
184 Pump Pack
280 Rack Mount With Slides
283 Internal Zero/Span With Valves (IZS)
325 RS-232/Status Output
355 Expendables

Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Ref. 56 27014	06/12/91
--	------	---------------	----------

356 Level One Spares Kit
357 Level Two Spares Kit
PE5 Permeation Tube for IZS

IDENTIFICATION NUMBER	SOURCE	MANUAL REF. OR FED. REGISTER OR AUTO EQUIV.		NOTICE DATE
		VOL.	PAGE	

NITROGEN DIOXIDE (Continued)

FNA-0991-083	"Monitor Labs Model 8841 Nitrogen Oxides Analyzer," operated on the 0-0.05 ppm*, 0-0.1 ppm*, 0-0.2 ppm*, 0-0.5 ppm, or 0-1.0 ppm range, with manufacturer-supplied vacuum pump or alternative user-supplied vacuum pump capable of providing 200 torr or better absolute vacuum while operating with the analyzer.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	56	47473	09/19/91
--------------	--	--	------	----	-------	----------

*NOTE: Users should be aware that designation of this analyzer for operation on ranges less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of these lower ranges does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

FNA-1192-089	"Dasibi Model 2108 Oxides of Nitrogen Analyzer," operated on the 0-500 ppb range, with software revision 3.6 installed in the analyzer, with the Auto thumbwheel switch and the Diag thumbwheel switch settings at 0, with the following internal CPU dipswitch settings:	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	57	55530	11/25/92
--------------	---	---	------	----	-------	----------

switch position	function
1	Recorder outputs are NO & NO ₂
5	3 minute time constant
6	3 minute time constant;

with a 5-micron Teflon filter element installed in the filter holder, and with or without any of the following options:
 Built-in Permeation Oven
 Rack Mounting
 RS-232 Interface
 Three-Channel Recorder Output
 4-20 mA Output

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

February 8, 1993

MANUAL REF. OR FED. REGISTER NOTICE
OR AUTO EQUIV. VOL. PAGE DATE

DESIGNATION IDENTIFICATION
NUMBER

SOURCE

NITROGEN DIOXIDE (Continued)

Ref. 57 60198 12/18/92

Lear Siegler Measurement Auto
Controls Corporation
74 Inverness Drive East
Englewood, CO 80112-5189

RFNA-1292-090 "Lear Siegler Measurement Controls Corpora-
tion Model ML9841 Nitrogen Oxides Analyzer,"
operated on any full scale range between
0-0.050 ppm* and 0-1.0 ppm, with auto-
ranging enabled or disabled, at any temperature
in the range of 15°C to 35°C, with a five-micron Teflon filter element installed in the filter assembly behind
the secondary panel, the service switch on the secondary panel set to the In position; with the following menu
choices selected:

Calibration: Manual or Timed; Diagnostic Mode: Operate; Filter Type: Kalman; Pres/Temp/Flow Comp: On;

Span Comp: Disabled;

with the 50-pin I/O board installed on the rear panel configured at any of the following output range setting:

Voltage, 0.1 V, 1 V, 5 V, 10 V; Current, 0-20 mA, 2-20 mA, 4-20 mA;

and with or without any of the following options:

Internal Floppy Disk Drive
Rack Mount Assembly

Valve Assembly for External Zero/Span (EVS)

