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PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS IMPLEMENTATION MANUAL

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U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Technical Support Division
Research Triangle Park, North Carolina 27711

March 1994

NOTICE

This document has been reviewed in accordance with United States Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

FOREWORD

This document replaces the ***Enhanced Ozone Monitoring Network Design and Siting Criteria Guidance Document***, EPA-450/4-91-033, dated November 1991. This implementation manual is being published in loose-leaf form for the convenience of the user; periodically, additional sections of the document not included with this first publication and subsequent revisions will be sent to the user community.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACT	-	Clean Air Act
AFS	-	AIRS Facility Subsystem
AG	-	AIRS Graphics
AGENCY	-	United States Environmental Protection Agency
AIRS	-	Aerometric Information Retrieval System
ALAPCO	-	Association of Local Air Pollution Control Officials
AMS	-	Area and Mobile Subsystem (AIRS)
AMTIC	-	Ambient Monitoring Technology Information Center
APTI	-	Air Pollution Training Institute
AQCR	-	Air Quality Control Region
AQS	-	Air Quality Subsystem (AIRS)
AREAL	-	Atmospheric Research and Exposure Assessment Laboratory
BACT	-	Best Available Control Technology
BBS	-	Bulletin Board System
BLIS	-	RACT/BACT/LAER Information Systems
BPS	-	Bytes Per Second
C	-	Carbon
CAAA	-	Clean Air Act Amendments of 1990
CBD	-	Central Business District
CDS	-	Compliance Data System
CFR	-	Code of Federal Regulations
CHIEF	-	Clearinghouse for Inventories/Emission Factors
CICS	-	Customer Information Control System
CMSA	-	Consolidated Metropolitan Statistical Area
COMPLI	-	COMPLIance Information on Stationary Sources of Air Pollution

CTC	-	Control Technology Center
CYO	-	Create-Your-Own
DQO	-	Data Quality Objective
EKMA	-	Empirical Kinetic Modeling Approach
EMTIC	-	Emission Measurement Technical Information Center
EPA	-	United States Environmental Protection Agency
FIPS	-	Federal Information Processing Standards
FRM	-	Federal Reference Method
FY	-	Fiscal Year
GCS	-	Geographic and Common Subsystem (AIRS)
HNO_3	-	Nitric Acid
ID	-	Identification
LAER	-	Lowest Achievable Emission Rate
MCB	-	Model Change Bulletin
MSA	-	Metropolitan Statistical Area
MW	-	Molecular Weight
NAAQS	-	National Ambient Air Quality Standards
NADB	-	National Air Data Branch
NAMS	-	National Air Monitoring Stations
NARS	-	National Asbestos Registry System
NATICH	-	National Air Toxics Information Clearinghouse
NCC	-	National Computer Center
NEDS	-	National Emissions Data System
NESHAP	-	National Emission Standards for Hazardous Air Pollutants
NMOC	-	Nonmethane Organic Compound
NO	-	Nitrogen Oxide
NO_2	-	Nitrogen Dioxide

NO_x	-	Oxides of Nitrogen
NO_y	-	Total Reactive Oxides of Nitrogen
NSPS	-	New Source Performance Standard
NSR	-	New Source Review
NWS	-	National Weather Service
O_3	-	Ozone
OAQPS	-	Office of Air Quality Planning and Standards
OMS	-	Office of Mobile Sources
PAMS	-	Photochemical Assessment Monitoring Stations
PAN	-	Peroxyacetyl Nitrate
PICS	-	Products of Incomplete Combustion
PPB	-	Parts Per Billion
PPM	-	Parts Per Million
PSD	-	Prevention of Significant Deterioration
PWD	-	Primary Wind Direction
QA	-	Quality Assurance
QC	-	Quality Control
RACT	-	Reasonably Available Control Technology
REVIEW COMMITTEE	-	EPA PAMS Network Design Review Committee
RFP	-	Reasonable Further Progress
ROM	-	Regional Oxidant Model
RTV	-	Ready-to-View
RULE	-	40 CFR Part 58, as Amended February 12, 1993
SAROAD	-	Storage and Retrieval of Aerometric Data
SCRAM	-	Support Center for Regulatory Air Models
SIP	-	State Implementation Plan

SLAMS	-	State and Local Air Monitoring Stations
SOP	-	Standard Operating Procedure(s)
SPM	-	Special Purpose Monitor
SSCD	-	Stationary Source Compliance Division
STAPPA	-	State and Territorial Air Pollution Program Administrators
SYSOP	-	Systems Operator
T	-	Temperature
TAD	-	Technical Assistance Document
TO	-	Toxic Organic Method
TTN	-	Technology Transfer Network
UAM	-	Urban Airshed Model
UTM	-	Universal Transverse Mercator
V	-	Volume
VOC	-	Volatile Organic Compound(s)
W	-	Weight

1.0 INTRODUCTION

1.1 REGULATORY BACKGROUND AND OBJECTIVES

Section 182(c)(1) of the 1990 Clean Air Act Amendments (CAAA) required the Administrator to promulgate rules for the enhanced monitoring of ozone, oxides of nitrogen (NO_x), and volatile organic compounds (VOC) to obtain more comprehensive and representative data on ozone air pollution. Immediately following the promulgation of such rules, the affected States were to commence such actions as were necessary to adopt and implement a program to improve ambient monitoring activities and the monitoring of emissions of NO_x and VOC. Each State Implementation Plan (SIP) for the affected areas must contain measures to implement the ambient monitoring of such air pollutants. The subsequent revisions to Title 40, ***Code of Federal Regulations***, Part 58 (40 CFR 58) (Reference 1) required States to establish Photochemical Assessment Monitoring Stations (PAMS) as part of their SIP monitoring networks in ozone nonattainment areas classified as serious, severe, or extreme (Figure 1-1). The criteria for judging the severity of an ozone nonattainment area utilizing the ozone design value is listed in Table 1-1. The air quality design value is intended to provide a measure of the need for reduction in ozone concentrations essential to achieve attainment or, equivalently, the degree of severity of the nonattainment area represented by the monitoring site. Given the expected exceedance form of the ozone National Ambient Air Quality Standard (NAAQS), the ozone design value is defined as the concentration with the expected number of exceedances equal to one (see References 2 and 3).

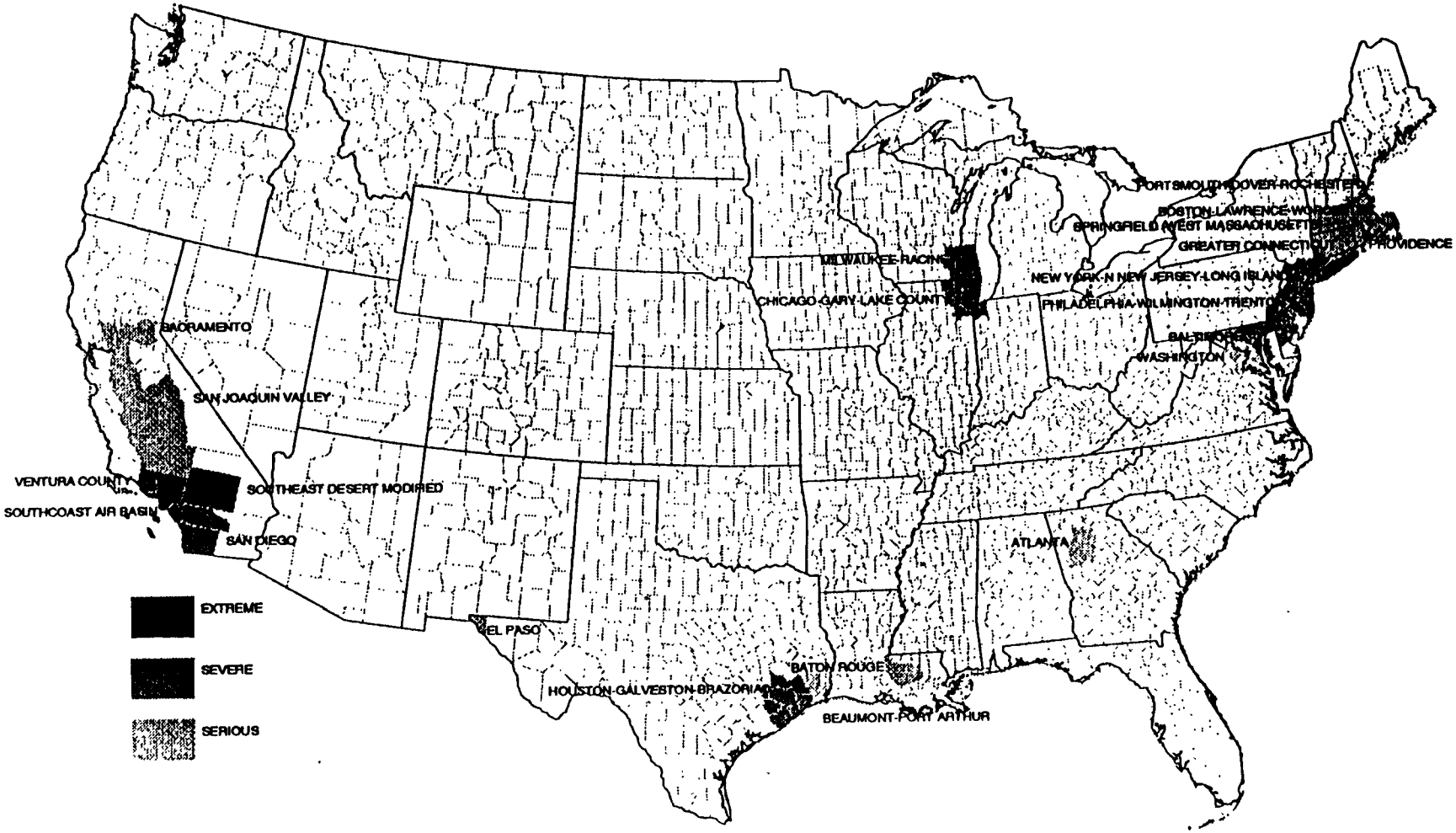


FIGURE 1-1. PAMS OZONE NONATTAINMENT AREAS

TABLE 1-1. NONATTAINMENT SEVERITY CLASSIFICATIONS

NONATTAINMENT AREA CLASSIFICATION	OZONE DESIGN VALUE (ppm)
Marginal	0.121 up to 0.138
Moderate	0.138 up to 0.160
Serious	0.160 up to 0.180
Severe	0.180 up to 0.280
Extreme	0.280 and above

The principal reasons for requiring the collection of additional ambient air pollutant and meteorological data are, primarily, the lack of attainment of the NAAQS for ozone nationwide, and, secondly, the need for a more comprehensive air quality database for ozone and its precursors.

The chief objective of the enhanced ozone monitoring revisions is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. Ambient concentrations of ozone and ozone precursors will be used to make attainment/nonattainment decisions, aid in tracking VOC and NO_x emission inventory reductions, better characterize the nature and extent of the ozone problem, and prepare air quality trends. In addition, data from the PAMS will provide an improved database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data will be particularly useful to States in ensuring the implementation of the most cost-effective regulatory controls.

This document was designed to familiarize State and local air authorities with the enhanced ozone monitoring program and to provide guidance for designing PAMS networks. In addition to this revised document, EPA has also prepared a revised guidance document on PAMS measurement methods for ozone and ozone precursor compounds entitled ***Technical Assistance Document for Sampling and Analysis of Ozone Precursors*** (Reference 4). The user is encouraged to refer to that document for information on manual and automated sampling techniques for VOC, nonmethane organic compounds (NMOC), and methodologies for measuring NO_x and carbonyls.

1.2 DEVELOPING DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are statements that relate the quality of environmental measurements to the level of uncertainty that decision-makers are willing to accept for results derived from the data. The process of developing DQOs starts with the program or project objectives, in which the goals of the monitoring are laid out. This is followed by a description of the data objectives, which state the kind of monitoring that will be performed. The DQOs then carry the process to its conclusion, stating how "good" the data need to be to satisfy the program objectives, with a specified level of confidence. Thus, it is critical that any set of DQOs be tied closely to the Program Objectives, ensuring that the monitoring will truly address the stated needs.

It is never possible to be absolutely certain that a future data set will satisfy the data needs exactly. There is always a chance that variables, variation, and uncertainty beyond the program's control will lead to a "softness" in the data and a resulting uncertainty that the subsequent decisions are appropriate. For example, it is not possible to be 100% certain that a downward trend in ozone concentration has been confirmed or denied, since it is possible that local meteorology unexpectedly affected the two highest-reading days, one way or the other. By carefully designing the equipment and schedules, however, it is possible to reduce

to acceptable levels the possibility of making an erroneous call. In order to accomplish this task, it is first necessary to narrow each Program Objective to one or more specific monitoring or data objectives that must be accomplished in order to allow the Program Objective to be met. Then, a meaningful DQO can be developed for each Program Objective.

The DQOs themselves must quantify the variability or possible error as well as possible in order for the decision-making risk to be assessed fairly. This can only happen if there is a base of experience using the technologies and/or methods to be used in the project. In the case of the PAMS Program, there has never been a monitoring program of this scope covering these parameters and with similar project objectives.

During the summer of 1990, the EPA conducted a major monitoring study in Atlanta, Georgia, to address ozone measurements and their precursors. This project was undertaken to obtain an information base to support the development and implementation of improved strategies for reducing ozone in cities that are not attaining the NAAQS for ozone. The study was jointly sponsored by the EPA Atmospheric Research and Exposure Assessment Laboratory (AREAL) and the Office of Air Quality Planning and Standards (OAQPS), located in the Research Triangle Park, North Carolina. This study is further described in References 5, 6, and 7. The data compiled in the Atlanta Study, among others, have provided initial information for the development of these DQOs.

The next section of this document contains the program objectives and specific DQOs that have been developed for the PAMS Program. As described above, these DQOs are tied directly to each of the Program Objectives. This is done informally through a narrowed focus on specific monitoring objectives. It is important to note, however, that all possible uses of the PAMS data are not now known; therefore, every practical attempt should be made to improve the quality of the data beyond that necessary to satisfy the explicit DQOs specified

here. In addition, the DQOs may be used as guides for evaluating requests to utilize alternative networks, methods, etc.

The DQOs included in this document are preliminary and are expected to be updated as

- improvements are made in the monitoring and statistical methodologies;
- changes and/or additions are made in the Program Objectives or in the specific uses of the data; and/or
- results of the monitoring indicate a need.

1.3 PAMS PROGRAM OBJECTIVES AND INITIAL DATA QUALITY OBJECTIVES

In contrast to the State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS) network and siting design criteria, which are pollutant specific, PAMS design considerations are site specific. Concurrent measurements of ozone, NO_x, speciated VOC (including carbonyls), and meteorology are obtained at each PAMS site; upper air meteorological parameters, however, are required only in one representative location in each affected area. Design criteria for the PAMS network are based on selection of an array of sites located specifically to monitor the impact of an area's emissions of ozone precursors given the predominant wind directions associated with high ozone events. Specific and often different monitoring objectives (and often different data uses) are therefore associated with each specific PAMS location. The overall network should supply information sufficient to develop responsible and cost-effective ozone control strategies; provide appropriate data support for photochemical grid modeling efforts; allow the reconciliation of emissions inventories; enable characterization of ozone, ozone precursor and meteorological trends; provide for improved assessments of ozone attainment; and provide a measure of information for determining population exposure. A maximum of five PAMS sites is required in an affected nonattainment area depending on the population of the Metropolitan Statistical

Area/Consolidated Metropolitan Statistical Area (MSA/CMSA) or nonattainment area, whichever is larger.

The monitoring objectives for PAMS can be classified into the six general categories depicted in Figure 1-2. A monitoring network based on these six principles will provide the initial stepping stones that constitute a pathway toward attainment of the NAAQS for ozone.

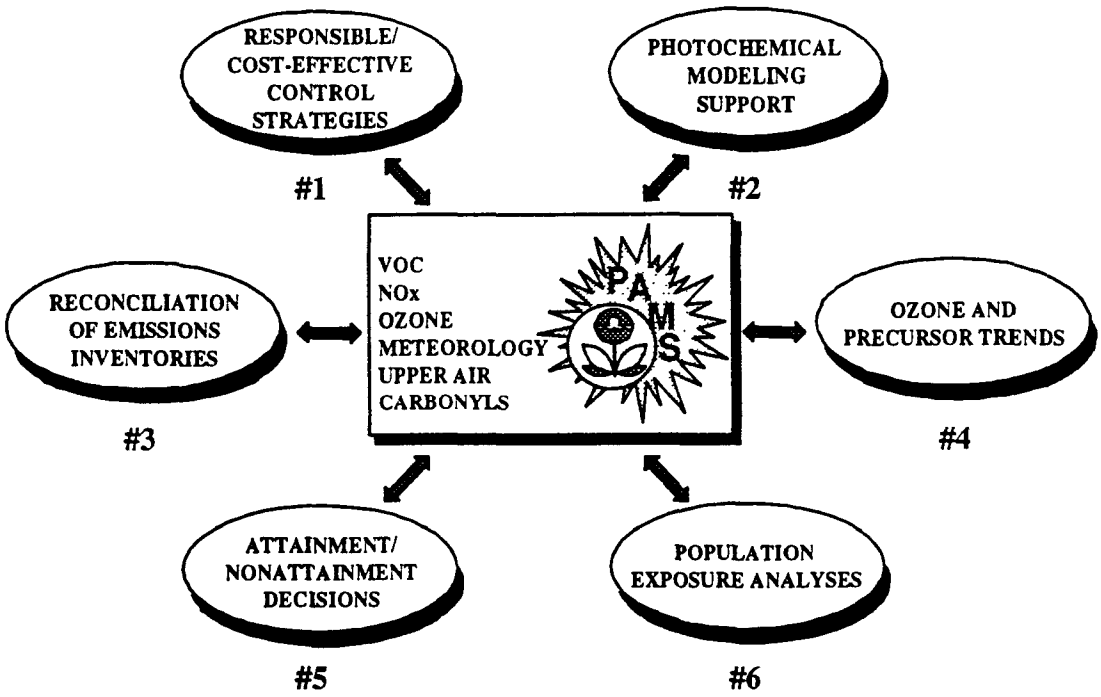
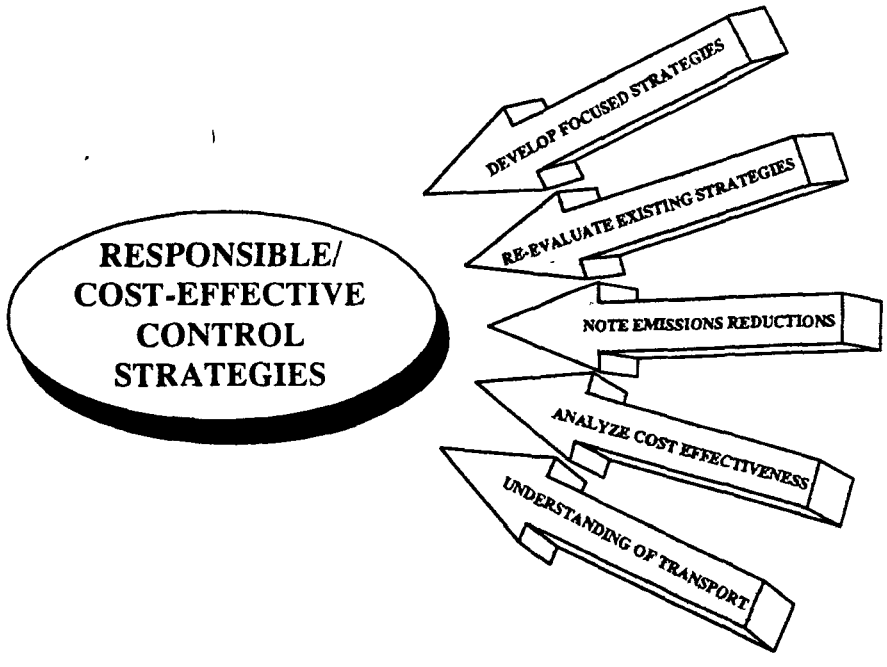


FIGURE 1-2. PAMS PROGRAM AND DESIGN OBJECTIVES

The design of a PAMS program should result in a network which can be used to maximize the utility of these data and program design objectives. The EPA acknowledges that compromises must be achieved (*i.e.*, some more crucial objectives will be better satisfied than other less important objectives). Nevertheless, each affected air pollution control agency should make every effort to craft a network which satisfies as many of these objectives as practicable, yet does not become a financial or operational burden.

OBJECTIVE #1: Provide a speciated ambient air database which is both representative and useful for ascertaining ambient profiles and distinguishing among various individual VOC. These data can later be used as evaluation tools for control strategies, cost-effectiveness, and for understanding the mechanisms of pollutant transport.



Clearly, a fundamental objective of the enhanced ozone and ozone precursor monitoring regulations is to provide a mechanism whereby air pollution control agencies can obtain an air quality database that will assist in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. This comprehensive

database will allow the States to focus their control strategies where they will be the most beneficial to attain the NAAQS and to reevaluate their existing ozone control programs with the aim of appropriate mid-course corrections as part of the continuing air quality management process. These PAMS data, especially those collected at Sites #1 and #2 (see Section 2.2 for network site descriptions), will enhance the characterization of ozone concentrations and provide critical information on the precursors which cause ozone. Speciation of measured VOC data and additional NO_x data are expected to allow the determination of which species are most affected by local emissions reductions and assist in developing cost-effective, selective VOC and/or NO_x reductions and control strategies.

INITIAL DQOs FOR OBJECTIVE #1:

The primary purpose of the PAMS monitoring networks is to provide speciated ambient air quality data that can be used

- initially, to provide baseline profiles, and
- eventually, to evaluate and develop cost-effective ozone control strategies.

Based on the results of the Atlanta Study and other recent ambient air monitoring projects, the PAMS network design and monitoring practices can provide this information. It is important to include both the network configurations and the monitoring practices themselves in defining the necessary quality of the monitoring efforts. The DQOs for this project objective are thus complex and, to some degree subjective. It is not possible to specify exactly the monitoring accuracy that is needed or possible, since an effort of this scope has never been conducted for the precursor compounds. However, based on the Atlanta Study and on EPA's considerable experience with the NAMS/SLAMS networks, it is possible to define DQOs that make sense.

Quantifiable DQOs refer to the ability of the network to identify diurnal trends in the monitoring data corresponding to the diurnal meteorological and emission patterns, and to detect changes in those patterns after control strategies have been implemented.

Daily Patterns

Ambient monitoring data for all of the pollutants considered in the PAMS program will be used to:

- Determine whether or not there is a daily cycle or pattern in the concentrations of one or more of the pollutants;
- Determine whether or not there is a change in the daily cycle or pattern over time; and,
- By implication, contribute to the evaluation of whether the SIP controls or other factors (such as land or resource use changes or voluntary emission reductions) are having an effect on the pattern.

Based on the ozone precursor and ozone data available, it is believed that the most likely daily cycle would be what is termed "a diurnal cycle" in which the concentration of one or more pollutants increases to a level significantly above the mean at one time during the day, and/or decreases to a level significantly below the mean at another time during the day. An easily measurable surrogate for the diurnal cycle would be the presence or absence of a single hourly (or three-hourly) time period within a day with a mean concentration 20% above or below the daily mean. In order to allow a determination of whether this represents a pattern, the data must be of sufficient quality to show that this phenomenon has occurred over a given period of time.

Thus, the following is the first DQO.

DQO #1.1 ***The data for any given pollutant measured at a PAMS site must be able to show the presence of a diurnal pattern, if one exists, with an 80% confidence level.***

In an individual day, a "diurnal cycle" is the presence of any given hourly (or three-hourly) time period at a given site for which the mean concentration of the specific pollutant is at least 20% above or below the mean concentration for that day. A "diurnal pattern" is the presence of a diurnal cycle that persists over a defined set of daily measurements. A diurnal pattern is defined as occurring when the mean of the averages of the single specific hourly (or three-hourly) periods is at least 20% above or below the mean of the daily averages over the defined set of days. In this case, the defined set of days (the averaging time periods) are defined as those days for all sites and pollutants for which daily data are available during the ozone season.

Effects of Controls on Daily Patterns

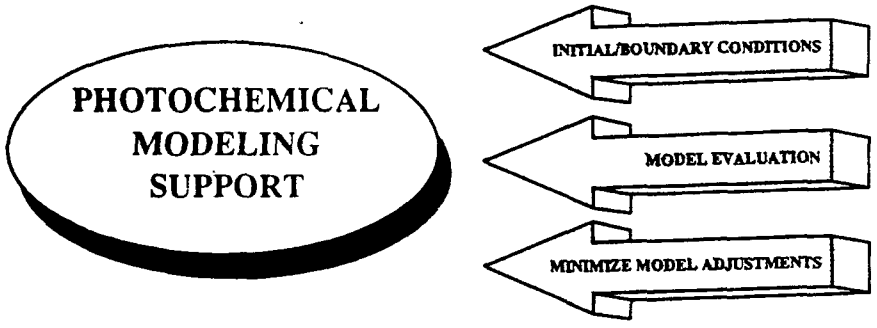
The second value of the PAMS data as they relate to daily patterns will be the data's ability to identify a change in the patterns once ozone control strategies have been implemented.

Thus, the following is the second DQO.

DQO #1.2 ***The data for any given pollutant measured at a PAMS site must be able to show a change in the diurnal pattern, if a change exists, with an 80% confidence level.***

A diurnal cycle and a diurnal pattern, as well as the defined set of monitoring days, are the same as for DQO #1.1. The magnitude of the diurnal pattern is the specific percent difference between the mean of the hourly (or three-hourly) values and the daily averages. A change in the diurnal pattern is defined as an increase or decrease in the percent differences of greater than 20% of the daily averages.

OBJECTIVE #2: Provide local, current meteorological and ambient data to serve as initial and boundary condition information for photochemical grid models. These data can later be used as a baseline for model evaluation and to minimize model adjustments and reliance on default settings.



The PAMS network requirements are tailored to provide specific data measurements which can be utilized by photochemical modelers to refine their estimates of initial and boundary conditions, provide a means to evaluate the predictive capability of the models, and minimize the adjustment of model inputs. Such information will tend to increase the probability that the model's calculations will reflect the "right answer for the right reason" rather than the "right answer for the wrong reason" and reduce the uncertainties associated with estimated model inputs. In fact, the upwind site (Site #1) and the downwind site (Site #4) are located so as to quantify the atmospheric conditions at the upwind and downwind extremes of the photochemical modeling domain.

Heretofore, the national air pollution control program has not had the benefit of comprehensive ozone precursor data as a tool for evaluating, calibrating, or otherwise adjusting and conducting reality checks on the operation of the Urban Airshed Model (UAM). EPA views the PAMS networks as vital steps forward in complementing grid model applications.

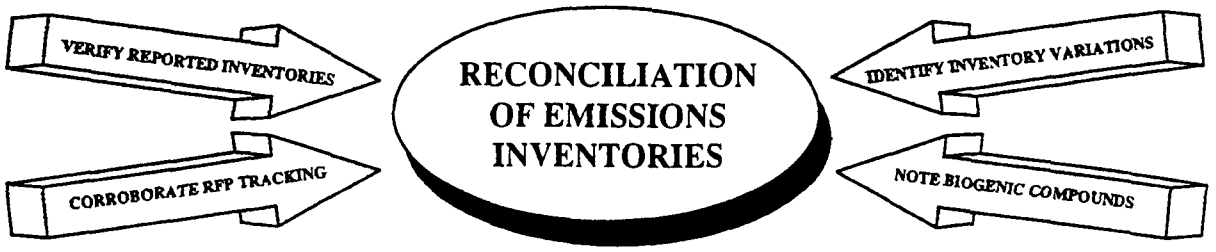
INITIAL DQO FOR OBJECTIVE #2:

PAMS data will serve as important inputs to mathematical and statistical photochemical grid models, in particular, the UAM. The networks, then, must be able to produce data and data quality sufficient for use in those models. The specific data quality needed, however, is not easily quantifiable, since the models will "run" with data of almost any quality. Better data will simply improve the predictive power of the models. As a result, modeling needs are that the data be "as good as they can be." In practice, this means that the monitoring must satisfy all of the criteria specified in the regulations. This includes all aspects of monitor siting, as well as operation.

Thus, the DQO is as follows.

DQO #2.1 ***The speciated VOC, ozone, NO_x and meteorological data must satisfy the regulations, including monitor siting, operation, and data quality criteria.***

OBJECTIVE #3: Provide a representative, speciated ambient air database which is characteristic of source emission impacts. These data can be particularly useful in analyzing emissions inventory issues and corroborating progress toward attainment.



The emissions inventory serves as an essential element of the air management process as well as a fundamental input for photochemical models. Verification of reported inventories and the tracking of changes in the atmospheric VOC profiles can assist in the evaluation of control strategy effectiveness. Given that the inventory is the foundation building block for the entire SIP development process, it is critical that its accuracy be optimized. While the regulatory assessments of progress will be made in terms of emission inventory estimates, the ambient data can provide independent trend analyses and corroboration of these assessments which either verify or highlight possible errors in emissions trends indicated by inventories. The ambient assessments, using speciated data, can gauge the accuracy of estimated changes in emissions. The speciated data can also be used to assess the quality of the speciated VOC and NO_x emission inventories. Utilizing other computer modeling techniques, PAMS data will help resolve the roles of transported and locally emitted ozone precursors in producing an observed exceedance and may be utilized to identify specific sources emitting excessive concentrations of precursors.

PAMS data will be used to corroborate the quality of VOC and NO_x emissions inventories. Although a perfect mathematical relationship between emissions inventories and ambient measurements does not exist, a comparison of the relative concentrations of various compounds in the ambient air over a given time period can be contrasted roughly to emissions inventory estimates over the same time period to evaluate the accuracy of the emissions inventory reductions. In addition, PAMS data that are gathered year round, such as the VOC and NO_x concentrations at the #2 Sites, will allow tracking of the VOC and NO_x emission reductions on peak and high ozone days (as well as on an annual and seasonal basis), provide additional information necessary to support Reasonable Further Progress (RFP) calculations, and corroborate emissions trends analyses.

INITIAL DQOs FOR OBJECTIVE #3:

There are two DQOs for this Program Objective, one dealing with total VOC, and the other with speciated VOC.

Total VOC Monitoring

In order for the PAMS data to be useful for this purpose, the network design and operation must be sufficient to allow a detection of a 3% annual reduction in the seasonal average concentration over a 5-year monitoring period. The same percent reduction is specified by Title I of the CAAA for emission reductions for most nonattainment areas. The season will most often be defined as the highest three-month period.

The results from the Atlanta Study are useful for predicting the likelihood of detecting a trend in ambient concentrations over time. Based on selected speciated VOC data and the pooled VOC data, the results indicate that the pooling of data from more than one site clearly improves the probability that the network will detect a trend in ambient concentrations. For this reason, the ability of the network to assess the relative accuracy of emissions inventories for an MSA/CMSA will increase significantly with the addition of a second #2 Site.

Based on the analysis of the predictive value of the Atlanta Study data, the following is the DQO.

DQO #3.1 ***The monitoring data for Total Volatile Organic Compound (Total VOC) concentrations collected at #2 Sites must be able to demonstrate a 3% annual trend (upward or downward) over a 5-year monitoring period, if it exists, with an 80% confidence level.***

The power, or probability of detecting such a trend for the #2 Site will be 70%. As an example, in an MSA with an actual reduction in Total VOC ambient concentrations of greater than 15% over a 5-year period (that is, more than 3% per year), we can have an 80% confidence level that the data will demonstrate that reduction at least 70% of the time.

Speciated VOC Monitoring

As part of the emissions inventory reconciliation, speciated VOC data will be used for the following:

- Determining baseline species profiles.
- Determining and differentiating the contributions of various sources and source types.
- Determining changes in species profiles over time (as may have resulted from emission control programs, land or resource use changes, voluntary reductions, etc.).

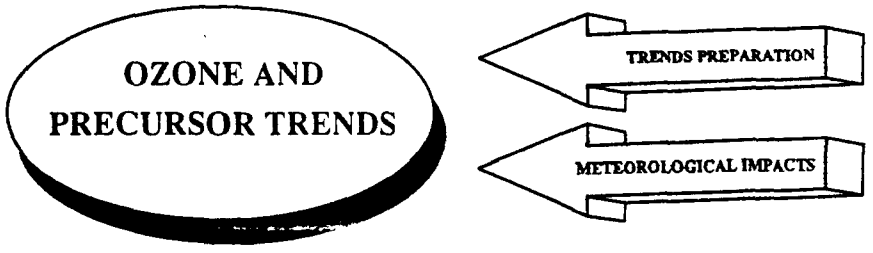
Because of the combined effects of the large mass of data that will be collected, and the expected variability between sites and between individual compounds, the data may not provide meaningful information on the changes in one compound from one year to the next. In order to assess these changes, it may be necessary to group the speciated VOC into classes.

The results from the Atlanta Study are useful for predicting the likelihood of detecting a trend in ambient concentrations over time. Selected speciated VOC data indicate that the pooling of data by compound class clearly improves the probability that the network will detect a trend in ambient concentrations.

Thus, the following is the second DQO.

DQO #3.2 ***The speciated VOC monitoring data collected at a #2 Site, when composited into categories, must be able to demonstrate a 20% change (upward or downward) in the seasonal average between two consecutive years, if it exists, with an 80% confidence level.***

OBJECTIVE #4: Provide ambient data measurements which would allow later preparation of unadjusted and adjusted pollutant trends reports.



Long-term PAMS data will be used to assess ambient trends for speciated VOC, NO_x, and, in a more limited way, for toxic air pollutants. Multiple statistical indicators will be tracked, including ozone and its precursors during the events encompassing the days during each year with the highest ozone concentrations, the seasonal means for these pollutants, and the annual means at representative locations. The more PAMS that are established in and near nonattainment areas, the more accurate the trends data will become. Note, however, that in general it will only be appropriate to combine data from like sites; therefore, trends will likely need to be constructed on a site-by-site or combination-of-like-sites basis. As the spatial distribution and number of ozone and precursor monitors improves, trends analyses will be less influenced by instrument or site location anomalies. The requirement that surface meteorological monitoring be established at each PAMS will help maximize the utility of

these trends analyses by permitting comparisons with meteorological data and transport influences. The meteorological data can also help interpret the ambient air pollution trends by taking meteorological factors into account.

There are two basic concepts which may be employed in preparing trends analyses: (1) displaying unadjusted measurements which portray the quality of the air actually breathed by the public, and (2) calculating adjusted trends to infer progress towards attainment of standards due to the influences of pollutant control programs. In either case, the cornerstone of the analyses are the actual air quality and meteorological measurements such as those required by PAMS. Particularly, for evaluating the effectiveness of control programs, it may be appropriate to integrate such factors as meteorology and emissions inventory data. (Note Appendix B of this document; a similar process could be utilized for VOC.) Since all PAMS sites will gather comprehensive ambient data in addition to surface meteorological measurements, all data will be useful for developing pollutant trends, particularly from Sites #2 and #3.

INITIAL DQOs FOR OBJECTIVE #4:

Based on the historical trends found to be of interest in previous Trends Reports, and on an analysis of the data from the Atlanta Study, the following is the DQO.

DQO #4.1 ***The composite monitoring data for a given MSA/CMSA for ozone, NO_y, and speciated VOC must be able to demonstrate a yearly downward trend with an 80% confidence level until an area achieves attainment.***

The composite data are defined as the average of the ozone season data for a given pollutant over like monitoring sites in the MSA/CMSA over a 10-year period, as follows:

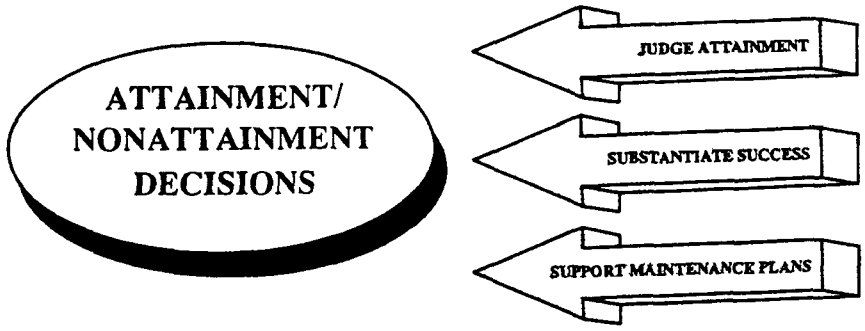
- Ozone - annual second highest daily maximum one-hour concentration
- VOC/NO_x - seasonal average

Depending on the total number of sites in an MSA/CMSA, the power, or probability of detecting such a trend will be as follows:

1 Site - 70%
2 Sites - 80%
3 Sites - 90%

As an example, in an MSA with a single #2 Site and with an actual reduction in toluene ambient concentrations of more than 30% over a 10-year period (that is, over 3% per year), we can have an 80% confidence level that the data will demonstrate that reduction at least 70% of the time.

OBJECTIVE #5: Provide additional measurements of selected criteria pollutants. Such measurements can later be used for attainment/nonattainment decisions and to construct NAAQS maintenance plans.



Like SLAMS and NAMS data, PAMS data will be used for monitoring ozone exceedances and providing input for attainment/nonattainment decisions (see Reference 8 and

Appendix C of this document). Additionally, the nitrogen dioxide (NO_2) data can be utilized to augment monitoring for compliance with the NAAQS for NO_2 where such data are gathered with the Federal Reference Method (FRM) and taken on a year-round basis. Ultimately, the success of any air pollution control strategy is appraised by its ability to achieve compliance with the NAAQS. (Note that the PAMS will expand the spatial coverage of NAAQS monitoring.) Although the data at any PAMS site can be used for these purposes, it is expected that Site #3 will more likely constitute the maximum concentration site for comparison with the NAAQS. Further, the additional data will provide an expanded foundation for developing and administering maintenance plans required by the CAA.

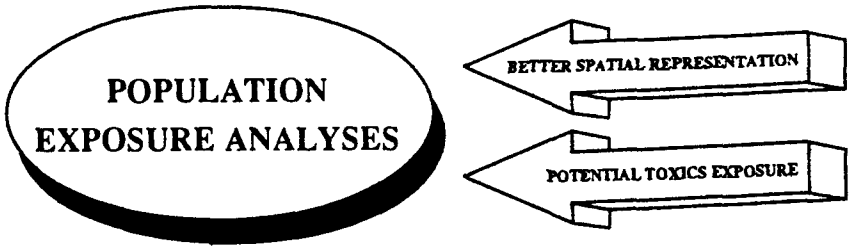
The ambient ozone monitoring data collected at the PAMS stations must be sufficient for use in the determinations of attainment status with respect to the ozone NAAQS. As such, the data must satisfy all of the criteria specified in the NAMS and SLAMS network regulations, namely 40 CFR 58, which specifies the monitoring criteria (such as monitor location) and the data quality criteria (such as the required precision and accuracy.)

INITIAL DQOs FOR OBJECTIVE #5:

Thus, the DQO is as follows.

DQO #5.1 ***The ozone (and NO_2 where appropriate) monitoring data must satisfy the criteria specified in the NAMS and SLAMS monitoring regulations (see Reference 1), including monitor siting, operation, and data quality criteria.***

OBJECTIVE #6: Provide additional measurements of selected criteria and non-criteria pollutants from properly-sited locations. Such measurements can later be used for evaluating population exposure to air toxics as well as criteria pollutants.



PAMS data can be used to better characterize ozone and toxic air pollutant exposure to populations living in serious, severe, or extreme areas. Annual mean toxic air pollutant concentrations can be calculated to help estimate the average exposure of the population in urban environments to individual VOC species which are considered toxic. Specifically, by measuring the VOC targeted by PAMS, a number of toxic air pollutants will also be measured. Although compliance with Title I, Section 182 of the CAAA does not require the measurement and analysis of additional toxic air pollutants, EPA believes that the PAMS stations can serve as cost-effective platforms for an enhanced air toxics monitoring program. The adjunct use of PAMS for air toxics monitoring will allow the consideration of air toxics impacts in the development of future ozone control strategies. The establishment of a second PAMS Site #2 in an MSA/CMSA will provide an even better database for such uses. Both Sites #2 and #3 will probably be the best choices for exposure analyses for air toxics and ozone respectively. EPA notes that the PAMS network is not ideal as a source of primary ambient air toxics data and regards the collection of air toxics data as an incidental and secondary, though still important, objective of the PAMS system (see also Appendix J).

INITIAL DQO FOR OBJECTIVE #6:

The DQO is as follows.

DQO 6.1 ***The speciated VOC monitoring data must be able to provide annual average concentration data at #2 Sites to within ±50%, with a confidence level of 80%.***

1.4 GENERAL APPROACH

Design criteria for the PAMS network are based on the selection of an array of data collection sites that satisfy the monitoring objectives as described in Section 1.3 of this document and which are further delineated in Appendix D, Section 4, of 40 CFR 58. These sites would allow ambient data on ozone precursor source areas and predominant wind directions associated with high ozone events to be collected and made accessible through the Aerometric Information Retrieval System (AIRS) national database. Specific monitoring objectives are associated with each site location or combination of site locations. The PAMS network design will enable better characterization of precursor emission sources within an MSA/CMSA, transport of ozone and ozone precursors into and out of an MSA/CMSA, and photochemical processes that result in ozone exceedances.

1.5 ORGANIZATION

Section 2.0 of this document describes the PAMS network design and includes minimum network requirements, and descriptions of monitoring sites and the site selection process. Section 3.0 defines monitoring methods and network operations. Section 4.0 describes the network planning and approval process. Section 5.0 is reserved. Section 6 contains information on AIRS. Section 7.0 deals with the Technology Transfer Network (TTN). Section 8.0 contains references.

2.0 NETWORK DESIGN AND SITING FOR PAMS

2.1 INTRODUCTION

Title 40, ***Code of Federal Regulations***. Part 58 establishes specific criteria and requirements for national ambient air monitoring systems and provides for the reporting of the collected measurements and associated data to a national computerized database. Inasmuch as the vast majority of ambient monitoring stations are operated by the State and local air pollution control agencies, these existing rules form the foundation for the SLAMS. Additionally, these agencies operate other ambient monitoring stations which are termed Special Purpose Monitors (SPM). Although the data collected at most SPM are acceptable to satisfy national monitoring goals, the stations have been established for SIP purposes and are not required to comply with the strict data reporting requirements of SLAMS.

A subset of the SLAMS monitors has been formally designated as NAMS. These stations require the approval of EPA Headquarters prior to establishment or alteration and therefore provide the nation with a sense of permanence for at least a base or core national monitoring network. The newly-instituted PAMS will also constitute a subset of the SLAMS monitors and may be located coincident to NAMS sites.

Each PAMS station will sample for speciated VOC including several carbonyls, ozone, NO_x, and surface (10-meter) meteorological parameters; the frequency requirements vary somewhat with the size of the MSA/CMSA. Additionally, each area must monitor upper air meteorology at one representative site. The Rules allow a 5-year transition or phase-in schedule for the program at a rate of at least one station per area per year. Further, the Rules provide for the submission and approval of alternative network designs and sampling schemes. Such alternative mechanisms for compliance with the Rules are especially valuable

to States which are currently engaged in other forms of ozone precursor monitoring which have proved adequate for their SIP needs.

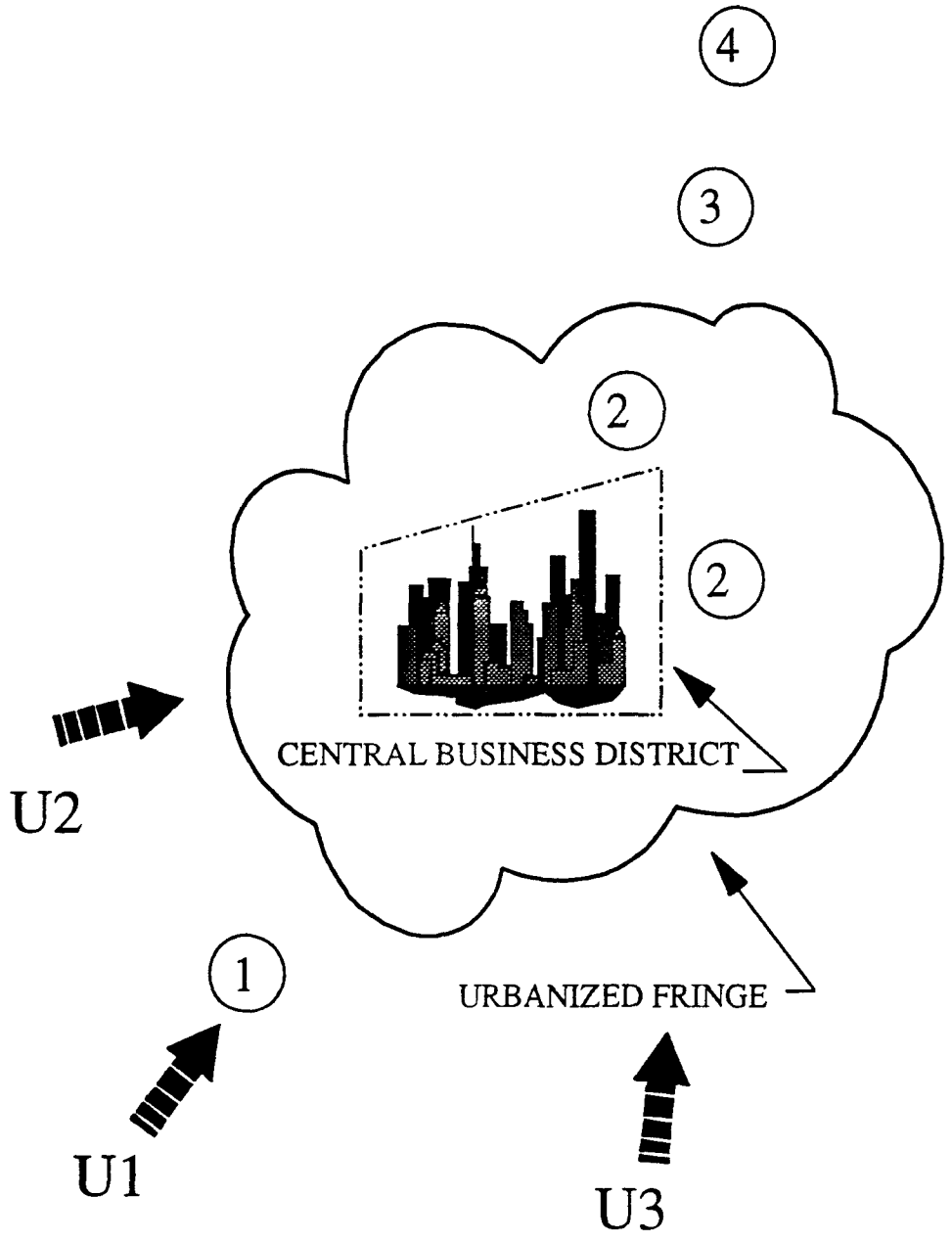
2.2 PAMS SITE DESCRIPTIONS

The PAMS network array for an area should be fashioned to supply measurements which will assist States in understanding and solving ozone nonattainment problems. EPA has determined that for the larger areas, the minimum network which will provide data sufficient to satisfy a number of important monitoring objectives should consist of five sites (Figure 2-1):

Site #1 - **Upwind and background characterization site.** These sites are established to characterize upwind background and transported ozone and its precursor concentrations entering the area and will identify those areas which are subjected to overwhelming incoming transport of ozone. The #1 Sites are located in the predominant morning upwind direction from the local area of maximum precursor emissions and at a distance sufficient to obtain urban scale measurements. Typically, these sites will be located near the upwind edge of the photochemical grid model domain.

Site #2 - **Maximum ozone precursor emissions impact site.** These sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions representative of the MSA/CMSA are expected to impact and are suited for the monitoring of urban air toxic pollutants. The #2 Sites are located immediately downwind (using the same morning wind direction as for locating Site #1) of the area of maximum precursor emissions and are typically

FIGURE 2-1. ISOLATED AREA NETWORK DESIGN



LEGEND:

(1) - PAMS SITES
U1 - HIGH OZONE DAY PREDOMINANT MORNING WIND DIRECTION
U2 - SECOND MOST PREDOMINANT HIGH OZONE DAY MORNING WIND DIRECTION
U3 - HIGH OZONE DAY PREDOMINANT AFTERNOON WIND DIRECTION

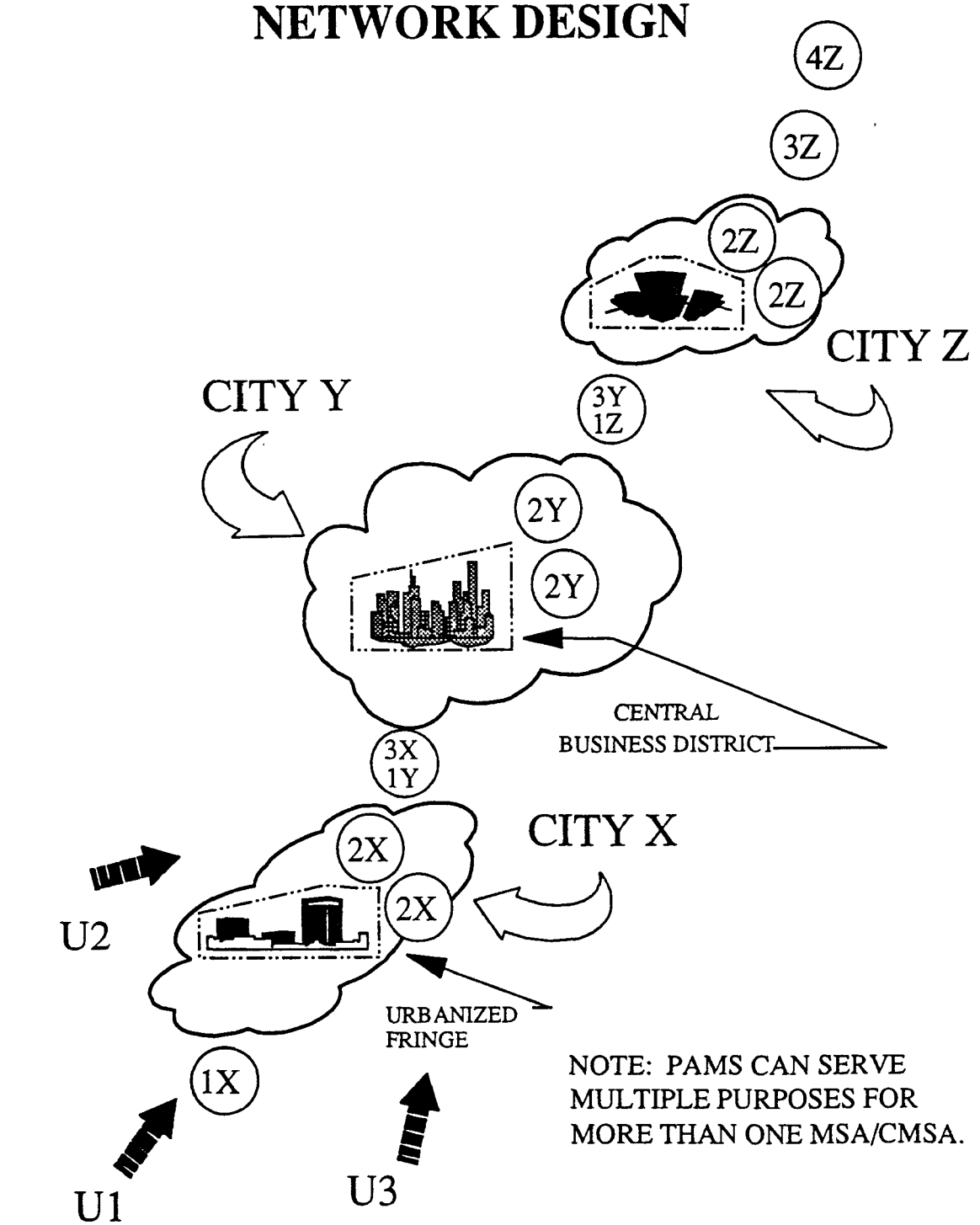
placed near the downwind boundary of the central business district (CBD) or primary area of precursor emissions mix to obtain neighborhood scale measurements. Additionally, **a second #2 Site may be required** depending on the size of the area, and should be placed in the second-most predominant morning wind direction.

Site #3 - **Maximum ozone concentration site.** These sites are intended to monitor maximum ozone concentrations occurring downwind from the area of maximum precursor emissions. Locations for #3 Sites should be chosen so that urban scale measurements are obtained. Typically, these sites are located 10 to 30 miles from the fringe of the urban area.

Site #4 - **Extreme downwind monitoring site.** These sites are established to characterize the extreme downwind transported ozone and its precursor concentrations exiting the area and will identify those areas which are potentially contributing to overwhelming ozone transport into other areas. The #4 Sites are located in the predominant afternoon downwind direction from the local area of maximum precursor emissions at a distance sufficient to obtain urban scale measurements. Typically, these sites will be located near the downwind edge of the photochemical grid model domain.

States which experience significant impact from long-range transport of ozone or its precursors or are proximate to other nonattainment areas (even in other States) can collectively submit a network description which contains alternative sites to those that would be required for an isolated area as shown in Figure 2-1. Such coordinated network plans should, as a guide, be based on the example depicted in Figure 2-2, and must include a

FIGURE 2-2. MULTI-AREA AND TRANSPORT AREA NETWORK DESIGN



LEGEND:

(1)- PAMS SITES
U1 - HIGH OZONE DAY PREDOMINANT MORNING WIND DIRECTION
U2 - SECOND MOST PREDOMINANT HIGH OZONE DAY MORNING WIND DIRECTION
U3 - HIGH OZONE DAY PREDOMINANT AFTERNOON WIND DIRECTION

demonstration that the alternative design satisfies the monitoring data uses and fulfills the PAMS objectives described in Section 1.3.

2.3 SELECTION OF CANDIDATE PAMS SITES

Site selection is one of the most important tasks associated with monitoring network design and must result in the most representative location to monitor the air quality conditions being assessed. General recommendations for site selection are provided in this document. Additional details concerning site selection for monitoring ozone and precursor pollutants may be found in ***Site Selection for the Monitoring of Photochemical Air Pollutants*** (Reference 9). PAMS site selection will follow the general guidance found in that reference. It is further recommended that photochemical models be used to assist in the design of the PAMS network.

2.3.1 Spatial Scales

The basis for monitor site selection, according to the referenced guidelines, is to first match each site-specific monitoring objective to an appropriate scale of spatial representation, and to then choose a monitoring location that is characteristic of that spatial scale. Five spatial scales are commonly applied to air pollution monitoring: microscale, middle scale, neighborhood scale, urban scale, and regional scale. The spatial scales that are most relevant to the enhanced ozone monitoring network are the urban and neighborhood scales.

The regional scale defines conditions within an area of reasonably homogeneous geography and extends in distance from tens to hundreds of kilometers.

The urban scale characterizes city-wide conditions with dimensions on the order of 4 to 50 km. Measurements on an "urban" scale represent concentration distributions over a metropolitan area. Monitoring on this scale relates to precursor emission distributions and

control strategy plans for an MSA/CMSA. PAMS Sites #1, #3, and #4 are characteristic of the urban scale.

The neighborhood scale defines conditions within some extended areas of the city that have a relatively uniform land use and range from 0.5 to 4 km. Measurements on a neighborhood scale represent conditions throughout a homogeneous urban subregion. Precursor concentrations, on this scale of a few kilometers, will become well mixed and can be used to assess exposure impacts and track emissions. Neighborhood data will provide information on pollutants relative to residential and local business districts. VOC sampling at Site #2 is characteristic of a neighborhood scale. Measurements of these reactants are ideally located just downwind of the edge of the urban core emission areas. Further definition of neighborhood and urban scales is provided in Appendix D of 40 CFR 58 and Reference 9.

2.3.2 General Monitoring Area

After choosing the appropriate spatial scale of representation, a general monitoring area must be selected that is characteristic of the required spatial scale and consistent with the monitoring objectives. This is done by reviewing certain background information, including area land use patterns, emissions inventories, population densities, traffic distributions, climatological and meteorological data, and any existing monitoring data. The use of gridded photochemical models is especially useful in defining expected areas of steep concentration gradients and important source/receptor relationships. Candidate monitoring sites are then selected from within the general monitoring area by eliminating from consideration all locations that might be unduly influenced by emissions from specific non-representative pollution sources or by non-representative topography.

Using the previous guidance, a close examination should be made of the MSAs or CMSAs under review before selecting the monitor locations. A distinction should be made

between MSAs that are isolated and those that are consolidated into a corridor of urban areas. The possibility of multi-day transport should be considered in defining isolated urban areas or corridors of urban areas. Table 2-1 shows all current areas in the United States listed as serious, severe, or extreme and delineates the size of the minimum PAMS network required by 40 CFR 58.

Meteorological factors are used to identify which general monitoring areas qualify for upwind or downwind PAMS sites. The wind patterns, combined with the length of time required to form ozone, are important factors in locating the monitors for measuring both maximum precursor and maximum downwind ozone concentrations. The idealized network design described in this section is partly based on consideration of meteorological conditions. Meteorological data measurements from existing sites or often from National Weather Service (NWS) stations can be used to determine the influence of prevailing wind patterns on major sources in order to pinpoint optimum monitor locations. If available, gridded photochemical air quality models should be utilized to assist in the siting process.

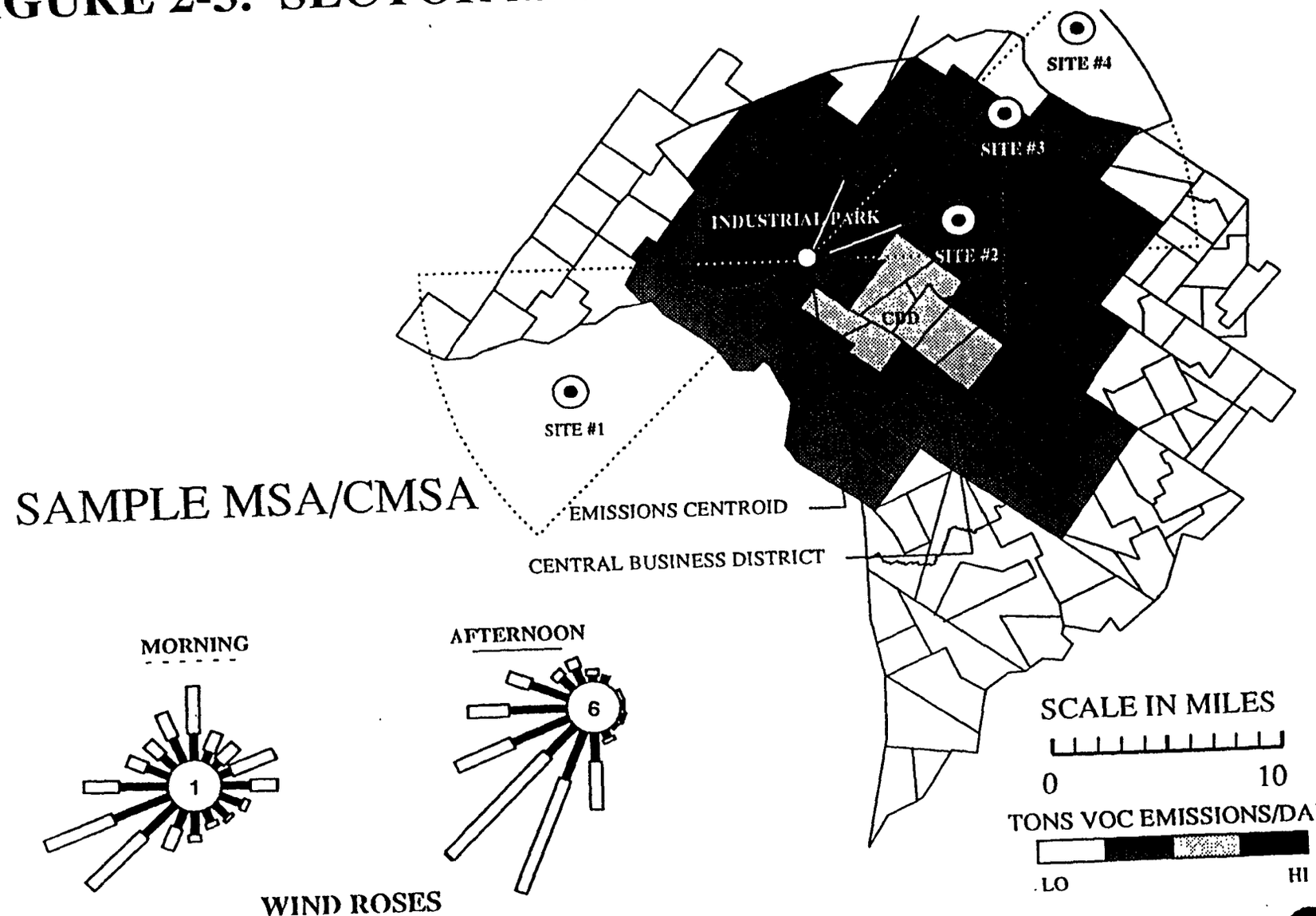
2.3.3 Selection of General Site Locations

There is considerable flexibility when micrositing each PAMS within a nonattainment area or transport region. Based on the Rule and the number of required sites obtained from Table 2-1 (or computed from Table 3-1), the recommended zone areas illustrated in Figure 2-3 should be considered for narrowing the choices for a final site location. The prime area for locating a site would be defined by a 45° sector drawn from the center of the MSA/CMSA (or more accurately, from the centroid of the emissions in the MSA/CMSA) utilizing the appropriate wind direction designated by the Rule. The centroid may be calculated utilizing computer modeling techniques or subjectively located using emissions density maps. The Sector would be limited at its ends by the stipulations of the Rule regarding approximate distances from the edge of the Central Business District (CBD) or area

TABLE 2-1. ESTIMATED PAMS REQUIREMENTS FOR CURRENTLY-AFFECTED AREAS

CURRENTLY-AFFECTED AREA NAME	POPULATION RANGE	CLASSIFICATION OF NONATTAINMENT AREA	MINIMUM NUMBER OF REQUIRED SITES
Beaumont-Port Arthur, TX	Less Than	Serious	2
Portsmouth-Dover-Rochester, NH-ME	500,000	Serious	2
Southeast Desert Modified AQMA, CA		Severe	2
Baton Rouge, LA		Serious	3
El Paso, TX	500,000 to	Serious	3
Springfield, MA	1,000,000	Serious	3
Ventura County, CA		Severe	3
Milwaukee-Racine, WI	1,000,000 to	Severe	4
Providence-Pawtucket-Fall River, RI-MA	2,000,000	Serious	4
Sacramento, CA		Serious	4
Atlanta, GA		Serious	5
Baltimore, MD		Severe	5
Boston-Lawrence-Worcester, MA-NH		Serious	5
Chicago-Gary-Lake County (IL), IL-IN-WI		Severe	5
Greater Connecticut, CT		Serious	5
Houston-Galveston-Brazoria, TX	More Than	Severe	5
Los Angeles-South Coast Air Basin, CA	2,000,000	Extreme	5
New York-New Jersey-Long Island, NY-NJ-CT		Severe	5
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD		Severe	5
San Diego, CA		Severe	5
San Joaquin Valley, CA		Serious	5
Washington, DC-MD-VA		Serious	5
Totals	-----	22 Areas	90

FIGURE 2-3. SECTOR ANALYSIS NETWORK DESIGN



of maximum precursor emissions. Note that as depicted in Figure 2-4, an MSA/CMSA may be proximate to a fixed area of stationary emissions sources which may be distinctly separate from the CBD. In such cases, the PAMS site should be located in conjunction with the centroid of the emissions, or in relation to an area which approximates the best mix of similar sources. The use of this sectoring technique allows an air pollution control agency to limit its area of search for appropriate PAMS monitoring sites.

2.3.4 Selection of Final PAMS Sites

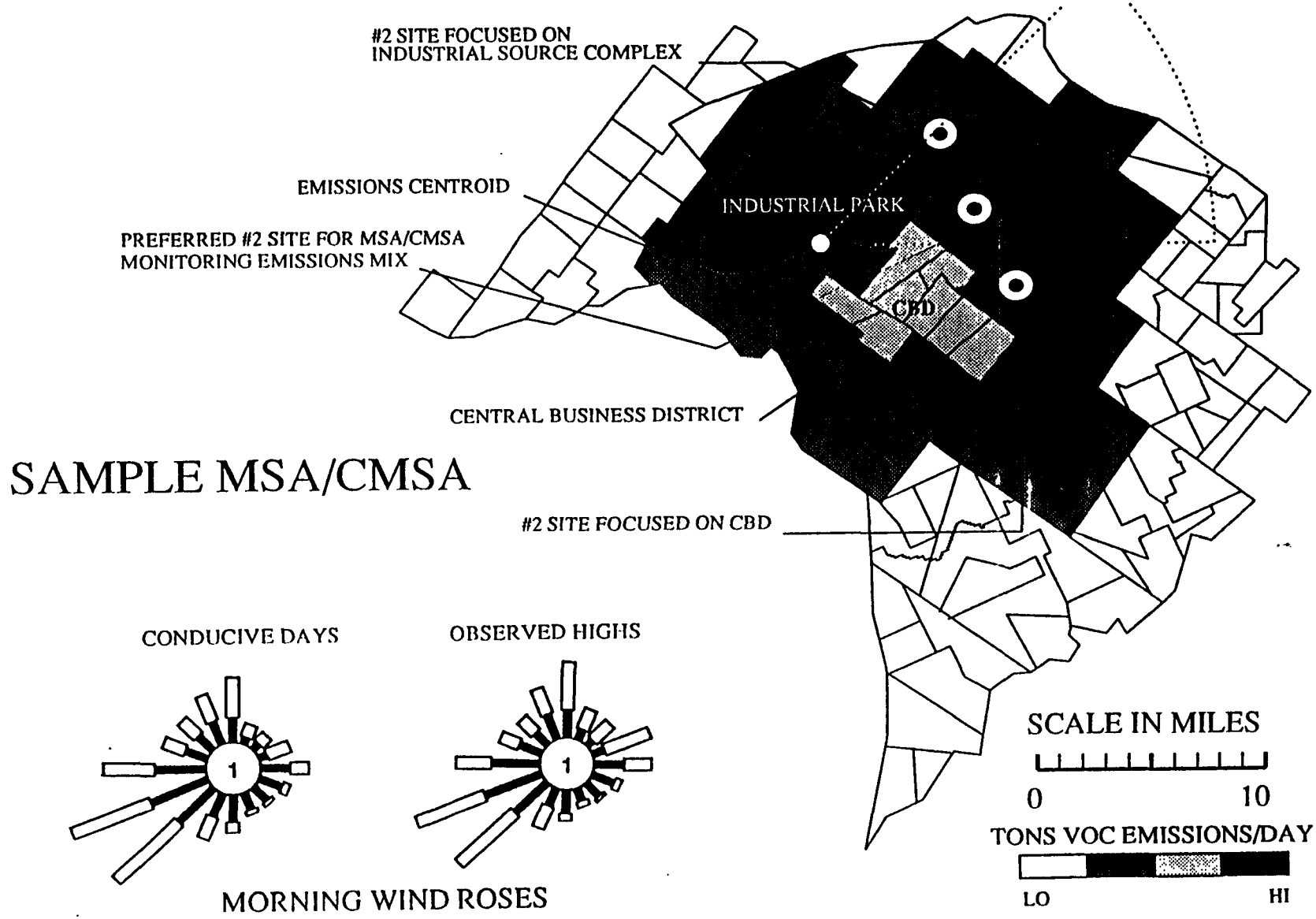
There are three fundamental criteria to consider when locating a final PAMS site: sector analysis, distance, and proximate sources. These three criteria are considered carefully by EPA when approving or disapproving a candidate site for PAMS.

Sector Analysis - The site needs to be located in the appropriate downwind (or upwind) sector (approximately 45°) and as indicated by Figure 2-3 utilizing appropriate wind directions. Ideally, local/nearby meteorological information is used to develop wind roses to place these sectors. If current, local information is not available, the wind roses contained in Appendix F may be used. These roses were generated in accordance with the intent of the Rule utilizing the following criteria:

- Years Used For The 10-Year Data Set: 1982-1991
- Years Used For The 5-Year Data Set: 1987-1991
- Months used: June, July, and August
- Ozone Conducive Criteria:

  Temperature $\geq$ 85° F
  7:00-10:00 a.m. Wind Speed $\leq$ 10 Knots
  1:00- 4:00 p.m. Wind Speed $\leq$ 14 Knots
  1:00- 4:00 p.m. Relative Humidity $\leq$ 60%

FIGURE 2-4. PREFERRED SITE #2 - EMISSIONS MIX



- Observed High Ozone Days: Ozone Concentration ≥ 0.10 ppm
- Morning Was Defined As 7:00-10:00 a.m. Local Time
- Afternoon Was Defined As 1:00-4:00 p.m. Local Time
- The Arms Of The Roses Point To Where The Wind Was Coming From
- The Length Of The Arm Is Proportional To The Percentage Of Time That The Wind Was Coming From That Direction
- The Various Pieces Of The Arm Represent Speed Categories

Rather than using a few single day wind roses to delineate the appropriate sectors, it is vital that long-term average roses be employed for the specified time periods on high ozone days or on those days which exhibit the potential for producing high ozone levels. A 5- or 10-year database should be sufficient to avoid problems with variability.

Distance - PAMS sites should be located at distances appropriate to obtain a representative sample of the area's precursor emissions and represent the appropriate monitoring scale as shown in Table 2-2.

TABLE 2-2. PAMS MEASUREMENT SCALES

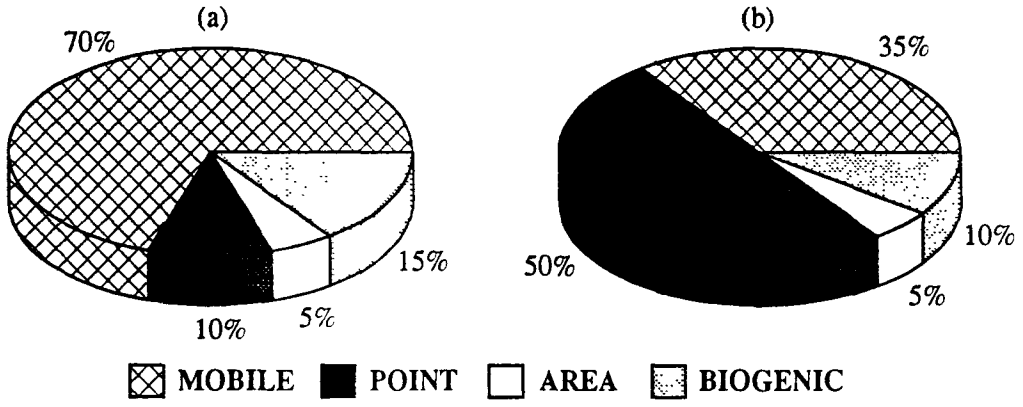
SITE	DIRECTION	LOCATION	MEASUREMENT SCALE
#1	Hi-Ozone (Or Ozone-Conducive) Day Predominant A.M. Wind	Upwind Edge of Photochemical Model Domain	Urban
#2	Hi-Ozone (Or Ozone-Conducive) Day Predominant A.M. Wind	Area of Representative Maximum Precursor Emissions - Immediately Downwind (Primary A.M. Wind)	Neighborhood
#2a	Hi-Ozone (Or Ozone-Conducive) Day Second-Most Predominant A.M. Wind	Area of Maximum Representative Precursor Emissions - Immediately Downwind (Secondary A.M. Wind)	Neighborhood
#3	Hi-Ozone (Or Ozone-Conducive) Day Predominant P.M. Wind	Fringe of Urban Area - 10 to 30 Miles Downwind	Urban
#4	Hi-Ozone (Or Ozone-Conducive) Day Predominant P.M. Wind	MSA/CMSA at Downwind Edge of Photochemical Model Domain	Urban

Most importantly, PAMS sites should be located to measure a representative mix of the ambient precursors present in a nonattainment MSA/CMSA. Sites #1 should be placed to intercept the incoming plume of precursors and ozone from other urban areas upwind and provide information to supplement the data for photochemical modeling.

Sites #2 should be placed in an area where the representative precursor mix from the particular MSA/CMSA is expected to impact. To ensure that the sensitivities of the sampling methods are optimized, it is vital that within this sector of impact the levels measured by the Site #2 are maximized. This location may differ dramatically from a monitoring site which has been noted to have the maximum historical ozone precursor measurements. Additionally, although the Rule observes that the #2 Site may typically be located near the downwind boundary of the CBD, there are a number of situations where this location would not be appropriate. For example, if a MSA/CMSA contained a significant percentage of stationary sources which were located in an area different from the CBD, the #2 Site might need to achieve a compromise location (Figure 2-5) which would monitor both CBD (mostly mobile and combustion) sources and the group of stationary sources. Ideally, the State would propose more than one #2 Site for these purposes. Further, a very large MSA/CMSA, especially those which extend over a number of smaller urban areas and across State lines, may need to adjust the location of the #2 Site such that it is close enough to the stationary sources so that the effects of the sources' emissions are not lost in the magnitude of the mobile source emissions.

Siting for #2 sites should also, within reason, represent the composition of the emissions inventory. For example, for an emissions inventory as shown in Figure 2-5(a) which has a 70% mobile source component, Site #2 should not be located so that it is entirely dominated by stationary point sources. Conversely, as depicted by Figure 2-5(b), an area which has a significant stationary source component should clearly not contain a PAMS

FIGURE 2-5. SAMPLE EMISSIONS INVENTORY DESCRIPTIONS



monitor which is overwhelmed by mobile sources. The difficulty for the Site #2 will be obtaining a reasonable mix of sources which complements the mix of the emissions inventory. Information on emissions inventories such as included in Figure 2-5, should be made a part of any PAMS network plan submittal.

Sites #3 should routinely correspond to the maximum ozone site for the MSA/CMSA which is located downwind. Note that this #3 Site may not necessarily be collocated with the ozone design value site for a particular MSA/CMSA. Historically, the design value site may even be located upwind of the area 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 a PAMS #3 Site. Site #3 should be reevaluated in light of the wind directions for siting stipulated by the PAMS Rules, possibly requiring the establishment of a new location for PAMS.

Sites #4 should be balanced to provide sufficient downwind information to assist in photochemical grid models, and also provide the information necessary to replace a Site #1 for a downwind MSA/CMSA whenever possible.

A State or local agency may wish to locate monitoring sites more precisely than this rather simplified sector analysis would allow. In such cases, conventional vector analysis employing the appropriate wind roses may be used to track emissions over time and locate the PAMS sites.

2.3.5 The Use of Saturation Monitoring Techniques

Following the use of a sector and/or vector analysis to locate the suitable area for a PAMS site, especially the #2 Site, it is preferable to utilize a short-term sampling study to choose the final PAMS location. A technique which is currently available to simplify such a monitoring project is the use of "saturation" monitors. Such a study entails the deployment of a number of portable samplers during the time period of interest, in this case the PAMS monitoring season, at potential PAMS sites located within the appropriate sector for the particular site being located. The data from as short a time period as 10 days can be analyzed to predict with some surety, which sites would be the best candidates for permanent PAMS installations.

For Sites #1, #3, and #4, such sampling could potentially focus on ozone with either portable monitors or with passive ozone monitors, modified for short-term use in the ambient air (see References 10, 11, and 12). These techniques will generally provide average concentrations. For Sites #2, VOC canister samplers with fixed orifices such as used by sampling method TO-12 with speciation would be more appropriate. PAMS sites would commonly be sited in the area of maximum concentration located in the appropriate sector, yet not unduly influenced by any particular point source of emissions. Since saturation

studies generally provide only a limited data set, avoiding these particular local influences is highly important. The usefulness of the short-term data sets can be enhanced by sampling only on days predicted to experience high ozone levels. Further information on the use of such saturation sampling techniques can be obtained from Reference 13.

2.3.6 Practical Considerations and Constraints

The are a number of practical considerations which may affect PAMS siting such as costs, security, topography, and meteorology.

Costs - Given the expense of installing the new technologies for monitoring required by the PAMS Rules, it is possible that one of the strong driving forces for choosing a particular site may be State or local budget constraints. EPA estimates the nationwide cost of constructing a minimum PAMS network to be in excess of $79 million over the first 5 years of the program, the period designated by the Rule for phase-in. In an effort to foster compliance with Congressional intent, the EPA formally began funding the PAMS program through the §105 Grant process in FY-93. It is expected that air pollution control agencies will supplement the grant funds via use of user fees such as permit charges, automobile tag fees, etc. Nevertheless, it is important that the quality of PAMS sites not be compromised simply for costs' sake. Since the data will be used to satisfy a number of program objectives, it is clearly advantageous to choose the best available site within the limits of the agency's budget constraints.

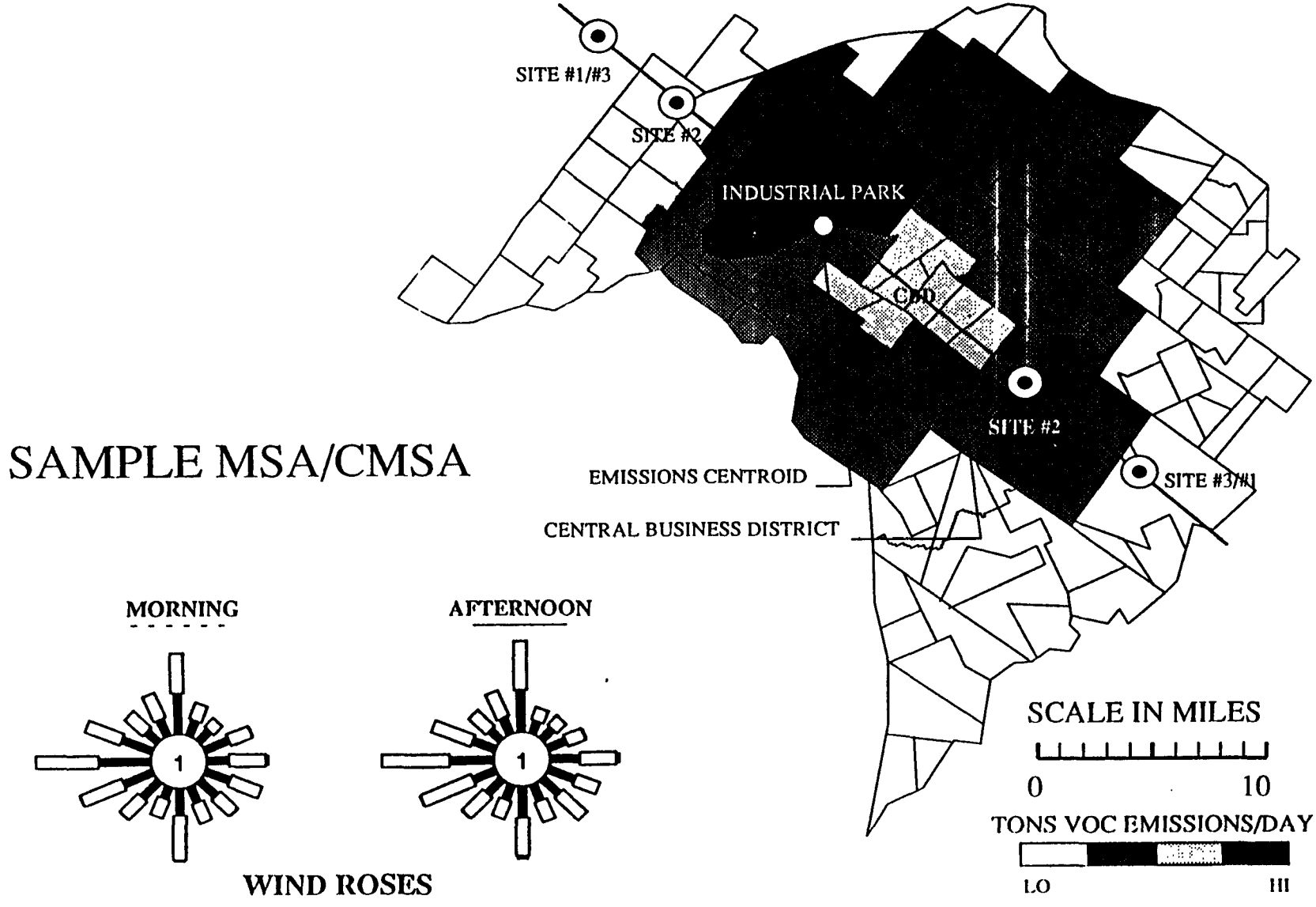
In some cases, a State or local agency may be able to locate the PAMS monitors at an existing SLAMS, NAMS, or private monitoring site. Since some of these existing site locations may be adequate for PAMS, it would be prudent, especially in light of funding shortfalls, to evaluate these existing stations to determine which are properly located to meet the PAMS objectives.

Security - Experience has shown that in some cases, a particular sector of a MSA/CMSA may not be appropriate for the establishment of an ambient monitoring station simply due to problems with the security of the equipment in a certain area. If the problems cannot be remedied via the use of standard security measures such as lighting, fences, etc., then attempts should be made to locate the site as near to the identified sector as possible while maintaining adequate security.

Topography - In cases where unique topography would cause difficulties in locating a PAMS site (*e.g.*, a site located offshore by the sector analysis), an alternate site or strategy may be proposed by the State or local agency. Such alternatives must meet the additional requirements outlined in Section 4.3 of this document.

Meteorology - (Reference 14) In many areas, there are three types of high ozone days: namely, overwhelming transport, weak transport (or mixed transport and stagnation) and stagnation. The wind rose concept to site monitors is only applicable to the transport types, but not applicable to the stagnation type. In general, transport types dominate north of 40°N, stagnation types dominate the Ohio River Valley and northern Gulf Coast, and a mixture of the two is observed in the rest of the eastern United States. In areas where stagnation dominates the high ozone days, a well-defined primary wind direction (PWD) may not be available. If no well-defined PWD can be resolved, the major axes of the emissions sources should be used as substitutes for the PWDs and the PAMS monitors should be located along these axes (Figure 2-6) with ozone monitors located not more than 10 miles from the urban fringe. The reasons for these recommendations are as follows: (1) Completely calm conditions seldom last more than one hour during the day. Most stagnation days have light (<3kts), but variable winds; (2) Ozone concentrations are likely to be the highest when the winds

FIGURE 2-6. NETWORK DESIGN - LIGHT WINDS



are along the axis of emissions, because precursor concentrations are likely to be highest and dispersion is minimal.

For coastal cities, synoptic winds are generally influenced by the seabreeze or lake breeze circulations. This is typically reflected in the difference of the morning and afternoon PWDs. The maximum ozone monitors should be located at the downwind side of the resultant winds (*i.e.*, the vector average of the morning and afternoon PWDs), keeping the monitors close to the sea/lake breeze convergence zone.

2.3.7 Screening for Effects from Nearby Emissions Sources

The success of the PAMS monitoring program is predicated on the fact that no site is unduly influenced by any one stationary emissions source or small group of emissions sources. Any significant influences would cause the ambient levels measured by that particular site to mimic the emissions rates of this source or sources rather than following the changes in nonattainment area-wide emissions as intended by the Rule. For purposes of this screening procedure, if more than 10% of the typical "lower end" concentration measured in an urban area is due to a nearby source of precursor emissions, then the PAMS site must be relocated or a more refined analysis conducted than is presented here. In order to minimize the possibility of locating a source-influenced site, the following simplified procedure has been included:

a. After locating potential PAMS sites, access the AIRS Facility Subsystem (see Section 6.0) database or other emissions information to determine the proximity of any ozone precursor emissions sources.

b. If any sources are closer than 3000 meters in the predominant upwind direction from the proposed monitoring site, calculate (from the emissions inventory) the average emissions rate during a typical summer day in grams per second.

c. Enter either Figure 2-7 for point sources (stack emissions) or Figure 2-8 for area sources (multiple sources and/or fugitive emissions, *e.g.*, landfills, lagoons, etc.) with the distance to the proximate source in meters on the X-axis. (Model inputs and outputs are located in Appendix G of this document for reference.)

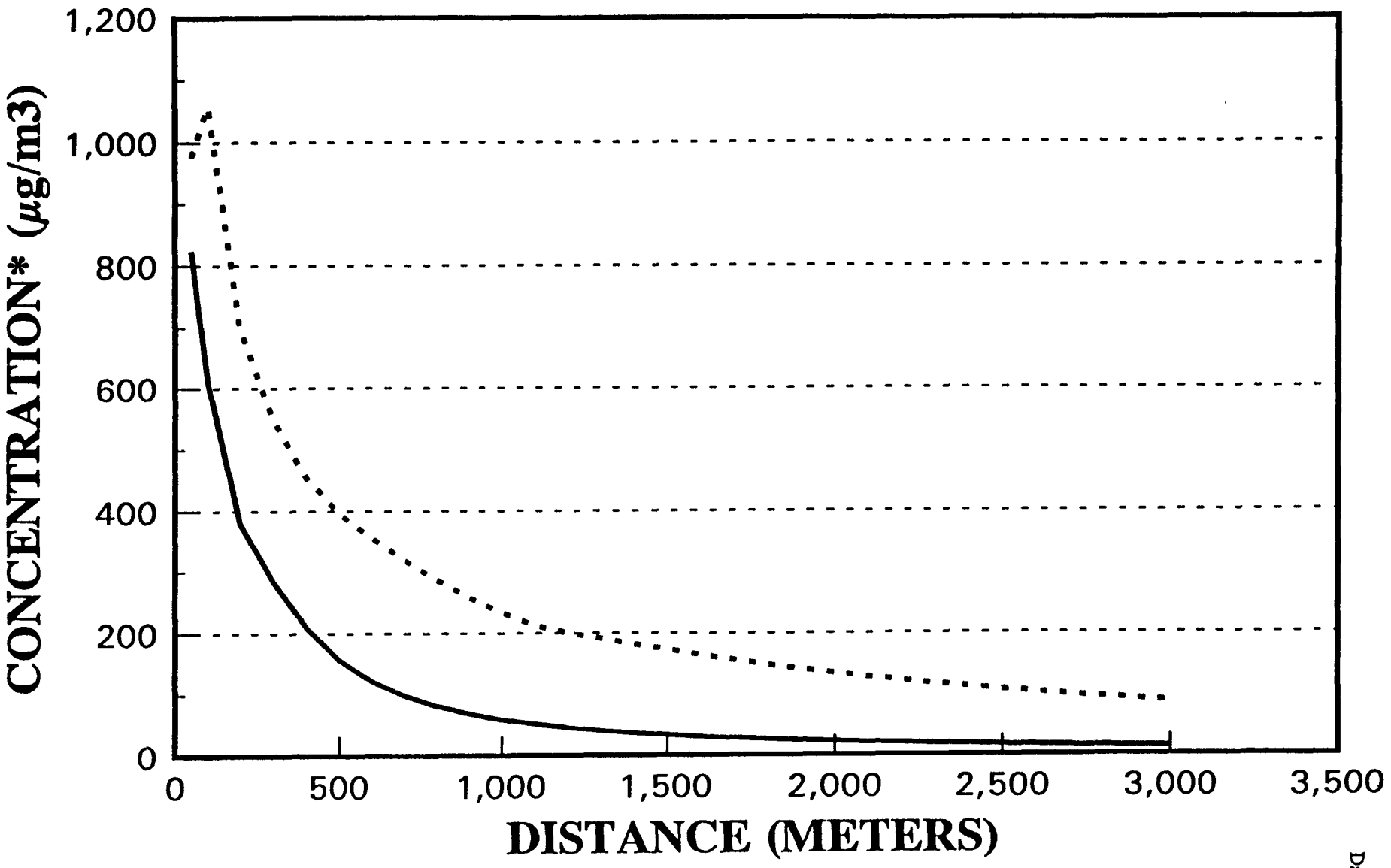
d. Read the corresponding concentration in micrograms per cubic meter ($\mu g/m^3$) from either the "urban" site or the "rural" site graph. Note that the algorithms utilized by the SCREEN2 Model (see Reference 15) differentiate between sites which are located in an urban setting and those which would be considered rural due to the differences in plume rise noted from large paved and "built-over" areas to natural areas such as fields, grass, and trees. As a "rule of thumb", Site #2 should be considered urban. Depending on the situation, Sites #1, #3, and #4 may be considered urban or rural. For example, in a transport area such as the northeastern United States, Sites #1, #3, and #4 are most likely to be urban in nature, whereas in an isolated nonattainment area, the upwind and downwind sites would more likely be considered rural.

e. Multiply the resultant concentration obtained from the graph by the emissions from the source in grams per second to obtain the resultant concentration due to the source at the proposed site location.

f. Compare this resultant concentration to a typical concentration for the nonattainment area in question.