*NOTE: Users should be aware that designation of this analyzer for operation on any full scale range less than 0.5 ppm is based on meeting the same absolute performance specifications required for the 0-0.5 ppm range. Thus, designation of any full scale range lower than the 0-0.5 ppm range does not imply commensurably better performance than that obtained on the 0-0.5 ppm range.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR FED. REGISTER NOTICE OR AUTO EQUIV.		
			VOL.	PAGE	DATE
*****	Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air	LEAD 40 CFR Part 50, Appendix G	Manual Ref. 43	46258	10/05/78
EQL-0380-043	"Determination of Lead Concentration in Ambient Particulate Matter by Flame Atomic Absorption Spectrometry Following Ultrasonic Extraction with Heated HNO ₃ -HCl"	Atmospheric Research & Exposure Assessment Laboratory U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv. 45	14648	03/06/80
EQL-0380-044	"Determination of Lead Concentration in Ambient Particulate Matter by Flameless Atomic Absorption Spectrometry (EPA/RTP, N.C.)"	Atmospheric Research & Exposure Assessment Laboratory U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv. 45	14648	03/06/80
EQL-0380-045	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (EPA/RTP, N.C.)"	Atmospheric Research & Exposure Assessment Laboratory U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Manual Equiv. 45	14648	03/06/80
EQL-0581-052	"Determination of Lead Concentration in Ambient Particulate Matter by Wavelength Dispersive X-Ray Fluorescence Spectrometry"	California Department of Health Services Air & Industrial Hygiene Laboratory 2151 Berkeley Way Berkeley, CA 94704	Manual Equiv. 46	29986	06/04/81
EQL-0483-057	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (State of Montana)"	State of Montana Department of Health and Environmental Sciences Cogswell Building Helena, MT 59620	Manual Equiv. 48	14748	04/05/83

LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS

IDENTIFICATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO EQUIV.	REF. OR EQUIV.	FED. REGISTER VOL.	NOTICE PAGE	DATE
QL-0783-058	"Determination of Lead Concentration in Ambient Particulate Matter by Energy-Dispersive X-Ray Fluorescence Spectrometry (Texas Air Control Board)"	LEAD (Continued) Texas Air Control Board 6330 Highway 290 East Austin, TX 78723	Manual	Equiv.	48	29742	06/28/83
QL-0785-059	"Determination of Lead Concentration in Ambient Particulate Matter by Flameless Atomic Absorption Spectrometry (Omaha-Douglas County Health Department)"	Omaha-Douglas County Health Department 1819 Farnam Street Omaha, NE 68183	Manual	Equiv.	50	37909	09/18/85
QL-0880-068	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (State of Rhode Island)"	State of Rhode Island Department of Health Air Pollution Laboratory 50 Orms Street Providence, RI 02904	Manual	Equiv.	53	30866	08/16/88
QL-1188-069	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (Northern Engineering and Testing, Inc.)"	Northern Engineering and Testing, Inc. P.O. Box 30615 Billings, MT 59107	Manual	Equiv.	53	44947	11/07/88
QL-1288-070	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (Silver Valley Laboratories)"	Silver Valley Labs, Inc. P.O. Box 929 Kellogg, ID 83837	Manual	Equiv.	53	48974	12/05/88
EQ-0589-072	"Determination of Lead Concentration in Ambient Particulate Matter by Energy-Dispersive X-Ray Fluorescence Spectrometry (NEA, Inc.)"	Nuclear Environmental Analysis, Inc. 10950 SW 5th Street, Suite 260 Beaverton, OR 97005	Manual	Equiv.	54	20193	05/10/89

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL REF. OR. FED. REGISTER NOTICE		DATE
			OR AUTO EQUIV.	VOL. PAGE	
		<u>LEAD (Continued)</u>			
EQL-1290-080	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (State of New Hampshire)"	State of New Hampshire Department of Environmental Services Laboratory Service Unit 6 Hazen Drive (P.O. Box 95) Concord, NH 03302-0095	Manual Equiv.	55 49119	11/26/90
EQL-0592-085	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (State of Kansas)"	State of Kansas Department of Health and Environment Forbes Field, Building 740 Topeka, KS 66620-0001	Manual Equiv.	57 20823	05/15/92
EQL-0592-086	"Determination of Lead Concentration in Ambient Particulate Matter by Inductively Coupled Argon Plasma Optical Emission Spectrometry (Commonwealth of Pennsylvania)"	Commonwealth of Pennsylvania Department of Environmental Resources P.O. Box 2357 Harrisburg, PA 17105-2357	Manual Equiv.	57 20823	05/15/92