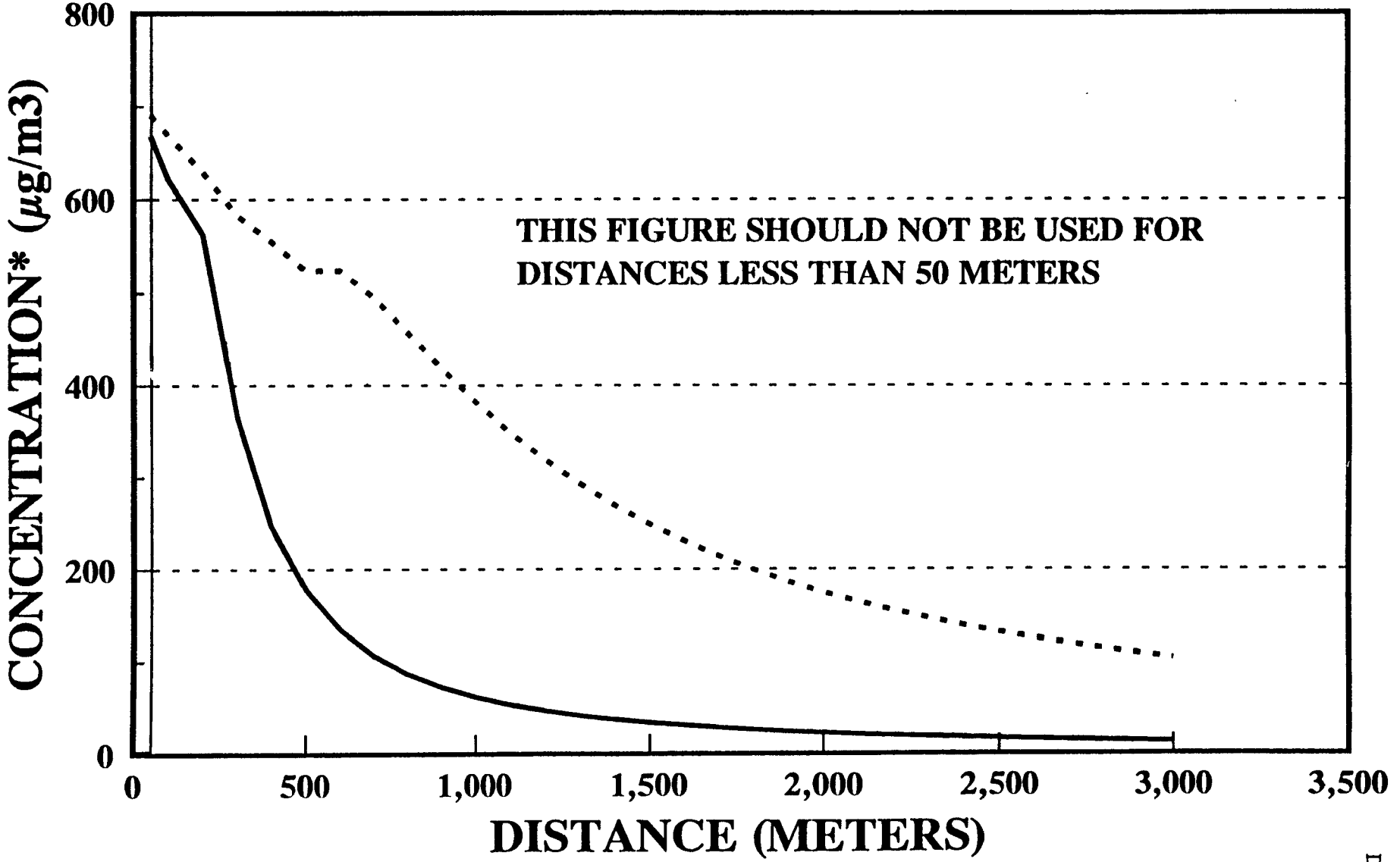
g. If the computed value is greater than 10% of the typical concentration, then the site may be improperly sited and be overly reflective of changes in precursor emissions from a local source or group of sources. In this case, further more detailed modeling analyses are recommended to clarify the actual impact of the source(s) on the monitoring site; or, the air pollution control agency should consider alternate site locations.

FIGURE 2-7. POINT SOURCE EFFECTS ON SITING



SCREEN2
*At an emission rate of 1 gram/second.

FIGURE 2-8. AREA SOURCE EFFECTS ON SITING



SCREEN2
* At an emission rate of 1 gram/second for a 50mx50m source.

FOR EXAMPLE, a typical "lower end" concentration of Total VOC noted in a recent short-term urban study was approximately .358 ppmC (358 ppbC).

a. AIRS identifies a stationary source of VOC approximately 2000 meters upwind of a potential PAMS Site #2 located in an urban setting. Most emissions were fugitive or from roof vents.

b. The average daily emissions for this source were determined to be approximately 157 pounds of VOC or 6.54 pounds per hour (24-hour operation). Since the emissions were determined to be approximately 6.54 pounds per hour then:

Emissions = (6.54 lb/hr)(454 g/lb)(1/3600 hr/sec) = .825 g/sec

The typical mix of compounds in the source emissions obtained from emissions inventory data [or in this case, from the EPA *Volatile Organic Compound/Particulate Matter Speciation Data System* (SPECIATE)] was as follows:

TABLE 2-3. SAMPLE SOURCE VOC EMISSIONS PROFILE

COMPOUND	NO. CARBONS	MOL. WEIGHT	%W/W
Hexane	6	86.17	7.00
Heptane	7	100.20	35.80
Trimethylfluorosilane	3	92.00	40.00
Benzene	6	78.11	13.60
Toluene	7	92.13	3.60

c. Since the emissions from this source were mostly fugitive or from roof vents without stacks, Figure 2-8 was consulted.

d. Accordingly, from this graph, at a PAMS site located 2000 meters downwind, this source could affect the VOC measurements by 23 $\mu g/m^3$ per gram/second of emissions.

e. Then, the

Change in Concentration Due to the Source = (.825 g/sec)(23 $\mu g\text{-sec}/m^3\text{-g}$)

$$= 19\ \mu g/m^3$$

Utilizing Equation #5 from Table 2-4 and the information in Table 2-3,

$$\text{Molecular Weight}_{MIX} = (86.17)(.07) + (100.20)(.358) + (92)(.4) + (78.11)(.136) + (92.13)(.036)$$

$$\text{Molecular Weight}_{MIX} = 92.\ g/g\text{-mole}$$

f. The typical urban concentration could be estimated by Equation #2 from Table 2-4,

$$\mu g/m^3 = \frac{(ppbV)(MW)}{22.4} \times \frac{273°K}{298°K}, \text{ assuming } T = 25°C$$

where ppbV is estimated from Equation #1 from Table 2-4 as,

$$ppbV = ppbC \div (\#C\ Atoms)$$

For this mix,

$$\#C\ Atoms_{AVERAGE} = (6)(.07) + (7)(.358) + (3)(.4) + (6)(.136) + (7)(.036)$$

from Equation #5 of Table 2-4, or

$$\#C\ Atoms_{AVERAGE} = 5.2$$

Then, given that ppbC = 358,

$$ppbV \approx 358 \div 5.2 = 68.8 \text{ ppbC}$$

and the typical urban concentration in $\mu g/m^3$ would be

$$\mu g/m^3 \approx \frac{(68.8)(92.6)}{22.4} \times \frac{273°K}{298°K}, \text{ assuming } T = 25°C$$

or

$$\mu g/m^3 \approx 260$$

Then the percent impact this one source has on the proposed PAMS site is estimated to be

$$(19\ \mu g/m^3 \div 260\ \mu g/m^3) \times 100\% = 7.3\%$$

g. Since this value is less than the "rule-of-thumb" cut-off value of 10%, the site is considered not unduly influenced by the identified source according to the screening procedure and may be approved as a PAMS monitoring site. If the screening value was greater than 10%, more complex analyses would need to be conducted to support site approval. For the site to be approved, the results of more comprehensive modeling analyses would need to indicate an impact of less than 10%.

2.3.8 Probe Siting and Exposure Criteria

The probe siting and exposure criteria for PAMS monitors are similar to those for NAMS/SLAMS monitors for such items as the minimum distance of the inlet probe from obstructions, vertical and horizontal probe placement, minimum distances from trees, and spacing from roadways. These criteria are given in the following subsections. More detailed guidance can be found in References 4, 9, and 16.

TABLE 2-4. USEFUL EQUATIONS FOR VOC MIXTURES

1. For estimating ppbV from ppbC:

   $$ppbV \approx ppbC \div (\#C\ Atoms)$$

   Example: For benzene (C_6H_6), with a concentration of 6.0 ppbC:

   $$ppbV \approx 6 \div 6 = 1 \text{ and therefore}$$

   6 ppbC ≈ 1 ppbV for benzene

   Where,

   ppbC = parts per billion as carbon

   ppbV = parts per billion by volume

2. For calculating concentrations in $\mu g/m^3$, given the constituents of a VOC mix and the concentration in ppbV then,

   $$\mu g/m^3 \approx \frac{(ppbV)(MW)}{22.4} \times \frac{273°K}{298°K}, \text{ assuming } T = 25°C$$

3. For calculating concentrations in ppbV, given the constituents of a VOC mix and the concentration in $\mu g/m^3$ then,

   $$ppbV = \frac{(\mu g/m^3)(22.4)}{MW} \times \frac{298°K}{273°K}, \text{ assuming } T = 25°C$$

   or $$ppbV = (\mu g/m^3) \times \frac{24.45}{MW}$$

4. Or,

   $$ppbC = (\#C)\ \frac{(\mu g/m^3)(22.4)}{MW} \times \frac{298°K}{273°K}, \text{ assuming } T = 25°C$$

   and, $$ppbC = (\#C)\ (\mu g/m^3) \times \frac{24.45}{MW}$$

5. For VOC mixes:

   $$\text{Molecular Weight} = MW = [\Sigma(MW)(\%w/w) \div 100] \text{ and}$$

   $$\#Carbons = \#C = [\Sigma(\#C)(\%w/w) \div 100]$$

Vertical and Horizontal Probe Placement - To achieve comparability with NAMS/SLAMS ozone monitoring data, the height of the inlet probe for PAMS monitors should be as close as possible to the breathing zone, but must be located 3 to 15 meters above ground level. Since PAMS involve multi-pollutant measurements, this range serves as a practical compromise for finding suitable probe positions in the siting area. The probe must also be located more than 1 meter vertically or horizontally away from any supporting structure. Since VOC are not routinely measured as part of most NAMS/SLAMS monitoring programs, additional siting criteria comparable to those required for Prevention of Significant Deterioration (PSD) (Reference 17) monitoring of noncriteria pollutants should also be applied. These criteria include a minimum separation distance of 2 meters between the inlet probe and any walls, parapets, penthouses, etc. for probes located on roofs or other structures. In addition, probes should be located far from any furnace or incineration flues.

Spacing from Obstructions - The probe must be located away from obstacles and buildings such that the distance between any obstacle and the inlet probe is at least twice the height that the obstacle protrudes above the sampler. There must be unrestricted airflow in an arc of at least 270° around the inlet probe, and the predominant and second most predominant wind direction during the sampling period must be included in the 270° arc. If the probe is located on the side of a building, 180° clearance is required.

Spacing from Trees - Trees can provide surfaces for adsorption and/or chemical reactions, and can also affect normal wind flow patterns. To limit these effects, probe inlets should be placed at least 20 meters from the dripline of any trees and must be more than 10 meters from the dripline of any trees that are located between the urban city core area (or other area of maximum ozone precursor emissions) and the monitoring station along the predominant sampling period daytime wind direction utilized for establishing the site.

Spacing from Roads - Motor vehicle emissions constitute a major source of both ozone precursors and ozone-scavenging compounds. It is important, therefore, to maintain a minimum separation distance between roadways and PAMS monitoring sites such that the representation of the resulting monitoring data is not compromised. Table 2-5 gives the required minimum separation distances from roadways for various traffic volumes. The minimum separation distance must also be maintained between a PAMS station and other similar areas of automotive traffic, such as parking lots. Nearby roads should be far enough away from Sites #2 and #3 probe inlets to avoid producing localized ozone sinks. Likewise, nearby roads should not be located near Sites #1, #3, and #4 probe inlets, as precursor pollutants could have a local influence on these area-representative sites.

TABLE 2-5. SEPARATION DISTANCE BETWEEN PAMS AND ROADWAYS (EDGE OF NEAREST TRAFFIC LANE)[1]

ROADWAY AVERAGE DAILY TRAFFIC VEHICLES PER DAY	MINIMUM SEPARATION DISTANCE BETWEEN ROADWAYS AND STATIONS IN METERS[2]
<10,000	>10
15,000	20
20,000	30
40,000	50
70,000	100
>110,000	>250

[1] Reference 1, Appendix E

[2] Distances should be interpolated based on traffic flow.

Exposure of Meteorological Instruments - The 10-meter meteorological tower at each PAMS site should be located such that the resulting measurement data are representative of the meteorological conditions that affect pollutant transport and dispersion within the area that the monitoring site is intended to represent. Meteorological instruments should be located away from the immediate influence of trees, buildings, steep slopes, ridges, cliffs, and hollows.

Additional guidance for siting meteorological instruments is given in References 4, 16, 17, 18, and 19.

3.0 MONITORING METHODS AND NETWORK OPERATIONS

3.1 MONITORING METHODS

The ***Code of Federal Regulations*** Part 50 (40 CFR 50) delineates the NAAQS for six ambient air pollutants, often termed "criteria" pollutants. The associated approved or "reference" methods for ambient sampling and analysis (in accordance with 40 CFR 53) are also codified in the appendices to Part 50. Acceptable equivalent methods, as determined by the procedures outlined in 40 CFR Part 53 (Reference 20), are periodically published by the EPA Atmospheric Research and Exposure Assessment Laboratory (AREAL). The most recent list is included in Appendix H of this document.

The PAMS rules (40 CFR 58) require the use of automated reference or equivalent methods to monitor for ambient concentrations of ozone, NO, NO_2, and NO_x, when measured at PAMS stations. Current methods for measuring NO_2 also measure NO and NO_x, therefore, the result of the PAMS rules is to require continuous monitoring for ozone and NO_2 and the additional reporting of the coincidently measured NO and NO_x.

The Federal Reference Method (FRM) for NO_2 has limited ability to accurately describe the role of NO_x in the local photochemical process during all periods of a summer day, and to discriminate among the impacts of various sources of NO_x. Consequently, EPA has encouraged State air pollution control agencies to employ more sensitive measurement techniques for NO_x. Additionally, EPA has noted the value of deploying instrumentation designed to measure total reactive oxides of nitrogen (NO_y), which includes such compounds as NO_x, NO, NO_2, peroxyacetyl nitrate (PAN), and nitric acid (HNO_3). Since the PAMS network is primarily designed to quantify the local precursors of ozone and not serve as an additional principal network for NO_2 attainment purposes, EPA is predisposed to allow such non-FRM techniques for the measurement of NO_x. Any techniques other than the FRM,

however, will need to be detailed in the network description required by 40 CFR 58.40 and subsequently approved by the Administrator as part of an area-specific plan. Further, the Agency has recognized that the measurement of more highly oxidized forms of nitrogen requires a high degree of skill/training using non-standard techniques to measure pollutants at very low concentrations and has determined that it is premature to require such efforts in a routinely-operated network. Future revisions to this guidance will contain information for conducting more sensitive and definitive NO_x measurements.

With the promulgation of the PAMS rules, for the first time, EPA rules require national ambient monitoring for pollutants (such as VOC and meteorological parameters) which do not have associated NAAQS. Additionally, no FRMs have been established for these compounds. Consequently, to maintain a reasonable level of national consistency and comparability, States are required by 40 CFR 58, Appendix C, to follow the guidance for sampling and analysis of these parameters published in References 4, 16, 17, 18, and 19.

The ***Technical Assistance Document for Sampling and Analysis of Ozone Precursors*** (hereafter referred to as the ***Technical Assistance Document*** or TAD) provides technical information and guidance to Regional, State, and local air pollution control agencies responsible for measuring ozone precursor compounds in the ambient air. Sampling and analytical methodology for speciated VOC, total non-methane organic compounds (NMOC) and selected carbonyl compounds (*i.e.*, formaldehyde, acetaldehyde and acetone) are specifically addressed. This document also addresses the methodology for measuring NO_x and discusses many of the issues associated with measuring NO_y and includes technical direction, to supplement the information provided in Reference 16, for measuring the meteorological parameters prescribed by the regulations.

The technical guidance for measuring VOC ozone precursors is based on emerging and developing technology. Guidance for automated applications, in particular, is based to a significant extent on the experience obtained from the application of the technology during past ozone precursor studies such as the 1990 Atlanta Ozone Precursor Study. The VOC sampling and analysis methods explained in the ***Technical Assistance Document*** are based on these state-of-the-art emerging technologies, and they will be subjected to continuing evaluation and will be periodically revised to incorporate resulting improvements and clarifications.

3.2 OPERATING SCHEDULES AND SAMPLING FREQUENCIES

3.2.1 General Operating Requirements

In addition to requiring reasonably consistent methodologies for sampling precursors and meteorological parameters, 40 CFR 58.13 (and subsequently 40 CFR 58, Appendix D), specifies minimum network requirements and sampling frequencies. For clarity, Table 2 of Appendix D of the codified Rule has been reformatted and follows as Table 3-1. The monitoring requirements are explained further in Sections 3.2.3 to 3.2.6 of this document. In summary, these standards require the use of continuous monitors for ozone, NO_x and meteorological parameters. VOC and carbonyls can utilize manual methods, but due to the required frequencies, continuous monitoring technology appears to be more cost-effective. Further information on the target VOC listed in Reference 4 may be found in Tables 3-2 and 3-3.

Section 4.3 of 40 CFR 58, Appendix D, stipulates that the PAMS monitoring should be conducted annually throughout the months of June, July and August as a minimum. In most States, these months incorporate the periods when peak ozone values are likely to occur. EPA, however, encourages the States to extend the PAMS monitoring period whenever feasible to include the entire ozone season or perhaps the entire calendar year. Monitoring

TABLE 3-1. PAMS MINIMUM NETWORK REQUIREMENTS

MINIMUM NETWORK REQUIREMENTS

POPULATION OF MSA/CMSA	FREQ TYPE	SITE LOCATION
LESS THAN 500,000	A or C	(1)
	A/D or C/F	(2)
500,000 TO 1,000,000	A or C	(1)
	B/E	(2)
	A or C	(3)
1,000,000 TO 2,000,000	A or C	(1)
	B/E	(2)
	B/E	(2)
	A or C	(3)
GREATER THAN 2,000,000	A or C	(1)
	B/E	(2)
	B/E	(2)
	A or C	(3)
	A or C	(4)

VOC SAMPLING FREQUENCY REQUIREMENTS

Type	Requirement
A	8 3-Hour Samples Every Third Day 1 24-Hour Sample Every Sixth Day
B	8 3-Hour Samples Everyday 1 24-Hour Sample Every Sixth Day (year-round)
C	8 3-Hr Samples 5 Hi-Event/Previous Days & Every 6th Day 1 24-Hour Sample Every Sixth Day

CARBONYL SAMPLING FREQUENCY REQUIREMENTS

Type	Requirement
D	8 3-Hour Samples Every Third Day
E	8 3-Hour Samples Everyday
F	8 3-Hr Samples 5 Hi-Event/Previous Days & Every 6th Day

MINIMUM PHASE-IN

YEARS AFTER PROMULGATION	NUMBER OF SITES OPERATING	OPERATING SITE LOCATION RECOMMENDATION
1	1	2
2	2	2,3
3	3	1,2,3
4	4	1,2,3,4
5	5	1,2,2,3,4

which is conducted on an intermittent schedule should be coincident with the previously-established intermittent schedule for particulate matter sampling. The codified ozone monitoring seasons for the PAMS-affected States are displayed in Table 3-4.

TABLE 3-2. TARGET VOC OZONE PRECURSORS AND SYNONYMS

CHEMICAL ABSTRACT SERVICE, (CAS) #	PAMS RECOGNIZED REPORTING NAME	COMMON SYNONYM
74-86-2	Acetylene	Ethyne
74-85-1	Ethylene	Ethene
74-84-0	Ethane	Methylmethane
115-07-1	Propylene	Propene
74-98-6	Propane	Dimethylmethane
75-28-5	Isobutane	2-Methylpropane
106-98-9	1-Butene	Ethylethylene
106-97-8	n-Butane	Butane
624-64-6	trans-2-Butene	
590-18-1	cis-2-Butene	
563-45-1	3-Methyl-1-Butene	Isopropylethylene
78-78-4	Isopentane	2-Methylbutane
109-67-1	1-Pentene	Propylethylene
109-66-0	n-Pentane	Amyl Hydride
78-79-5	Isoprene	3-Methyl-1,3-Butadiene
646-04-8	trans-2-Pentene	
627-20-3	cis-2-Pentene	cis-ß-n-Amylene
513-35-9	2-Methyl-2-Butene	
75-83-2	2,2-Dimethylbutane	Neohexane
142-29-0	Cyclopentene	
691-37-2	4-Methyl-1-Pentene	
287-92-3	Cyclopentane	Pentamethylene
79-29-8	2,3-Dimethylbutane	Diisopropyl
107-83-5	2-Methylpentane	Isohexane
96-14-0	3-Methylpentane	Diethylmethylmethane
76-32-91	2-Methyl-1-Pentene	1-Methyl-1-Propylethylene
110-54-3	n-Hexane	
4050-47-7	trans-2-Hexene	
7688-21-3	cis-2-Hexene	
96-37-7	Methylcyclopentane	
108-08-7	2,4-Dimethylpentane	
71-43-2	Benzene	
110-82-7	Cyclohexane	Hexamethylene
591-76-4	2-Methylhexane	Isoheptane
565-59-3	2,3-Dimethylpentane	
589-34-4	3-Methylhexane	
540-84-1	2,2,4-Trimethylpentane	
142-82-5	n-Heptane	Dipropylmethane
108-87-2	Methylcyclohexane	Hexahydrotoluene
565-75-3	2,3,4-Trimethylpentane	
108-88-3	Toluene	Methylbenzene
592-27-8	2-Methylheptane	Isooctane
589-81-1	3-Methylheptane	
111-65-9	n-Octane	
100-41-4	Ethylbenzene	Phenylethane
106-42-3	p-Xylene**	1,4-Dimethylbenzene
100-42-5	Styrene	Ethenylbenzene
95-47-6	o-Xylene	1,2-Dimethylbenzene
111-84-2	n-Nonane	Nonyl Hydride
98-82-8	Isopropylbenzene	Cumene
103-65-1	n-Propylbenzene	1-Phenylpropane
7785-70-8*	α-Pinene	
108-67-8	1,3,5-Trimethylbenzene	Mesitylene
95-63-6	1,2,4-Trimethylbenzene	Pseudocumene
127-91-3*	ß-Pinene	Nopinene
124-18-5	n-Decane	
1120-21-4	n-Undecane	
108-38-3	m-Xylene**	1,3-Dimethylbenzene
50-00-0	Formaldehyde	Oxymethylene
67-64-1	Acetone	Dimethylketone
75-07-0	Acetaldehyde	Acetic Aldehyde
-	Total non-methane organic compounds	Total NMOC

*Generic CAS #'s for these compounds. **Co-eluters on the GC column.

TABLE 3-3A. TARGET VOC OZONE PRECURSORS - HYDROCARBONS

CHEMICAL ABSTRACT SERVICE, (CAS) #	PAMS RECOGNIZED REPORTING NAME	AIRS PARAMETER CODE #	CHEMICAL FORMULA	PAMS RECOGNIZED ABBREVIATION
74-86-2	Acetylene	43206	C_2H_2	acety
74-85-1	Ethylene	43203	C_2H_4	ethyl
74-84-0	Ethane	43202	C_2H_6	ethan
115-07-1	Propylene	43205	C_3H_6	prpyl
74-98-6	Propane	43204	C_3H_8	propa
75-28-5	Isobutane	43214	C_4H_{10}	isbta
106-98-9	1-Butene	43280	C_4H_8	1bute
106-97-8	n-Butane	43212	C_4H_{10}	nbuta
624-64-6	trans-2-Butene	43216	C_4H_8	t2bte
590-18-1	cis-2-Butene	43217	C_4H_8	c2bte
563-45-1	3-Methyl-1-Butene	43282	C_5H_{10}	3m1be
78-78-4	Isopentane	43221	C_5H_{12}	ispna
109-67-1	1-Pentene	43224	C_5H_{10}	1pnte
109-66-0	n-Pentane	43220	C_5H_{12}	npnta
78-79-5	Isoprene	43243	C_5H_{10}	ispre
646-04-8	trans-2-Pentene	43226	C_5H_{10}	t2pne
627-20-3	cis-2-Pentene	43227	C_5H_{10}	c2pne
513-35-9	2-Methyl-2-Butene	43228	C_5H_{10}	2m2be
75-83-2	2,2-Dimethylbutane	43244	C_6H_{14}	22dmb
142-29-0	Cyclopentene	43283	C_5H_8	cypne
691-37-2	4-Methyl-1-Pentene	43234	C_5H_{10}	4m1pe
287-92-3	Cyclopentane	43242	C_5H_{10}	cypna
79-29-8	2,3-Dimethylbutane	43284	C_6H_{14}	23dmb
107-83-5	2-Methylpentane	43285	C_6H_{14}	2mpna
96-14-0	3-Methylpentane	43230	C_6H_{14}	3mpna
763-29-1	2-Methyl-1-Pentene	43246	C_6H_{12}	2m1pe
110-54-3	n-Hexane	43231	C_6H_{14}	nhexa
4050-47-7	trans-2-Hexene	43289	C_6H_{12}	t2hex
7688-21-3	cis-2-Hexene	43290	C_6H_{12}	c2hex
96-37-7	Methylcyclopentane	43262	C_6H_{12}	mcpna
108-08-7	2,4-Dimethylpentane	43247	C_7H_{16}	24dmp
71-43-2	Benzene	45201	C_6H_6	benz
110-82-7	Cyclohexane	43248	C_6H_{12}	cyhxa
591-76-4	2-Methylhexane	43263	C_7H_{16}	2mhxa
565-59-3	2,3-Dimethylpentane	43291	C_7H_{16}	23dmp
589-34-4	3-Methylhexane	43249	C_7H_{16}	3mhxa
540-84-1	2,2,4-Trimethylpentane	43250	C_8H_{18}	224tmp
142-82-5	n-Heptane	43232	C_7H_{16}	nhept
108-87-2	Methylcyclohexane	43261	C_7H_{14}	mcyhx
565-75-3	2,3,4-Trimethylpentane	43252	C_8H_{18}	234tmp
108-88-3	Toluene	45202	C_7H_8	tolu
592-27-8	2-Methylheptane	43960	C_8H_{18}	2mhep
589-81-1	3-Methylheptane	43253	C_8H_{18}	3mhep
111-65-9	n-Octane	43233	C_8H_{18}	noct
100-41-4	Ethylbenzene	45203	C_8H_{10}	ebenz
--	m/p-Xylene**	45109	--	m/pxy
106-42-3	(p-Xylene)**	45206	C_8H_{10}	pxyl
100-42-5	Styrene	45220	C_8H_8	styr
95-47-6	o-Xylene	45204	C_8H_{10}	oxyl
111-84-2	n-Nonane	43235	C_9H_{20}	nnon
98-82-8	Isopropylbenzene	45210	C_9H_{12}	ispbz
103-65-1	n-Propylbenzene	45209	C_9H_{12}	npbz
7785-70-8*	alpha-Pinene	43256	α-$C_{10}H_{16}$	apine
108-67-8	1,3,5-Trimethylbenzene	45207	C_9H_{12}	135tmb
95-63-6	1,2,4-Trimethylbenzene	45208	C_9H_{12}	124tmb
127-91-3	beta-Pinene	43257	β-$C_{10}H_{16}$	bpine
124-18-5	n-Decane	43238	$C_{10}H_{22}$	ndec
1120-21-4	n-Undecane	43954	$C_{11}H_{24}$	nundc
108-38-3	(m-Xylene)**	45205	C_9H_{12}	mxyl
--	Total Non-Methane Organic Compounds	43102	--	tnmoc

*Generic CAS # for this compound. **m-Xylene and p-Xylene co-elute on the GC column, use m/p-Xylene parameter code for reporting.

TABLE 3-3B. TARGET VOC OZONE PRECURSORS - CARBONYLS

CHEMICAL ABSTRACT SERVICE, (CAS) #	PAMS RECOGNIZED REPORTING NAME	AIRS PARAMETER CODE #	CHEMICAL FORMULA	PAMS RECOGNIZED ABBREVIATION
50-00-0	Formaldehyde	43502	HCHO	form
67-64-1	Acetone	43551	CH_3COCH_3	acet
75-07-0	Acetaldehyde	43503	CH_3CHO	aceta

TABLE 3-4. OZONE MONITORING SEASONS PAMS-AFFECTED STATES

STATE	BEGIN MONTH	END MONTH
California	January	December
Connecticut	April	October
Delaware	April	October
District of Columbia	April	October
Georgia	March	November
Illinois	April	October
Indiana	April	October
Louisiana	January	December
Maine	April	October
Maryland	April	October
Massachusetts	April	October
New Hampshire	April	October
New Jersey	April	October
New York	April	October
Pennsylvania	April	October
Rhode Island	April	October
Texas AQCR 4, 5, 7, 10, 11	January	December
Texas AQCR 1, 2, 3, 6, 8, 9, 12	March	October
Virginia	April	October
Wisconsin	April	October

3.2.2 Explanation of Specific PAMS Network Requirements

For ease in determining the specific monitoring requirements for any particular MSA/CMSA, the following sections detail the minimum network requirements specified by Table 3-1.

3.2.3 Requirements for MSA/CMSAs With Populations Less Than 500,000

The following is a summary of the PAMS monitoring requirements for small MSA/CMSAs having populations of less than 500,000, according to the most recent decennial United States census population report:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING FREQUENCIES
SITE #1	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) OR if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC
SITE #2	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) and, Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) OR if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) and,
	Carbonyls	Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)

In addition to the required monitoring for VOC and carbonyls, the following monitoring for other measurements is specified by the Rule:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING REQUIREMENTS
ALL SITES	Ozone	Continuous monitoring during the entire ozone season listed in Table 3-2
	Oxides of Nitrogen	Continuous monitoring during the PAMS monitoring period (preferably year-round)
	Meteorology	Surface (10-meter) continuous monitoring of wind speed/direction, ambient °T, barometric pressure, relative humidity, and solar radiation during the PAMS monitoring period (preferably year-round)
ONE REPRESENTATIVE SITE PER AREA	Upper Air Measurements	Continuous monitoring of mixing height or surrogate during the PAMS monitoring period (preferably year-round)

Since only two PAMS monitoring stations are required for these MSA/CMSAs, the recommended order for establishing sites is Site #2, then Site #1. The network should be complete within 2 years.

3.2.4 Requirements for MSA/CMSAs With Populations of 500,000 to 1,000,000

The following is a summary of the PAMS monitoring requirements for MSA/CMSAs having populations of 500,000 to 1,000,000, according to the most recent decennial United States census population report:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING FREQUENCIES
SITE #1	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC
SITE #2	VOC	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round and,
	Carbonyls	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round
SITE #3	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC

In addition to the required monitoring for VOC and carbonyls, the following monitoring for other measurements is specified by the Rule:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING REQUIREMENTS
ALL SITES	Ozone	Continuous monitoring during the entire ozone season listed in Table 3-2
	Oxides of Nitrogen	Continuous monitoring during the PAMS monitoring period (preferably year-round)
	Meteorology	Surface (10-meter) continuous monitoring of wind speed/direction, ambient °T, barometric pressure, relative humidity, and solar radiation during the PAMS monitoring period (preferably year-round)
ONE REPRESENTATIVE SITE PER AREA	Upper Air Measurements	Continuous monitoring of mixing height or surrogate during the PAMS monitoring period (preferably year-round)

Since three PAMS monitoring stations are required for these MSA/CMSAs, the recommended order for establishment of sites is Site #2, Site #3, then Site #1. The network should be complete within 3 years.

3.2.5 Requirements for MSA/CMSAs With Populations of 1,000,000 to 2,000,000

The following is a summary of the PAMS monitoring requirements for MSA/CMSAs having populations of 1,000,000 to 2,000,000, according to the most recent decennial United States census population report:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING FREQUENCIES
SITE #1	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC
SITE #2	VOC	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round and,
	Carbonyls	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round
SITE #2 (Second)	VOC	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round and,
	Carbonyls	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round
SITE #3	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC

In addition to the required monitoring for VOC and carbonyls, the following monitoring for other measurements is specified by the Rule:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING REQUIREMENTS
ALL SITES	Ozone	Continuous monitoring during the entire ozone season listed in Table 3-2
	Oxides of Nitrogen	Continuous monitoring during the PAMS monitoring period (preferably year-round)
	Meteorology	Surface (10-meter) continuous monitoring of wind speed/direction, ambient °T, barometric pressure, relative humidity, and solar radiation during the PAMS monitoring period (preferably year-round)
ONE REPRESENTATIVE SITE PER AREA	Upper Air Measurements	Continuous monitoring of mixing height or surrogate during the PAMS monitoring period (preferably year-round)

Since four PAMS monitoring stations are required for these MSA/CMSAs, the recommended order for establishment of sites is Site #2, Site #3, Site #1, then the second Site #2. The network should be complete within 4 years.

3.2.6 Requirements for MSA/CMSAs With Populations of Greater Than 2,000,000

The following is a summary of the PAMS monitoring requirements for MSA/CMSAs having populations of greater than 2,000,000, according to the most recent decennial United States census population report:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING FREQUENCIES
SITE #1	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC
SITE #2	VOC	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round and,
	Carbonyls	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING FREQUENCIES
SITE #2 (Second)	VOC	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round and,
	Carbonyls	Eight 3-hour samples every day during the monitoring period and, One 24-hour sample every sixth day year-round
SITE #3	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC
SITE 4	VOC	Eight 3-hour samples every third day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round) **OR** if an agency chooses to monitor episodes, the following may be substituted: Eight 3-hour samples on the five peak ozone days plus each previous day and, Eight 3-hour samples every sixth day during the monitoring period and, One 24-hour sample every sixth day during the monitoring period (preferably year-round)
	Carbonyls	No regulatory requirement - Monitoring is preferred according to the schedule chosen for VOC

In addition to the required monitoring for VOC and carbonyls, the following monitoring for other measurements is specified by the Rule:

REQUIRED MONITORING SITE	POLLUTANT	MINIMUM MONITORING REQUIREMENTS
ALL SITES	Ozone	Continuous monitoring during the entire ozone season listed in Table 3-2
	Oxides of Nitrogen	Continuous monitoring during the PAMS monitoring period (preferably year-round)
	Meteorology	Surface (10-meter) continuous monitoring of wind speed/direction, ambient °T, barometric pressure, relative humidity, and solar radiation during the PAMS monitoring period (preferably year-round)
ONE REPRESENTATIVE SITE PER AREA	Upper Air Measurements	Continuous monitoring of mixing height or surrogate during the PAMS monitoring period (preferably year-round)

Since five PAMS monitoring stations are required for these MSA/CMSAs, the recommended order for establishment of sites is Site #2, Site #3, Site #1, Site #4, and then the second Site #2. The network should be complete within 5 years.

Intermittent monitoring in all MSA/CMSAs, regardless of population, should be coincident with the previously-established intermittent schedule for particulate matter to ensure a degree of national consistency in accordance with 40 CFR 58, Appendix D, Section 4.3.

3.3 ALTERNATIVE SAMPLING AND ANALYSIS METHODOLOGY

EPA recognizes that State and local air pollution control agencies will be subject to unique problems and authority limitations. Further, their operation of the PAMS network may need to be tailored to complement unusual geographical and demographical situations, especially distinctive meteorology. Appendix C of 40 CFR 58 notes that deviations from the guidance are acceptable for sampling and analysis so long as the alternatives are detailed in the network description required by §58.40 and subsequently approved by the Administrator.

3.4 MONITORING FOR AIR TOXICS

An urban air toxics monitoring research program is required for a number of VOC species and other hazardous air pollutants by Title III, Section 301, of the CAAA. EPA believes that the PAMS stations will be available as platforms for the additional monitoring of air toxics compounds. Specifically, it is noted by the Agency that by measuring the VOC targeted in Reference 4, a number of toxic air pollutants will also be measured. Although compliance with Title I, Section 182 of the Act does not require the measurement and analysis of additional toxic air pollutants, the Agency believes that the PAMS stations can serve as cost-effective platforms for an enhanced air toxics research and ambient monitoring program. The adjunct use of PAMS for air toxics monitoring will allow the consideration of air toxics impacts in the development of future ozone control strategies. The establishment of a second PAMS #2 site will provide an even better database for such uses. The Agency, however, notes that the PAMS network is not ideally located as a source of primary air toxics data, but the network will serve as a base for future air toxics monitoring activities.

Methods typically used for air toxics measurement are not addressed in this guidance document. Manual methods, such as canister sampling for VOC species, will be used for both quality assurance purposes to check the continuous VOC measurement data and to provide estimates of annual means for air toxics assessment purposes. Other hazardous compounds, including metals, pesticides, semi-volatiles, polar compounds and products of incomplete combustion (PICs) will be measured, provided resources are available.

4.0 PAMS NETWORK PLAN AND APPROVAL

4.1 INTRODUCTION

Two types of network plans are allowed under the Part 58 PAMS regulations: (1) a standard network plan, which conforms to the criteria for a network description as described in Section 58.41 and Appendices A and D of the Rule, including all of the elements listed: and (2) an alternate network plan, which includes one or more of the acceptable alternative network elements described in the Rule, but otherwise complies with the criteria for a standard network.

The procedures for reviewing a State or local agency PAMS network plan consist of two steps: in the first step, the submitted network plan is reviewed for administrative completeness; in the second step, the plan is reviewed for conformance to the PAMS acceptance criteria.

4.2 REQUIREMENTS FOR STANDARD PAMS NETWORK PLANS

The Part 58 regulations allow for submittal of standard or alternate network plans. Standard network plans, which are described in this section, conform to the criteria for a network description outlined in Section 58.41 and Appendices A and D of the Rule. In order for a standard plan to be approved the plan must meet the completeness criteria contained in Section 4.2.2 and the acceptance criteria of Section 4.2.3. A summary of the review and approval process and a description of the completeness and acceptability criteria for standard network plans are included in the remainder of this section. A decision tree flow diagram of this procedure is presented in Figure 4-1.

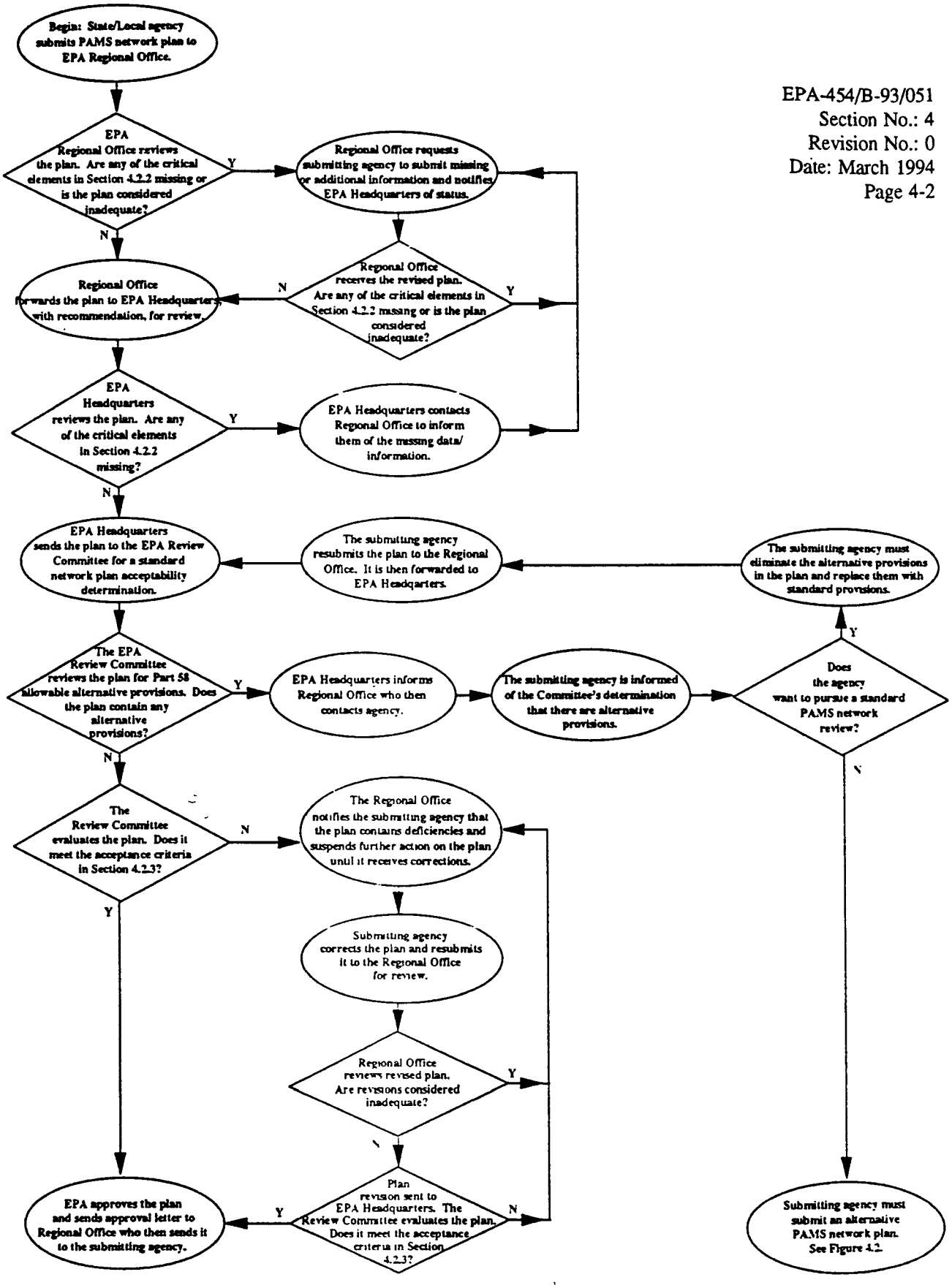


FIGURE 4-1. PROCEDURES FOR REVIEW AND APPROVAL OF STANDARD PAMS NETWORK PLANS

4.2.1 Summary Procedures for Review and Approval of a Standard PAMS Network Plans

1. State/local agencies prepare a PAMS standard network plan (including the critical elements and sub-items of a standard plan which are listed and described in Section 4.2.2) and declare the plan as a standard plan. Joint network plans may be submitted by groups of State/local agencies in accordance with Section 58.40 of the 40 CFR Part 58 regulations. Agencies are encouraged to work with Regional Offices in network plan development.

2. The plan is submitted to the appropriate EPA Regional Office for preliminary review. If any of the critical elements are missing or considered inadequate, the Regional Office requests that the submitting agency remit the additional or revised material and notifies EPA Headquarters of the plan receipt and status.

3. State/local agencies submit missing and/or new material to the Regional Office which reviews the material for completeness and adequacy, and subsequently forwards the information to EPA Headquarters with the Regional recommendation when deemed complete.

4. EPA Headquarters conducts a general review of the overall plan and reviews the standard network plan according to the standard plan completeness criteria described in Section 4.2.2. If any of the critical items are judged to be incomplete or missing, the Regional Office is contacted, which in turn requests the additional or missing material from the responsible agency or agencies (in the case of a multi-area plan).

5. EPA Headquarters reviews the resubmitted material and determines if the plan submittal is complete. If incomplete, the cycle is repeated until the plan satisfies the

completeness criteria. After a plan is determined to be complete, it is sent to the EPA PAMS Network Design Review Committee (Review Committee) for a standard network plan acceptability determination. If the submitted plan is judged to contain any of the Part 58 allowable alternative plan revisions, the plan is reviewed according to the alternative plan review procedures presented in Section 4.3.1. Before proceeding with the alternative plan review process, EPA Headquarters notifies the Regional Office that the plan is considered to be an alternative plan and that a final decision is needed from the responsible agency official(s) on whether EPA should proceed. The Regional Office notifies the appropriate agency; if that agency's official(s) agree that the plan is an alternative network plan and desire an alternative plan review, the plan is processed according to the alternative plan review procedures presented in Section 4.3.1. If the agency disagrees and prefers to continue to seek a standard plan review, alternative plan provision(s) must be removed and replaced with the standard network plan provision(s).

6. The Review Committee reviews the standard network plan for conformance to the standard plan acceptance criteria listed and described in Section 4.2.3 (Alternative plan acceptance criteria are described in Section 4.3.3). If the submitted plan is determined to conform to the standard plan acceptance criteria, the Review Committee recommends approval of the network plan and forwards it to the EPA approving official for formal approval. **Note that formal approval is only for each of the sites that are to be established in the next ozone monitoring period. The process is repeated each year additional sites are to be implemented. Complete approval of the entire network plan is contingent upon completion of each phase of the network description including conformance to the PAMS network design criteria.**

7. The EPA approving official signs an approval memorandum and sends it to the Regional Office which notifies responsible agency official(s).

8. If the Review Committee determines that the standard network plan does not satisfy the critical elements, the Regional Office is contacted. The Regional Office notifies the responsible submitting agency official(s) of the deficiencies and requests corrective action to be taken. EPA Headquarters holds the plan in abeyance until the plan corrections are received.

9. The State/local agency submits the corrected deficiencies to the Regional Office. The Regional Office reviews the material for completeness and forwards it to EPA Headquarters with the Regional recommendation when judged complete.

10. The Review Committee reviews corrections and if the revised plan is determined to conform to the standard plan acceptance criteria, the Review Committee recommends plan approval and forwards it to the EPA approving official for formal approval.

11. The EPA approving official signs the PAMS standard network plan approval memorandum and submits it to the Regional Office which then notifies the responsible agency official(s).

4.2.2 Completeness Criteria for Standard PAMS Network Plans

The completeness determination consists of checking the submitted plan against the prescribed list of critical elements of a network plan, which have been grouped into the following categories:

- Network overview
- Site identification
- Sampling and analysis methods
- Monitoring period
- Sampling frequencies
- Meteorological monitoring
- Network implementation schedule
- Quality assurance

In order to be considered complete, a plan must include each of these basic elements. Within these basic elements are a number of specific items that need to be included in the plan in order for the basic element to be complete. These specific items are described in Section 4.2.3.

When submitting a completed standard network plan to the EPA Regional Office, the responsible State or local agency should label it as a standard plan, and ensure that it contains all the critical elements described in this section and listed in the Checklist contained in Section 4.4. The elements of the submitted network plan must fully conform to the criteria laid out in this section and 40 CFR Part 58. If the review by the EPA Regional Office determines that any of the critical elements are missing and/or the plan is considered inadequate, the submitting agency will be requested to provide the missing items and/or submit additional material. After the standard network plan is deemed complete and adequate by the Regional Office, it is forwarded to EPA Headquarters.

To avoid delay and confusion in the approval process, all materials required as part of a network plan submittal must be included in the submittal package. References alone to other documents or database retrievals are not acceptable.

The remainder of this section is devoted to detailed descriptions of the categories of critical elements listed previously. The individual critical elements which make up each category are enumerated, along with the criteria for acceptability.

4.2.3 Acceptance Criteria for Standard PAMS Network Plans

Once the standard network plan is determined to be administratively complete, it is forwarded to the Review Committee where it is reviewed for conformance to the standard plan acceptance criteria, which are based on the network plan requirements specified in the regulations.

Network Overview - In order to be acceptable, a PAMS MSA/CMSA network plan must include a clear description of the entire network. The network overview should contain a brief narrative describing the number and types of sites that will make up the network, and the rationale for their placement. The narrative should also briefly describe the monitoring area represented, noting any geographical features, emissions information, meteorological and climatological trends, or other factors which influenced the design of the network. Pertinent information must be included as a part of the network plan submittal package, rather than referenced.

Each PAMS network description must include a description of the monitoring area represented [Section 58.41 (a)]. The description of the monitoring area represented must include information on the population and nonattainment status of the network plan MSA/CMSA. The number and types of PAMS sites required for a given area depend on these two factors (Table 4-1). For areas with serious, severe, or extreme nonattainment status, the minimum requirements vary from two sites for an MSA/CMSA with a population under 500,000; to five sites for an MSA/CMSA with a population over 2,000,000. Further guidance on network design and siting is provided in Section 2 of this document. The description must

TABLE 4-1. MINIMUM PAMS NETWORK REQUIREMENTS[a]

Population of MSA/CMSA or nonattainment area[b]	Number of sites of each type			
	Upwind Background (#1)	Maximum Representative Precursors (#2)	Maximum Ozone (#3)	Downwind Transport (#4)
Less than 500,000	✓	✓		
500,000 to 1,000,000	✓	✓	✓	
1,000,000 to 2,000,000	✓	✓✓	✓	
More than 2,000,000	✓	✓✓	✓	✓

[a] For nonattainment areas classified as serious, severe, or extreme
[b] Whichever is larger

also include a map of the entire MSA/CMSA, showing the proposed relative location of the sites that make up the PAMS network, and a detailed area map showing the precise location for the sites to be installed during the current ozone monitoring period. In addition, the description should include the street address, County, Parish, or Township; Latitude/Longitude; and Universal Transverse Mercator (UTM) coordinates for each proposed site which is scheduled for operation in the next ozone monitoring period. Other information, such as emissions inventories for ozone precursors, meteorological data, climatological summaries, or topographic maps showing land features and geographical influences must be included. Preferred examples of this information are provided in Appendix I.

Provisions have been made in the regulations to allow for alternative networks with a different number or arrangement of sites, including multi-area networks covering several MSAs/CMSAs (40 CFR Part 58, Appendix D, Section 4.2). Plans containing an alternate number or arrangement of sites must be submitted as alternate network plans in accordance

with the requirements for submittal of alternative network plans discussed in Section 4.3 of this manual.

Site Identification - Detailed information, noted in the previous section and further described or demonstrated in Appendix I, must be supplied for sites to be implemented in the next ozone monitoring period. In order to be complete, a PAMS network plan should include the following for each site scheduled for operation in the next ozone monitoring period.

1. AIRS site and monitor ID information for each proposed station [See list of required information in the Checklist (Section 4), Section III, Part B].

2. Morning wind roses for high ozone days (days exceeding 0.1 ppm) or ozone conducive days for Site #1 and Site #2 monitoring sites. Alternate methods of specifying the wind direction must be approved by EPA. (40 CFR Part 58, Appendix D, Section 4.2). In situations where simple wind roses are not applicable, appropriate representative wind direction summaries should be included.

3. Afternoon wind roses for high ozone days or ozone conducive days for Site #3 and Site #4 monitoring sites. Alternate methods of specifying the wind direction must be approved by EPA. (40 CFR Part 58, Appendix D, Section 4.2).

4. Maps showing nearby ozone precursor emission sources of 10 tons/year or greater for the immediate surroundings of the site (within ¼ mile of the site), and a less detailed map for the entire MSA/CMSA (See Appendix I of this document for a detailed description of required emissions information for sites to be established in future years).

5. Breakdown of source categories (mobile/point/area). (See Appendix I of this document).

6. Description of terrain around sites, including roadways and land use (topographic map preferred).

7. Photographs and/or video of sites.

8. Details of meteorological monitoring.

9. Other information as available - modeling information, saturation monitoring results, etc.

Detailed site information must be submitted to the Regional Office no later than January 1 of the year in which a site is scheduled for implementation [40 CFR Part 58, Section 58.41(d)]. Less detailed information (a map of the general location of the site, a description of the site number, and morning and afternoon wind roses for high ozone days) should be supplied for sites to be implemented in future years [40 CFR Part 58, Section 58.41(d)].

Sampling and Analysis Methods - The PAMS program requires monitoring of multiple pollutants (NO, NO_2, NO_X, ozone, carbonyls, and speciated VOC) at each of the sites in affected MSAs/CMSAs. In order to ensure that comparable data are produced, it is essential that the sampling and analysis methodologies called for in the Part 58 regulations and the ***Technical Assistance Document***, are used by all PAMS networks.

Use of automated reference or equivalent methods (40 CFR Part 58, Section 50.1) is required for ozone, and recommended for NO, NO_2, and NO_x (40 CFR Part 58, Appendix C, Sections 4.1 and 4.2). VOC and carbonyl monitoring must be performed using the methods described in the TAD (40 CFR Part 58, Appendix C, Section 4.3) or approved alternative methodology. Meteorological measurements must be conducted according to the guidance in the TAD described above, and the ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV, Meteorological Measurements*** (40 CFR Part 58, Appendix C, Section 4.3). Details of reference or equivalent methods and unmodified methods from the TAD need not be included in network plan submittals; they may be referenced.

Regulatory provisions allow for the use of alternative methods to measure NO, NO_2, NO_x, VOC, and carbonyls (40 CFR Part 58, Appendix C, Sections 4.2 and 4.3). Plans which

include any modifications to the designated methods, or propose alternate methodologies, must be submitted as alternative network plans in accordance with the requirements discussed in Section 4.3 of this document. Complete documentation of the modification or alternative methods must be submitted with the alternate network plan.

Monitoring Period - At a minimum, ozone precursor monitoring must be conducted during the months of June, July, and August, when peak ozone conditions are generally expected. Monitoring during the entire prescribed ozone season for an area as defined in 40 CFR Part 58, Appendix D, is preferred. Alternate precursor monitoring periods may be submitted for approval as part of a PAMS alternative network description (40 CFR Part 58, Appendix D, Section 4.3) in accordance with the requirements described in Section 4.3 of this manual.

Sampling Frequencies - Monitoring of ozone for the PAMS network must be continuous, and on the same schedule as the NAMS/SLAMS networks (40 CFR Part 58, Appendix D, Section 2.5). Monitoring for NO, NO_2, and NO_x should be continuous and may be limited to the months of June, July and August. Several sampling frequency options are available for monitoring of VOC and carbonyls by PAMS networks (see Section 4.3.2 of this document) (40 CFR Part 58, Appendix D, Section 4.4, Table 2). Some of the available sampling frequency options call for monitoring on and before peak ozone days. Agencies choosing to use these options must provide a description of the ozone event forecasting scheme they will use to predict peak ozone days and a demonstration of its effectiveness (40 CFR Part 58, Appendix D, Section 4.4). The demonstration must be based on recent ambient ozone data (preferably not more than 5 years old), from years that are representative of typical weather patterns in the area.

The regulations provide for the use of alternative sampling frequencies [40 CFR Part 58, Section 58.40(a)(3)]. Plans containing alternative sampling frequencies must be submitted

as alternate network plans, in accordance with the requirements described in Section 4.3. In order to be approved, a PAMS network plan incorporating an alternative sampling frequency must include a demonstration of its equivalency with the prescribed Part 58 PAMS frequency.

Meteorological Monitoring - Each PAMS station, or a nearby area representative of each PAMS, must be equipped with meteorological monitoring equipment, including wind measurements at 10 meters above ground (40 CFR Part 58, Appendix D, Section 4.6). Details on the meteorological equipment at each site must be included in the individual site description.

One upper air meteorological monitoring site is required for each PAMS-affected area. The upper air monitoring site may be located separately from the other PAMS sites, but it must be representative of the upper air data in the MSA/CMSA nonattainment area (40 CFR Part 58, Appendix D, Section 4.6). The PAMS network description must contain a detailed description of the upper air monitoring measurement system, including monitoring methods and frequencies, and specific site location.

Network Implementation Schedule - PAMS network plans must include a schedule for implementing the entire network [40 CFR Part 58, Section 58.41(h)]. The schedule must include a timetable for locating, establishing, and submitting the AIRS site ID form for each scheduled PAMS site that has not been located at the time the network plan is submitted. The schedule must include a timetable for phasing in the required number and types of sites according to the priorities defined in 40 CFR Part 58, Appendix D, Sections 4.4 and 4.5. The recommended order of site implementation called for in Part 58 is as follows: primary Site #2, Site #3, Site #1, Site #4, and last, the secondary Site #2.

Quality Assurance (QA) - PAMS network plans must include a schedule for modification of the QA program already in place for NAMS/SLAMS to include QA for the PAMS network [40 CFR Part 58, Section 58.41 (h)(3)]. PAMS QA programs must be designed in accordance with the provisions of 40 CFR Part 58, Appendix A, which includes requirements for QA activities and reporting, and data quality assessment.

4.3 REQUIREMENTS FOR ALTERNATIVE PAMS NETWORK PLANS

If a proposed plan has been determined to contain any of the alternative elements that are allowed under the alternative element provisions of the regulations (alternate sampling and analysis methods, sampling frequency, sampling period, number and type of sites, and alternate procedures for selecting wind direction), the plan is declared an alternate plan. In order for an alternative plan to be approved the plan must meet the completeness criteria contained in Section 4.3.3 and the acceptance criteria of Section 4.3.4. The completeness criteria for alternative plans include all of the requirements of a standard plan plus the Section 4.3.3 criteria. Alternate plans are subject to additional network plan submittal requirements as described in this section. The plan is examined for administrative completeness with regard to these additional items. If the plan is found to be incomplete, the submitting agency will be notified and requested to submit the missing information or data. After the alternative plan is judged to be administratively complete, it is forwarded to the Review Committee and evaluated for conformance to the acceptance criteria for alternative plans. The alternative network plan review and approval process is summarized below, and illustrated in a decision tree flow diagram (Figure 4-2).

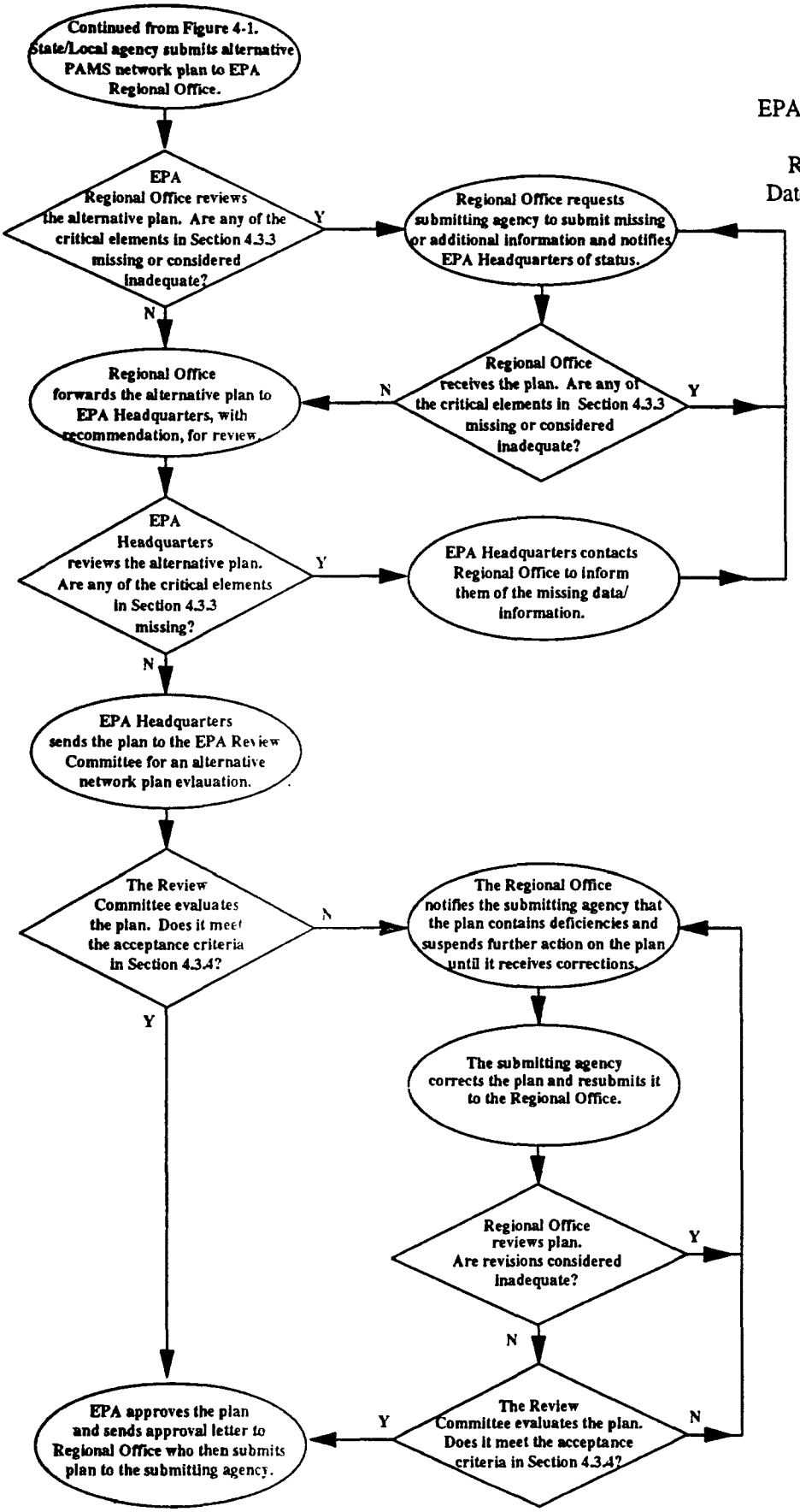


FIGURE 4-2. PROCEDURES FOR REVIEW AND APPROVAL OF ALTERNATIVE PAMS NETWORK PLANS

4.3.1 Summary Procedures for Review and Approval of Alternative PAMS Network Plans

1. State/local agencies prepare a PAMS alternative network plan (includes the critical elements of an alternative plan which are listed and described in this section). Agencies are encouraged to work with the Regional Offices during plan development.

2. The plan is submitted to the EPA Regional Office for preliminary review. If any of the PAMS alternative plan critical elements items are missing or considered inadequate, the Regional Office requests the submitting agency to send the missing material and/or revise the submitted material.

3. The State/local agencies submit missing or revised material to the Regional Office; the Regional Office reviews the material for completeness and adequacy and forwards it to EPA Headquarters with the Regional recommendation when it is considered complete and adequate.

4. EPA Headquarters reviews the network plan for the alternative plan completeness determination. If any of the critical element items of an alternative plan are valued as incomplete or missing, the Regional Office is contacted, which in turn requests the additional or missing material from the responsible agency or agencies (in the case of a multi-area plan).

5. The State/local agency sends the missing or additional material to the appropriate Regional Office. Regional Office sends the material to EPA Headquarters with the Regional recommendation when ruled complete and adequate.

6. EPA Headquarters reviews the resubmitted material and determines whether the alternative plan submittal is complete. If incomplete, the cycle is repeated until the plan satisfies the completeness criteria. After the alternative plan is determined to be complete, it is sent to the EPA Review Committee for an alternative plan acceptability determination.

7. The EPA Review Committee reviews the alternative network plan for conformance to the acceptance criteria for an alternative plan. If the submitted plan is determined to conform to the alternative plan acceptance criteria, the Review Committee recommends approval of the network plan and forwards the plan to the EPA approving official for formal approval. **Note that the PAMS alternative network plan formal approval only applies to each of the sites that are to be established in the next ozone monitoring period. The process is repeated each year for all additional sites scheduled for implementation in that same year. Complete approval of the entire network plan is contingent upon completion of each phase of the entire network description.**

8. The EPA approving official signs an alternative network plan approval memorandum and sends it to the Regional Office, which notifies the responsible agency official(s).

9. If the EPA Review Committee determines that the alternative network plan does not satisfy the critical elements delineated in Section 4.3, the Regional Office is contacted. The Regional Office notifies the responsible submitting agency official(s) of the deficiencies and requests that corrective action be taken. EPA Headquarters holds the plan in abeyance until the plan corrections are received. In some cases EPA may consider a plan for conditional approval.

10. The State/local agency submits the corrected deficiencies to the appropriate Regional Office. The Regional Office reviews the material for completeness and forwards to EPA Headquarters with a recommendation when the Region considers the corrected alternative network plan complete.

11. The EPA Review Committee reviews the corrections. If the revised plan is determined to conform to the alternative plan acceptance criteria, the Review Committee recommends approval of the alternative plan and forwards the plan to the EPA PAMS network plan approving official for formal approval.

12. The EPA approving official signs the PAMS alternative network plan approval memorandum and submits it to the Regional Office which then notifies the responsible agency official(s).

4.3.2 Regulatory Provisions for Alternative PAMS Network Plans

The PAMS regulations have been crafted to allow PAMS networks to be tailored to fit the individual needs of State and local programs. The purpose of the flexibility written into the rule is to ensure that the overall goals of the PAMS program are met while allowing for States to design their networks and take into account any factors that are unique to their own programs (*e.g.*, problems, strategies, limitations, and particular authorities, or physical constraints such as geography, demographics, or unusual meteorology).

The PAMS regulations contain provisions for alternative network elements in five areas:

- Sites - Number and Arrangement
- Methodology - Sampling and Analysis
- Monitoring Season - Months with Highest Ozone

- Sampling Frequency
- Meteorology - Establishing Wind Directions for Siting

If a State chooses to incorporate one or more of these alternative elements in its PAMS network design submittal, it must state that its 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 objectives and program objectives. The PAMS monitoring objectives are the basis for the four PAMS site designations and include the following:

- Upwind background (#1 Sites)
- Representative maximum precursors (#2 Sites)
- Maximum ozone (#3 Sites)
- Downwind transport (#4 Sites)

The PAMS program objectives are also referred to as PAMS data uses and include the following (more detailed descriptions are included in Section 4.3.4):

- NAAQS attainment and control strategies
- SIP control strategy evaluation
- Emissions tracking
- Exposure assessment
- Support for urban airshed modeling

4.3.3 Completeness Criteria For Alternative PAMS Network Plans

Network plans for PAMS networks containing alternative elements must include all the elements of a standard PAMS network plan. Alternative network plans must also include the following documentation:

- Narrative explanation of the alternative element(s)
- Justification for the alternative elements
- Demonstration of comparability

An alternative network plan will be considered complete if each of these items and associated material is presented. Alternative elements must correspond to one of the five alternative element areas specified in the regulations. If material from one part of a network plan submittal is applicable elsewhere (for example, a justification for an alternative method), it may be referenced in the other portions of the plan. For each required documentation, however, the applicable material must be contained somewhere within the submittal package. Network plan submittals containing references to sources not contained within the submittal package will be considered incomplete. After review by the Regional Office, if any element is found missing or considered inadequate, the submitting agency will be asked to supply the missing items.

Section 4.3.4 of this document contains more detailed guidance on the types of information that may be used to fulfill this requirement, and instances in which such demonstrations may be required.

4.3.4 Acceptance Criteria For Alternative PAMS Network Plans

After the alternative network plan is determined to be administratively complete, it must be reviewed for conformance to the alternative plan acceptance criteria. These criteria are as follows:

- The acceptance criteria for all the standard elements contained in the alternative plan (Section 4.2.2 of this document)
- A detailed narrative explanation of the alternative elements
- A justification for the alternative elements
- A demonstration of compliance with the monitoring objectives and data uses

The standard network plan acceptance criteria are described in Section 4.2.2 of this document. To be considered acceptable, the narrative explanation must clearly describe the proposed alternative elements. For example, if an alternate measurement method is proposed, a complete description of the alternate method must be included in the plan. Details similar to those included in standard operating procedures (SOPs) should be submitted. The justification should fully explain why the alternative element is proposed, such as geographical constraints, local ordinance restrictions, physical obstructions, and/or improved data quality. The comparability demonstration must provide a thorough explanation showing that the proposed alternative network will produce results comparable to those produced by a standard PAMS network, and that the proposed network will fulfill the PAMS monitoring objectives and data uses. When using alternative sampling or analytical methods (including meteorological methods) or alternative sampling or monitoring frequencies, the documentation for the demonstration must: (a) include historical data collected within the last three years or during the time period used to declare the MSA/CMSA nonattainment, and (b) show a relationship between the proposed alternative methodology and the methodology described in

the TAD. Rulings on the acceptability of alternative methods will be made on a case-by-case basis by the EPA Review Committee.

The PAMS regulations were designed to allow flexibility in implementation. They contain several provisions for alternatives to the prescribed standard network design. Section 58.40(a)(3) of the PAMS regulations states "Alternative networks, including different monitoring schedules, periods, or methods, may be submitted, but they must include a demonstration that they satisfy the monitoring data uses and fulfill the PAMS monitoring objectives as described in sections 4.1 and 4.2 of appendix D to this part." Sections 4.1 and 4.2 of Appendix D to 40 CFR Part 58 contain detailed descriptions of the PAMS data uses and monitoring objectives, respectively.

There are five major PAMS data uses described in Section 4.1 of Appendix D to 40 CFR Part 58. Alternative network plans must demonstrate that they can meet these data uses:

- NAAQS attainment and control strategy development
- SIP control strategy evaluation
- Emissions tracking
- Trends
- Exposure assessment

The five major data uses, examples of particular data uses specified in the regulations, and how alternative network plans will be assessed on their ability to meet these data uses are discussed in the following sections.

In addition, the regulations specify certain uses within the five major categories of data uses. Each of these particular uses is listed below and discussed in the context of how

to demonstrate that an alternative network plan will meet these particular uses. In cases where a particular use may be met based on another objective or criterion, the discussion will indicate how to reference the material contained elsewhere and explain how the other material is relevant to meeting a particular data use.

NAAQS Attainment and Control Strategy Development - For this PAMS data use category, the regulations list the following six particular uses and additional subsidiary uses:

- monitor exceedances
- provide input for attainment/nonattainment decisions
- help resolve roles of transported and locally emitted ozone precursors in producing an observed exceedance
- identify specific sources emitting excessive ozone precursor concentrations and potentially contributing to ozone exceedances
- enhance the characterization of ozone concentrations
- provide critical information on the precursors causing ozone and thus extend the database for future demonstrations based on photochemical grid modeling and other approved analytical methods
  - -- areas and episodes to model to develop appropriate control strategies
  - -- boundary conditions required by the models to produce quantifiable estimates of necessary emissions reductions
  - -- evaluation of the predictive capability of the models used

Particular uses, such as monitoring exceedances of the NAAQS and helping to resolve the role transported and locally emitted ozone precursors play in producing observed exceedances, are strongly dependent on meeting criteria for site locations, sampling frequency, and monitoring period. The criteria used to assess the adequacy of the alternative

plan for a particular data use will be whether the alternative network plan provides data of sufficient quantity, quality, representativeness, and comparability compared to the standard network design. Among the questions that should be answered are the following:

1. Will the alternative network design provide data that are compatible with making an informed attainment/nonattainment decision? For example, will the design capture the highest ozone concentration days? Will the time resolution of ozone precursors be compatible with meteorological measurements and allow adequate differentiation of upwind/downwind conditions and transport?

2. Will the alternative network design provide data that are compatible in spatial and temporal bounds and resolution with applicable photochemical grid models?

3. Are there special conditions (either geographic, meteorological, or logistical) that would prevent the standard network design from being implemented or providing the data intended, or are there special conditions that mean that the alternative network design will do a better job of meeting the data uses or other PAMS objectives?

Identifying specific sources emitting excessive ozone precursor concentrations and potentially contributing to ozone exceedances is strongly dependent on siting criteria, particularly those dealing with location with respect to certain source types, the scale of representativeness, the absence of very localized influences, etc.

Among the questions to be answered are the following:

1. Will the alternative network design provide data that are comparable to and representative of the general conditions of the typical type of PAMS?

2. On what basis were the specific sources identified as possibly emitting excessive ozone precursors, and how much of a contribution to ozone exceedances are these sources expected to make?

3. How will the alternative network design characterize precursor emissions from these sources?

SIP Control Strategy Evaluation - The PAMS regulations discuss the following data uses under the category SIP control strategy evaluation:

- Evaluating the effectiveness of control strategies using long term PAMS data
- Evaluating the impact of VOC and NO_x emission reductions on ambient air quality ozone levels
- Determining which organic species are most affected by emissions reductions

The PAMS alternative network plan must demonstrate that the VOC and NO_x data will be comparable to the data collected by the sampling stations from a standard network. At a minimum, the comparability demonstration required should answer the following questions:

1. Will the alternative plan provide fixed permanent monitoring stations that will provide valid, quality assured data for long-term PAMS control strategy evaluation and in particular for the time period covering control strategy implementation?

2. Will the alternative plan capture VOC speciated compounds and NO_x concentrations in the area of representative maximum concentrations in order to tie in air quality levels with emission sources in the MSA/CMSA?

3. Will the data collected by the alternative network represent around-the-clock concentrations so that any major VOC emissions occurring at different time periods during the day are accounted for, thus allowing for the development of strategies that are most suited and cost-effective for the area?

Emissions Tracking - The following four uses are cited in the Part 58 regulations for the PAMS data use category of emissions tracking:

- Corroborate the quality of VOC and NO_x emission inventories
- Track the reduction of VOC and NO_x emissions
- Support reasonable further progress (RFP) calculations
- Corroborate emissions trends reporting

In general, for emission inventory corroboration, tracking of emissions, RFP calculations, and the corroboration of emissions trends, an alternative network plan must demonstrate that its VOC and NO_x ambient air quality data will be capable of providing enhanced or similar data compared to a standard network plan. The following questions need to be answered:

1. Will the alternative network capture the maximum representative VOC concentration?

2. Will the alternative network be able to discriminate among anthropogenic and biogenic VOC contributors?

3. Will the alternative plan allow for the corroboration of RFP calculations?

Preliminary guidance recommends that data from Site #2 be used for comparison to emissions inventory estimates and that data from Site #3 may be used on a case-by-case basis. The alternative network plan must demonstrate that its proposed monitoring stations will provide data comparable to a Site #2. In addition, the alternative network plan must show that its sampling schedule will provide data comparable to sampling for all of the weekdays to comply with the emission inventory's collection and reporting of data based on a summer weekday. Weekdays should be emphasized in the comparability analyses. Since RFP emission reduction requirements apply exclusively to anthropogenic emissions, emission

inventory estimates should exclude biogenic emissions. Also, since acetaldehyde and formaldehyde are normally secondary reactive products in ozone formation, it is good practice to exclude them from the emissions estimates unless they are emitted as primary pollutants. Finally, ethane, which is not considered a reactive hydrocarbon, should also be omitted. Because the emission inventories exclude these pollutants, the alternative plan should demonstrate that appropriate procedures could be implemented to subtract such pollutants from the ambient data collected.

Trends - For this PAMS data use category, the regulations give the following five particular uses and additional subsidiary uses:

- establish speciated VOC, NO_x, and limited toxic air pollutant trends using long-term data
- supplement the ozone trends database
- track multiple statistical indicators
  - -- ozone and its precursors during the events for the days of each year with the highest ozone concentrations
  - -- seasonal means for these pollutants
  - -- annual means at representative locations
- compare pollutant trends analyses with meteorological trends and transport influences through the use of PAMS surface meteorological monitoring
- help to interpret ambient air pollution trends by taking meteorological factors into account with the use of PAMS meteorological data

In general, an alternative network design must demonstrate that its speciated VOC, NO_x, and limited toxic air pollutant data will be roughly comparable to or better than the data from the standard network design in terms of representativeness (spatial and temporal), data quality for statistical indicators (*e.g.*, accuracy and precision), and compatibility with

meteorological data. The design should explicitly list and candidly discuss any tradeoffs in trend analyses. For example, will the alternative monitoring network design provide better statistical analysis for events with high ozone concentrations at the expense of poorer or biased statistical analysis of seasonal or annual trends? Will an alternative design provide for a better analysis of toxic air pollutant trends at the expense of annual and seasonal ozone means? On what basis were these choices made? Reviewers of alternative designs will evaluate their suitability for trends reporting giving greatest weight to the following:

1. tracking statistical indicators for ozone and its precursors for the highest ozone concentration events during the year
2. providing unbiased seasonal and annual means at representative locations
3. establishing speciated VOC, NO_x, and toxic air pollutant trend data over the long-term
4. providing the appropriate quantity and precision of measurements to permit trends reporting

The alternative network design must also address the ability of the design to provide pollutant data and meteorological data that are consistent with one another spatially and temporally. Will the meteorological data be representative of the area where the pollutant data are being acquired? For example, will airport data or other meteorological data in complex terrain be adequate to characterize the movement of air parcels over the area where toxic pollutants are being sampled?

Exposure Assessment - The regulations provide two particular uses for this data category.

- Better characterize ozone and toxic air pollutant exposure to populations living in serious, severe, or extreme areas

- Calculate the annual mean toxic air pollutant concentrations to help estimate the average risk to the population associated with individual toxic VOC species in urban environments

In general, alternative PAMS network designs must demonstrate that they can provide equivalent or improved estimates of population exposure to ozone and toxic air pollutants. In practice, it is desirable that the network design show that one or more monitoring locations will be representative of general population exposure and demonstrate that annual mean concentrations of toxic air pollutants will not be biased by the proposed sampling schedule or frequency. For example, alternative network designs using a predictive scheme for sampling on the highest ozone concentration days must show how statistically representative and unbiased sampling can be obtained for annual sources of toxic air pollutants. In addition, the application should address any tradeoffs made by alternative designs between trend reporting and exposure assessments, and the rationale for doing so. For example, a given nonattainment area may have varied and geographically dispersed sources of toxic air pollutants. If the meteorological and boundary conditions for the area are believed to be relatively simple, the network may be appropriate to better characterize exposure to toxic pollutants.

4.4 COMPLETENESS CHECKLIST FOR PAMS NETWORK PLANS

4.4.1 Instructions for Using Checklist

The following checklist is intended for persons preparing PAMS network plans and for persons reviewing and approving those plans. The checklist will help the user determine whether or not the information requirements of a PAMS network plan have been satisfied.

The checklist is organized into five sections. Section I identifies background information about the proposed plan, such as the agency submitting it and the classification of the ozone nonattainment area. Section II covers the design of the network; the required

number and types of sites for the nonattainment area. Section III reviews several site-specific information requirements, such as AIRS site ID forms, and several network information requirements, such as the sampling methods to be used at all of the network's proposed sites. Section IV covers the network schedule for both the implementation and operation of new sites. The last section, Section V, provides a quick overview of the completeness status of the proposed network plan.

If a State or local agency has not provided the necessary data and information in its plan, this should be indicated on the checklist. The agency using the appropriate procedures should be contacted to obtain the necessary data and information. If the proposed plan includes alternative provisions, such as a site layout that differs from those stipulated in the regulations, documentation must be provided supporting the alternative elements. The documentation must demonstrate that the plan will meet the data uses and monitoring objectives of a standard PAMS network plan.

4.4.2 Completeness Checklist for PAMS Network Plan

Section I ***General Information***

A. State or Local Agency:_____
Contact:_____
Address:_____
_____
Telephone #:_____

State or Local Agency (if more than one):_____
Contact:_____
Address:_____
_____
Telephone #:_____

State or Local Agency (if more than one):_____
Contact:_____
Address:_____
_____
Telephone #:_____

B. EPA designation of the ozone nonattainment area. Please check the one that applies.

Serious:_____ Severe:_____ Extreme:_____

C. In which range does the population of the metropolitan statistical area (MSA) or the consolidated metropolitan statistical area (CMSA) fall?

Less than 500,000:_____
500,000 to 1,000,000:_____
1,000,000 to 2,000,000:_____
More than 2,000,000:_____

D. AIRS Name and number of the MSA/CMSA

_____

E. Is the proposed plan for an isolated area network or for a multi-area, transport network? Please circle one.

Isolated area network or Multi-area, transport network

F. If the plan is for a multi-area network, are all the other affected agencies identified in the plan? Please circle one. Y or N

Section II *Network Design*

A. Based on the information provided in Section I, please fill in the box as it applies.

Population of MSA/CMSA	Required # of Sites	Required Types of Sites	Proposed # of Sites	Proposed Types of Sites
Less than 500,000	2	1, 2		
500,000 to 1,000,000	3	1, 2, 3		
1,000,000 to 2,000,000	4	1, 2, 2, 3		
More than 2,000,000	5	1, 2, 2, 3, 4		

B. **If the State has submitted a plan for a network design that differs from the required number of sites or types of sites, the plan is considered an alternative plan.** If this occurs, has the following information been supplied? Please check appropriate space for each question:

		Y	N
1.	A narrative explanation?		
2.	Sufficient justification?		
3.	Demonstration of comparability?		
4.	Demonstration that the monitoring objectives are met?		
5.	Demonstration that the data uses are satisfied?		

Section III *Network Description - Site Specific*

A. Identification of the Monitoring Area

Each PAMS network description must include a description of the monitoring area. Are the following items included in the description?

		Y	N
1.	A map of the entire MSA/CMSA with the proposed location of each site, including those to be established in future years? (Sites to be established in future years may be indicated within a 2 km radius on the MSA/CMSA map.)		
2.	Climatological information?		

B. Identification of PAMS Sites

		Y	N
1.	Full Site Description: The following requirements apply to individual PAMS sites that are scheduled to be implemented during the coming year. Except for the sites scheduled to begin monitoring in 1993, the information for each site should be supplied before the first of January of the year in which they are to be implemented. Was the information included in the plan?		
	a. Completed AIRS site ID information for each proposed site? (AMP380 report required, not individual ID forms)		
	Site Identification Form Items		
	i. Card A1, Columns 1–59, 79–80		
	ii. Card A2, Columns 1–22, 35–36, 79–80		
	iii. Card A3, Columns 1–52, 79-80, repeat for each major roadway surrounding the site. A minimum of one roadway group is required.		
	iv. Card A4, Columns 1–12, 13–27, 79–80 or 28–50, 79–80		
	v. Card A5, Columns 1–80		
	b. Completed AIRS monitor ID information for each proposed site as an AMP380 report? ID information required for each monitored pollutant (VOC, carbonyls, ozone, NO_x, meteorological parameters).		
	Monitor Identification Form Items		
	i. Card F1, Columns 1–38, 72–75, 79–80, plus 39-44 for existing sites		
	ii. Card F2, Columns 1–80		
	iii. Card F3, Columns 1-16, 23-46 (as applicable), 79-80		

		Y	N
	c. A map of the area within a 1/4 mile radius of the proposed site? (Should include roadways, buildings, stationary sources, tree lines, etc.)		
	d. A topographical map showing land features and geographical influences?		
	e. Emissions inventories and maps for ozone precursors (as described in Section 2 and Attachment C)?		
	f. Meteorological data?		
	i. A.M. wind roses for number 1 and 2 sites on high ozone or ozone conducive days?		
	ii. P.M. wind roses for number 3 and 4 sites on high ozone or ozone conducive days?		

2.	General Site Description: The following information applies to PAMS sites to be implemented in future years.		
	a. Description of the role the site will play in the network (*e.g.*, PAMS site number)?		
	b. Wind roses for high ozone or ozone conducive days?		
	i. A.M. wind roses for number 1 and 2 sites?		
	ii. P.M. wind roses for number 3 and 4 sites?		

C. Sampling and Analysis Methods

		Y	N
1.	Do the proposed sampling and analysis methods adhere to the following guidelines?		
	a. Reference or equivalent methods for ozone?		
	b. Reference or equivalent methods for NO_2, NO, NO_x?		
	c. For VOC monitoring, the methods described in *Technical Assistance Document for Sampling and Analysis of Ozone Precursors (TAD)*?		
	d. For meteorological measurements, the guidance provided by the *TAD* and the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements*?		
2.	If the answer to 1.b. is no, do the NO, NO_2 and NO_x methods adhere to the guidance in the TAD?		
3.	For reference or equivalent methods, have the designation numbers been supplied?		
4.	Does the plan account for the sampling of all of the pollutants (VOC, NO_x, carbonyls) at each of the sites?		
5.	**If the State/local agency has indicated that the sampling and analysis method(s) differ from the methods described in the TAD, the plan is considered an alternative plan.** If this occurs, has the following information been supplied?		
	a. A narrative explanation?		
	b. Sufficient justification?		
	c. Demonstration of comparability?		
	d. Demonstration that the monitoring objectives are met?		
	e. Demonstration that the data uses are satisfied?		

D. Sampling Frequencies

	Y	N
1. Are NO_x (including NO and NO_2) measured continuously?		

2. Which of the following sampling frequencies does the State propose to use? Please circle the letters that apply.

Population of MSA or CMSA	Required Site Type	Minimum Speciated VOC Sampling Frequency	Minimum Carbonyl Sampling Frequency
Less than 500,000	1	A or C	
	2	A or C	D or F
500,000 to 1,000,000	1	A or C	
	2	B	E
	3	A or C	
1,000,000 to 2,000,000	1	A or C	
	2	B	E
	2	B	E
	3	A or C	
More than 2,000,000	1	A or C	
	2	B	E
	2	B	E
	3	A or C	
	4	A or C	

A = Eight 3-hour samples every third day and one additional 24-hour sample every sixth day during the monitoring period.

B = Eight 3-hour samples every day during the monitoring period and one additional 24-hour sample every sixth day year-round.

C = Eight 3-hour samples on the five peak ozone days plus each previous day, eight 3-hour samples every sixth day and one additional 24-hour sample every sixth day during the monitoring period.

D = Eight 3-hour samples every third day during the monitoring period.

E = Eight 3-hour samples every day during the monitoring period.

F = Eight 3-hour samples on the five peak ozone days plus each previous day and eight 3-hour samples every sixth day during the monitoring period.

		Y	N
3.	Do the sampling frequencies for carbonyls match the sampling frequencies for speciated VOC including year round 1/6 day sampling?		
4.	If sampling frequencies C or F are proposed, did the State submit an ozone event forecasting scheme?		
5.	If the site will collect multiple samples on a daily basis, do the samples begin at midnight local time and consist of sequential nonoverlapping sampling periods?		
6.	**If the State proposes to use alternative sampling frequencies, the plan is considered an alternative plan.** If this occurs, has the following information been supplied?		
	a. A narrative explanation?		
	b. Sufficient justification?		
	c. Demonstration of comparability?		
	d. Demonstration that the monitoring objectives are met?		
	e. Demonstration that the data uses are satisfied?		

E. Meteorological Monitoring

		Y	N
1.	Does the plan include a provision for equipping each of the proposed PAMS sites or area representative of a PAMS with surface meteorological monitoring equipment, including a 10-meter tower?		
2.	Is there a plan for establishing an upper air meteorological monitoring site?		
3.	Is the site representative of the upper air data in the nonattainment area?		
4.	Has the State supplied documentation that the upper air meteorological data will meet the needs of the State's modeling program?		

Section IV *Network Schedule*

The following items on the checklist pertain to the entire PAMS network for the given nonattainment area:

A. Implementation Schedule

		Y	N
1.	Does the plan include a schedule for implementing each PAMS site?		
2.	Does the schedule comply with the EPA recommendations for priority of implementation? (See Appendix D, Section 4.4, 40 CFR Part 58.)		
3.	Does the schedule include a timetable for submitting the AIRS site ID information (AMP380 report) for each scheduled PAMS site that had not been located at the time the network description was submitted?		
4.	Does the plan include a schedule for implementing quality assurance procedures?		

B. Operating Schedules

		Y	N
1.	Does the operating schedule of the PAMS network meet the minimum requirement that the monitoring be conducted during the months of June, July and August?		
2.	**If the State proposes an alternative operating schedule for the site, the plan is considered an alternative plan.** If this occurs, has the following information been supplied?		
	a. A narrative explanation?		
	b. Sufficient justification?		
	c. Demonstration of comparability?		
	d. Demonstration that the monitoring objectives are met?		
	e. Demonstration that the data uses are satisfied?		

Section V *Summary Checklist for PAMS Network Plan*

Item On Checklist	Yes	No
Section I *General Information*		
A. Name of agency, address, contact, etc.		
B. EPA designation of nonattainment area		
C. Population range of MSA/CMSA		
D. AIRS Name and number of MSA/CMSA		
E. Isolated vs. multi-area network		
F. Identification of other affected agencies		
Section II *Network Design*		
A. Table 1. Network Design		
B.1. **Narrative explanation (for alternative plan)**		
B.2. **Sufficient justification (for alternative plan)**		
B.3. **Demonstration of comparability (for alternative plan)**		
B.4. **Monitoring objectives met (for alternative plan)**		
B.5. **Data uses satisfied (for alternative plan)**		

Section III *Network Description - Site Specific*		
A.1. Map of MSA/CMSA area		
A.2. Climatological information (optional)		
B.1.a. Completed AIRS site ID information (AMP380 report)		
B.1.b. Relevant hardcopy form for PAMS		
B.1.c. 1/4 mile radius map		
B.1.d. Topographical map		
B.1.e. Emissions inventories for ozone precursors (VOC, NO, NO_2, NO_x)		
B.1.f. Meteorological data		
B.1.f.i High ozone or ozone conducive days - A.M. wind roses for number 1 and 2 sites		
B.1.f.ii High ozone or ozone conductive days - P.M. wind roses for number 3 and 4 sites		
B.2.a. Description of sites role within network		
B.2.b.i High ozone or ozone conducive days - A.M. wind roses for number 1 and 2 sites		
B.2.b.ii High ozone or ozone conducive days - P.M. wind roses for number 3 and 4 sites		

Item On Checklist	Yes	No
Section III *Network Description - Site Specific cont'd.*		
C.1.a. Reference or equivalent methods for ozone		
C.1.b. Reference or equivalent methods for NO_2		
C.1.c. VOC monitoring - TAD		
C.1.d. Meteorological measurements - TAD and QA Handbook		
C.2. Adherence of NO, NO_2 and NO_x methods to guidance in the TAD		
C.3. Designation numbers for reference or equivalent methods (optional)		
C.4. Accounting for the sampling of all relevant pollutants		
C.5.a. **Narrative explanation (for alternative plan)**		
C.5.b. **Sufficient justification (for alternative plan)**		
C.5.c. **Demonstration of comparability (for alternative plan)**		
C.5.d. **Monitoring objectives met (for alternative plan)**		
C.5.e. **Data uses satisfied (for alternative plan)**		
D.1. Continuous measuring of ozone and NO_x		
D.2. Table 2. Sampling Frequencies for VOC, carbonyls		
D.3. Matching of sampling frequencies for carbonyls and speciated VOC		
D.4. Ozone event forecasting scheme for sampling frequencies C or F		
D.5. Daily sampling - beginning at midnight local time; sequential, nonoverlapping periods		
D.6.a. **Narrative explanation (for alternative plan)**		
D.6.b. **Sufficient justification (for alternative plan)**		
D.6.c. **Demonstration of comparability (for alternative plan)**		
D.6.d. **Monitoring objectives met (for alternative plan)**		
D.6.e. **Data uses satisfied (for alternative plan)**		
E.1. Equipping PAMS sites or locations representative of PAMS with meteorological monitoring equipment		
E.2. Upper air meteorological monitoring site		
E.3. Site representative of upper air data in nonattainment area		
E.4. Upper air data meeting needs of State's modeling program		

Item On Checklist	Yes	No
Section IV *Network Schedule*		
A.1. Schedule for implementing each site of PAMS network		
A.2. Timetable for phasing in required number and types of sites		
A.3. EPA's recommendations for priority of implementation met by schedule		
A.4. Schedule for sites not located on network description		
A.5. Schedule for implementing quality assurance procedures		
B.1. Requirement for conducting monitoring during June, July, and August		
B.2.a. **Narrative explanation (for alternative plan)**		
B.2.b. **Sufficient justification (for alternative plan)**		
B.2.c. **Demonstration of comparability (for alternative plan)**		
B.2.d. **Monitoring objectives met (for alternative plan)**		
B.2.e. **Data uses satisfied (for alternative plan)**		

5.0 "RESERVED"

6.0 THE AEROMETRIC INFORMATION RETRIEVAL SYSTEM

6.1 OVERVIEW

The Aerometric Information Retrieval System (AIRS) is a computer-based repository of information about airborne pollution in the United States. AIRS was developed to allow State and local air pollution control agencies to submit and retrieve air pollution data. The system is administered by the EPA and may be used by anyone with access to the EPA computer system.