METHOD CODES

Method	Designation Number	Method Code	Method	Designation Number	Method Code
SO. Manual Methods			NO. Manual Methods		
Ref. method (pararosaniline)	-	097	Sodium arsenite (orifice)	EQN-1277-026	084
Technicon I (pararosaniline)	EQS-0775-001	097	Sodium arsenite/Technicon II	EQN-1277-027	084
Technicon II (Pararosaniline)	EQS-0775-002	097	TGS-ANSA (orifice)	EQN-1277-028	098
SO. Analyzers			NO. Analyzers		
Advanced Pollution Instr. 100	EQSA-0990-077	077	Advanced Pollution Instr. 200	RFNA-0691-082	082
Asarco 500	EQSA-0877-024	024	Beckman 952A	RFNA-0179-034	034
Beckman 953	EQSA-0678-029	029	Bendix 8101-B	RFNA-0479-038	038
Bendix 8303	EQSA-1078-030	030	Bendix 8101-C	RFNA-0777-022	022
Dasibi 4108	EQSA-1086-061	061	Dasibi 2108	RFNA-1192-089	089
Environnement S.A. AF21M	EQSA-0292-084	084	CSI 1600	RFNA-0977-025	025
Lear Siegler AM2020	EQSA-1280-049	049	Lear Siegler ML9841	RFNA-1292-090	090
Lear Siegler SM1000	EQSA-1275-005	005	Meloy NA530R	RFNA-1078-031	031
Lear Siegler ML9850	EQSA-0193-092	092	Monitor Labs 8440E	RFNA-0677-021	021
Meloy SA185-2A	EQSA-1275-006	006	Monitor Labs 8840	RFNA-0280-042	042
Meloy SA285E	EQSA-1078-032	032	Monitor Labs 8841	RFNA-0991-083	083
Meloy SA700	EQSA-0580-046	046	Philips PW9762/02	RFNA-0879-040	040
Monitor Labs 8450	EQSA-0876-013	513	Thermo Electron 14B/E	RFNA-0179-035	035
Monitor Labs 8850	EQSA-0779-039	039	Thermo Electron 14D/E	RFNA-0279-037	037
Monitor Labs 8850S	EQSA-0390-075	075	Thermo Environmental Inst. 42	RFNA-1289-074	074
Philips PW9700	EQSA-0876-011	511			
Philips PW9755	EQSA-0676-010	010			
Thermo Electron 43	EQSA-0276-009	009			
Thermo Electron 43A	EQSA-0486-060	060			
O. Analyzers			Pb Manual Methods		
Advanced Pollution Instr. 400	EQOA-0992-087	087	Ref. method (hi-vol/AA spect.)	-	803
Beckman 950A	RFOA-0577-020	020	Hi-vol/AA spect. (alt. extr.)	EQL-0380-043	043
Bendix 8002	RFOA-0176-007	007	Hi-vol/Energy-disp XRF (TX ACB)	EQL-0783-058	058
CSI 2000	RFOA-0279-036	036	Hi-vol/Energy-disp XRF (NEA)	EQL-0589-072	072