AIRS consists of five subsystems: the Air Quality Subsystem (AQS), the AIRS Facility Subsystem (AFS), the Area and Mobile Subsystem (AMS), the Geographic and Common Subsystem (GCS), and AIRS Graphics (AG).

- AQS contains air quality information, such as measurements of ambient air pollutant concentrations and meteorological conditions reported by thousands of monitoring stations operated by State and local agencies and the EPA. In addition to individual measurements, this subsystem contains summary statistics for each monitoring station, such as the annual arithmetic mean and number of times the measured concentration exceeded a national ambient air quality standard. AQS also contains descriptive information about each monitoring station, including its geographic location and the operating agency. AQS will be the subsystem designated for the storage of PAMS ambient measurements data. AQS contains four types of air quality data:

  (1) **Monitoring Site Descriptions** characterize the monitoring sites that provide data to AIRS. The information, which resides in the AIRS Site file, includes site location [geographic coordinates, street address, city, county, State, Air Quality Control

Region (AQCR), etc.], site operational dates, the organization responsible for the monitor operation, and many other items. State and local agencies provide site information to AIRS.

(2) **Raw Data** are the individual values of pollutant concentrations or meteorological conditions measured at the monitoring sites and supplied to AIRS by the State and local agencies that operate the monitors. AIRS contains three raw data files:

(a) The hourly file contains data sampled at intervals of less that 24 hours (of which the 1-hour interval is most common).

(b) The daily file contains data for sampling intervals of 24 hours or more (of which the 24-hour interval is most common).

(c) The composite file contains data from composite samples (multiple samples combined and analyzed as one).

There are actually two sets of raw data files. One set holds public data, and the other holds private, or "secured" data that are available only to the supplying organization.

(3) **Summary Data** are derived from raw data. There are two summary files in AIRS: the air quality summary file and the SLAMS summary file. The air quality summary file is derived entirely by AIRS software from information in the raw data files; there is no direct input to the file. Conversely, the SLAMS summary file consists entirely of the annual summary data each SLAMS monitoring agency is required to submit to the EPA in accordance with the CAA.

(4) **Precision and Accuracy Data** characterize the precision and accuracy of air quality monitors. The AIRS precision-accuracy file contains summaries of the precision and accuracy of groups of monitors (all those operated by a particular reporting organization).

The AIRS AQS site file, raw data files, and air quality summary file contain all data that were in SAROAD, the predecessor of AIRS. The AIRS/AQS site file includes information about discontinued monitoring sites as well as active sites. The AQS raw data and summary files contain all values from SAROAD, some of which date back to 1957. Since the AQS uses the Federal Information Processing Standards (FIPS) geographic codes, site IDs were changed when the data were converted from SAROAD.

- **AFS** contains point source emissions and compliance information. AFS is essentially a merging of the former National Emissions Data System (NEDS) and the Compliance Data System (CDS). AFS became operational in 1989.

- **AMS** contains emissions information from sources that are too small to be stored in AFS and also holds information about mobile sources as well as biogenic data. AMS is the newest of the subsystems and became operational in 1993.

- **GCS** contains reference information that is used by all the subsystems. Reference information includes codes and code descriptions used to identify places, pollutants, and processes; populations of cities, counties, and similar geo-political entities; and numerical values, such as air quality standards and emission factors. EPA compiles and maintains this reference information.

- **AG** utilizes information from all the above subsystems, and displays the data graphically. Maps, bar charts, line graphs, and multiple line charts are all available via AG. Maps may be generated on a national, State, or county level. Future enhancements include maps by MSA and zip codes. (Samples of typical outputs from AG may be found in Appendix K.)

6.2 DATA INPUT AND UPDATE PROCEDURES

Nearly all the air quality data in AQS come directly from the SLAMS and NAMS air monitoring networks, which are operated by State and local pollution control agencies. A small amount of raw data comes from the EPA or private sources.

New air quality data are loaded into the AQS and existing data are modified or deleted using transactions that have the format of punched cards (80-character records). There are transactions for site and monitor information, SLAMS summary data, and raw data. A local, State, or EPA organization submitting air quality data to AQS creates a file of transactions (usually on magnetic tape) on the IBM computer system at the EPA's National Computer Center (NCC). The organization submitting data uses AQS software to load the transaction into a "screening file," check the validity of the transactions, and correct any errors found. A screening file is part of the AQS database and is used to hold AQS transactions during validation. Each organization submitting data to AQS has a screening file for its own exclusive use.

When the transactions in a screening file have passed validation checks, the organization submitting the data notifies the AIRS database administrator that the screening file is ready to be used for updating the AIRS database. The database administrator performs updates on a regular schedule (usually once per week) using all screening files that are ready at that time. The transactions used to update the database are automatically removed from the screening file by the update program; any transactions that have not passed validation checks or that have been excluded from update processing by the submitting organization remain in the screening file. To complete the update cycle, the database administrator notifies the submitting organization that the update has been completed, and that the screening file is ready to accept a new set of transactions. Further information on data submission, validation, and updates procedures can be found in volumes ***AQ2 - The AQS Data Coding Manual*** (Reference 21) and ***AQ3 - AQS Data Storage Manual*** (Reference 22).

6.3 DATA RETRIEVAL

The air quality data in AIRS are public and as such are available to any person or organization with legitimate access to the EPA NCC. There are a few minor procedural requirements for retrieving air quality data, however, which result from computer center policies and procedures. AIRS users must be able to use the Customer Information Control System (CICS) and NATURAL (programming language) on the IBM computer system. Users also must have the functional equivalent of an IBM 3270 terminal. The AIRS hotline may be contacted for further information at 1-800-333-7909.

There are three ways to retrieve air quality data from the AIRS database. The easiest way is to use the standard reports that have been defined by the National Air Data Branch (NADB). There are two types of standard reports, batch and on-line. The batch standard reports allow users to produce a printed report or data file (or both). The user specifies the criteria for data selection and sorting, and chooses the option that affect the report format or content. The AIRS software automatically takes this information and submits a batch run to produce the report and/or workfile. Therefore, the user does not have to construct the output format of the report. The on-line standard reports allow users to view a report screen. The user specifies the criteria for data selection and the AIRS software retrieves the data that meet the criteria and produces a report screen. Volume ***AQ4 - Air Quality Retrievals Manual*** (Reference 23) contains instructions for using the standard reporting facility and describes the features of each report.

If the standard air quality reports or the on-line data retrievals do not satisfy the user's requirements, other reports can be defined using the AIRS ad hoc reporting function. The use of "ad hoc" requires reasonable knowledge of the organization of the database, names of data fields, etc. Volume ***AQ5 - AQS Ad Hoc Retrievals Manual*** (Reference 24) explains how to use the ad hoc reporting function.

The third type of data retrieval available for air quality data is via AIRS Graphics. AG has both "ready-to-view" (RTV) maps (such as monitor locations, nonattainment areas) as well as "create-your-own" (CYO) maps. The information used in constructing the RTV maps cannot be changed. The CYO maps allow the users to select geographic areas, parameters desired, and time period of interest. Used in conjunction with a raw data listing workfile from AQS, AG can even produce time-series line graphs. The data from AG can be viewed on-line and/or in hard copy.

Further information on data handling for PAMS and AIRS may be found in References 21-24 of this manual.

7.0 TECHNOLOGY TRANSFER NETWORK (TTN)

7.1 BACKGROUND

The Technology Transfer Network (TTN) is a network of electronic bulletin boards developed and operated by EPA's OAQPS in the Research Triangle Park. North Carolina. The network provides information and technology exchange in multiple areas of air pollution control, ranging from emission test methods to regulatory air pollution models.

The TTN is comprised of a number of electronic bulletin board systems (BBS) which are computer systems comprised of hardware and software that receive telephone calls from other computers. The BBS concept began as a means for users to enter messages and read messages addressed to them by other users. The modern BBS performs a variety of services that include the exchange of programs, software, databases, and files of all descriptions. The most important function of a BBS is easy and friendly access to expedite and promote the exchange of information. Users are free to scan messages and pick those which are of particular interest. Information may be exchanged over long distances and at high speeds. For the ambient air monitoring community, especially PAMS users, the TTN is a vehicle for accessing the Ambient Monitoring Technology Information Center (AMTIC).

7.2 THE AMBIENT MONITORING TECHNOLOGY INFORMATION CENTER BULLETIN BOARD

The AMTIC BBS is accessed through the TTN and is available to all persons interested in ambient monitoring. It currently contains all FRM and Equivalent Methods for the criteria pollutants, all Toxic Organic (TO) Methods, all Federal regulations pertaining to ambient air monitoring, information on quality assurance/quality control (QA/QC), monitoring studies, information pertaining to ambient monitoring publications and documents, available related training courses, upcoming meetings of interest, air quality trend and nonattainment information,

photochemical assessment monitoring documents and regulations, points of contact, public message boards, and more.

There is no cost to utilize AMTIC unless the user is accessing the system through a long distance telephone line (in which case the user is paying the cost of the call). To access the AMTIC or TTN, the following steps are necessary:

Step 1 - Install a modem and communications software on your computer; a wide variety are available.

Step 2 - Set the following parameters on your communications software:

Data Bits:	8
Parity:	N
Stop Bits:	1
Terminal Emulation:	VT100 or ANSI

Step 3 - Call the network using your communications software:
(919) 541-5742 for a 1200, 2400, or 9600 bps modem

Step 4 - Log on to the system and answer the questions on the screen.

First Name? - Type your first name and press **ENTER**.
Last Name? - Type your last name and press **ENTER**.
Calling from (City, State)? - Type your city and state abbreviation, for example, **Raleigh, NC** and press **ENTER**.

You are then asked to verify this information - Type **Y** or **N**.

Next, select a password that you can easily remember. After this, you will see some information about the system. Press **ENTER** until you reach the main menu for unregistered users. At this point you can select an option or exit the system. Options available include *Descriptions of OAQPS TTN Bulletin Board System*, which contains a brief description of the different bulletin boards available on the network, and *System Utilities*, which contains

various options that are also available after you are a registered user. To select an option, type the character shown within the brackets (< >).

Step 5 - Select ***Registration*** and enter your company name, address, and telephone number. Then select the bulletin board you plan to use most often. For PAMS users, this should be AMTIC. Note that you will still be able to access any bulletin board on the network.

You are asked to verify this information. (Type **Y**, **N**, or **Q** for quit.)

After this information is accepted, you will see the Registered Users menu. From here you can access any BBS.

7.3 OTHER TTN BULLETIN BOARDS

Currently, in addition to AMTIC, access to the following bulletin boards is available through the TTN:

AIRS - Aerometric Information Retrieval System - The focus of the AIRS BBS is to encourage the exchange of information among State and local agencies that utilize AIRS documents and information. AIRS BBS is operated by OAQPS and NADB.

The AIRS BBS maintains the current AIRSLETTER; relevant brochures, pamphlets, and bulletins; and information on meetings, conferences, training seminars, and permits. User-supplied AIRS-related demonstration software is circulated, as well as EPA PC-based AIRS related software. All AIRS user's manuals and guides are available for download. The AIRS bulletin board also contains a current listing of AIRS contact personnel. Answers to frequently asked questions are available, as well as public and private electronic mail for use in obtaining information from the AIRS user community.

APTI - Air Pollution Training Institute - The Air Pollution Training Institute (APTI) offers the widest scope of air pollution training in the United States. Funded by the EPA, APTI develops instructional material for and provides technical assistance to training activities conducted in support of the nation's regulatory programs of air pollution abatement.

EPA-sponsored lecture and laboratory courses, using APTI materials, are scheduled at several locations across the country. Self-instructional courses, providing opportunities for individual training at home or in places of employment, are obtainable from APTI. Training material is continually updated, and individual courses undergo periodic major revision.

APTI publishes a "Chronological Schedule of Air Pollution Training Courses" generally once a year. This publication describes the training being offered with a description of the APTI courses and how to obtain the training. If you would like a copy of "Chronological Schedule of Air Pollution Training Courses" contact the Registrar at (919) 541-2497.

BLIS - RACT/BACT/LAER Information System - The BLIS BBS contains information from the Reasonably Available Control Technology (RACT)/Best Available Control Technology (BACT)/Lowest Achievable Emission Rate (LAER) Clearinghouse. This information is distilled from air permits submitted by most of the State and local air pollution control programs in the United States. The data are meant to assist State/local agency personnel and private companies in determining what types of controls other air pollution agencies have applied to various sources. The BLIS database option allows the user to perform interactive searches of the database.

CAAA - Clean Air Act Amendments - The Clean Air Act Amendments Bulletin Board System (CAAA BBS) is designed to provide access to information on the CAAA. Through this electronic information dissemination vehicle, the CAAA BBS allows regulators, the

regulated community and members of the general public to easily obtain access to that information that is relevant to the CAAA. In this manner, the task of understanding, implementing and complying with the requirements of the new law will be made easier.

CHIEF - Clearinghouse for Inventories/Emission Factors - The CHIEF BBS provides access to tools for estimating emissions of air pollutants and performing air emission inventories. CHIEF will serve as EPA's central clearinghouse for the latest information on air emission inventories and emission factors. Emission estimation databases, newsletters, announcements, and guidance on performing inventories will be included in CHIEF.

COMPLI - COMPLIance Information on Stationary Sources of Air Pollution - The COMPLI BBS contains three databases:

- NARS - National Asbestos Registry System - A listing of all asbestos contractors, their inspections and the results of them. This database is used to target contractors for inspection.

- Determinations Index - This is a compilation of clarifications and determinations issued by EPA concerning selected subparts of the *Federal Register*. It consists of two major parts: NSPS determinations and NESHAP determinations.

- Woodstoves - A database of EPA Certified Woodstoves and woodstove manufacturers.

This COMPLI BBS is maintained by EPA's Stationary Source Compliance Division (SSCD). Problems, suggestions, or additional information should be directed to the COMPLI BBS SYSOP.

CTC - Control Technology Center - The CTC is a cooperative effort for engineering assistance to State and local air pollution control agencies (and private companies to an extent) by the Air and Energy Engineering Research Laboratory (AEERL) and OAQPS. It is a cooperative effort with the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO).

The CTC provides three levels of assistance:

- HOTLINE - (919) 541-0800
- Engineering Assistance
- Technical Guidance

The CTC's goal is to provide technical support to State and local agencies and to EPA Regional Offices in implementing air pollution control programs. The CTC assists regulatory and permitting agencies, but does not provide policy guidance and compliance advice which is the responsibility of the EPA Regional Office. CTC services are available at no cost to State and local air pollution control agencies and EPA Regional Offices. Other government agencies may use the HOTLINE for technical assistance or to order CTC documents.

EMTIC - Emission Measurement Technical Information Center - The EMTIC BBS provides technical guidance on stationary source emission testing issues, particularly to those who conduct and/or oversee emissions tests in support of the development and implementation of emission standards, emission factors, and SIPs.

NATICH - National Air Toxics Information Clearinghouse - NATICH is an information service cooperatively provided by EPA and STAPPA/ALAPCO to support their efforts at controlling toxic (non-criteria) air pollutants. Thus, the Clearinghouse is designed to facilitate

the exchange of information among federal, State, and local agencies concerned with control of toxic air pollutants.

To achieve this goal the Clearinghouse annually collects, classifies, and disseminates information submitted by State and local agencies regarding their air toxics programs. In addition, NATICH also provides information on current federal activities in controlling air toxics.

The Clearinghouse provides the following:

- Quarterly Newsletter
- Hardcopy Reports of the Database Contents
- Telephone Helpline: (919) 541-0850

NSR - New Source Review - The NSR BBS provides material and information pertaining to New Source Review (NSR) permitting. The user can search the abstracted index of the "New Source Review Prevention of Significant Deterioration and Nonattainment Area Guidance Notebook" by selected key words or a customized text word or text string.

OAQPS - Office of Air Quality Planning and Standards - This bulletin board provides fundamental information regarding the organization and function of each unit in EPA's OAQPS. Additionally, information services and reports on the status of air pollution control activities are available.

OMS - Office of Mobile Sources - The purpose of the bulletin board is to provide the user with information pertaining to mobile source emissions, including regulations, test results, models, guidance, etc. The following information is available on the BBS:

- Office of Mobile Sources Contact List
- OMS Rulemaking Packages and Reports per the Clean Air Act
- Vehicle and Engine Certification Guidance
- Fuel Economy Information
- Vehicle Emissions Models (*e.g.*, MOBILE5)
- Public Awareness Information ("Fact Sheets")
- Other Relevant Mobile Source Emission Documents

SCRAM - Support Center for Regulatory Air Models - The SCRAM BBS is the Agency's primary source for the acquisition of the computer codes for the regulatory air models. Changes to the models, including updates, corrections, and new regulatory codes are main features of the SCRAM. Significant announcements and new information are indicated in the SCRAM ALERTS section of the BBS.

The new user can obtain a quick review of BBS services by browsing through the main menu options. In addition to code, model related news and important bulletins are provided concerning model modifications, status, etc. An especially important feature is the "Model Change Bulletin" (MCB) provided for each model/program. MCB #1 lists information on the initial status of that model; new MCBs are posted for each model as required.

7.4 USING THE AMTIC/TTN

The TTN and AMTIC are available 24 hours per day, 7 days per week except for Monday morning 8:00 a.m. to 12:00 noon Eastern Time (unless otherwise noted), when the system is down for maintenance and system backup.

There are several methods for accessing the TTN BBS. Some methods may involve incurring long distance telephone charges, but others are completely free. Not all methods are available to all people. The following access methods are currently available:

- Conventional Modem Dialup
- EPA Ethernet Connection
- X.25 Pads (Packet Switching Network)
- Internet

7.4.1 Conventional Modem Dialup

Anyone with a computer, a modem, and communications software may log on to the TTN by setting their modem to 8 data bits, no parity, and 1 stop bit (8-N-1), and dialing (919)541-5742. New users must fill out a short registration survey, and will be given full access on their first call. Using this method, the user must pay any long distance charges that are accrued.

7.4.2 EPA Ethernet Connection

This method of connection is available only to EPA employees located in Research Triangle Park, NC. The EPA Ethernet allows all users free access to the TTN through Crosstalk.

7.4.3 X.25 Pads (Packet Switching Network)

To promote electronic communications among the EPA Regional Offices, the EPA has arranged for a network of X.25 pads connecting the EPA Regional Offices to computer facilities in Research Triangle Park, NC. The X.25 pads allow users to dial up a local number in their city and connect to remote computer facilities. Access to the X.25 pads is available to all EPA Regional Offices and may be available to State and local Air Quality Control Offices as well. For further information, contact your local EPA Regional Office.

7.4.4 Internet

The TTN is now available through Internet. If you are connected to the Internet via an "Internet Access Provide" you can now reach the TTN. To reach the TTN on Internet, you must invoke the "TELNET" service. "TELNET" is capable of hosting a fully interactive session. Other Internet services such as Internet mail and FTP will not allow you to connect to the TTN.

Use the following "TELNET" command, which includes the TTN Internet address:

TELNET ttnbbs.rtpnc.epa.gov

Your Internet provider may use a slightly different procedure or syntax. If you are unsure how to initiate a "TELNET" session, please check with your Internet provider. Accessing the TTN through the Internet is free of charge. However, your Internet access provider may charge a fee for access to the Internet.

Assistance with accessing the systems may be obtained during normal business hours (Eastern Time) by contacting the TTN Helpline at (919)541-5384.

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15. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources*, Revised, EPA-454/R-92-019, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, October 1992.

16. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume IV: Meteorological Measurements, EPA-600/4-82-060, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 1989.

17. *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*, EPA-450/4-87-007, U.S. Environmental Protection Agency, Research Triangle Park, May 1987.

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19. *On-Site Meteorological Instrumentation Requirements to Characterize Diffusion from Point Sources*, EPA-600/9-81-020, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 1981.

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A list of bibliographic material related to PAMS implementation and monitoring is included in Appendix L.

APPENDIX A

PAMS PROPOSAL AND FINAL RULE

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 58

[AD-FRL-4099-6]

Ambient Air Quality Surveillance

AGENCY: Environmental Protection Agency.

ACTION: Proposed rule.

SUMMARY: This notice proposes to revise the ambient air quality surveillance regulations (40 CFR part 58) to include provisions for enhanced monitoring of ozone and oxides of nitrogen, and for additional monitoring of volatile organic compounds (including aldehydes) and meteorological parameters. These revisions are being proposed in accordance with title I, section 182 of the 1990 Clean Air Act Amendments. The revisions would require States to establish photochemical assessment monitoring stations (PAMS) as part of their State Implementation Plan (SIP) monitoring network in ozone nonattainment areas classified as serious, severe, or extreme. Included in the proposal are minimum criteria for network design, monitor siting, monitoring methods, operating schedule, quality assurance, and data submittal.

DATES: Comments must be received on or before April 3, 1992.

ADDRESSES: Submit comments to (duplicate copies are preferred) to: Central Docket Section, U.S. Environmental Protection Agency, Attn. Docket No. A-91-22, 401 M Street, SW., Washington, DC 20460. Docket No. A-91-22 is located in the Central Docket Section of the U.S. Environmental Protection Agency, West Tower Lobby Gallery I, 401 M St., SW., Washington, DC 20460. The docket may be inspected between 8 a.m. and 4 p.m. on weekdays. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Geraldine J. Dorosz, Technical Support Division (MD-14), Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, N.C. 27711, phone: 919-541-5492 or (FTS) 629-5651.

SUPPLEMENTARY INFORMATION:

Background

Section 110(a)(2)(C) of the Clean Air Act requires ambient air quality monitoring for purposes of the State Implementation Plan (SIP) and reporting of the data to EPA. Uniform criteria for measuring air quality and provisions for the reporting of a daily air pollution index are required by section 319 of the Act. To satisfy these requirements, on May 10, 1979 (44 FR 27571), EPA established 40 CFR part 58 which provided detailed requirements for air quality surveillance and data reporting for all the pollutants except lead for which ambient air quality standards (criteria pollutants) has been established. On September 3, 1981 (46 FR 44164) similar rules were promulgated for lead and on July 1, 1987 (52 FR 24760) for particulate matter (PM_{10}).

The intent of the enchanced ozone monitoring revisions being proposed today is to provide an air quality data base that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone National Ambient Air Quality Standards (NAAQS). Ambient concentrations of ozone (O_3), oxides of nitrogen (NO_y, NO_2, and NO), and speciated volatile organic compounds (VOC) including aldehydes (or their surrogates) and meteorological data collected by the PAMS will be used to make attainment/nonattainment decisions, aid in tracking VOC and NO_x emission inventory reductions, better characterize the nature and extent of the ozone problem, and prepare air quality trends. In addition, data from the PAMS will provide an improved data base for evaluating model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data will be particularly useful to states in ensuring the implementation of the most cost effective, socially acceptable regulatory controls.

The regulations proposed in this notice address the minimum requirements for the enhancement of ambient air monitoring for ozone and nitrogen oxides as well as monitoring for speciated VOC and meteorological parameters. Title I, section 182 of the 1990 Clean Air Act Amendments requires enchanced monitoring for ozone and its precursors. Also, section 184(d) requires that the best available air quality monitoring and modeling techniques be used in making determinations concerning the contribution of sources in one area to concentrations of ozone in another area which is a nonattainment area for ozone. In the process of developing proposed regulations to address this requirement, the EPA sought the assistance of the Standard Air Monitoring Work Group (SAMWG). SAMWG members represent State and local air pollution control agencies and EPA program and regional offices. SAMWG members were an active partner in developing and reviewing the 1979 part 58 rulemaking package which formally established the existing framework of the ambient air quality surveillance and data reporting regulations. They also played a prominent role in all subsequent revisions to part 58.

Accordingly, the Agency is soliciting comment on all aspects of the proposed rules and particularly on the general scope and adequacy of the proposal, the necessity and/or adequacy of the individual components of the monitoring approach, and the Agency's estimated monitoring costs.

Proposed Revisions to Part 58—Ambient Air Quality Surveillance

Section 58.1 Definitions

The revisions proposed today would add definitions of the terms "PAMS" (photochemical assessment monitoring stations), "NO_2" (nitrogen dioxide), "NO" (nitrogen oxide), "NO_y" (oxides of nitrogen), "VOC" (volatile organic compounds), and meteorological measurements.

Section 58.2 Purpose

Currently, part 58 contains a provision to establish a national ambient air quality monitoring network for the purpose of providing timely air quality data upon which to base national ambient air assessments and policy decisions. This national network is a subset of the State and Local Air Monitoring Stations (SLAMS), and these stations in the network are designated as National Air Monitoring Stations (NAMS). The NAMS are subject to monitoring and reporting requirements contained in subpart D of part 58. The proposed revision to this section adds a revised paragraph (d) which explains that part 58 acts to establish a network of PAMS which are also subsets to SLAMS but subject to monitoring and reporting requirements contained in the redesignated and revised subpart E of this part.

Section 58.13 Operating Schedule

The current operating schedule for SLAMS continuous analyzers is given in paragraph (a) of this section and requires collecting consecutive hourly averages except during periods of routine maintenance, instrument calibration, and periods or seasons exempted by the Regional Administrator. This same operating schedule also applies to the proposed PAMS continuous O_3 and NO_y analyzers and automated gas chromatographs. For manual methods except for lead, the

current requirements are specified in paragraph (b) and require States to obtain at least one 24-hour sample every 6 days except during periods or seasons exempted by the Regional Administrator. Paragraph (b) is being revised to also exempt manual VOC samples. In addition, a new paragraph (c) is proposed which presents the operating schedule for manual speciated VOC measurements. Changes to operating schedules for PAMS must be approved by the Administrator. The existing paragraph (c) is redesignated as paragraph (d). The Agency seeks comment on the proposed operating schedule for PAMS and the sampling frequencies for VOC and aldehydes.

Section 58.20 Air quality surveillance: Plan content

This section originally required States by January 1, 1980 to submit a SIP revision which included provisions for establishing and operating the SLAMS network to measure ambient concentrations of those pollutants for which standards have been established in part 50 of title 40 (criteria pollutants). The section included provisions to apply to criteria of part 58 of title 40, appendices A (quality assurance), C (monitoring methods), D (network design), and E (probe siting) to designing and implementing the SLAMS network. It also provided for an annual network review and monitoring during all stanges of air pollution episodes. Currently, § 58.20 does not require States to include in their SIP a provision for monitoring non-criteria pollutants. Because enhanced ozone monitoring will require monitoring of non-criteria pollutants (NO_y, NO, and speciated VOC) and meteorology, paragraph (a) of this section is revised to include a provision that SLAMS designated as PAMS will obtain these additional measurements. It is likely that due to the multiple monitoring objective for PAMS, that the site locations will, in some cases, coincide with existing SLAMS (or NAMS) monitoring sites. In these cases, the sites only need to be supplemented with those instruments necessary to comply with PAMS monitoring requirements. To establish the PAMS, a new paragraph (f) provides that States with ozone nonattainment areas designated as serious, severe, or extreme will be required to submit a SIP revision which includes additional provisions for monitoring these non-criteria pollutants and obtaining meteorological data. These revisions would be due 6 months after the effective date of promulgation or redesignation and reclassification of any area to serious, severe, or extreme ozone nonattainment. The Agency seeks comment regarding the adequacy of the 6-month period for preparation and promulgation of SIP revisions to accommodate PAMS.

This revision is in accord with section 182 of title I of the 1990 Clean Air Act Amendments. Other revisions to § 58.20 include a change to paragraph (c) which adds the word "criteria" before the words "pollutant except Pb". This change is being proposed since the proposed revisions in paragraph (a) include monitoring non-criteria pollutants while the requirement for monitoring during an emergency episode was only intended to apply to criteria pollutants.

Subpart E—Air Quality Index—Redesignation as Photochemical Assessment Monitoring Stations

For purposes of continuity in Subpart Headings and Content (subpart C addresses SLAMS, subpart D addresses NAMS) the existing subpart E—Air Quality Index Reporting, and subpart F—Federal Monitoring are proposed to be redesignated as subparts F and G, respectively. In addition to being redesignated, subpart F would be renumbered starting with § 58.50 and subpart G would be renumbered starting with § 58.60. The newly designated subpart E would start with § 58.40 and address PAMS network establishment.

Section 58.40 PAMS Network Establishment

This section would require that a description of the PAMS network and a schedule for implementation be submitted to the Administrator within 6 months of the effective date of promulgation of the regulations or redesignation and reclassification of any area to serious, severe, or extreme ozone nonattainment. The network description is not a part of the SLAMS SIP revision required by § 58.20 and need not be submitted with the SLAMS SIP revision which also has the same submittal date. The Agency requests comment concerning the adequacy of the 6-month period to prepare the PAMS network description. Also included in this section is a requirement that the network design criteria in appendix D be followed in the process of designing the PAMS network. In cases where the ozone nonattainment areas extend beyond State or EPA Regional boundaries, the affected States are encouraged to collectively design and submit a combined PAMS network for the adjoining areas and to cooperate in establishing PAMS sites in areas which fall outside of a nonattainment area, if necessary. If States choose to submit individual network descriptions for each affected nonattainment area irrespective of its proximity to other affected areas, those networks must fulfill the requirements for isolated areas as described in section 4 of appendix D. In all cases, network descriptions are to be submitted to the Administrator through the appropriate Regional office(s). Provisions are included which allow the submittal of alternative network designs, but those designs must include a demonstration that they satisfy the monitoring data uses and fulfill the PAMS monitoring objectives described in sections 4.1 and 4.2 of appendix D. Certain alternative plans must be published in the Federal Register, subjected to public comment, and subsequently approved by the Administrator. The Agency seeks comment on what criteria should be used to determine whether such alternative monitoring plans are "equivalent" to the proposed statutory minimum, given the intended uses for the PAMS data.

Section 58.41 PAMS Network Description

In order for the Administrator to approve individual or combined State PAMS network descriptions certain information pertaining to the stations such as station location, AIRS site identification codes, methodology, operating schedule and schedule for implementation are needed at the national level. This section describes the information to be included in the network description submittal required by § 58.40.

Section 58.42 PAMS Approval

Ambient air data from the PAMS are intended for diverse multiple uses including supporting NAAQS attainment decisions and demonstrations, corroborating VOC and NO_y emission inventories and tracking emission reductions, evaluating the effectiveness of control strategies, providing input for future photochemical grid modeling exercises and evaluating model performance, characterizing population exposure, preparing national air quality trends, and developing national policies. Users of the data collected from the PAMS will include State and local air pollution control agencies and EPA regions. EPA offices at the national level will likewise be a major user of the data particularly for preparing national trends, evaluating national control strategies, and developing national policy. Because of these latter uses, the need for national consistency, the concern for uniformity of methods and

operating schedule, and the recognized need for flexibility, the PAMS networks be subject to the approval of the inistrator. More detailed ormation regarding the uses of PAMS data may be found in appendix D of the proposal. The Agency seeks comment on the appropriateness of the intended PAMS data uses and probable data users.

Section 58.43 PAMS Methodology

This section would require that all PAMS meet the PAMS monitoring methodology requirements specified in appendix C. Existing stations would be required to meet the method requirements at the time of network description submittal. Future stations would need to meet those requirements upon their establishment.

Section 58.44 PAMS Network Completion

The completion date for the establishment of the PAMS network would be 5 years after the effective date of the promulgation of the regulations or redesignation and reclassification of the area to serious, severe, or extreme ozone nonattainment. A five-year phase-in period was proposed to follow a reasonable buildup of resources at the State and local agency level, to accommodate the expected evolution of sampling technology, and to allow a ring-up" period to develop the essary expertise and infrastructure to conduct this complex mointoring effort. Full details of the proposed 5-year transition process are provided in appendix D.

In light of the importance of the PAMS data to the development and evaluation of alternative State Implementation Plan (SIP) strategies, the Agency seeks comment on the pros and cons of shorter or longer phase-in periods, especially as they relate to modelling demonstrations required of the affected areas. The Agency therefore seeks comment on periods of 1, 2, 3 years or longer.

Section 58.45 PAMS Data Submittal

This section would establish the reporting requirements for the PAMS data. The data from O_3, and NO_x (including NO and NO_2 data) monitors would be required to be submitted to EPA's Aerometric Information Retrieval System (AIRS)—Air Quality Subsystem (AQS) within 60 days following the end of each quarterly reporting period. Meteorological data and speciated VOC data must be submitted within 6 months after the end of the quarterly reporting period. Inasmuch as meteorological data will often be used to interpret ozone ecursor ambient data and how they relate to ozone precursor emissions, it also is required to be submitted within the 6-month time frame specified for speciated VOC data. Given the complexity and interpretive expertise required to analyze speciated VOC data and especially given the rapid evolution of the monitoring technology, 6 months was established as a reasonable time period for speciated VOC data submittal. The Agency seeks comment on the reasonableness of this time peirod.

Section 58.46 System Modification

This section would include a requirement that any changes in the PAMS network be evaluated during the annual SLAMS review specified in § 58.20. Changes that are proposed by the State would be evaluated by the EPA Regional Office and must be approved by the Administrator. An implementation time of 1 year would be granted to complete the approved changes. This procedure would also apply to changes to the PAMS network which resulted from a redesignation of the area to attainment.

Revisions to Appendix A—Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)

Appendix A is being revised to include a provision that refers to Agency guidance on quality assurance criteria for VOC measurements. Monitoring techniques for speciated VOC are emerging technologies, and quality assurance criteria equivalent to that in part 58 for the criteria pollutants are currently not available for VOC. EPA is, however, preparing guidance on VOC mointoring technology and this document will address quality assurance for VOC as well as for meteorological measurements.

Appendix C—Monitoring Methodology

The requirements in appendix C were promulgated to provide limitations on the allowance of methods to be used in the SLAMS and NAMS network. The purpose of the limitations are to restrict allowable methods to those which have been tested and proven to be reliable or to those which show significant probability of being reliable.

The proposed revisions to appendix C would include a similar but less restrictive limitation on PAMS measurements. The revisions would require that PAMS O_3 and NO_x monitoring methods be automated reference or equivalent methods. However, reference or equivalent methods for meteorological measurements or speciated VOC measurements are not available since reference or equivalent requirements or specifications for these methods are not currently included in EPA regulations. In the absence of such specifications and because of EPA concerns about the need for minimum uniform criteria concerning measurement methodology, EPA has prepared a document which provides Agency guidance on methods for conducting meteorological measurements and measurements for VOC. Appendix C would require States to use this guideline document in selecting and conducting such measurements at PAMS. Should States prefer to propose alternative methods for conducting VOC measurements, the methods must be detailed in the network description required by § 58.40. Such proposed alternative methodology must be published in the Federal Register, subjected to public comment, and subsequently approved by the Administrator.

Appendix D—Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)

Appendix D currently contains criteria to be used in designing networks to meet the monitoring objectives for SLAMS and NAMS. The design criteria are intended to provide uniformity in locating air monitoring stations for the SLAMS and NAMS networks. A new section 4 of appendix D is being proposed to provide a similar concept of minimum criteria for designing a PAMS network. Section 4 contains a description of the major uses of data from the PAMS. These uses include ozone attainment/nonattainment decisions, preparation of control strategies for ozone nonattainment areas, tracking of VOC, NO_x, and toxic air pollutant emission inventory reductions, providing future input to photochemical models and data for model evaluation, preparation of air quality trends, and characterization of population exposure to ozone and urban air toxic pollutants. Specific objectives that must be addressed include assessing ambient trends in VOC and its species, determining spatial and diurnal variability of VOC species and assessing changes in the species profiles that occur over time, particularly those occurring due to the reformulation of fuels. Note that data from stations which operate NO_x monitors year round can also be utilized to determine attainment or nonattainment with the NO_2 National Ambient Air Quality Standard which is

expressed as an annual arithmetic mean.

Designing and implementing a network to adequately satisfy all of these data uses would require extraordinary resources; consequently, a practical compromise on the minimum number of stations in a PAMS network is proposed. The proposal identifies five types of PAMS, which have different monitoring objectives or functions relative to the MSA/CMSA nonattainment area. The number and types of stations vary depending on the size of the MSA/CMSA or nonattainment area, whichever is larger. For a larger MSA/CMSA, as many as five sites would be needed to provide a data base sufficient to consider spatial variations and to develop trends for VOC and its species within that MSA/CMSA. By utilizing population as a surrogate for total MSA/CMSA (or nonattainment area) emissions density, the requirements for numbers of sites is stratified from two to five sites per area. Such differing criteria are required to accomodate the impact of transport on the smaller MSA's/CMSA's, to account for the spatial variations inherent in large areas, and to satisfy the differing data needs of large versus small areas due to the intractability of the ozone nonattainment problem. Given these assumptions, the Agency seeks comment on the extent to which the aforesaid "practical compromise" network requirements would provide sufficient data to fulfill the data uses described in appendix D, section 4.1 and 4.2, and summarized in Table 1. Additionally, comment is sought regarding the cost and content of substitute mechanisms for establishing the minimum monitoring requirements which would also fulfill the proposed objectives and data uses. In particular, the Agency seeks information on substitute sampling regimes (both frequency and duration), the use of statistical approaches to supplement (or in lieu of) sampling, and other sampling methods.

The Agency recognizes that other proxies for emissions density, and therefore requirements for numbers of sampling sites, could have been tendered. The Agency also seeks comment on whether more complex mechanisms which include factors such as precursor emissions, geography, meteorology, other demographical indicators, etc., should be utilized.

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TABLE 1. MEASUREMENTS NECESSARY TO MEET MONITORING OBJECTIVES

MONITORING OBJECTIVES			NECESSARY MEASUREMENTS — SITE TYPE (1)					(2)					(3)					(4)					(5)				
			OZN	VOC	NOX	TOX	MET	OZN	VOC	NOX	TOX	MET	OZN	VOC	NOX	TOX	MET	OZN	VOC	NOX	TOX	MET	OZN	VOC	NOX	TOX	MET
NAAQS ATTAINMENT & CONTROL STRATEGY DEVELPMNT	OVERWHELMING	TRANSPORT	•	•	•		•	••	••	••		••															
	PHOTOCHEMICAL GRID MODELS	BOUNDARY CONDITIONS	•	•	•		•						••	••	••		••	•	•	•		•	•	•	•		•
		MODEL INPUT REQUIREMENT	•	•	•		•	•	•	•		•	•	•	•		•	•	•	•		•	•	•	•		•
		MODEL PERFORMANCE	•	•	•		•	•	•	•		•	•	•	•		•	•	•	•		•	•	•	•		•
	ATTAINMENT DECISIONS		••		••		••	•		••		••	•		•		••	•		•		••	•		•		••
SIP CONTROL STRATEGY EVALUATION	EVALUATE EFFECTIVENESS OVER LONG-TERM		•	•	•		•	•	•	•		•	••	••	••		••	•	•	•		•	•	•	•		•
EMISSIONS TRACKING	CORROBORATE NOX AND VOC EMISSION INVENTORIES		••	•	•		•	••	•	•		•	••	•	•		•	••	•	•		•	••	•	•		•
	TRACK NOX AND VOC EMISSION INVENTORY REDUCTIONS			•	•	•	•		•	•	•	•		•	•	••	•		••	••	••	•		••	••	••	•
TRENDS			•	•	•	•	•	••	•	••	•	•	•	•	•	•	•	•	••	••	••	•	•	••	••	••	•
EXPOSURE ASSESSMENT			••	••	••	••	••	•	••	••	•	•	•	••	••	•	•	•	••	••	••	•	•	••	••	••	•

LEGEND
VOC – VOLATILE ORGANIC COMPOUNDS
NOX – OXIDES OF NITROGEN (NO, NO2, & NOX)
TOX – TOXIC AIR POLLUTANTS ALSO MEASURED AS VOC
OZN – OZONE

• – PRIMARY OBJECTIVE ,
•• – SECONDARY OBJECTIVE

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Type (1) PAMS sites would characterize the upwind background and transported precursor concentrations entering the nonattainment area. Type (2) sites would be intended to monitor areas of maximum precursor (VOC and NO_x) emissions, be ideally suited for the monitoring of urban air toxic pollutants, and might typically be located near the predominantly downwind edge of the central business district or other area of maximum precursor emissions such as from a large industrial area or major traffic area. Type (2) sites, however, should not be unduly influenced by single emission sources. The Agency seeks comment on the reasonableness of the view that this one site would suffice for the purpose of reporting on urban air toxics and assessing exposure. Type (3) sites would monitor changes in precursor concentrations and ratios downwind of the emission sources and would be located between sites (2) and (4) typically at the population fringe of the urbanized area. Type (4) and Type (5) sites would be sites located to measure the maximum ozone concentrations. Site (4) would be located in the predominant downwind direction during the ozone period and site (5) would be located in the second most predominant downwind direction. Given the large variability in emissions, meteorology, geography, etc., from area to area, the Agency recognizes that situations may occur where the minimum monitoring system required by the proposed rule is inadequate. The Agency also seeks comment on the criteria for determining such inadequacy and on a process for resolving the issue.

Because of the relatively large resource requirements to conduct PAMS monitoring, 3 months is being proposed as the minimum annual precursor monitoring period for the PAMS; however, EPA encourages the establishment of a monitoring period for the entire ozone season in order to provide a more comprehensive air quality data base and increase the possibility of actually conducting monitoring during most of the worst ozone episodes. PAMS ozone monitors must adhere to the ozone monitoring season specified in section 2.5 of appendix D.

Also included in appendix D are ciriteria for establishing ground level meteorological stations and a recommendation for obtaining upper air meteorological data. Ground level stations would be required to be operational upon establishment of the station. The Agency requests comment on the general need for meteorological stations and the adequacy of the proposed on-site measurements. Based on comments received during the Streamlined review process, the Agency recognizes that in rare cases it may not be possible to site a 10-meter meteorological monitoring tower at a particular PAMS site. The Agency, therefore, seeks comments on the criteria to determine how meteorological data collected at a nearby site could be used to represent the meteorology at a PAMS site where the tower and the air monitoring equipment cannot be collocated.

Appendix E—Probe Siting Criterio for Ambient Air Quality Monitoring

This appendix currently contains detailed provisions for specifically locating the sampler or analyzer probe inlet after the general location of the SLAMS or NAMS sampler or monitor has been selected.

Overall, the siting criteria for the PAMS monitors are similar to the NAMS/SLAMS criteria for such items as the minimum distance of the inlet probe from obstructions, vertical and horizontal probe placement, minimum distances from trees and spacing from roadways. The intent is that nearby roadways should not provide a local ozone sink for site Types (2) and (3), nor serve as precursor sources for site Types (1), (4), and (5).

Waiver provisions are revised to indicate that written requests for PAMS waivers must be forwarded to the Administrator for consideration.

In addition to seeking comment on the issues previously mentioned, the A[illegible] solicits comment on adding the following requirements: Monitoring upper air meteorology in each area; adding more PAMS sites; increasing the monitoring frequency at those sites operating less than everyday, e.g., to daily; requiring shorter sampling averaging times, e.g., hourly samples, at all sites; elevated (altitude) sampling for all parameters; monitoring for other nitrogen and oxygen containing compounds which participate in ozone formation (e.g., peroxyacetylnitrate, nitric acid, etc.), often termed NOy; and ozone-season long monitoring for all precursor and meteorological parameters.

Estimated Cost of Proposal

The regulations proposed in this notice affect only those MSA/CMSAs which are located in ozone nonattainment areas designated as serious, severe, or extreme; therefore, the economic impact will be focused on the State and local air pollution control agencies having jurisdiction in those areas. These affected areas have been formally designated by amendments to 40 CFR part 81, published in the Federal Register on Wednesday, November 6, 1991. The specific MSA/CMSAs affected by this notice, and therefore subject to the enhanced ozone monitoring requirements, are lsited in Table 2. Each of the involved State and local air pollution control agencies have previously been sent a detailed compendium of the monitoring requirements and expected costs associated with the PAMS program. The primary responsibility for implementing the program with its associated costs rests with the States. EPA expects to supplement the funds provided by the States with grant monies pursuant to section 105 of the Clean Air Act.

TABLE 2. ESTIMATED REQUIREMENTS FOR PAMS

(Jan. 8, 1992)

CMSA/MSA	Number of new sites					Estimated cumulative cost FY-93 to FY-97
	O3	NO2	Meteor.	Aldehyde	VOC	
Los Angeles-Anaheim-Riverside, CA	0	0	5	2	5	$2,050,000
Houston-Galveston-Brazoria, TX	0	0	5	2	5	2,050,000
New York-Northern New Jersey-Long Island, NY-NJ-CT	0	0	5	2	5	2,050,000
Baltimore, MD	0	2	5	2	5	2,117,800
Chicago-Lake County (IL), IL-IN-WI	0	0	5	2	5	2,050,000
San Diego, CA	0	0	5	2	5	2,050,000
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD	0	0	5	2	5	2,050,000
Milwaukee-Racine, WI	0	2	4	2	4	1,973,820
Muskegon, MI	1	2	2	1	2	1,3[illegible]

TABLE 2. ESTIMATED REQUIREMENTS FOR PAMS—Continued

[Jan. 8, 1992]

CMSA/MSA	Number of new sites					Estimated cumulative cost FY-93 to FY-97
	O3	NO2	Meteor.	Aldehyde	VOC	
Sheboygan, WI	1	2	2	1	2	1,383,520
Hartford-New Britain-Middletown, CT	1	3	4	2	4	2,072,420
Fresno, CA	0	0	3	1	3	1,590,160
El Paso, TX	0	2	3	1	3	1,729,560
Bakersfield, CA	0	0	3	1	3	1,590,160
Springfield, MA	1	2	3	1	3	1,742,060
Boston-Lawrence-Salem, MA-NH	0	1	6	2	5	2,880,000
Washington, DC-MD-VA	0	0	5	2	6	2,050,000
Portsmouth-Dover-Rochester, NH-ME	1	2	2	1	2	1,383,520
Baton Rouge, LA	0	1	3	1	3	1,853,060
Atlanta, GA	1	3	5	2	5	2,217,800
Providence-Pawtucket-Fall River, RI-MA	2	3	4	2	4	2,184,820
Sacramento, CA	0	0	4	2	4	1,890,120
Beaumont-Port Arthur, TX	0	0	2	1	2	1,306,320
Totals	6	25	80	37	69	42,486,960

Table 2 also delineates the estimated increases in monitoring costs (above the present national ambient air monitoring network) associated with the establishment of PAMS sites in the affected areas. For the purpose of these estimates, EPA has assumed that 84 ozone monitors and 86 NO_x monitors which are currently in operation will be converted to PAMS components. The cost estimates, therefore, do not include any provision for these monitors since operation and sample analysis costs are already included in the current national ambient air monitoring program. The cost estimates for each MSA/CMSA do include new capital expenditures, operational costs, and labor costs associated with the hiring of new senior environmental chemists/chromatographers and statisticians/data analysts. The PAMS costs are expressed as 5-year cumulative costs, from initiation of the network through required completion (based on the phase-in schedule proposed in appendix D) which amounts to a total of approximately $45 million nationally. Continuing annual costs for the operation and maintenance of the PAMS system, including an allowance for equipment replacement, are about $11.6 million. By comparison, current national costs for routine ozone-related monitoring programs involve the operation of 826 ozone monitors for $13.8 million and 329 NO_x monitors at $6.9 million per year. Current total criteria monitoring capital and operating costs amount to $57 million annually. Further detail on the bases for these cost estimates is provided in Table 3.

TABLE 3. COST PER ENHANCED OZONE MONITORING STATION

Item	Yearly operational cost	Capital cost
Establish Monitoring Station (1st year only)	$800	$8,700
Ozone (O3)		20,300
7-month	7,500	
9-month	9,800	
12-month	12,800	
Nitrogen Dioxide (NO_2)		22,100
7-month	7,900	
9-month	10,200	
12-month	13,600	
Volatile Organic Compounds (VOC)		
Frequency "A" (Canister)	60,200	47,700
Frequency "B" (GC & Canister)	57,300	85,400
Frequency "C" (GC & Canister)	41,500	80,800
Aldehydes		
Frequency "D"	15,400	2,800
Frequency "E"	41,800	6,800
Meteorology	2,400	8,000
Data Analyses & Trends	12,500	

During the first year of operation, the PAMS network is likely to cost approximately $5.2 million. Additionally, present ozone control cost estimates amount to $8–10 billion on an annual basis compared to a continuing investment of less than $12 million to operate PAMS (only 0.2 percent). PAMS are designed to ensure that the most cost-effective ozone control strategies are devised in implemented and provide the basis to track their success.

Impact on Small Entities

The Regulatory Flexibility Act requires that all Federal Agencies consider the impacts of final regulations on small entities, which are defined to be small businesses, small organizations, and small governmental jurisdictions (5 U.S.C. 601 et seq.). EPA's consideration pursuant to this Act indicates that no small entity group would be significantly affected in an adverse way by the proposal. Therefore, pursuant to 5 U.S.C. 605(b), the Administrator certifies that these proposed amendments would not have a significant economic impact on a substantial number of small entities.

Other Reviews

Since this revision is classified as minor, no additional reviews are required. The proposed revisions to part 58 were submitted to the Office of Management and Budget (OMB) for review (under Executive Order 12291). This is not a "major" rule under E.O. 12291 because it does not meet any of the criteria defined in the Executive Order.

Paperwork Reduction Act

The Office of Management and Budget (OMB) has approved the information collection requirements for Ambient Air Quality Networks under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* and has assigned OMB control number 2060–0084. The information collection requirements in this proposed rule, which will amend the Information Collection Request (ICR) for Ambient Air Quality Networks, have been submitted for approval to the OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* An ICR has been prepared by EPA (ICR No. 940.09) and a copy may be obtained from Sandy Farmer, Information Policy Branch (PM–223Y); U. S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460 or by calling (202) 260–2740.

This proposed rule is estimated to increase the annual burden of affected control agencies by 99,840 hours for the

first full year of operation. This burden would increase to 287,495 hours in the fifth year of implementation when all required sampling is operational. This estimate includes the time for site installation, sampler operation, data reduction, data reporting, and data analysis.

Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief, Information Policy Branch (PM-223Y); U. S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, marked "Attention: Desk Officer for EPA." The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

List of Subjects in 40 CFR Part 58

Air pollution control, Intergovernmental relations, Air quality surveillance and data reporting, Pollutant standard index, Quality assurance program, Ambient air quality monitoring network design and siting.

Dated: January 22, 1992.

William K. Reilly,

Administrator.

For the reasons set forth in the Preamble, part 58 of chapter I of title 40 of the Code of Federal Regulations is proposed to be amended as follows:

PART 58—AMBIENT AIR QUALITY SURVEILLANCE

1. Authority citation for 40 part 58 is revised to read as follows:

Authority: 42 U.S.C. 7410, 7601(a), 7613, and 7619.

2. Section 58.1 is amended by revising paragraph (f) and by adding paragraphs (w), (x), and (y) to read as follows:

§ 58.1 Definitions.

* * * * *

(f) *NO_2* means nitrogen dioxide. *NO* means nitrogen oxide; *NO_x* means oxides of nitrogen and is defined as the sum of the concentrations of NO_2 and NO.

* * * * *

(w) *PAMS* means Photochemical Assessment Monitoring Stations.

(x) *VOC* means volatile organic compounds.

(y) *Meteorological* measurements means continuous measurements of wind speed, wind direction, barometric pressure, temperature, relative humidity, and solar radiation.

3. Section 58.2 is amended by redesignating paragraph (d) as paragraph (e) and by adding a new paragraph (d) to read as follows:

§ 58.2 Purpose.

* * * * *

(d) This section also acts to establish a Photochemical Assessment Monitoring Stations (PAMS) network as a subset of the State's SLAMS network for the purpose of enhanced monitoring in ozone nonattainment areas listed as serious, severe, or extreme. The PAMS network will be subject to the data reporting and monitoring methodology requirements as contained in subpart E of this part.

4. Section 58.13 is amended by revising paragraph (b); redesignating paragraph (c) as paragraph (d); and adding a new paragraph (c) to read as follows:

§ 58.13 Operating schedule.

* * * * *

(b) For manual methods (excluding PM_{10} samplers and PAMS VOC samplers), at least one 24-hour sample must be obtained every sixth day except during periods or seasons exempted by the Regional Administrator.

(c) For PAMS VOC samplers, samples must be obtained as specified in section 4.4 of appendix D to this part. PAMS operating schedules must be included as part of the network description required by § 58.40 and must be approved by the Administrator.

* * * * *

5. Section 58.20 is amended by revising paragraphs (a) and (c) and adding paragraph (f) to read as follows:

§ 58.20 Air quality surveillance: Plan content.

* * * * *

(a) Provide for the establishment of an air quality surveillance system that consists of a network of monitoring stations designated as State and Local Air Monitoring Stations (SLAMS) which measure ambient concentrations of those pollutants for which standards have been established in part 50 of this chapter. SLAMS (including NAMS) designated as PAMS will also obtain ambient concentrations of speciated VOC and NO_x, and meteorological measurements. PAMS may therefore be located at existing SLAMS or NAMS sites when appropriate.

* * * * *

(c) Provide for the operation of at least one SLAMS per criteria pollutant except Pb during any stage of an air pollution episode as defined in the plan.

* * * * *

(f) Within 6 months after the effective date of promulgation or date of nonattainment designation (whichever is later), States with ozone nonattainment areas designated as serious, severe, or extreme shall adopt and submit a plan revision to the Administrator. The plan revision will provide for the establishment and maintenance of PAMS. Each PAMS site will provide for the monitoring of ambient concentrations of criteria pollutant (O_3, NO_2,), and non-criteria pollutant (NO_x, NO, and speciated VOC) as stipulated in section 4.2 of appendix D to this part, and meteorological measurements. The PAMS network is part of the SLAMS (including NAMS) network and the plan provisions in paragraphs (a) through (e) of this section will apply to the revision.

Subpart E (§ 58.40) [Redesignated as Subpart F (§ 58.50)]

Subpart F (§§ 58.50, 58.51) [Redesignated as Subpart G (§§ 58.60, 58.61)]

6. Subparts E (§ 58.40) and F (§§ 58.50 and 58.51) are redesignated as subparts F (§ 58.50) and G (§§ 58.60 and 58.61), respectively. Subpart E is added to read as follows:

Subpart E—Photochemical Assessment Monitoring Stations (PAMS)

Sec.

58.40 PAMS network establishment.
58.41 PAMS network description.
58.42 PAMS approval.
58.43 PAMS methodology.
58.44 PAMS network completion.
58.45 PAMS data submittal.
58.46 System modification.

Subpart E—Photochemical Assessment Monitoring Stations (PAMS)

§ 58.40 PAMS network establishment.

(a) In addition to the plan revision, the State shall submit a photochemical assessment monitoring network description including a schedule for implementation to the Administrator within 6 months after the effective date of promulgation or redesignation and reclassification of the area to serious, severe, or extreme ozone nonattainment. The newtwork description will apply to all serious, severe, and extreme ozone nonattainment areas within the State. Some ozone nonattainment areas may extend beyond State or Regional boundaries. In instances where PAMS network design criteria as defined in appendix D to this part require monitoring stations located in different States and/or Regions, the network description and implementation schedule may be submitted jointly

the States involved. Network descriptions shall be submitted through the appropriate Regional Office(s).

Alternative networks may be submitted, but they must include a demonstration that they satisfy the monitoring data uses and fulfill the PAMS monitoring objectives described in sections 4.1 and 4.2 of appendix D to this part. Certain alternative plans described in section 4.2 of appendix D to this part must be published in the Federal Register, subjected to public comment, and subsequently approved by the Administrator.

(b) For purposes of plan development and approval, the stations in the PAMS network must be stations from the SLAMS network required by § 58.20.

(c) The requirements of appendix D to this part applicable to PAMS must be met when designing the PAMS network.

§ 58.41 PAMS network description.

The PAMS network description required by § 58.40 must contain the following:

(a) Identification of the monitoring area represented.

(b) The AIRS site identification form for existing stations.

(c) The proposed location for scheduled stations.

(d) Identification of the site type and location within the PAMS network design for each station as defined in appendix D to this part.

(e) The sampling and analysis method for each of the measurements.

(f) The operating schedule for each of the measurements.

(g) A schedule for implementation. This schedule should include the following:

(1) A timetable for locating, and submitting the AIRS site identification form for each scheduled PAMS that is not located at the time of submittal of the network description.

(2) A timetable for phasing-in operation of the required number and type of sites as defined in appendix D to this part, and

(3) A schedule for implementing the quality assurance procedures of appendix A to this part for each PAMS.

§ 58.42 PAMS approval.

The PAMS network required by § 58.40 is subject to that approval of the Administrator. Such approval will be contingent upon completion of the network description as outlined in § 58.41 and upon conformance to the PAMS network design criteria contained in appendix D to this part.

§ 58.43 PAMS methodology.

PAMS monitors must meet the monitoring methodology requirements of appendix C to this part applicable to PAMS.

§ 58.44 PAMS network completion.

(a) The complete, operational PAMS network will be phased in as described in appendix D to this part over a period of 5 years after the effective date of promulgation or redesignation and reclassification of any area to serious, severe, or extreme ozone nonattainment.

(b) The quality assurance criteria of appendix A to this part must be implemented for all PAMS.

§ 58.45 PAMS data submittal.

(a) The requirements of this section apply only to those stations designated as PAMS by the network description required by § 58.40.

(b) All data shall be submitted to the Administrator in accordance with the format and for the reporting periods specified in § 58.35.

(c) The State shall report O_3, NO, NO_2, and NO_y data within 60 days following the end of each quarterly reporting period.

(d) The State shall report speciated VOC data and meteorological data within 6 months following the end of each quarterly reporting period.

§ 58.46 System modification.

(a) Any proposed changes to the PAMS network description will be evaluated during the annual SLAMS Network Review specified in § 58.20. Changes proposed by the State must be approved by the Administrator. The State will be allowed 1 year (until the next annual evaluation) to implement the appropriate changes to the PAMS network.

(b) PAMS network requirements are mandatory only for serious, severe, and extreme ozone nonattainment areas. When such area is redesignated to attainment, the State may revise its PAMS monitoring program subject to approval by the Administrator.

7. A new sentence is added before the last sentence in the first paragraph of section 2.2 of appendix A to read as follows:

Appendix A—Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)

* * * * *

2.2 * * * Quality assurance guidance for VOC and meteorological measurements at PAMS is contained in reference 5. * * *

* * * * * * *

8. References 5, 6, and 7, of Appendix A are redesignated as references 6, 7, and 8 repectively and new reference 5 is added to read as follows:

References

* * * * *

5. Technical Guidance for Monitoring Ozone Precursor Compounds. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft May 1991.

* * * * *

9. Sections 4.0, 5.0 and 5.1 of appendix C are redesignated as sections 5.0, 6.0, and 1, respectively (reference 5.1 therefore will become reference 1 of section 6.0), sections 4.0, 2, and 3 are added and newly redesignated Section 6.0 is revised to read as follows:

Appendix C—Ambient Air Quality Methodology

* * * * *

4.0 Photochemical Assessment Monitoring Stations (PAMS)

4.1 Methods used for O_3 monitoring at PAMS must be automated reference or equivalent methods as defined in § 50.1 of this chapter.

4.2 Methods used for NO and NO_y monitoring at PAMS must be automated reference or equivalent methods as defined for NO_2 in § 50.1 of this chapter.

4.3 Methods for meteorological measurements and speciated VOC monitoring are included in the guidance provided in references 2. and 3. If alternative VOC monitoring methodology, which is not included in the guidance, is proposed, it must be detailed in the network description required by § 58.40 and must be published in the Federal Register, subject to public comment, and subsequently approved by the Administrator.

* * * * *

6.0 References

1. Pelton, D.J. Guideline for Particulate Episode Monitoring Methods. GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. EPA 450/4-83-005. February 1983.

2. Technical Guidance for Monitoring Ozone Precursor Compounds. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Draft May 1991.

3. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4-82-060. February 1983.

10. The heading of Appendix D is revised to read as follows:

Appendix D—Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)

11. The second sentence of the first paragraph of Section 1 of Appendix D is revised to read as follows:

1. * * * It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS) and Photochemical Assessment Monitoring Stations (PAMS). These criteria will also be used by EPA in evaluating the adequacy of the SLAMS/NAMS/PAMS networks.* * *

* * * * *

12. Section 4 and section 5 of appendix D are redesignated as section 5 and section 6, respectively. A new section 4 is added to read as follows:

4 Network Design for Photochemical Assessment Monitoring Stations (PAMS)

In order to obtain more comprehensive and representative data on ozone air pollution, the 1990 Clean Air Act Amendments require enhanced monitoring for ozone (O_3),oxides of nitrogen (NO_x), and volatile organic compounds (VOC) in ozone nonattainment areas classified as serious, severe, or extreme. This will be accomplished through the establishment of a network of photochemical assessment monitoring stations (PAMS).

4.1 PAMS data uses.—Data from the PAMS are intended to satisfy several coincident needs related to attainment of the National Ambient Air Quality Standards (NAAQS), SIP control strategy development and evaluation, corroboration of emissions tracking, preparation, of trends appraisals, and exposure assessment.

(a) *NAAQS attainment and control strategy development.* Like SLAMS and NAMS data, PAMS data will be used for monitoring ozone exceedances and providing input for attainment/nonattainment decisions. In addition, PAMS data will help resolve the roles of transported and locally emitted ozone precursors in producing an observed exceedance and may be utilized to identify specific sources contributing to observed exceedances and excessive concentrations of ozone precursors. PAMS data will also assist in characterizing the concentrations of ozone and precursors occurring on days when high ozone levels are measured and therefore extend the data base available for future attainment demonstrations. These demonstrations will be based on photochemical grid modeling and other approved analytical methods and will provide a basis for prospective mid-course control strategy corrections. PAMS data will provide (1) information concerning which areas and episodes to model to develop appropriate control strategies; (2) boundary conditions required by the models to produce quantifiable estimates of needed emissions reductions; and (3) a means to evaluate the predictive capability of the models used.

(b) *SIP control strategy evaluation.* The PAMS will provide data for SIP control strategy evaluation. Long-term PAMS data will be used to evaluate the effectiveness of these control strategies. Data could be used to validate the impact of VOC and NO_x emission reductions on air quality levels for ozone if retrieved at the end of a time period during which control measures were implemented. Additionally, ambient monitoring data will be used to determine in what portion of the day, the VOC emissions reductions occur. Speciation of measured VOC data will allow determination of which organic species are most affected by the emissions reductions and assist in developing cost effective selective VOC reductions and control strategies. A State or local air pollution control agency can therefore ensure that strategies which are implemented in their particular nonattainment area, are those which are best suited for that area and achieve the greatest VOC and NO_x emissions reductions (and therefore largest impact) at the least cost.

(c) *Emissions tracking.* PAMS data will be used to corroborate the quality of VOC and NO_x emission inventories. Although a perfect mathematical relationship between emission inventories and ambient measurements does not yet exist, a qualitative assessment of the relative contributions of various compounds to the ambient air could be roughly compared to current emission inventory estimates to judge the accuracy of the emission inventories. In addition, PAMS data which is gathered year round will allow tracking of VOC and NO_x emission reductions, provide additional information necessary to demonstrate Reasonable Further Progress (RFP) toward the specific reductions required to achieve the ozone NAAQS, and corroborate emissions trends analyses. While the regulatory assessments of progress will be made in terms of emission inventory estimates, the ambient data can provide independent trends analyses and corroboration of these assessments which either verify or highlight possible errors in emissions trends indicated by inventories. The ambient assessments, using speciated data, can gage the accuracy of estimated changes in emissions. The speciated data can also be used to assess the quality of the VOC speciated and NO_x emission inventories for input during photochemical grid modeling exercises and identify urban air toxic pollutant problems which deserve closer scrutiny.

The speciated VOC data will be used to determine changes in the species profile, resulting from the emission control program, particulary those resulting from the reformulation of fuels.

(d) *Trends.* Long-term PAMS data will be used to establish speciated VOC, NO_x, and toxic air pollutant trends, and supplement the O_3 trends data base. Multiple statistical indicators will be tracked, including ozone and its precursors on the ten days during each year with the highest ozone concentration, the seasonal means for these pollutants, and the annual means at representative locations.

The more PAMS that are established in and near nonattainment areas, the more effective the trends data will become. As the spatial distribution and number of ozone and ozone precursor monitors improves, trends analyses will be less influenced by instrument or site location anomalies. The requirement that surface meteorological monitoring be established at each PAMS, help maximize the utility of these trends analyses by comparisons with meteorological trends, and transport influences. The meteorological data will also help interpret the ambient air pollution trends.

(e) *Exposure assessment.* PAMS data will be used to better characterize ozone and toxic air pollutant exposure to populations living in serious, severe, or extreme areas. Annual mean toxic air pollutant concentrations will be calculated to determine the risk to the population associated with individual VOC species in urban environment.

4.2 *PAMS monitoring objectives.*—Unlike the SLAMS and NAMS design criteria which are pollutant specific, PAMS design criteria are specific to site location. Concurrent measurements of O_3, NO_x, speciated VOC, and meteorology are obtained at PAMS. Design criteria for the PAMS network are based on selection of an array of site locations relative to ozone precursor source areas and predominant wind directions associated with high ozone events. Specific monitoring objectives are associated with each location. The overall design should enable characterization of precursor emission sources within the area, transport of ozone and its precursors into and out from the area, and the photochemical processes related to ozone nonattainiment, as well as developing an initial urban air toxic pollutant data base. Specific objectives that must be addressed include assessing ambient trends in O_3, NO, NO_2, NO_x, VOC, and VOC species, determining spatial and diurnal variability of O_3, NO, NO_2, NO_x, and VOC species and assessing changes in the VOC species profiles that occur over time, particularly those occurring due to the reformulation of fuels. A maximum of five PAMS sites are required in an affected nonattainment area depending on the population of the Metropolitan Statistical Area/Consolidated Metropolitan Statistical Area (MSA/CMSA) or nonattainment area, whichever is larger. Specific monitoring objectives associated with each of these sites result in five distinct site types.

Type (1) sites are established to characterize upwind background and transported ozone and its precursor concentrations entering the area and will identify those areas which are subjected to overwhelming transport. Type (1) sites are located in the predominant upwind direction from the local area of maximum precursor emissions during the ozone season and at a distance sufficient to ensure urban scale measurements are obtained as defined elsewhere in this Appendix. Typically, the (1) sites will be located 10–30 miles in the predominant upwind direction from the city limits or fringe of the urbanized area. Data measured at site type (1) will be used principally for the following purposes:

- Future development and evaluation of control strategies.
- Identification of incoming emissions.
- Corroboration of NO_x and VOC emission inventories.
- Establishment of boundary conditions for future photochemical grid modeling and mid-course control strategy changes.
- Analysis of pollutant trends.

Type (2) sites are established to monitor the magnitude and type of precursor emissions in the area where maximum emissions are expected to impact and are ideally suited for the monitoring of urban air toxic pollutants. Type (2) sites are located immediately downwind of the area of maximum precursor emissions and are typically placed near the downwind boundary of the central business district to ensure neighborhood scale measurements are obtained. Data measured at site type (2) will be used principally for the following purposes:

- Development and evaluation of imminent and future control strategies.
- Corroboration of NO_x and VOC emission inventories.
- Augmentation of RFP tracking.
- Verification of photochemical grid model performance.
- Characterization of ozone and toxic air pollutant exposures (maximum site for toxic emissions impact).
- Analysis of pollutant trends, particularly toxic air pollutants and annual ambient speciated VOC trends to compare with trends in annual VOC emission estimates.
- Determination of attainment with the NAAQS for NO_2 and O_3

Type (3) sites monitor changes in precursor concentrations and ratios downwind of the emissions source. Type (3) sites should be located in an intermediate position between the area of maximum precursor emissions and the downwind area where maximum ozone concentrations would be expected to ensure neighborhood scale measurements are obtained (between sites (2) and (4)). Typically, type (3) sites are 10–20 miles from the central business district or at the fringe of the urbanized area in the predominant downwind direction during the ozone season. Data measured at site type (3) will be used principally for the following purposes:

- Determination of attainment with the NAAQS for NO_2 and O_3 (this site may coincide with an existing maximum NO_2 NAMS monitoring site).
- Measurement of transport and reactivity of precursors.
- Verification of photochemical grid model performance.
- Characterization of air pollutant exposures.
- Corroboration of NO_x and VOC emission inventories.
- Augmentation of RFP tracking.
- Analysis of pollutant trends.

Type (4) and (5) sites are intended to monitor maximum ozone concentrations occurring downwind from the area of maximum precursor emissions in the first and second most frequently occurring wind directions, respectively. Locations for type (4) and (5) sites should be chosen so that urban scale measurements are obtained. Typically, type (4) and (5) sites will be located 10–30 miles downwind from the fringe of the urban area or from site type (3). Data measured at site types (4) and (5) will be used principally for the following purposes:

- Determination of attainment with the NAAQS for ozone and NO_2 (this site may coincide with an existing maximum concentration ozone or a population exposure NO_2 NAMS monitoring site).
- Establishment of boundary conditions for photochemical grid modeling.
- Future development and evaluation of control strategies.
- Analysis of pollutant trends.
- Characterization of ozone pollutant exposures.

States choosing to submit individual network descriptions for each affected nonattainment area irrespective of its proximity to other affected areas, must fulfill the requirements for isolated areas as described in section 4 of appendix D and illustrated by Figure 1. States containing areas which experience significant impact from long-range transport or are proximate to other nonattainment areas (even in other States) may collectively submit a network description which contains alternative sites to those that would be required for an isolated area. Such a submittal should, as a guide, be based on the example provided in Figure 2, but must include a demonstration that it satisfies the monitoring data uses and fulfills the PAMS monitoring objectives described in sections 4.1 and 4.2 of this Appendix D. EPA recognizes that specific monitoring sites identified for one area may serve to fulfill the monitoring objectives for different site in another area: for example, a downwind site for one area may suffice as an upwind site for another. These alternative network designs must be reviewed and approved by the Administrator.

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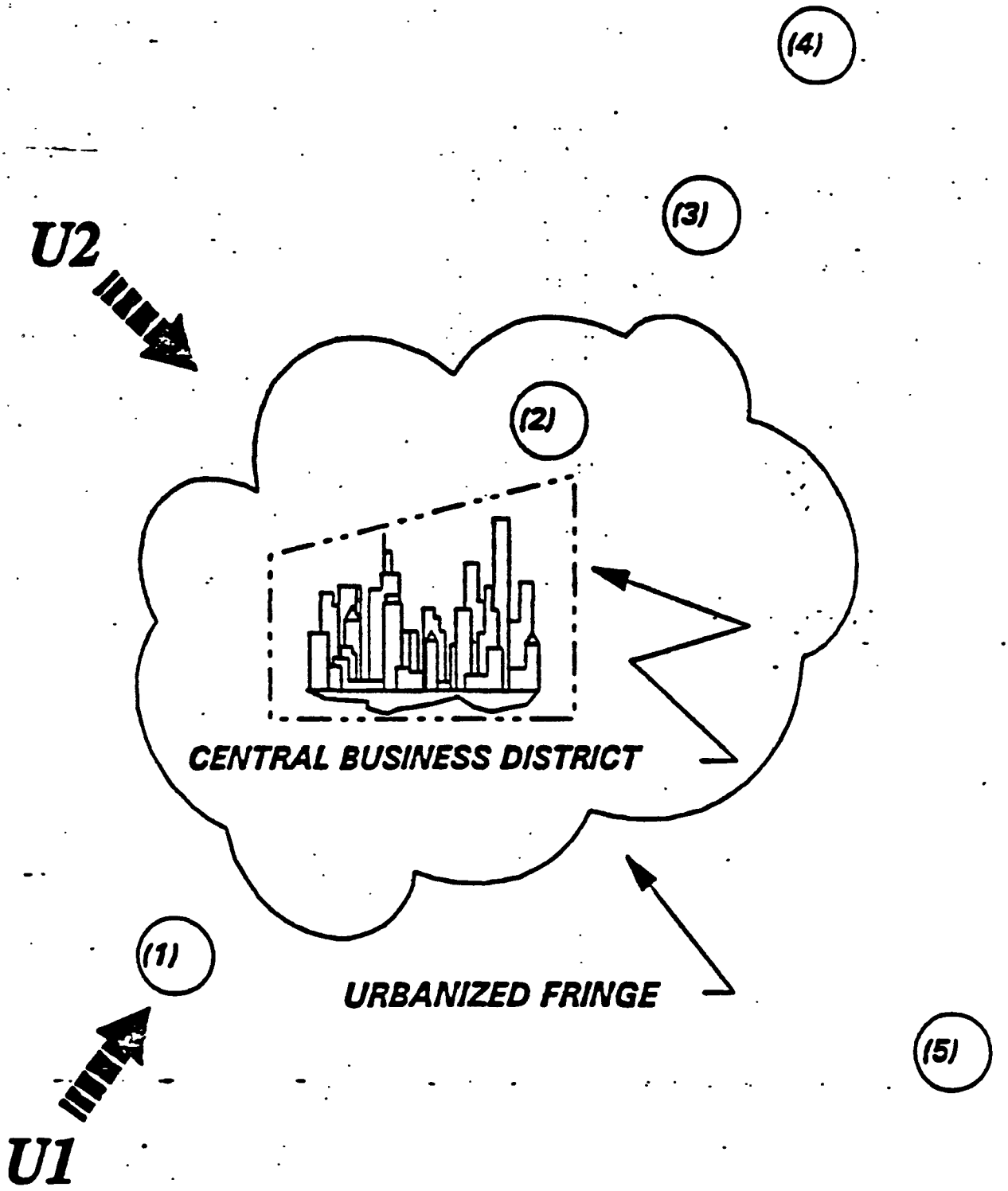
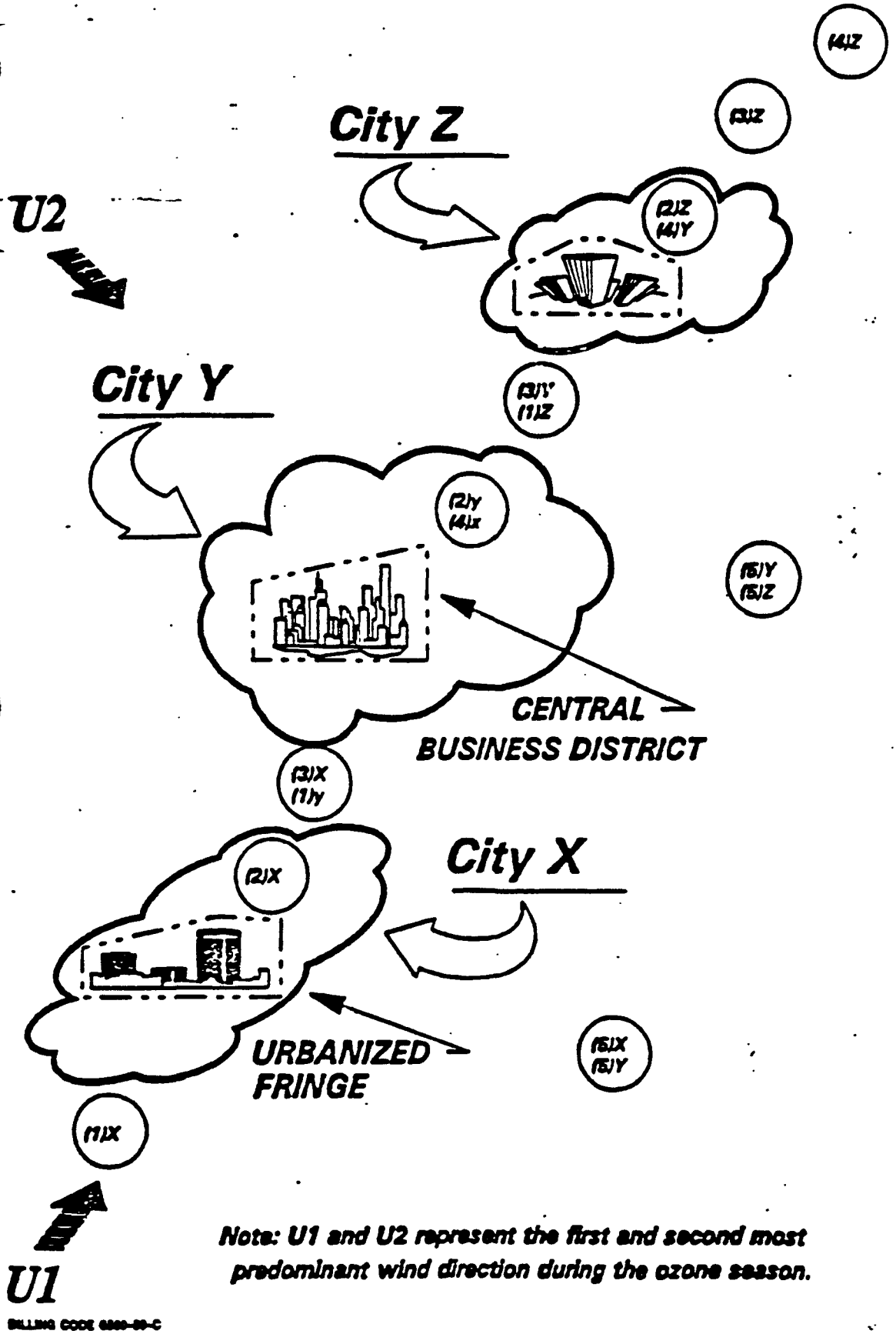
Figure 1 - Isolated Area Network Design



Note: U1 and U2 represent the first and second most predominant wind direction during the ozone season.

Figure 2 - Multi-Area/Transport Network Design



Note: U1 and U2 represent the first and second most predominant wind direction during the ozone season.

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Alternative plans which propose different or reduced frequencies of sampling or reduced spatial coverage must also be proposed for approval by the Administrator in the Federal Register, subjected to public comment, and subsequently considered by the Administrator for final approval or disapproval based on the comments received. Site locations are submitted as part of the network description required by § 58.40 and are subject to approval by the Administrator.

4.3 Monitoring period.—PAMS precursor monitoring will be conducted annually throughout the months of June, July and August (as a minimum) when peak ozone values are expected in each area; however, precursor monitoring during the entire ozone season for the area is preferred. Alternate precursor monitoring periods may be submitted for approval as a part of the PAMS network description required by § 58.40. Changes to the PAMS monitoring period must be identified during the annual SLAMS Network Review specified in § 58.20. PAMS ozone monitors must adhere to the ozone monitoring season specified in Section 2.5 of this Appendix D.

4.4 Minimum network requirements.—The minimum required number and type of monitoring sites and sampling requirements are based on the population of the affected MSA/CMSA or nonattainment area (whichever is larger). The MSA/CMSA basis for monitoring network requirements was chosen because it typically is the most representative of the area which encompasses the emissions sources contributing to nonattainment. The MSA/CMSA emissions density can also be effectively and conveniently portrayed by the surrogate of population. Additionally, a network which is adequate to characterize the ambient air of an MSA/CMSA often must extend beyond the boundaries of such an area (especially for ozone and its precursors); therefore, the use of smaller geographical units (such as counties or nonattainment areas which are smaller than the MSA/CMSA) for monitoring network design purposes is inappropriate. Various sampling requirements are imposed according to the size of the area to accommodate the impact of transport on the smaller MSA's/CMSA's, to account for the spatial variations inherent in large areas, to satisfy the differing data needs of large versus small areas due to the intractability of the ozone nonattainment problem, and to recognize the potential economic impact of implementation on State and local government. Population figures must reflect the most recent decennial U.S. census population report. Specific guidance on determining network requirements is provided in reference 19. Minimum network requirements are outlined below:

Population of MSA/CMSA or nonattainment area [1]	Required site type [2]	Minimum VOC sampling frequency [3]	Minimum aldehyde sampling frequency [3]
Less than 500,000.	(1)	A	—
	(2)	A	D
500,000 to 1,000,000.	(1)	A	—
	(2)	B	E
	(4)	A	—
1,000,000 to 2,000,000.	(1)	A	—
	(2)	B	E
	(3)	C	E
	(4)	A	—
More than 2,000,000.	(1)	A	—
	(2)	B	E
	(3)	C	E
	(4)	A	—
	(5)	A	—

[1] Whichever area is larger.
[2] See figure 1.
[3] Frequency requirements are as follows: A—Eight 3-hour samples every third day and one 24-hour sample every sixth day during the monitoring period; B—Eight 3-hour samples, everyday during the monitoring period and one 24-hour sample every sixth day year-round; C—Eight 3-hour samples, everyday and one 24-hour sample every sixth day during the monitoring period; D—Four 6-hour samples, every third day during the monitoring period; E—Four 6-hour samples, everyday during the monitoring period.

Note that for purposes of network implementation and transition only, priority has been given to the particular monitoring sites as follows:

- Site type (2) which provides the most comprehensive data concerning ozone precursor emissions and toxic air pollutants,
- Site type (1) which delineates the effect of incoming precursor emissions and concentrations of ozone,
- Site type (4) which provides a maximum ozone measurement and total conversion of ozone precursors,
- Site type (3) which depicts the changes in concentrations of ozone and precursors as the pollutants travel across an area, and
- Site type (5) which serves a similar purpose as site type (4) in the second most predominant wind direction.

4.5 *Transition period.*—A variable period of time is proposed for phasing in the operation of all required PAMS. Within 1 year after the effective date of promulgation or redesignation and reclassification of the area to serious, severe, or extreme ozone nonattainment (whichever is later), a minimum of one type (2) site must be operating. Operation of the remaining sites must, at a minimum, be phased in over the subsequent 4 years as outlined below:

Years after promulgation/designation	No. of sites operating	Operating site type [1]
1	1	(2)
2	2	(1),(2)
3	3	(1),(2),(4)
4	4	(1),(2),(3),(4)
5	5	(1),(2),(3),(4),(5)

[1] See figure 1

Note that given the need to differentiate the monitoring network requirements due to the spatial and emissions characteristics of the various sizes of MSA/CMSA or nonattainment areas, the criteria and priorities given in Section 4.4 were applied. These criteria and priorities result in networks of varying proportions, provid[e] reasonable data coverage, and stratifie[d] monitoring requirements.

4.6 *Meteorological monitoring.*—In order to support monitoring objectives associated with the need for various air quality analyses and model inputs and performance evaluations, meteorological monitoring at 10 meters above ground is required at each PAMS site. Monitoring should begin with site establishment. In addition, upper air meteorological monitoring should be initiated as warranted in areas where such data is not available. The upper air station may be located separately from sites (1) through (5). The location should be representative of the upper air data in the nonattainment area. Upper air meteorological data should be collected for approximately 10 to 20 key days per year corresponding to model input requirements. Specific guidance on monitoring methods and siting is provided in reference 20 and 21.

5 Summary

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13. In appendix D references 19 through 23 are added to section 6 to read as follows:

6 References

• • • • •

19. Enhanced Ozone Monitoring Network Design and Siting Criteria Guideline Document. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft May 1991.

20. Technical Guidance for Monitoring Ozone Precursor Compounds. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft May 1991.

21. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4-82-060. February 1983.

22. Criteria for Assessing the Role of Transported Ozone/Precursors in Ozone Non-Attainment Areas. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA-450/4-91-015. May 1991.

23. Guidelines for Regulatory Application of the Urban Airshed Model. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft, March 1991.

14. Appendix E is amended by adding a new paragraph after the first paragraph in section 9, by redesignating sections 10, 11, and 12 as sections 11, 12, and 13, redesignating Table 5 as Table 6, adding a new Table 5, adding a new section 10, amending the last sentence

newly redesignated section 11 to add reference to PAMS, and amending newly redesignated section 12 by adding an entry to the bottom of Table 6 for VOC to read as follows:

Appendix E—Probe Siting Criteria for Ambient Air Quality Monitoring

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For VOC monitoring at those SLAMS designated as PAMS, FEP teflon is unacceptable as the probe material because of VOC adsorption and desorption reactions on the FEP teflon. Borosilicate glass, stainless steel, or its equivalent are the acceptable probe materials for VOC and aldehyde sampling. Care must be taken to ensure that the sample residence time is 20 seconds or less.

• • • • •

10 Photochemical Assessment Monitoring Stations (PAMS)

10.1 *Horizontal and Vertical Probe Placement.*—The height of the probe inlet must be located 3 to 15 meters above ground level. This range provides a practical compromise for finding suitable sites for the multi-pollutant PAMS. The probe inlet must also be located more than 1 meter vertically or horizontally away from any supporting structure.

10.2 *Spacing From Obstructions.*—The probe must be located away from obstacles and buildings such that the distance between the obstacles and the probe inlet is at least twice the height that the obstacle protrudes above the sampler. There must be unrestricted airflow in an arc of at least 270° around the probe inlet and the predominant wind direction for the season of greatest pollutant concentration must be included in the 270° arc. If the probe is located on the side of the building, 180° clearance is required.

10.3 *Spacing From Roads.*—It is important in the probe siting process to minimize destructive interferences from sources of nitrogen oxide (NO) since NO readily reacts with ozone. Table 5 below provides the required minimum separation distances between roadways and PAMS (excluding upper air measuring stations):

TABLE 5.—SEPARATION DISTANCE BETWEEN PAMS AND ROADWAYS

[Edge of nearest traffic lane]

Roadway average daily traffic	Minimum separation distance between roadways and stations in meters
Vehicles per day:	
<10,000	[1]>10
15,000	20
20,000	30
40,000	50
70,000	100
>110,000	>250

[1] Distances should be interpolated based on traffic flow.

Sites types (1), (4) and (5) are intended to be regionally representative and should not be unduly influenced by an NO_x source from a nearby roadway. Similarly, a nearby roadway should not act as a local ozone sink for site types (2) and (3).

10.4 *Spacing From Trees.*—Trees can provide surfaces for adsorption and/or reactions to occur and can obstruct normal wind flow patterns. To minimize these effects at PAMS, the probe inlet should be placed at least 20 meters from the drip line of trees. Since the scavenging effect of trees is greater for ozone than for the other criteria pollutants, strong consideration of this effect must be given in locating the PAMS probe inlet to avoid this problem. Therefore, the samplers must be at least 10 meters from the drip line of trees that are located between the urban city core area and the sampler along the predominant summer daytime wind direction.

10.5 *Meteorological Measurements.*—The 10-meter meteorological tower at each PAMS site should be located so that measurements can be obtained that are not immediately influenced by surrounding structures and trees. It is important that the meteorological data reflect the origins of, and the conditions within, the air mass containing the pollutants collected at the probe. Specific guidance on siting of meteorological towers is provided in references 31 and 32.

11 Waiver Provisions

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For those SLAMS also designated as NAMS or PAMS, the request will be forwarded to the Administrator.

12 Discussion and Summary

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TABLE 6.— SUMMARY OF PROBE SITING CRITERIA

Pollutant	Scale	Height above ground, meters	Distance from supporting structure, meters		Other spacing criteria
			Vertical	Horizontal [a]	
• • •					
VOC	—	3–15	>1	>1	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from probe inlet to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted air flow in an arc of at least 270° around the probe inlet and the predominant wind direction for the season of greatest pollutant concentration must be included in the 270° arc. If probe located on the side of a building unrestricted air flow must be 180°. 4. Spacing from roadways (see Table 5).

[a] When probe is located on rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof.

• • • • •

15. References number 31 and 32 are added to newly redesignated section 13 of appendix E to read as follows:

13 References

• • • • •

31. Technical Guidance for Monitoring Ozone Precursor Compounds. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft May 1991.

32. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4-82-060. February 1983.

[FR Doc. 92-2535 Filed 3-3-92; 8:45 am]

BILLING CODE 6560-50-M

40 CFR Part 180

[OPP-300239; FRL-3948-9]

RIN 2070-AC-18

Acetic Acid; Tolerance Exemption

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule.