Dasibi 1003-AH,-PC,-RS	EQOA-0577-019	019	Hi-vol/Flameless AA (EMSL/EPA)	EQL-0380-044	044
Dasibi 1008-AH	EQOA-0383-056	056	Hi-vol/Flameless AA (Omaha)	EQL-0785-059	059
Environics 300	EQOA-0990-078	078	Hi-vol/ICAP spect. (EMSL/EPA)	EQL-0380-045	045
Lear Siegler ML9810	EQOA-0193-091	091	Hi-vol/ICAP spect. (Kansas)	EQL-0592-085	085
McMillan 1100-1	RFOA-1076-014	514	Hi-vol/ICAP spect. (Montana)	EQL-0483-057	057
McMillan 1100-2	RFOA-1076-015	515	Hi-vol/ICAP spect. (NE&T)	EQL-1188-069	069
McMillan 1100-3	RFOA-1076-016	016	Hi-vol/ICAP spect. (N. Hampshire)	EQL-1290-080	080
Meloy OA325-2R	RFOA-1075-003	003	Hi-vol/ICAP spect. (Pennsylvania)	EQL-0592-086	086
Meloy OA350-2R	RFOA-1075-004	004	Hi-vol/ICAP spect. (Rhode Is.)	EQL-0888-068	068
Monitor Labs 8410E	RFOA-1176-017	017	Hi-vol/ICAP spect. (S.V. Labs)	EQL-1288-070	070
Monitor Labs 8810	EQOA-0881-053	053	Hi-vol/WL-disp. XRF (CA A&IHL)	EQL-0581-052	052
PCI Ozone Corp. LC-12	EQOA-0382-055	055			
Philips PW9771	EQOA-0777-023	023			
Thermo Electron 49	EQOA-0880-047	047			
CO Analyzers			PM₁₀ Samplers		
Advanced Pollution Instr. 300	RFCA-1093-093	093	Oregon DEQ Med. vol. sampler	RFPS-0389-071	071
Beckman 866	RFCA-0876-012	012	Sierra-Andersen/GMW 1200	RFPS-1287-063	063
Bendix 8501-5CA	RFCA-0276-008	008	Sierra-Andersen/GMW 321-B	RFPS-1287-064	064
Dasibi 3003	RFCA-0381-051	051	Sierra-Andersen/GMW 321-C	RFPS-1287-065	065
Dasibi 3008	RFCA-0488-067	067	Sierra-Andersen/GMW 241 Dichot	RFPS-0789-073	073
Horiba AQM-10, -11, -12	RFCA-1278-033	033	Wedding & Assoc. high volume	RFPS-1087-062	062
Horiba 300E/300SE	RFCA-1180-048	048			
Lear Siegler ML 9830	RFCA-0992-088	088			
MASS - CO 1 (Massachusetts)	RFCA-1280-050	050			
Monitor Labs 8310	RFCA-0979-041	041			
Monitor Labs 8830	RFCA-0388-066	066			
MSA 202S	RFCA-0177-018	018			
Thermo Electron 48	RFCA-0981-054	054			
			PM₁₀ Analyzers		
			Andersen Instr. Beta FH621-N	EQPM-0990-076	076
			R & P TEOM 1400, 1400a	EQPM-1090-079	079
			Wedding & Assoc. Beta Gauge	EQPM-0391-081	081
			TSP Manual Method		
			Reference method (high-volume)	-	802