SUMMARY: This document proposes that an exemption from the requirement of a

Federal Register

Friday
February 12, 1993

Part II

Environmental Protection Agency

40 CFR Part 58

Ambient Air Quality Surveillance; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 58

[AD-FRL-4099-6]

RIN 2060-AD18

Ambient Air Quality Surveillance

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: This final rule revises the ambient air quality surveillance regulations to include provisions for the enhanced monitoring of ozone and its precursors including oxides of nitrogen, volatile organic compounds (including carbonyls) and meteorological parameters. These revisions satisfy the requirements of title I, section 182 of the 1990 Clean Air Act Amendments. These revisions require States to establish photochemical assessment monitoring stations (PAMS) as part of their State Implementation Plan (SIP) monitoring network in ozone nonattainment areas classified as serious, severe, or extreme. Included in these revisions are minimum criteria for network design, monitor siting, monitoring methods, operating schedules, quality assurance, and data submittal.

EFFECTIVE DATE: These regulations take effect on February 12, 1993.

ADDRESSES: Docket Statement: All comments received relative to this rule have been placed in Docket No. A-91-22, located in the Central Docket Section, Room M1500 (First Floor, Waterside Mall), U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460. This docket is available for public inspection and copying from 8:30-12 a.m. and from 1:30-3:30 p.m., Monday through Friday. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Geri Dorosz-Stargardt, Technical Support Division (MD-14), Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, phone: (919) 541-5492.

SUPPLEMENTARY INFORMATION:

Background

Section 110(a)(2)(C) of the Clean Air Act requires ambient air quality monitoring for purposes of the State Implementation Plan (SIP) and reporting of the data to EPA. Uniform criteria for measuring air quality and provisions for the reporting of a daily air pollution index are required by section 319 of the Act. To satisfy these requirements, on May 10, 1979 (44 FR 27571), EPA established 40 CFR part 58 which provided detailed requirements for air quality surveillance and data reporting for all the pollutants except lead for which ambient air quality standards (criteria pollutants) had been established. On September 3, 1981 (46 FR 44164) similar rules were promulgated for lead and on July 1, 1987 (52 FR 24740) for particulate matter (PM_{10}).

On March 4, 1992, these rules were proposed in the Federal Register as amendments to 40 CFR part 58. These regulations address the minimum requirements for the monitoring of speciated volatile organic compounds (VOC), oxides of nitrogen (NO_X), and meteorological parameters as well as additional ambient air monitoring for ozone (O_3). Title I, section 182 of the 1990 Clean Air Act Amendments requires EPA to promulgate regulations for the enhanced monitoring of O_3 and its precursors and for the affected States to incorporate the requirements as a part of their State Implementation Plans. Also, section 184(d) requires that the best available air quality monitoring and modeling techniques be used in making determinations concerning the contribution of sources in one area to concentrations of O_3 in another area which is a nonattainment area for ozone. Additionally, these enhanced ozone and ozone precursor monitoring rules adhere to the fundamental recommendations, regarding ambient monitoring, of the National Academy of Sciences (NAS) in the report entitled, Rethinking the Ozone Problem in Urban and Regional Air Pollution, which was prepared pursuant to section 185B of the 1990 Clean Air Act Amendments. In that report, the NAS noted the need for additional feedback mechanisms for evaluating the effectiveness of ozone control strategies.

The intent of these enhanced ozone and ozone precursor monitoring regulations is to require air pollution control agencies to obtain an air quality database that will assist in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone National Ambient Air Quality Standards (NAAQS). Photochemical assessment monitoring stations (PAMS) will be established to collect ambient concentrations of ozone (O_3), oxides of nitrogen (NO_X), nitrogen dioxide (NO_2), nitrogen oxide (NO), and speciated VOC including carbonyls, and meteorological data to better characterize the nature and extent of the O_3 problem, aid in tracking VOC and NO_X emission inventory reductions; assess air quality trends, and make attainment/nonattainment decisions. In addition, the PAMS will provide a more definitive database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data will be particularly useful to States in ensuring the implementation of the most cost-effective regulatory controls.

In the process of developing these regulations, EPA sought the assistance of the Standing Air Monitoring Work Group (SAMWG). SAMWG was established by EPA in 1975 to assist in developing air monitoring strategies, correcting identified monitoring problems, and improving overall national monitoring operations. SAMWG members represent State and local air pollution control agencies and EPA program and Regional Offices. SAMWG members were active partners in developing and reviewing the 1979 part 58 rulemaking package which formally established the existing framework of the ambient air quality surveillance and data reporting regulations. The group also played a prominent role in all subsequent revisions to part 58.

Public Comments

The object of Federal Register proposals is to allow comments on new regulations prior to their promulgation, thereby providing an opportunity for the public to participate in the rulemaking process. On March 4, 1992, these rules were proposed in the Federal Register with a 30-day comment period. In response to requests from the public, especially from the regulated community of State and local air pollution control agencies, on April 3, 1992, EPA extended the public comment period on the enhanced O_3 and O_3 precursor monitoring regulations until May 4, 1992.

EPA received 40 written comment letters on the proposal of March 4, 1992. All of the written comments submitted to EPA are contained in EPA's Docket No. A-91-22. Of the letters reviewed, 16 come from State agencies, 10 from industry, 2 from institutes and universities, 6 from State/local associations, 5 from local agencies, and 1 from a federal agency. A list of all commenters writing to the public docket is provided in Docket A-91-22.

The following discussion covers the substantive comments. A detailed discussion of the basic concepts of the regulations can be found in the preamble to the March 4, 1992 proposal.

A. General Comments

The comments discussed under this heading were not specific to any rule or appendix, but were general comments on some aspect of the proposed monitoring program.

One commenter noted that the Muskegon nonattainment area had been reclassified from a serious to a moderate classification and therefore should be withdrawn from consideration in the final rules. Since this area and the Sheyboygan area have been reclassified and are no longer serious, severe, or extreme O_3 nonattainment areas, EPA agrees that these rules would not apply to either Muskegon or Sheyboygan. Accordingly, Muskegon and Sheyboygan are not included in EPA's estimated requirements for PAMS. Note that applicability of these enhanced O_3 and O_3 precursor monitoring rules is determined by the classification of the O_3 nonattainment area and not by the fact that an area is listed specifically in or omitted from this notice.

One commenter observed that Ventura County, California, was created as a separate O_3 nonattainment area from the Los Angeles Consolidated Metropolitan Statistical Area (CMSA) and requested clarification as to this area's status with regard to the enhanced O_3 and O_3 precursor monitoring requirements. EPA notes that since Ventura County was classified as a severe O_3 nonattainment area, the county is subject to these rules.

One commenter agreed with the basic concepts proposed on March 4, but suggested that the final promulgation not add additional requirements. A second commenter expressed a similar opinion that EPA not kill the effort with additional mandates unless the Agency is willing to proceed slowly and absorb the costs. EPA evaluated the substantive comments on their individual and collective merits and has incorporated a number of modifications to the original proposal. Only those additional activities addressed, in the March 4 proposal, were added. Regarding resources, EPA has demonstrated its willingness to participate in the funding process; a further discussion of resource needs and funding follows under Resources and Costs.

One commenter indicated that although the regulation is reasonably specific concerning network design, it lacks specificity for the submittal of SIP revisions. Given the complexity of the rules, EPA believed that it was necessary to provide extensive detail concerning the design of the new PAMS networks. The wide variability, inherent in SIPs, precludes such specificity when requiring SIP revisions. Each currently-approved SIP contains appropriate provisions for establishing and operating the network of State and Local Air Monitoring Stations (SLAMS) including those stations identified as National Air Monitoring Stations (NAMS). The SIPs generally provide that SLAMS and NAMS will measure ambient concentrations of those criteria pollutants for which standards have been established in 40 CFR part 50. The SIP revisions submitted to comply with these revisions to 40 CFR part 58.20 will additionally provide for the monitoring of ambient concentrations of non-criteria pollutants such as speciated VOC including carbonyls, NO and NO_x, as well as meteorological parameters in the same manner that the criteria pollutants were addressed. Note that the reference to aldehydes has been changed to carbonyls to more accurately reflect the requirements of the technical assistance document (Reference 2 of Appendix C). The guidance currently stipulates sampling and analysis for the following carbonyls: Formaldehyde, acetaldehyde, and acetone.

The same commenter contends that the rules indicate virtually no need for new O_3 sites and a modest expansion of the NO_2 monitoring effort and believes that these conclusions are based in great part on the assumption that PAMS monitors could be located at existing O_3 and/or NO_2 monitoring sites. The commenter was concerned that if this assumption is in error, the expansion needs of the networks may be underestimated. In fact, EPA did assume that some of the PAMS stations could be located at existing SLAMS or NAMS sites. For example, the PAMS type (3) site is located at the downwind site where maximum O_3 concentrations are expected to occur. This description corresponds to the category (a) NAMS O_3 site specified in appendix D of 40 CFR part 58. Such a site is required for all urban areas having a population of greater than 200,000. Because most of the nonattainment areas classified as severe, serious, or extreme for O_3 are located in urbanized areas which exceed this population threshold, each area would currently be expected to be operating a category (a) NAMS O_3 site. Assuming that these sites are properly located, it would therefore be common to find the PAMS type (3) site and the NAMS category (a) site coincident. In siting NAMS NO_2 sites in urban areas with populations greater than 1,000,000, the monitoring sites could potentially be collocated with one of the two PAMS type (2) sites. Generally, EPA believes that some collocation of PAMS and SLAMS/NAMS sites is highly likely. In addition, in areas where a substantial number of SLAMS O_3 and NO_2 sites currently exist, it is not unreasonable, for purposes of estimating costs, to assume that the State air pollution control agency will relocate ambient monitors and appurtenances rather than purchase only new monitors to develop the PAMS network. For example, in one nonattainment area, 26 O_3 monitors and 15 NO_2 monitors were in operation during the 1991 fiscal year compared to a PAMS requirement of only 5 sites, some of which could obviously be located coincident with existing sites. In response to the concerns expressed by the commenters, however, EPA has adjusted its cost estimates to reflect the collocation of PAMS with existing monitors at only two sites in a five-site network.

One commenter was doubtful that the potential benefits to be received from the program would be justified given the estimated implementation costs and the unaddressed technical questions. A slower, more cautious schedule was recommended. In designing the requirements for the PAMS network, EPA considered the potential benefits of the data and weighed those against the projected costs and uncertainties. In light of the Agency's estimate for future O_3 control costs of $8 to 12 billion per year (Ozone Nonattainment Analysis—Clean Air Amendments of 1990. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. DRAFT. September 1991), the potential return in benefits for a cost of $5 to 12 million per year provides an exceptionally prudent investment. Nevertheless, the Agency made every effort to craft a minimum requirement which would in great part satisfy a number of important objectives, yet not become a financial burden either upon the air pollution control agencies or the States (note further discussions of financial burden in this preamble under Resources and Costs). Modifications to the proposed five-year transitional period address the commenter's concern and should provide ample flexibility.

This commenter also indicated that computer model sensitivity analyses should be conducted for all parameters to be measured and that the rule should acknowledge the need for measuring pollutant concentrations aloft. EPA notes that although the PAMS network design is not the direct result of sensitivity analyses for each affected area, it nevertheless reflects the current expectations of the photochemical models. Heretofore, the national program has not had the benefit of the

availability of comprehensive O_3 precursor data as a tool to evaluate, calibrate, or otherwise adjust and conduct reality checks on the operation of the Urban Airshed Model (UAM). EPA views the PAMS networks as a vital step forward in complementing grid model applications and control strategy assessments and refinements.

Although the sampling of pollutant concentrations aloft may also be a highly valuable activity, EPA does not agree that such activities should be included in the specifications for minimum routine measurements. These rules, however, do not preclude a State agency from proposing such pollutant measurements (made either on a routine basis or at periodic intervals during more intensive sampling efforts), including them in their EPA-approved comprehensive network description, and subsequently utilizing Clean Air Act Section 105 Grant monies, in part, to support these monitoring efforts. In fact, EPA has encouraged affected air pollution control agencies to view these rules as a base upon which to tailor and expand the precursor monitoring program to meet the States' individual needs. Monitoring pollutant concentrations aloft has therefore been assigned to the category of desirable, yet optional activities.

Two commenters suggested that EPA adjust its program to reflect information from previous field studies (i.e., base the rules on actual field-verified techniques rather than on good technical assumptions alone). EPA recognizes the value of quality measurements and field-proven techniques. In fact, the fundamental tenets of the proposal were based on the demonstration of emerging measurement technology and data obtained during a number of field studies, particularly the Atlanta O_3 Precursor Study conducted during the summer of 1990 (Reference 32 of Appendix D). Although technical assumptions were necessary to some extent due to the emerging nature and complexity of the measurement technology, EPA believes that these assumptions were warranted considering the need for more definitive O_3 precursor data to develop improved O_3 control strategies. States are encouraged to take full advantage of experience and data obtained in past studies and routine monitoring efforts, and use that experience to refine and focus their individual PAMS network designs.

One commenter noted that the requirements for intensive daily sampling will engender major database management activities. EPA agrees that the measurement of numerous compounds during multiple hours of the day will create a very large database. Consequently, the Agency is proceeding to revise the capabilities of its computer-based Aerometric Information and Retrieval System (AIRS) to allow these data to be securely stored, retrieved, and adequately analyzed via the existing national system. The AIRS is currently utilized by all States for the storage and/or retrieval of NAMS and SLAMS data. The data required to be submitted by § 58.45 will be deposited in this same data bank. Further information on AIRS and its capabilities may be obtained by contacting any of the 10 EPA Regional Offices or the National Air Data Branch, Technical Support Division (MD-14), Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. The Agency is also revising its technical assistance document (Reference 2 of Appendix C) to include additional guidance regarding the processing of data at the State and local agency level, i.e., generic procedures for data processing and validation.

In a related topic, another commenter estimated that the proposed rules will result in a workload increase of 60 percent, predominantly in data reporting burden. This commenter advocates the development by EPA of expert software for use with the VOC analyzers. The Agency notes this concern and has therefore undertaken the aforesaid modifications to the AIRS system and to its technical assistance document.

One commenter was concerned that a bias in O_3 measurements often occurs on design-value days, in part due to differences in measurement techniques. While the Agency cannot substantiate a particular problem occurring on O_3 design value days, the Agency notes that data which is gathered in accordance with 40 CFR part 58 and the quality assurance procedures of appendix A, are acceptable for use in computing design values and for conducting attainment/nonattainment determinations.

The same commenter believes that EPA should examine the following four areas more carefully before finalizing the rule: (1) The linking of monitoring specifications with monitoring objectives, (2) the consequences for an urban area adhering to the minimum stipulated monitoring requirements, (3) the rationale for recommended averaging times and frequencies for sampling of VOC, and (4) the rationale for air quality and meteorological siting requirements. The Agency considered these suggestions, recognized their value, and subsequently incorporated these considerations into the final rules. Specific recommendations made by this commenter are addressed elsewhere in this preamble.

Two commenters expressed concern that EPA had not adequately addressed critical issues relating to the role of NO_x in the photochemical process. These commenters assert that EPA must ensure that the data gathered will be appropriate for NO_x sensitivity modeling and will facilitate discrimination and impact of various sources of NO_x. EPA is concerned about the function of nitrogenous compounds in O_3 formation, particularly in the southeastern United States. Special studies are being initiated as joint projects with EPA in the Southeast employing research monitoring concepts to derive the most effective strategies for NO_x monitoring and control. These integrated projects are expected to have a significant impact on future O_3 control actions. Modeling predictions of various nitrogen species (e.g., total reactive oxides of nitrogen (NO_y), NO_x, NO, NO_2, peroxyacetyl nitrate (PAN), and nitric acid (HNO_3), etc.) can then be examined by the research community to determine the performance of chemical mechanisms in predicting non-O_3 oxidants. This will help ensure that chemistry, leading to O_3 formation in urban and rural areas, is properly characterized and may lead to further modeling improvements. Note that the measurement of more highly oxidized forms of nitrogen requires a high degree of skill/training using nonstandard techniques to measure pollutants at very low concentrations. EPA has determined that it is premature to require such efforts in a routinely operated network, but encourages and recommends that States consider the option of deploying more sensitive NO_x instruments when establishing future PAMS sites. For the near term, the current NO_x monitoring methodology (Federal Reference Method for NO_2) will be acceptable. The Agency will develop future guidance for more sensitive and definitive NO_x methods and measurements.

One commenter expressed concern that many technical, logistical, and fiscal issues remain to be resolved to ensure the success of the PAMS monitoring program. This respondent asserted that its comments, analyses and suggestions were, for the most part, ignored. On the contrary, however, the Agency has considered all comments and suggestions received by the Agency. This commenter's suggestions, being rather comprehensive, complicated, and unique, received careful scrutiny by EPA. In a number of cases, these

suggestions were incorporated both in the previous draft proposals as well as in this final promulgation. In fact, the final regulation has been revised to allow alternative monitoring schemes and intermittent sampling frequencies in section 4 of appendix D, in part in direct response to this commenter. The fact that EPA did not radically change its approach to identically match the suggestions of this particular respondent in no way diminishes the importance of the suggestions, nor does it equate to ignoring the recommendations. Each specific recommendation has been addressed elsewhere in this preamble.

B. Public Comments—Resources and Costs

Several commenters were concerned with the statement in the proposal which says that the primary responsibility for implementing the program with its associated costs rests with the States. The commenters feel strongly that EPA needs to make a much larger financial commitment to the program to ensure its success. EPA understands that this unique program will require a strong federal presence both as a partner in system management and in providing appropriate technical and financial assistance. EPA has provided funds during FY–92 to initiate monitoring for air toxics in 10 areas. These sites, which are generally located consistent with the requirements for PAMS type (2) sites, will be continued as part of the PAMS program in 1993. Additionally, the Agency has earmarked approximately $4,000,000 in § 105 Grant monies for distribution to the States in FY–93 and has provided technical support via contract and direct EPA involvement and participation. Overall, EPA will have borne the burden of financing a significant portion of the costs of initiating sampling during FY–92 and FY–93. The Agency has plans for subsequent years which will ensure a major financial role in this partnership for EPA.

Eighteen commenters submitted other observations related to funding and resource needs to properly implement the PAMS program. Ten of those commenters believed that the proposed levels of federal funding (discussed above) are generally inadequate to support the PAMS program. Three commenters noted that the potential benefits of the program outweigh the projected costs, that serious consideration should be given to utilizing permit fees collected under title V of the Clean Air Act Amendments for this program, and/or that the monitoring costs are only a fraction of the costs incurred by society in attaining the air quality standards. Two commenters expressed strong objections to the use of reprogramming of existing funds to support the PAMS program. As previously discussed, EPA has provided substantial section 105 Grant funds to support both FY–92 and FY–93 monitoring activities. The Agency expects to continue to provide significant support through section 105 grants in subsequent years. Reprogramming of existing monies is an action which historically has been used by the Agency to designate certain portions of section 105 Grant funds, provided annually to the States for support of air pollution planning and control programs. EPA believes that this mechanism is a legitimate tool to focus its limited grant funds in part on particular air pollution problems having high national priorities. Rarely does the Agency suggest using this mechanism unless the priority of a competing program or project is significantly greater than the currently-funded activity. EPA has determined that the potential benefits of the PAMS program are significant enough to justify taking this unilateral action.

One commenter suggested that the distribution of section 105 Grant funds be based on the number of sites and monitors operated regardless of the location of the nonattainment areas. Perennially, it has been EPA's practice to develop reasonable allocation schemes for the available grant dollars based on defensible parameters such as activity levels, numbers of sources, etc. In the case of the monies set aside for the photochemical assessment monitoring program, EPA concluded that an appropriate mechanism for the distribution of funds was to consider the number of required PAMS sites. Each affected Regional Office receives an allocation of funds based on a national prorata scheme; the final allocation to State or local grantees is computed by the Region. During FY–93, the primary allocation criteria was essentially the minimum number of PAMS sites that would be required in each area by the regulation. By FY–94, the Agency will have received more information on individual network designs from each affected State and will therefore be able to consider the actual number of sites to be operated during the year as one of the criteria for the distribution of grant funds.

Another commenter suggested that if States are unable to hire additional personnel, they could return grant monies in exchange for EPA contracted services or perhaps pool analytical support among a group of States. Given the continuing nature of much of the federal funding for photochemical assessment monitoring, EPA asserts that it would not be inappropriate for a State agency to utilize the monies to hire new personnel. Further, due to economies of scale and within permissible limitations, States may take advantage of EPA contracts which are designed to provide support to State agencies. Additionally, the EPA Regions may at the urging of a group of States, reserve certain monies for a particular State who would agree to, in turn, provide services to the others.

One commenter was concerned that the design of the enhanced O_3 and O_3 precursor monitoring program was influenced more by financial constraints than by scientific constraints. EPA disagrees with this contention, and instead has attempted to provide a sensible balance between the costs of the program and degree to which the program objectives are satisfied. In any case, EPA has only provided the framework for a minimum required monitoring strategy. States are encouraged to implement larger, more comprehensive networks if those networks will provide a superior database for the fulfillment of the data objectives.

Five commenters expressed concern that EPA's estimates for the costs of implementing this monitoring program were too low. EPA's costs estimates were prepared from data gathered during 1990 and 1991, and therefore are generally expressed as 1990 and 1991 dollars. It is not surprising that estimates prepared in 1992 should be somewhat higher. In many cases it was difficult to compare estimates prepared by the commenters, since they often utilized different wage scales, different quoted equipment costs, and different operating scenarios. In most cases, recognizing that these figures are only estimates of the true implementation costs, the Agency believes that its original estimates reflected a reasonable appraisal of the resources needed to implement a minimally-acceptable program at that time. EPA has, however, incorporated many of the suggestions of the commenters for computing costs and has compiled an updated version of its cost estimates. These estimates reflect the changes in the boundaries of several nonattainment areas, changes in classification of others, higher equipment and labor costs, revised sampling frequencies, additional allocations for data processing, upper air measurements, O_3 and NO_x monitors, security concerns, and larger monitoring shelters. For information, the Agency's updated cost estimates for each affected area may be found in Table 1.

TABLE 1.—ESTIMATED REQUIREMENTS FOR PAMS

Area name	Population range	Classification of nonattainment area	Number of required sites	Estimated five-year cumulative cost[1]
Beaumont-Port Arthur, TX	Less Than 500,000.	Serious	2	$2,321,820
Portsmouth-Dover-Rochester, NH-ME	do	Serious	2	2,227,135
Southeast Desert Modified AQMA, CA	do	Severe	2	2,280,880
Baton Rouge, LA	500,000 to 1,000,000.	Serious	3	3,188,135
El Paso, TX	do	Serious	3	3,188,135
Springfield, MA	do	Serious	3	3,127,485
Ventura County, CA	do	Severe	3	3,188,135
Milwaukee-Racine, WI	1,000,000 to 2,000,000.	Severe	4	3,788,490
Providence-Pawtucket-Fall River, RI-MA	do	Serious	4	3,788,490
Sacramento, CA	do	Serious	4	3,873,070
Atlanta, GA	More than 2,000,000.	Serious	5	4,031,150
Baltimore, MD	do	Severe	5	3,986,300
Boston-Lawrence-Worcester, MA-NH	do	Serious	5	3,986,300
Chicago-Gary-Lake County (IL), IL-IN-WI	do	Severe	5	3,986,300
Greater Connecticut, CT	do	Serious	5	3,986,300
Houston-Galveston-Brazoria, TX	do	Severe	5	4,084,850
Los Angeles-South Coast Air Basin, CA	do	Extreme	5	4,084,850
New York-New Jersey-Long Island, NY-NJ-CT	do	Severe	5	3,986,300
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD	do	Severe	5	3,986,300
San Diego, CA	do	Severe	5	4,084,850
San Joaquin Valley, CA	do	Serious	5	4,084,850
Washington, DC-MD-VA	do	Serious	5	3,986,300
Totals			90	79,348,410

[1] 1992 Dollars.

Additionally, several commenters were concerned that EPA only computed costs for the three-month period of June, July, and August, while the draft rule implies that monitoring should be conducted during the entire O_3 season, which can be much longer. EPA indeed states that monitoring for precursors should be conducted during the entire O_3 season, but recognizes that monitoring for only 3 months is an acceptable minimum. The preamble from the March 4, 1992 proposal clearly stated that because of the relatively large resource requirements to conduct PAMS monitoring, 3 months was proposed as the minimum annual precursor monitoring period for the PAMS. EPA did encourage, however, the establishment of a monitoring period for the entire O_3 season in order to provide a more comprehensive air quality database and increase the possibility of actually conducting monitoring during most of the worst O_3 episodes. EPA goes further, however, in the revised section 4.3 of appendix D, stating that alternate precursor monitoring periods may be submitted for approval as a part of the PAMS network description. This action, therefore, allows a State to propose a monitoring season which will best meet its particular needs as long as the proposal will capture those worst O_3 events. The length of any particular PAMS monitoring season may therefore vary from area to area.

Two commenters asserted that the data collection requirements of the rule were excessive for some of the stated purposes and inadequate for others. EPA has continually maintained that in formulating the data requirements for the PAMS program, it was necessary to achieve some compromises, (i.e., some more crucial objectives would be better satisfied than other less important objectives). Regardless, the Agency has reconsidered the requirements for data collection, and has modified the specifications to better reflect a balance of the needs of the data users.

One commenter alleged that EPA committed to provide full funding for all efforts required under the Photochemical Assessment Monitoring Program and further alleged that EPA committed that it would not require state or local agencies to perform the specified monitoring if full funding of all materials, equipment and labor is not provided by EPA. That commenter also requested that EPA clearly articulate this assertion in the rules promulgated today. Another commenter asserts that EPA indicated this intent in the proposed regulation. It is common practice for State agencies to share substantially in the costs of implementing and operating all air pollution monitoring and control programs. In fact, the Clean Air Act Amendments of 1990, section 802, revise section 105 of the Act to require that States provide an overall minimum of 40 percent of the costs of implementing programs for the prevention and control of air pollution or implementation of national primary and secondary ambient air quality standards. EPA is therefore unable to commit that it would provide 100 percent of the funding for such a substantial program. Evidently, some confusion has resulted from EPA's attempts to provide maximum monetary support for the implementation of the enhanced O_3 and O_3 precursor monitoring regulations.

One commenter believed that although the proposed funding for this program may be adequate to encompass capital expenses, provisions for skilled labor costs will be a problem. EPA notes that provisions for the hiring of highly skilled chemists and statisticians were included in its cost estimates and planning for PAMS. Further, these estimates were reviewed by the Agency and revised upward to reflect changes in the national labor burden and the expressed needs of the State and local air pollution control agencies.

One commenter believed that the comprehensive sampling and analysis schedule stipulated by the proposed rules is the primary contributor to the high costs of the program. As previously stated, EPA is committed to only requiring a minimum program which will comprise the best technical-fiscal balance to satisfy a variety of data objectives. Since the proposal was

published, EPA has refined its sampling and analysis requirements to better reflect the data needs.

In an effort to focus resources and reduce the costs of implementation, several commenters have recommended totally different strategies that they believe will also achieve the data objectives of the PAMS program. The Agency has reviewed these different proposals and believes that they do not constitute appropriate national minimum requirements, but may be considered as alternative networks for particular nonattainment areas if they are submitted pursuant to the requirements of § 58.40 and appendix D as promulgated. EPA has determined that the suggestions were too closely tailored to particular geographic areas to be applied nationally.

One commenter was concerned that the costs of measuring air toxics was a substantial addition to the price of the PAMS program. EPA has noted that the PAMS stations would be available as platforms for the additional monitoring of air toxics compounds if necessary. Specifically, it is noted by the Agency that by measuring the VOC targeted in reference 2 appendix C, a number of toxic air pollutants will also be measured. Although compliance with title I, section 182 of the Clean Air Act Amendments does not require the measurement and analysis of additional toxic air pollutants, the Agency believes that the PAMS stations can serve as cost-effective platforms for an enhanced air toxics monitoring program. The adjunct use of PAMS for air toxics monitoring will allow the consideration of air toxics impacts in the development of future O_3 control strategies. The establishment of a second PAMS type (2) site will provide an even better data base for such uses. The Agency, however, takes note of the concerns of several respondents that the PAMS network is not ideal as a source of primary air toxics data and further, regards the collection of air toxics data as an incidental and secondary, though important, objective of the PAMS system.

In overall response to concerns over the estimates of costs previously provided by the Agency, EPA has recomputed its estimates including such additions noted previously as inflation factors, additional capital equipment, etc.; the new computations are summarized in Table 1.

C. Public Comments—Regulations

The following discussions address the comments received on specific provisions of the enhanced O_3 and O_3 precursor monitoring regulations:

1. Public Comments—Section 58.1—Definitions

Four commenters suggested adding definitions for the term NO_y, a relatively new term for total reactive oxides of nitrogen including NO, NO_2, PAN, HNO_3, and organic nitrite compounds which all participate in the photochemical process. Current research has revealed that these other compounds may indeed play a significant role in O_3 formation. EPA does not disagree with the commenters. Since no readily-available monitoring method has been designated for these species, however, and most information on the role of NO_y, or other such compounds, still lies within the research community, EPA has determined that inclusion of any definition and/or regulatory requirements for monitoring for NO_y is premature. Future revisions to 40 CFR part 58 will reexamine the state of the research and reconsider this issue. Nevertheless, EPA encourages the deployment of this emerging technology at PAMS sites to further augment the value of the O_3 and O_3 precursor measurements.

Additionally, two commenters recommended that the definition of VOC be clarified and perhaps focused to indicate a reference to reactive organic gases. Further, one commenter suggested that an acronym be included for toxic air pollutants. Inasmuch as EPA has specifically named the compounds (VOC) targeted for monitoring and analysis by this program, see reference 2 appendix C, and expects that list to evolve as the monitoring program matures, the Agency believes that a more focused regulatory definition is not needed at this time. Such a move, made prematurely, might unnecessarily constrain development of the program in future years and inadvertently limit the data available to the States to craft the most effective O_3 control strategies. Since the foci of this monitoring program are clearly O_3 precursors and O_3, these rules are not the most appropriate vehicle to define or name air toxics compounds. Such actions will be subsequently considered by the Agency's air toxics control programs.

2. Public Comments—Section 58.2—Purpose

One commenter felt that it is an oversight not to consider application of this regulation to moderate O_3 nonattainment areas. EPA notes that enhanced information on O_3, O_3 precursors, and meteorology would be beneficial to any State government wrestling with the enigma of any level of O_3 nonattainment. Section 182(c)(1) of the Clean Air Act Amendments of 1990, however, authorized the Agency to develop rules only for those areas classified as serious or above for O_3 nonattainment. The fact that States with moderate areas will not be required to institute these specifications, should not impede those State agencies from configuring monitoring strategies which are similar to the photochemical assessment monitoring program.

3. Public Comments—Section 58.13—Operating Schedule

One commenter recommended that this section be amended to restate the monitoring period requirements of section 4.3 of appendix D. EPA notes that it would be beneficial to include a reference to section 4.3 in § 58.13, and has amended the final rule accordingly.

4. Public Comments—Section 58.20—Air Quality Surveillance Plan Content

Four commenters expressed concern that the requirements for VOC and/or meteorological parameters were too comprehensive and constituted excessive collection of data. Additionally, several commenters believed that the substitution of measurements for total VOC, non-methane organic compounds (NMOC), or total non-methane hydrocarbons (NMHC) (note that these acronyms essentially represent the same group of species) would be adequate to fulfill the PAMS data objectives, at least at some of the designated sites. EPA has reexamined its position regarding requirements for the speciation of VOC analyses and has concluded that continuation of the speciated requirement is both appropriate and necessary. This conclusion is based on the need for more definitive information regarding VOC at the specific geographic locations where O_3 exceeds the National Ambient Air Quality Standard (NAAQS), in order to address the multi-faceted PAMS objectives. The sampling for speciated VOC data allows the verification of NMOC measurements and provides a better understanding of the biogenic contribution to the O_3 problem. The corroboration of progress in the reduction of O_3 precursor emissions inventories would necessitate the quantification of the biogenic and anthropogenic fractions for those areas where biogenics represent a significant component of the ambient air. Additionally, the Agency has modified the sampling and analysis requirements to reflect the acceptance of event sampling at 3 of the 5 minimally-required sites. Such a modification has

the potential to reduce the data handling requirements, costs, and level of technology needed. The amended sampling and analysis requirements are specified in section 4.4 of appendix D. Alterations to the requirements for the measurement of meteorological parameters are discussed in section 4.6 of appendix D. Note, however, that the promulgated sampling requirements for speciated VOC do not preclude the submittal of alternative sampling schemes as a part of the network design required by § 58.40.

Three commenters felt that 6 months is too short a time frame for SIP development, processing, and approval. Note the brief discussion of SIPs under General Comments, EPA believes that the required SIP revision to empower States to implement the enhanced O_3 and O_3 precursor monitoring regulations will be a relatively uncomplicated procedure. Given the intrinsic need for the data required in this promulgation, the Agency recommends that all States, including those which are not affected by these rules, develop such SIP revisions. Based on a review of common SIP procedures, EPA has subsequently modified § 58.20 to allow 9 months for the submittal of a revision to the SIP for the establishment and maintenance of PAMS.

5. Public Comments—Section 58.40—PAMS Network Establishment

Seven commenters asserted that 6 months is insufficient time for a State to develop and submit a PAMS network description. Inter- and intra-State cooperation, data needs, and complexity issues were cited as reasons for the demand for more time. EPA Headquarters and the EPA Regional Offices have been working with affected State and local air pollution control agencies as well as cooperative bodies such as the Northeast States for Coordinated Air Use Management (NESCAUM) and the Mid-Atlantic Regional Air Management Association (MARAMA), to develop the basics of individual and regional PAMS network descriptions. Additionally, EPA has provided funding during FY-92 to begin the establishment of monitoring sites, many of which will eventually constitute the first PAMS type (2) sites. Given the extensive preparatory work conducted since 1990 by both the Agency and the States, EPA believes that a 6-month requirement for the submittal of a network design is both achievable and appropriate. In response to the concerns of the commenters, however, EPA has clarified, in § 58.41, its need for detail in the initial network design submittal and has indicated that specific details on the first PAMS type (2) site plus general information on other sites, would constitute a complete submittal for fulfillment of the requirements of § 58.40. Note, however, that since the network design must receive the approval of the Administrator as stipulated by § 58.42, EPA will require the submittal of subsequent phases of detailed network design by January 1 of each year of implementation. In this way, a State may focus its resources on an annual basis toward the establishment of one site per area. For groups of States planning to submit coordinated network designs, the process will also be simplified somewhat. Sections 58.40, 58.41, and 58.42 have been amended accordingly.

Four commenters felt that the language of § 58.40, which allows the joint submittal of network descriptions and implementation schedules by disparate States (and further discussed in section 4.2 of appendix D), should be strengthened to make such inter/intra-State cooperation mandatory to ensure consistency and coordination, especially in O_3 transport regions. In general, EPA believes that cooperation among State and local air pollution control agencies should be encouraged, but not required. The Agency has demonstrated its preference for cooperation by its technical, administrative, and financial support of such multi-State cooperative agencies as the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAPPA/ALAPCO), NESCAUM and permanent Federal-State-local work groups such as the Standing Air Monitoring Work Group (SAMWG), the Standing Air Emissions Work Group (SAEWG), and the Standing Air Simulation Work Group (SASWG), affiliated with STAPPA/ALAPCO. This particular provision of the rule is designed to enable the exercise of cooperative efforts, but does not serve as the tool to require States to plan and implement programs jointly. Note, however, that section 182(j) of the Clean Air Act Amendments of 1990 does stipulate that each State in which there is located a portion of a single O_3 nonattainment area which covers more than one State should take all reasonable steps to coordinate, substantially and procedurally, the revisions and implementation of State implementation plans applicable to the nonattainment area concerned. Also, interstate transport regions established pursuant to section 176A of the Clean Air Act Amendments should be guided in multi-State coordination and consistency via the establishment of transport commissions. Further, section 184 of the Act indicates that such procedures are requisite for those northeastern States included in an O_3 transport region. These premises have been articulated in an advance notice of how EPA generally intends to take action on SIP submissions and to interpret various title I provisions in the Federal Register on April 16, 1992, as amendments to 40 CFR part 52. It is therefore inappropriate for EPA to separately require such cooperation as a part of these enhanced O_3 and O_3 precursor monitoring rules. The Agency has, however, modified the rules to indicate this preference for cooperation and joint network design submittal, where appropriate.

One commenter suggested that EPA support joint submittals, but not joint implementation schedules. In § 58.40, EPA indicates a preference for coordination, but does not necessarily require identical designs and implementation schedules for cooperating States. Differences in designs and schedules would be evaluated on a case-by-case basis.

One commenter recommended that regional plans be given favorable if not at least equal attention as is given to State-by-State plans within the same regional area. EPA has previously expressed its preference for regionally coordinated network designs, but must provide equal consideration to both types of descriptions allowed by these rules.

Two commenters suggested that the approval of the PAMS program be relegated to the Regional Offices in lieu of requiring approval by the Administrator. In considering this comment, EPA agrees with the contention of the commenter that the Regions are more familiar with the idiosyncrasies of each O_3 nonattainment area and, as a result, Regional Office concurrence on each network design is required. In several cases, however, the areas subject to these rules, cross both State and EPA Regional boundaries. The Agency is convinced that a program of this magnitude requires intensive national oversight and a high degree of consistency and coordination; final approval must therefore rest with a central reviewing authority.

Two commenters suggested that flexibility be included to allow each network to be designed on a case-by-case basis because each area has unique features such as irregular terrain or distinct meteorology, such as sea/lake breezes, which should be addressed separately. EPA also believes that each

area's network design should be specifically tailored to fit that particular area or region. The network design parameters promulgated today are those considered by the Agency as a minimum and/or a default network for those State agencies wishing to omit comprehensive, area-specific planning exercises. Although EPA does not recommend minimizing planning, the Agency recognizes that State resources and technical expertise often demand a fallback position in lieu of extensive investments in the planning process. Note that the Agency is revising the siting criteria guidance document (Reference 19 of Appendix D) to provide guidance on siting and network design for areas with complex terrain or unique meteorology.

One commenter recommended that a working group be established to deal with the coordination of monitoring strategies and network designs in the Northeast Ozone Transport Region. The commenter recommended two specific groups associated with electric utilities as technical resources for such a working group. EPA maintains that the responsibility for the implementation, and therefore the coordination, of SIP strategies lies with the States. The Agency is therefore cooperating with NESCAUM, MARAMA, and the Regional Ozone Modeling for Northeast Transport (ROMNET) committees to form a working group of State, local, and EPA officials to provide guidance in the development of a coordinated monitoring network for the Northeast.

Another commenter encouraged EPA to perform quantitative statistical analyses to ensure that the minimum-required network is sufficient to corroborate emission inventories and determine precursor trends. Due to the emerging nature of the technology for corroborating emission inventories and procedures for determining precursor trends, it is not feasible at this time to perform quantitative statistical analyses for this purpose. EPA believes, however, that these analyses can be performed effectively once the PAMS networks are in place and producing data. Adjustments based on these analyses will be appropriate when the procedures are more mature and the data bases are more complete. To shed light on these comments, EPA has prepared a Data Quality Objectives (DQO) document which was used to evaluate the original network proposal of March 4, 1992, and this modified final rule. That document is identified as reference 24 of appendix D. Additionally, EPA supported and/or noted other analyses concerning data for emissions inventory applications and trends. Those studies are noted as references 26, 27, 28, 29, and 30 of appendix D.

Several commenters pointed out the need for EPA to better articulate guidance on the submittal of information for network approval and any criteria EPA would utilize for approval of these and any alternative network submittals. Further information concerning network design is included in section 4 of appendix D. EPA has also incorporated additional information and criteria regarding the approval of alternative networks in section 4 of appendix D as a part of this promulgation.

During the comment period, several agencies submitted proposals for their areas which are considered to be alternative network descriptions. EPA will review those designs individually and respond directly to the particular agency. Those designs are not considered germane to the requirements of the regulation and so are not specifically reviewed in this notice of rulemaking.

One commenter urged EPA to eliminate the public notice requirements of alternative plans and subject them to the same process as other network designs. EPA realizes that although it is today promulgating minimum criteria for PAMS networks, many designs will have peculiarities which may qualify them as alternative networks and subject them to the proposed public notice requirements of § 58.40 and further, sections 4.3 of appendix C and 4.2 of appendix D. To facilitate the submittal of network descriptions and to expedite their processing by the Agency, EPA is today removing the proposed requirements for public notice for alternative network descriptions and will instead focus resources on improving the quality of the negotiation, review and approval process.

One commenter noted that it may be necessary to site PAMS monitoring stations near major roadways and certain large stationary sources because of the possibility of their direct influence on local concentrations of O_3. The regulations promulgated today require the siting of certain monitors at the location of the maximum impact of emissions from sources of O_3 precursors. EPA recognizes that in some instances this site may be substantially affected by one or more very large major stationary sources which constitute a principal source of O_3 precursors for the nonattainment area. Additionally, if the major impact on O_3 in a particular area originates from mobile sources, it would be logical to place a PAMS site downwind of a major roadway. In any case, it is crucial to consider and account for local NO_x sources including roadways which may act as local depressors for O_3 when designing a network as described in section 10 of appendix E.

8. Public Comments—Section 58.42—PAMS Approval

Note that comments submitted recommending approval of network designs at the EPA Regional Office level were previously addressed under § 58.40.

One commenter in voicing support of the flexibility of allowing alternative plans noted that their agency does not feel that national consistency and uniformity of methods are essential, given that different areas are at different levels of learning with respect to their area's O_3 precursor composition and concentrations. EPA notes that each air pollution control agency program is subjected to its own particular set of problems, strategies, limitations, and coverage; in many cases some of these factors are quite unique. EPA, on the other hand, must deal with national databases and national problems under an entirely dissimilar set of limitations than any particular air pollution control agency. To that end, EPA is charged with ensuring some reasonable degree of national consistency so that national trends, comparisons, and strategies can be devised. Further, the Agency is convinced that during the phase-in period specified in section 4.5 of appendix D, most agencies will be capable of rising to the challenge of developing the necessary expertise to operate PAMS.

Concerning the approval of network designs, one commenter recommended that this section (and specifically section 4.2 of appendix D) be revised to require an EPA approval or disapproval within 60 days of the receipt of an alternative plan. Although EPA notes this commenter's sense of urgency with regard to the approval and implementation of the PAMS monitoring program, the Agency has determined that instituting artificial approval deadlines would not prove beneficial to improving the quality of alternatives, nor would the public be served by imposing restrictions which could result in lowering the quality of the review and approval process. EPA has therefore not incorporated this 60-day deadline.

7. Public Comments—Section 58.43—PAMS Methodology

One commenter suggested that additional language be added to the

rules to establish a process by which EPA could streamline the review and approval of innovative monitoring and analytical techniques. Further, this commenter recommended the use at PAMS of a particular new type of monitor which continuously tracks key photochemical oxidant components. The Agency believes that the new requirements provide sufficient flexibility for the incorporation of innovative monitoring and analytical techniques. The Atmospheric Research and Exposure Assessment Laboratory (AREAL) is currently responsible for the development, evolution, review and testing of new methodology to ensure its applicability and appropriateness for emerging national air monitoring needs. Regarding the use of this new measurement technology for photochemical oxidant tracking, AREAL, in conjunction with other interested parties, is engaged in an evaluation study of the proposed instrumentation to determine its utility in depicting the photochemical process. Additionally, research is underway to ascertain the usefulness of the data gathered by this instrument and others in meeting necessary O_3 control objectives such as those described in this rule. The results of these investigations will likely have a significant bearing on the future uses of the proposed instrumentation. In any case, neither the current research status of the procedures nor the innovative nature of the methods preclude their use at PAMS stations. A State air pollution control agency may, at its own initiative, implement this monitoring strategy as an adjunct to the minimum PAMS requirements; or, may submit a sampling scheme utilizing this technology exclusively, for consideration by EPA as an alternative pursuant to § 58.40 of this regulation.

8. Public Comments—Section 58.44—PAMS Network Completion

Ten commenters provided observations regarding the 5-year transition (phase-in) period further delineated in section 4.5 of appendix D. Four of those respondents indicated that total implementation of the program was not only possible, but also desirable in a 2- to 3-year period. One commenter, however, in supporting a 3-year transition, indicated that the reporting of VOC data should be deferred for 5 years due in great part to the technical, financial, and technology issues associated with VOC monitoring. Four of the ten commenters also characterized the urgency of expediting the implementation of PAMS to provide data support to the 1994 SIP photochemical grid modeling process. Five commenters indicated that the 5-year schedule is reasonable or at least ambitious, although two of these respondents suggested that the initial phases of the transition be either deferred or prolonged, essentially to allow for testing and evaluation of the new monitoring technologies and for training of professional staff. One commenter suggested that due to technology issues, the implementation simply be delayed one year. Five of the ten commenters reiterated their concerns with funding and urged EPA to provide substantial, adequate resources to complete the PAMS transition. One additional commenter urged EPA to allow sufficient flexibility for States to phase-in the program over time in a manner consistent with the level of available resources.