APPROVED METHODS AS OF NOVEMBER 12, 1993

	MANUAL		AUTOMATED	
	REFERENCE	EQUIVALENT	REFERENCE	EQUIVALENT
CO			1. CE (Bendix) E501-SCA (50) 2. Beckman 866 (50) 3. MSA 3025 (50) 4. Horiba AQM-10,11,12 (50) 5. Monitor Labs 8310 (50) 6. Horiba APMA-300E (20, 50, 100) 7. MASS-CO 1 (50) 8. Dairi 3003 (50) 9. TEI 48 (50) 10. Monitor Labs 8300 (50) 11. Dairi 3028 (50) 12. Lear Single ML 9830 (5-100) 13. API 300 (10-50)	
NO ₂		1. Sodium Arsenite 2. Sodium Arsenite/Technician II 3. TGS-ANSA	1. Monitor Labs 844/E (.5) 2. CE (Bendix) 8101-C (.5) 3. CSI 1600 (.5) 4. Meloy NACOR (.1, .25, .5, 1.0) 5. Beckman 952-A (.5) 6. TEI 14 B/E (.5) 7. TEI 14 D/E (.5) 8. Bendix 8101-B (.5) 9. Philips PW9762/02 (.5) 10. Monitor Labs 85-C (.5, 1.0) 11. TEI 42 (.05, .1, .2, .5, 1.0) 12. API 300 (.5, 1.0) 13. Monitor Labs 8841 (.05, .1, .2, .5, 1.0) 14. Dairi 210E (.5) 15. Lear Single ML 9841 (.05-1.0)	
O ₃			1. Meloy OA325-2R (.5) 2. Meloy OA350-2R (.5) 3. CE (Bendix) 8002 (.5) 4. McMillan 1100-1 (.5) 5. McMillan 1100-2 (.5) 6. McMillan 1100-3 (.5) 7. Monitor Labs 8410E (.5) 8. Beckman 950A (.5) 9. CSI 2000 (.5)	1. Dairi 1003-AH,PC,RS (.5,1.0) 2. Philips PW9771 (.5) 3. TEI 49 (.5, 1.0) 4. Monitor Labs 8810 (.5, 1.0) 5. PCI Ozone Corp. LC-12 (.5) 6. Dairi 1008-AH,PC,RS (.5,1.0) 7. Envirocon 300 (.5) 8. API 400 (.1-1.0) 9. Lear Single ML 9810 (.05-1.0)
Pb	HV with Flame AA	1. HV/Flame AA (EPA) 2. HV/Flameless AA (EPA) 3. HV/ICAP (EPA) 4. HV/WDXRF (AHR, CA) 5. HV/ICAP (MT) 6. HV/EDXRF (TX) 7. HV/Flameless AA (Omaha-Douglas Co.) 8. HV/ICAP (RI) 9. HV/ICAP (NET) 10. HV/ICAP (SML) 11. HV/EDXRF (NEA) 12. HV/ICAP (NH) 13. HV/ICAP (KS) 14. HV/ICAP (PA)		
PM ₁₀	1. W & A PM ₁₀ Critical Flow HV Sampler 2. SA/GMW 12ED 3. SA/GMW 321-B 4. SA/GMW 321-C 5. Oregon DEQ HV Special Sampler 6. SA/GMW 241 & 241M Direct Sampler			1. Andersen Inst. FH621-N PM ₁₀ Beta Attenuation Monitor 2. Rupperts & Passalunghi TEOM® Series 1400 and 1400a PM-10 Monitors 3. Wadding & Associates' PM-10 Beta Gauge Automated Particle Sampler
SO ₂	Parosolline Method	1. Technician I 2. Technician II		1. Lear Single SM1000 (.5) 2. Meloy SA185-2A (.5, 1.0) 3. TEI 43 (.5, 1.0) 4. Philips PW9755 (.5) 5. Philips PW9700 (.5) 6. Monitor Labs 8450 (.5, 1.0) 7. ASARCO 300 (.5), 600 (1.0) 8. Beckman 953 (.5, 1.0) 9. Bendix 8303 (.5, 1.0) 10. Meloy SA285E (.05, .1, .5, 1.0) 11. Monitor Labs 8850 (.5, 1.0) 12. Meloy SA700 (.25, .5, 1.0) 13. Lear Single AM2020 (.5, 1.0) 14. TEI 43A (.1, .2, .5, 1.0) 15. Dairi 410E (.1, .2, .5, 1.0) 16. Monitor Labs 8850S (.5, 1.0) 17. API 100 (.5) 18. Environment S.A. AF21M (.5) 19. Lear Single ML 9850 (.05-1.0)
TSP	High Volume Method (HV)			

NOTE: The numbers in parentheses that follow the manufacturer name i.e., (.05), (.1), (.2), (.5), (1.0), or (50) indicate the full scale range(s) approved for that method. Ranges that are specified as (.05-1.0), (1-1.0), (5-100), or (10-50) indicate any full scale range between the indicated values.

APPENDIX I

SAMPLE SUBMITTAL MATERIALS AND ADDITIONAL GUIDANCE