Due to expected near-term changes to the atmospheric mix of O_3 precursors and the need to begin monitoring as soon as practicable to provide a measure of support to SIP strategy development and emission inventory corroboration efforts, EPA believes that deferral of implementation is not a preferred option. Accordingly, the Agency is continuing efforts to support FY–92 and FY–93 PAMS-type monitoring initiatives via the Section 105 Grant process. Noting, however, the real concerns of State and local air pollution control agencies regarding the phase-in details, EPA is, in this promulgation, reconfirming the transition requirements, previously proposed, of one station per year and modifying the requirements to include provisions for flexibility.

9. Public Comments—Section 58.45—PAMS Data Submittal

Seven respondents expressed the opinion that the 6-month time period allowed by § 58.45 is reasonable and adequate for the submittal of VOC data. Three of these commenters indicated that allowing a reporting deadline of 9 months to a year for the first 2 years or so of the program would be preferable. This data phase-in would then allow added time for training in the implementation and interpretation of data and the data acquisition system. The final rules stipulate that the VOC data must be reported within 6 months following the end of each quarterly reporting period. Since the PAMS minimum monitoring season runs from June through August and encompasses two quarterly reporting periods, the June data would not be due until January 1 of the following year, and the remainder of July and August data would not be due until the following April 1. The Agency believes that when the systems of data analysis, handling, and reporting are routinized, these time periods will be more than adequate for VOC data reporting. The Agency understands, however, as States begin to wrestle with new personnel and technology, that even such a reasonable reporting deadline may be difficult to meet during the initial years of implementation.

One commenter questioned the need to delay submittal of the meteorological data past the time period required for submittal of the NO_x and O_3 data. EPA agrees that the measurement and data handling technology for meteorological parameters is currently sufficient for States to be capable of submitting such information on a more expedited schedule. The Agency recognizes, however, that the uses for such data in photochemical modeling, receptor analysis, and emissions inventory functions, generally requires integration with the VOC data. Since the utility of expediting this data submittal would be only marginal, EPA has required that the meteorological measurements be submitted on the same time schedule as the VOC data.

Concurrent with the development of the photochemical assessment monitoring proposal of March 4, 1992, EPA was considering a modification to the data reporting requirements for SLAMS and NAMS monitoring as iterated in §§ 58.26 and 58.35. The stipulation for 60-day reporting for O_3, NO, NO_2, and NO_x, outlined in § 58.45(c), was patterned after the changes to the draft requirements for NAMS, since at that time it was expected that these other revisions would be complete. Since the revisions to NAMS and SLAMS requirements have not yet been proposed and subjected to public comment, EPA today is promulgating a modification to § 58.45(c) which would cause these pollutants to be reported on an identical schedule to that stipulated in § 58.35 for NAMS. Changes to the reporting schedule for all monitors will thus be considered in a separate Federal Register notice at a later date. This modification would also be consistent with the comments from two of the respondents.

Two commenters expressed the belief that EPA should make a greater commitment to assist the States in developing and implementing VOC data acquisition and processing systems to ensure timely compliance with the 6-month requirement for VOC data submittal. An additional commenter expressed a similar concern, that given the large data handling requirements,

the 6-month limitation would be difficult to meet. EPA has sponsored parallel projects involving the acquisition, processing, analysis, and interpretation of VOC data which may provide needed assistance to States in the handling of the massive VOC data base. Further, the Agency has revised its PAMS cost estimates upwards to consider the necessary costs of VOC data acquisition and processing and is considering the inclusion of additional guidance in the technical assistance document (Reference 2 of Appendix C).

One respondent suggested that a target list of VOC species should be developed and augmented with a shorter priority list for reporting. EPA notes that such a target list has been published by the Agency in reference 2 of appendix C, but believes that placing limits on reporting via a priority list is premature and would in no case be universally applicable.

Two commenters pointed out the immediate need to make appropriate changes to the Aerometric Information Retrieval System (AIRS), the national ambient air monitoring database, to accommodate the new PAMS data elements. EPA has incorporated such changes to AIRS.

One commenter suggested that § 58.45(d) be reworded to allow the monitoring and reporting of NMHC (non-methane hydrocarbons) in lieu of VOC. Note that this issue has been previously addressed in comments pertaining to § 58.20.

10. Public Comments—Section 58.46—System Modification

One commenter stated that they believe that changes in attainment status should not reduce the requirements of the PAMS and that monitoring should continue to be funded by EPA. A second commenter suggested that once an area demonstrates attainment of the O_3 NAAQS, EPA should either reduce the PAMS monitoring requirements or assume responsibility for the PAMS funding in that area. EPA believes that continued PAMS monitoring, even after a demonstration of attainment is performed, will be crucial to maintaining the O_3 NAAQS over time. Nevertheless, if a State can demonstrate that it can properly track unexpected changes in the ambient VOC mix and emission inventories, while maintaining the NAAQS, it may propose changes, even reductions, in its PAMS monitoring network as stipulated by § 58.46(b). EPA is not authorized to accept a cessation of PAMS monitoring, however, until an area is redesignated to attainment.

EPA has demonstrated its willingness to provide substantial funding to States for ambient air monitoring activities via the section 105 Grant process. Although the Agency is predisposed to continue to contribute to ambient air monitoring programs such as PAMS, it is of course subject to the limitations of section 105, in part described in the Resources and Costs section of this Preamble.

One commenter felt that the annual network review should be conducted and approved by the Regional Administrator. EPA notes that the network review for ambient air monitoring systems described in § 58.20 is currently conducted and approved annually by the appropriate EPA Regional Office. Section 58.46 articulates a national approval process for changes to PAMS networks similar to that required for NAMS and referenced in §§ 58.32 and 58.36. National data needs and consistency dictate Headquarters EPA approval for changes in both cases.

11. Public Comments—Appendix A—Quality Assurance

All five commenters on this section pointed out the explicit need for a specific, uniform, improved system of quality assurance (QA) for the VOC sampling and analysis requirements (especially) mandated by PAMS. One respondent added the following three recommendations for a national QA program: (1) The establishment of uniform QA criteria including calibration schedules, duplicates schedules, blanks schedules, (2) the establishment of standardized audit procedures, and (3) the establishment of laboratory audit samples and an interlaboratory exchange program between States and EPA laboratories.

EPA is aware that the PAMS sites will require a QA program similar to the one now used for SLAMS criteria pollutants. EPA is currently developing the audit materials and QA guidance required to establish such a system for the pollutant monitoring systems that will be located at the PAMS sites. These materials for the VOC measurement systems are being developed in conjunction with the evaluation study EPA is now conducting on the candidate VOC instrumentation for use at PAMS sites. This study is briefly described in the public comments on § 58.43—PAMS Methodology. Additionally, EPA plans to provide VOC samples to the State and local agencies operating PAMS sites to assist them in validating their VOC monitoring systems and the performance of the personnel operating these systems.

12. Public Comments—Appendix C—Monitoring Methodology

Five commenters recommended that equivalency of methodology must be established at least on a regional level and perhaps even nationally. Several commenters went so far as to recommend that EPA develop federal reference and equivalent methods for VOC. Further, several commenters reiterated their perception of the need for routine inter-State, inter-area quality assurance procedures. Given that the complexity of the technology for VOC sampling and analysis and its rapid rate of development and change, EPA has chosen to publish specific guidance for monitoring methodology in lieu of publishing federal reference or equivalent methods. Such guidance has been published and is available as reference 2 of appendix C. The Agency will track the progress of the development of new methods and will reconsider the specificity of methods in the future. EPA agrees that common and continuing, or at least comparable, methodologies are desirable on a region-wide basis. Comparability of data will be one factor used by the Agency in approving coordinated, region-wide network designs.

One commenter pointed out that the rules should not preclude the expansion of the monitoring period to longer than 3 months, noting also that the length of the monitoring season is not necessarily proportional to the total network operational costs. EPA notes that provisions for changing the monitoring period are promulgated today in section 4.3 of appendix D. EPA agrees with this respondent that monitoring periods should be consistent across a regional network. This factor would also be scrutinized when approving joint networks. EPA recognizes the role that the length of the monitoring period plays in the computations of total costs and has weighted that role accordingly.

One commenter felt that EPA should specify a particular chromatographic column for use on gas chromatographs (GCs) analyzing for the various VOC. Reference 2 of appendix C specifies those column characteristics which AREAL believes are necessary to produce meaningful data on the target VOC compounds. The laboratory even goes so far as to provide specifications on several acceptable columns, but falls short of requiring a chromatographer to choose any one particular design. EPA reiterates its position that the technology for VOC sampling is simply evolving too quickly to allow such specificity at this time.

One commentor believed that the VOC monitoring technology is not yet advanced enough for State and local agencies to economically operate a speciated VOC monitoring program. As previously stated, the Agency believes that States are capable of competency in utilizing new monitoring methods, and in fact a number of State agencies are currently employing such emerging techniques with success. Per this commentor's suggestion, EPA is providing significant financial and technical assistance for implementation of this technology.

In a related issue, a commentor suggested that the rules should tighten the equipment design and performance standards for VOC in order to drive the technology. Noting the progress made to date by the researchers, designers, and fabricators of VOC sampling equipment, EPA believes that the existing technical specificity and market pressures are sufficient to spark development in new and emerging sampling and analysis methods. One other respondent encourages the development of less labor-intensive methodologies to counter the specter of future resource constraints. AREAL has continued to articulate its support for such efforts and will continue to exercise flexibility in investigating new, more economical, and uncomplicated procedures as recommended by yet another commentor.

One commentor felt that EPA should append the provisions of the rules (and particularly appendix C) to facilitate and encourage the use of innovative analytical technologies which are useful for O_3 control strategies. Although EPA is investigating the use of such innovative monitoring technology, and specifically the technology recommended by this commentor, the Agency has not yet determined how the use of these sampling methods will fit into the current SIP process. Nevertheless, EPA does not wish to preclude the use nor discourage the development of new monitoring technologies and so has amended the language of appendix C accordingly. In a related issue, a second commentor was concerned that the stipulations of section 4.2 of appendix C required the use of reference or equivalent methods for the monitoring of NO and NO_X at PAMS. This respondent recommends the use of more advanced and sensitive methods for such monitoring. EPA notes that in great part, the use of the NO_X data measured at PAMS is dictated by the need for precursor information rather than for comparison with the NO_2 NAAQS. Since the Agency does not wish to preclude the use of potential innovations or more sensitive monitoring devices for either VOC or NO_X, it has therefore added additional language to sections 4.2 and 4.3 of appendix C to indicate that such other methodology may be proposed by the State as alternatives. Further, although the Agency has determined that such new technologies may be proposed and even encourages and recommends their use, it is premature to make their use a requirement.

One commenter specifically raised a number of technical questions for consideration by EPA. In response, EPA has determined that pressurized and nonpressurized canister samples are equivalent and that drying of samples prior to analysis to reduce water content is an acceptable procedure. Additionally, the Agency notes that an O_3 scrubber is required on the carbonyl samplers, and C-18 cartridges are equivalent to silica gel cartridges for such analyses. Guidance on standardization protocols (what gas, how many points, what concentrations?) will be addressed in future revisions to the Technical Assistance Document for Sampling and Analysis of O_3 Precursors (EPA 600/8-91-215). Further detail concerning such information may be found in reference 2 of appendix C.

13. Public Comments—Appendix D—Network Design for SLAMS, NAMS, and PAMS

The following discussions address the comments received on specific provisions to appendix D:

14. Public Comments—Section 4.1 of Appendix D—PAMS Data Uses

Five commenters expressed concern that the PAMS program might be insufficient for the purpose of verifying emissions inventories. One suggested that further flexibility be built into the regulation since techniques for inventory verification are still in the developmental stages. Further, two commenters expressed conflicting views in the use of air quality data and/or emissions inventory data for the tracking of emissions reductions over time. The use of air quality data, and especially that of photochemically reactive species, is admittedly an evolving science. EPA does believe, however, that such data have been demonstrated to be a constructive adjunct tool to emissions inventories in qualitatively verifying their accuracy and serving as a corroborative instrument to calculations of reasonable further progress (RFP) in reductions of emissions (See References 26-30 of Appendix D). Note that the Clean Air Act clearly stipulates that RFP is defined via reductions of emissions rather than progress in air quality measurements for precursors or for O_3. Emissions inventory reduction calculations must therefore persist as the primary tool for evaluating both progress and reductions. These facts do not lessen the importance, however, of ensuring that those calculated values are corroborated by actual air quality measurements. EPA would be remiss if it allowed the disregard of air quality information in judging the adequacy of State Implementation Plan performance. The Agency notes that since the inventory corroboration techniques are not specified or limited by this section, adequate flexibility is incorporated in the rule.

In a related matter, one commenter suggested that EPA has not shown the correlation of target list compounds to actual emissions inventories and proposes that continuous NMOC monitoring in conjunction with integrated canister samples would be a better indicator of emissions inventories. As previously iterated, EPA is promulgating rules which can be applied nationally as a minimum requirement. The Agency recognizes and clearly articulates that the PAMS network requirements are designed to provide information which can be used in maximizing the utility of a number of data objectives. Were a commenter to demonstrate that their particular method of monitoring is superior to PAMS for one data use, it is possible that further scrutiny would reveal that it is not ideal for the remainder. Air pollution agencies are not precluded by the rule from instituting monitoring strategies additional to the PAMS minimums or proposing alternatives more tailored to their particular geographic area. Similarly, one commenter was concerned that the program may not fulfill the needs for SIP control strategy evaluation and suggests that modeling is the preferable tool for this purpose. The Agency agrees that modeling is the more appropriate tool to determine the potential for the success of a proposed SIP strategy; however, the Agency asserts that knowing what changes actually occurred in the ambient air is an extremely useful measure of the true effectiveness of any control program.

Two commenters indicated the need for the Agency to publish a data uses guidance document. They imply that such a document should expound on the details of how the data generated by PAMS can be used to meet the data objectives. One respondent complained that it currently does not have a program that can use the data provided

by the PAMS. EPA has prepared documents dealing with the data quality objectives (DQOs) for the PAMS program. Additionally, other demonstrations of the continuing use of such data are noted as references 26–31 of appendix D. Further, in response to these comments, minor revisions have been made to clarify section 4.1 of appendix D. Those State agencies which have recognized their lack of ability to use these important data may employ the additional section 105 Grant monies made available for PAMS toward enhancing their data processing and analysis capabilities.

Four respondents noted that although some of the stated objectives for PAMS support application of photochemical grid modeling techniques, the network design does not seem to effectively accomplish this feat. Further, three commenters protest that the network specifically does not meet the data requirements of their State's photochemical modeling protocol. EPA has reexamined the overall data needs of the photochemical modeling community and has modified the network to be more responsive. Since the Agency is attempting to ensure that PAMS is compatible with national needs, particular States may find that the requirements provide better data than needed to execute a minimal modeling run or that their particular model application demands other information not measured by PAMS. In the latter case or as one commenter noted, when more intensive data is needed, the State is free to measure those additional parameters which they feel are necessary to drive and/or evaluate future model applications.

One commenter questioned why the methodology to determine air quality trends is not specified in the rules. This respondent joined with another to point out the need to address and eliminate the variability of air quality data due to meteorology. EPA maintains that a rule which specifies monitoring requirements and network design, is not an appropriate vehicle to promulgate particular statistical techniques for calculating or presenting trends analyses. Given the variety of such techniques available to the State and local air pollution agencies today, it would be nearly presumptuous for EPA to attempt to limit their ability to analyze their own data via rulemaking. The absence of specific trends requirements allows the States to retain the maximum flexibility and employ the most appropriate state-of-the-art analysis techniques. Clearly, there are two basic concepts which may be employed in preparing trends analyses: (1) Displaying unadjusted measurements which portray the quality of the air actually breathed by the public, or (2) calculating adjusted trends to infer progress towards attainment of standards due to the influences of pollutant control programs. In either case, the cornerstone of the analyses are the actual air quality and meteorological measurements such as those required by PAMS. Particularly, for evaluating the effectiveness of control programs, it may be appropriate to integrate such factors as meteorology and emissions inventory data. EPA simply disagrees that this rule is the correct forum to expound on specific procedures for the analysis of pollutant trends. Trends techniques utilized by EPA for criteria pollutants have appeared perennially in the Agency's National Air Quality and Emissions Trends Report. Further, EPA is currently evaluating techniques for improving the effectiveness of O_3 control strategies including indicators for assessing progress. This work will address techniques for integrating meteorology, emissions, and ambient data.

The second commenter concerning trends went further to question whether or not the 5-site PAMS network is sufficient to conduct O_3 and O_3 precursor trends analyses. Since PAMS sites are located to detect particular characteristics of the air quality, such as maximum O_3 or upwind transport, the 5 sites have been determined by EPA to be the minimum network necessary for larger areas to encompass specific situations of interest. Experience with the NAMS network requirements has shown that some areas may choose to supplement this minimum network to meet their own objectives. EPA has decided that the 5-site network represents a minimum core requirement which will provide a consistent and stable database to be used for trends. Additionally, the Agency notes that for areas which submit coordinated, joint network designs, it is expected that more than 5 sites will be established and become available for trends analyses.

One commenter noted that sampling sites located to measure either VOC or air toxics impacts may not be an optimal location for the other. EPA has previously articulated its view on this matter in this preamble's discussion of Resources and Costs.

One commenter vociferously criticized the basic tenets of the PAMS program and professes that a successful PAMS program can be cultivated via a program of less-frequent focused sampling for generalized precursor data (e.g., NMOC) with a minimum of speciation information. They believe that their experience with this type of program has been largely ignored in designing the PAMS program. EPA again observes that a program which has been simplified or merely focused to meet the specific data needs of a particular locale, may not be appropriate to fulfill the data uses for a national program which is generally routine O_3 precursor data-poor. Nevertheless, the opportunity is provided by section 4 of appendix C and section 4 of appendix D for the approval of such focused alternative networks in accordance with § 58.40, especially where significant historical precursor monitoring data are available. The adoption of different or more comprehensive requirements, as discussed further in the Agency's response to comments on § 58.42, does not imply deficiencies in an existing monitoring program. EPA's program simply highlights that national needs are often different and more inclusive than local needs.

15. Public Comments—Section 4.2 of Appendix D—PAMS Monitoring Objectives

Four respondents revived the issue that the sites chosen for PAMS would not necessarily constitute appropriate locations for the monitoring of air toxics. Further, these commenters seem to support a separate and expanded air toxics monitoring effort. As noted by EPA in the discussion of resources and costs in this preamble, the Clean Air Act Amendments call for a network which is geared toward the monitoring of photochemical parameters. The Agency agrees that PAMS may not be the ideal platform for monitoring air toxics, but feels that the establishment of additional air toxics monitoring at these sites is a valuable adjunct to the PAMS program. Separate national air toxics monitoring networks are not currently a highly-ranked, nationally mandated priority.

Two additional commenters requested that the Agency continue its efforts to define and monitor NO_y. EPA previously expressed, in addressing comments to § 58.1, its reluctance to rush the regulatory and monitoring program for NO_y. EPA will continue its investigations of this concept and will propose future revisions to 40 CFR part 58 if appropriate.

One commenter espoused the importance of measuring VOC aloft. EPA has previously indicated its reluctance to require this monitoring in the discussions of the general comments.

The same commenter felt that rural sites for the collection of boundary condition carbon monoxide (CO) and NO_x data should be added to the PAMS program. EPA also has recognized the importance of including sites that will better define boundary conditions. Consequently, section 4.2 of appendix D and its associated Figures have been modified to better reflect the measurement of boundary conditions. Note that since CO was not addressed in section 182 of the Clean Air Act Amendments as a required pollutant for PAMS, no monitoring requirements for CO were included. This omission does not preclude a State from adding CO monitoring to its network design.

One commenter believes that due to the effects of complex meteorology, the placement of PAMS sites should be based more on studies of past O_3 episodes rather than the generic model proposed by EPA. The Agency agrees in principal with this comment and has altered the location of the PAMS sites to correspond more closely with the wind conditions associated with O_3 events.

One commenter requested that EPA provide more specificity for locating PAMS type (2) sites, the sites where maximum emissions are expected to impact. In response, EPA has clarified and added additional detail for this site's location.

One commenter was concerned that many of their current NAMS and SLAMS monitors are not located at potential PAMS sites. EPA notes this concern and considered that some, but not all PAMS sites might be coincident with SLAMS or NAMS in its recomputation of cost estimates. Reference is made to a similar discussion under General Comments and Resources and Costs in this preamble.

One commenter also requested that existing data be allowed to be used as a part of alternative PAMS monitoring schemes. Note as discussed in § 58.40 that EPA has amended section 4.2 of appendix D to include broad criteria for the approval of alternative networks. The use of existing information and existing monitoring networks is not precluded by these changes to the rule.

16. Public Comments—Section 4.3 of Appendix D—Monitoring Period

Ten commenters expressed opinions regarding the length and specificity of the monitoring period for the PAMS. Three of those respondents supported the proposed requirement of 3 months, especially June, July, and August, although they indicated that more sampling would obviously be better; that consistency across regions is crucial, and that more specificity would be useful. Three others indicated that they felt that the 3-month period was too short and would create staffing problems for affected State governments with a minimal cost savings over sampling for longer periods such as the entire O_3 season. One of these commenters asserted that 5 months would be a better choice, especially in the State of California. Five commenters believed that employing O_3 level forecasting and episode monitoring would be a more efficient use of resources and provide a more intensive database for the critical periods and could make better use of manual sampling methods. One commenter felt that the length of the sampling period should best be specified on a regional basis and that while a 3-month period would likely capture the majority of episodes in the Northeast, such a period would be insufficient for the South and West.

EPA agrees that more than 3-months would be preferable and has articulated this opinion in section 4.3. The Agency has recognized, however, that other particular months rather than June, July, and August may, on a case-by-case basis be more appropriate. Accordingly, EPA has expressed its intent to allow other monitoring periods if submitted and approved as a part of the network description required by § 58.40. In the discussion concerning comments to § 58.40 in this preamble, EPA has clearly espoused its support for coordination and consistency among States and across regions and noted that other requirements of the Clean Air Act Amendments may require such coordination, in this case in establishing the monitoring period for PAMS. The Agency's goal in choosing the 3-month period was to attempt to capture the highest O_3 events for the year. The Agency has established only a minimum sampling period; any affected State or region may expand this period to a longer time to meet its particular needs. Flexibility has been included in the rule to allow the use of either manual or continuous sampling technologies. Given that the Agency recognizes the utility and efficiency of focussing its efforts on O_3 events, section 4.4 sampling requirements have been amended in this promulgation to allow the sampling for such events and as an option make the use of manual methods more feasible. A discussion of those changes follow under section 4.4. EPA has included a stipulation in section 4.3 that intermittent sampling must follow the previously-established national schedule for intermittent sampling such as the one-in-six-day schedule used for particulate matter.

17. Public Comments—Section 4.4 of Appendix D—Minimum Network Requirements

Twenty-four commenters responded to this section of the proposed rule concerning the details of PAMS network sampling and design. Eleven of those respondents specifically indicated their concern that the proposed requirements for VOC sampling were excessive and the rule should be amended to allow less intensive sampling. Many suggested that such a less-intensive sampling program would save funds which could be better allocated for other purposes, upper atmospheric monitoring for example. Several commenters included suggested sampling plans for implementation in lieu of the proposed schedule. Six commenters believed that a better use of limited resources would be to focus VOC monitoring on days when high O_3 levels would be expected or forecast. EPA has examined the proposed optional sampling schedules, considered the economic impact of the schedule, revisited the current state of the monitoring technology and has concluded that it is appropriate to make a number of changes to the minimum sampling schedule for VOC. To respond to the data needs of the Agency and the State and local air pollution control agencies, EPA has decided the following: Sampling schedules for NO, NO_2, NO_x, O_3 and surface meteorological parameters remain unchanged. EPA has determined that the minimum requirements for pollutant sampling will continue to mirror those for gaseous criteria pollutants, (i.e., continuous measurements). The minimum sampling period for precursors is designated as three months, specifically June, July, and August unless a different 3-month period is proposed by the State and approved by EPA. The minimum sampling period for ozone remains for the entire ozone season. The Agency has added an option for VOC monitoring at sites other than PAMS type (2) sites. In lieu of one in 3-day sampling (as stipulated by Frequency A in section 4.4 of appendix D), a State may substitute monitoring before and during O_3 events as specified by section 4.4 of appendix D plus one in 6-day sampling. Since the Agency is not promulgating a preferred event forecasting method, each State choosing this option (identified as sampling Frequency C by section 4.4 of appendix D), must submit an O_3 event forecasting scheme as a part of the PAMS network description as delineated in § 58.41. States or areas

proposing the joint submittal of network descriptions and choosing this option should include a strategy for ensuring a coordinated, network-wide response to O_3 event monitoring. Such a change in focus to event monitoring will also increase the feasibility of utilizing manual sampling methods as requested by several commenters.

Also in response to these concerns and in order to ensure the collection of data sufficient to conduct emission inventory verification and reconciliation exercises, establish source-receptor relationships, corroborate reasonable further progress (RFP) calculations, and produce meaningful precursor trends analyses, the proposed PAMS type (3) site has been changed to an additional PAMS type (2) site. To respond to other photochemical modeling concerns, the proposed PAMS type (5) site has been moved downwind of the new type (3) site and renumbered PAMS type (4). Responding to observations by six commenters that sampling schedules should be standardized to promote data comparability among parameters, carbonyl sampling requirements have been amended to more closely coincide with the required frequencies for VOC.

Eleven respondents suggested alternative locations or numbers of PAMS sampling stations. There was considerable variation among the suggested options, with several commenting that more sites were needed, others noting that specific local terrain and meteorological effects require different station placement. Five respondents in particular recommended that the collected data should be more responsive to the needs of the photochemical grid modeling process. EPA has closely surveyed the specific data needs engendered by the program objectives, especially the necessity to provide a measure of support for photochemical grid modeling, and has concluded that further clarification on the location of the PAMS sites is requisite. Accordingly, EPA has provided detail regarding the use of particular high O_3 day wind data, rather than general seasonally-predominent winds, for the location of potential PAMS monitoring sites. Further the Agency has provided guidance in reference 19 of appendix D to aid in specifying the location of sites, particularly sites type (2), when there are no predominant high O_3 day winds which can be accurately identified. Also, the Agency has relocated the upwind and downwind sites to correspond more appropriately to the data needs for photochemical grid models and has added guidance on the location of monitors, especially site types (3) or (4), in areas of complex terrain, e.g., mountain-valley, coastal, etc., to reference 19.

One commenter inquired why there is no requirement for a site in the area of greatest O_3 concentration given that the rule's objectives include making attainment/nonattainment decisions and characterizing the nature and extent of the O_3 problem. EPA notes that the siting requirements for PAMS type (3) sites and its monitoring objectives as articulated in section 4.2 and section 4.4 of appendix D clearly require its location to be the maximum O_3 monitoring site for the area.

Several respondents suggested that the requirement for each PAMS site to monitor all parameters was not necessary, i.e., that some PAMS sites should be allowed to operate with monitoring conducted for only some of the specified pollutants. EPA has revisited its PAMS data objectives and has determined this monitoring requirement should remain unchanged. Elimination of parameters at individual sites would weaken an otherwise comprehensive database and decrease its utility for fulfillment of the PAMS data objectives and future undiscovered data needs.

One commenter, while recommending alternate monitoring technologies for the PAMS, stated that in lieu of monitoring 1-hour averages for VOC monitoring, the sampling of 10-minute average for VOC equivalents or surrogates should be allowed. The technology recommended by this commenter is currently being scrutinized by the AREAL laboratory to determine its utility in the SIP process as noted in the discussion of § 58.43. EPA has otherwise determined that VOC monitoring at increments of 10 minutes is not practical at this time.

Several other commenters suggested the use of 24-hour and/or continuous NMOC monitoring (with periodic speciation) as an adjunct to or even as a replacement for the PAMS speciated VOC monitoring. They assert that the technology for NMOC monitoring is proven and that the subsequent data are sufficient for the development and tracking of control strategies. EPA has considered these arguments and has determined that although some of the PAMS objectives may be fulfilled via total NMOC data, the remainder require the gathering of speciated VOC measurements. The Agency has therefore not adopted the use of NMOC instead of speciated VOC as a national requirement as discussed previously under the public comments to § 58.20. The PAMS requirements, however, do not preclude the collection of additional NMOC data as an adjunct or for the submittal of alternative networks which propose elements of NMOC monitoring.

Two commenters questioned the utility of gathering a 24-hour integrated and speciated VOC sample to supplement the 1-hour speciated VOC samples. EPA notes that given the variations inherent in continuous/1-hour VOC measurement technology, the addition of a periodic 24-hour sample for purposes of quality assurance is a prudent and necessary reality check. Additionally, the year-round 24-hour periodic sample will provide information on emissions inventories, RFP, and long-term VOC trends and data for exposure assessments.

One State commenter felt that the guidance for regional network design, provided by figure 2 of appendix D, is too generic. This respondent suggests specifically that EPA should develop the PAMS monitoring network description for the Northeast O_3 Transport Region. EPA recognizes the unique nature of the O_3 problem occurring in the northeastern United States. Further, the Agency agrees with the principle that a strong federal contribution to the development of a region-wide monitoring network is critical to develop the needed consistency, cohesiveness, and comparability of the PAMS in the Northeast. Accordingly, the Agency has offered and is supplying both technical and financial assistance to coordinated region-wide State and local efforts. EPA does not agree, however, that the Agency should, by rule, usurp the State Implementation Plan process established by section 110 of the Clean Air Act, nor shortcut the requirements for the submittal of a network description for PAMS. Failure of a State to comply with the requirements for submittal of a SIP could, however, ultimately require EPA to promulgate and implement a Federal Implementation Plan for that State pursuant to section 110.

Several agencies submitted a PAMS monitoring plan which was fundamentally different from the proposed rule and requested that EPA substitute those requirements as the national requirements for PAMS monitoring. EPA observes that these agencies, being proximate to one another, would benefit greatly by submitting and implementing similar monitoring strategies. In this respect, EPA applauds those agencies' efforts toward consistency across a geographical region. On the contrary, however, for the same reasons that the requirements are specifically tailored to the characteristics of that particular

region, the Agency does not believe that it would suffice as a national minimum program.

18. Public Comments—Section 4.5 of Appendix D—Transition Period

Six commenters responded to this section, with varying points of view, although most were discussed as part of the debate outlined in § 58.44. Additionally, however, two commenters suggested that the early years of the program requirements should not be overly prescriptive and that areas be allowed to build up their programs over time, intimating that technology changes and resource needs could be phased in along with the monitoring program. In response, EPA has incorporated additional transition period flexibility as iterated in the discussion of § 58.44.

19. Public Comments—Section 4.6 of Appendix D—Meteorological Monitoring

Sixteen commenters provided observations regarding the meteorological monitoring requirements proposed by section 4.6 of appendix D and further stipulated by reference 2 of appendix C. Eleven of these respondents indicated support for the collection of upper air meteorological data in each area, especially if high quality upper air data are not currently available. Several supported this suggestion with notations that the photochemical grid models demand such data. One commenter, although recognizing the need for upper air monitoring, advised caution and deferral of such requirements due to the current state of atmospheric sounding technology. EPA has investigated the merits and projected costs of upper air meteorological monitoring and has concluded that the benefits of incorporating a requirement for upper air measurements are substantial. In response, therefore, the Agency has amended section 4.6 to reflect these requirements and has further indicated its predisposition to allow adequate time for securing data from this network. EPA also believes that States should take advantage of existing upper air monitoring programs and where possible, substitute these data for the PAMS requirements. EPA will provide guidance for the collection of these data.

Several respondents provided specific recommendations concerning the particular meteorological parameters which should be monitored and those for which they believed monitoring should be limited. EPA notes that with the exception of dew point measurements, the recommendations for particular parameters are incorporated into reference 2 of appendix C. Concerning dew point, one commenter stated that their meteorological staff find dew point temperature measurements to be much more useful than relative humidity to the study and forecasting of O_3 episodes. The measurement technique for dewpoint is straightforward; States are encouraged to include such measurements at PAMS, if they find them useful. The Agency has not required the measurement of this parameter since it may not be essential for all locations and may be derived from temperature and relative humidity measurements. As observed by one commenter, barometric pressure generally does not vary widely within a large area, except in areas with complex terrain features. EPA therefore indicates its predisposition to allow approved network designs which offer limited measurements of barometric pressure (or other parameters) if the State can demonstrate that the area's topography is not conducive to significant pressure (or other) variations.

One respondent indicated that the rule should allow measurements at a minimum height, or a range, above ground rather than specify 10 meters. For consistency, EPA has retained the 10-meter requirement. The Agency has determined that the lack of flexibility in this requirement should not constitute any hardship inasmuch as measurements at 10 meters are traditional as well as practical. States may institute additional monitoring at other heights, at their own volition.

In the preamble to the March 4, 1992 proposal, EPA recognized the potential difficulty in siting a 10-meter meteorological monitoring tower at a particular PAMS site. The Agency therefore requested comments on criteria to determine how such data collected at a nearby site could be used to represent the meteorology at a PAMS site where the tower and air monitoring equipment could not be collocated. One respondent agreed with the premise that nearby data (such as collected at airports or National Weather Service stations) should be accepted, but provided no suggestions for criteria to judge the representativeness of those data. EPA has consequently decided to consider requests to use nearby existing meteorological data, both surface and upper air, on a case-by-case basis.

20. Public Comments—Appendix E—Probe Siting Criteria for Ambient Air Quality Monitoring

Four respondents provided specific comments regarding the placement of the probe and siting criteria for PAMS. One was particularly concerned over the description for the PAMS site to be located downwind in the second-most prevalent wind direction noting that the probe siting criteria were based on the primary wind direction. EPA recognizes this deficiency, and notes that the rules have been amended to eliminate this PAMS type (5) site. Additional language has been added to sections 10.2 and 12 of appendix E to correct this anomaly for the other sites.

One commenter, based on experience, recommends that VOC samplers should be located further from sources than criteria pollutant monitors if they are to measure area-emitted and regionally-transported VOC. EPA notes that the minimum network detailed in section 4 of appendix D, stipulates 3 site types which are located to adequately measure incoming transported emissions [type (1)], maximum O_3 measurements [type (3)], and downwind outgoing conditions [type (4)], all sited as urban scale monitors.

Two agencies recommend the use of a vertical manifold for the measurement of ambient O_3 precursor data rather than a horizontal manifold. They further recommend that a heated line from the manifold to the GC be employed to ensure the transmission of heavy hydrocarbons through the line. EPA notes no compelling reason to specify the orientation of the sampling manifold. The requirements published in the technical assistance document (Reference 2 of Appendix C) do not preclude the use of a vertical sampling manifold. Likewise, the Agency has not specified nor prohibited the heating of the manifold which may be necessary in high humidity areas.

One commenter believes that the specifications for separation distance between PAMS and roadways, trees and obstacles appear to be lenient and should be more stringent. EPA believes that the specifications are adequate based on current best judgement. As more information becomes available, the Agency will revisit this issue.

D. Public Comments Concerning Impact on Small Entities

The U.S. Small Business Administration (SBA) requested further detail regarding the impact of these regulations on small entities which are defined to include small businesses, small organizations, and small governmental jurisdictions (5 U.S.C. 601 et seq.). Since EPA is utilizing the State Implementation Plan process as outlined in section 110 of the Clean Air Act, the provisions of these regulations promulgated today, apply directly only to State Governments, and particularly,

to the State air pollution control agencies having jurisdiction over O_3 nonattainment areas classified as severe, serious, or extreme. EPA therefore has concluded that no small entities would be affected by the proposal. At the request of the SBA's Chief Counsel for Advocacy, this certification has been clarified. Therefore, pursuant to 5 U.S.C. 605(b), the Administrator certifies that these amendments would not have a significant economic impact on a substantial number of small entities.

Classification

Since this revision is classified as minor, no additional reviews are required. The rules were submitted to the Office of Management and Budget (OMB) for review (under Executive Order 12291). This is not a major rule under E.O. 12291 because it does not meet any of the criteria defined in the Executive Order.

List of Subjects in 40 CFR Part 58

Air pollution control, air quality surveillance and data reporting, ambient air quality monitoring network design and siting, intergovernmental relations, pollutant standard index, quality assurance program.

Effective Date of Regulation

These revisions to 40 CFR Part 58 incorporate a flexible, reasonable, transition schedule for efficient phase-in of the rules in lieu of a waiting period for a rule effective date. This schedule accounts for the anticipated delays encountered by States in hiring qualified personnel, obtaining equipment, and providing training. Given that States will need to begin as soon as possible to prepare for O_3 season sampling, a 30-day waiting period is not appropriate and an effective date of immediately upon promulgation is deemed necessary. This explanation is provided pursuant to the requirements of 5 U.S.C. 553.

Dated: January 19, 1993.

William K. Reilly,

Administrator.

For the reasons set forth in the preamble, part 58 of chapter I of title 40 of the Code of Federal Regulations is amended as follows:

PART 58—AMBIENT AIR QUALITY SURVEILLANCE

1. The authority citation for part 58 is revised to read as follows:

Authority: 42 U.S.C. 7410, 7601(a), 7613, and 7619.

2. Section 58.1 is amended by revising paragraph (f) and by adding paragraphs (w), (x), and (y) to read as follows:

§ 58.1 Definitions.

* * * * *

(f) *NO_2* means nitrogen dioxide. *NO* means nitrogen oxide. *NO_X* means oxides of nitrogen and is defined as the sum of the concentrations of NO_2 and NO.

* * * * *

(w) *PAMS* means Photochemical Assessment Monitoring Stations.

(x) *VOC* means volatile organic compounds.

(y) *Meteorological measurements* means measurements of wind speed, wind direction, barometric pressure, temperature, relative humidity, and solar radiation.

3. Section 58.2 is amended by redesignating paragraph (d) as paragraph (e) and by adding a new paragraph (d) to read as follows:

§ 58.2 Purpose.

* * * * *

(d) This section also acts to establish a Photochemical Assessment Monitoring Stations (PAMS) network as a subset of the State's SLAMS network for the purpose of enhanced monitoring in O_3 nonattainment areas listed as serious, severe, or extreme. The PAMS network will be subject to the data reporting and monitoring methodology requirements as contained in subpart E of this part.

* * * * *

4. Section 58.13 is amended by revising paragraph (b), redesignating paragraph (c) as paragraph (d), and adding a new paragraph (c) to read as follows:

§ 58.13 Operating schedule.

* * * * *

(b) For manual methods (excluding PM10 samplers and PAMS VOC samplers), at least one 24-hour sample must be obtained every sixth day except during periods or seasons exempted by the Regional Administrator.

(c) For PAMS VOC samplers, samples must be obtained as specified in sections 4.3 and 4.4 of appendix D to this part. Area-specific PAMS operating schedules must be included as part of the network description required by § 58.40 and must be approved by the Administrator.

* * * * *

5. Section 58.20 is amended by revising paragraphs (a) and (c) and adding paragraph (f) to read as follows:

§ 58.20 Air quality surveillance: Plan content.

* * * * *

(a) Provide for the establishment of an air quality surveillance system that consists of a network of monitoring stations designated as State and Local Air Monitoring Stations (SLAMS) which measure ambient concentrations of those pollutants for which standards have been established in part 50 of this chapter. SLAMS (including NAMS) designated as PAMS will also obtain ambient concentrations of speciated VOC and NO_X, and meteorological measurements. PAMS may therefore be located at existing SLAMS or NAMS sites when appropriate.

* * * * *

(c) Provide for the operation of at least one SLAMS per criteria pollutant except Pb during any stage of an air pollution episode as defined in the plan.

* * * * *

(f) Within 9 months after:

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme, affected States shall adopt and submit a plan revision to the Administrator.

The plan revision will provide for the establishment and maintenance of PAMS. Each PAMS site will provide for the monitoring of ambient concentrations of criteria pollutants (O_3, NO_2), and non-criteria pollutants (NO_X, NO, and speciated VOC) as stipulated in section 4.2 of appendix D, and meteorological measurements. The PAMS network is part of the SLAMS network, and the plan provisions in paragraphs (a) through (f) of this section will apply to the revision. Since NAMS sites are also part of the SLAMS network, some PAMS sites may be coincident with NAMS sites and may be designated as both PAMS and NAMS.

Subparts E and F—[Redesignated as Subparts F and G]

6. Subparts E (§ 58.40) and F (§§ 58.50 and 58.51) are redesignated as subparts F (§ 58.50) and G (§§ 58.60 and 58.61), respectively. Subpart E is added to read as follows:

Subpart E—Photochemical Assessment Monitoring Stations (PAMS)

Sec.

58.40 PAMS network establishment.
58.41 PAMS network description.
58.42 PAMS approval.
58.43 PAMS methodology

Sec.
58.44 PAMS network completion.
58.45 PAMS data submittal.
58.46 System modification.

Subpart E—Photochemical Assessment Monitoring Stations (PAMS)

§ 58.40 PAMS network establishment.

(a) In addition to the plan revision, the State shall submit a photochemical assessment monitoring network description including a schedule for implementation to the Administrator within 6 months after:

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme O_3 nonattainment.

The network description will apply to all serious, severe, and extreme O_3 nonattainment areas within the State. Some O_3 nonattainment areas may extend beyond State or Regional boundaries. In instances where PAMS network design criteria as defined in appendix D to this part require monitoring stations located in different States and/or Regions, the network description and implementation schedule should be submitted jointly by the States involved. When appropriate, such cooperation and joint network design submittals are preferred. Network descriptions shall be submitted through the appropriate Regional Office(s). Alternative networks, including different monitoring schedules, periods, or methods, may be submitted, but they must include a demonstration that they satisfy the monitoring data uses and fulfill the PAMS monitoring objectives described in sections 4.1 and 4.2 of appendix D to this part.

(b) For purposes of plan development and approval, the stations established or designated as PAMS must be stations from the SLAMS network or become part of the SLAMS network required by § 58.20.

(c) The requirements of appendix D to this part applicable to PAMS must be met when designing the PAMS network.

§ 58.41 PAMS network description.

The PAMS network description required by § 58.40 must contain the following:

(a) Identification of the monitoring area represented.

(b) The AIRS site identification form for existing stations.

(c) The proposed location for scheduled stations.

(d) Identification of the site type and location within the PAMS network design for each station as defined in appendix D to this part except that during any year, a State may choose to submit detailed information for the site scheduled to begin operation during that year's PAMS monitoring season, and defer submittal of detailed information on the remaining sites until succeeding years. Such deferred network design phases should be submitted to EPA for approval no later than January 1 of the first year of scheduled operation. As a minimum, general information on each deferred site should be submitted each year until final approval of the complete network is obtained from the Administrator.

(e) The sampling and analysis method for each of the measurements.

(f) The operating schedule for each of the measurements.

(g) An O_3 event forecasting scheme, if appropriate.

(h) A schedule for implementation. This schedule should include the following:

(1) A timetable for locating and submitting the AIRS site identification form for each scheduled PAMS that is not located at the time of submittal of the network description;

(2) A timetable for phasing-in operation of the required number and type of sites as defined in appendix D to this part; and

(3) A schedule for implementing the quality assurance procedures of appendix A to this part for each PAMS.

§ 58.42 PAMS approval.

The PAMS network required by § 58.40 is subject to the approval of the Administrator. Such approval will be contingent upon completion of each phase of the network description as outlined in § 58.41 and upon conformance to the PAMS network design criteria contained in appendix D to this part.

§ 58.43 PAMS methodology.

PAMS monitors must meet the monitoring methodology requirements of appendix C to this part applicable to PAMS.

§ 58.44 PAMS network completion.

(a) The complete, operational PAMS network will be phased in as described in appendix D to this part over a period of 5 years after:

(1) February 12, 1993; or

(2) Date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme; or

(3) The designation of a new area and classification to serious, severe, or extreme O_3 nonattainment.

(b) The quality assurance criteria of appendix A to this part must be implemented for all PAMS.

§ 58.45 PAMS data submittal.

(a) The requirements of this section apply only to those stations designated as PAMS by the network description required by § 58.40.

(b) All data shall be submitted to the Administrator in accordance with the format, reporting periods, reporting deadlines, and other requirements as specified for NAMS in § 58.35.

(c) The State shall report NO and NO_x data consistent with the requirements of § 58.35 for criteria pollutants.

(d) The State shall report VOC data and meteorological data within 6 months following the end of each quarterly reporting period.

§ 58.46 System modification.

(a) Any proposed changes to the PAMS network description will be evaluated during the annual SLAMS Network Review specified in § 58.20. Changes proposed by the State must be approved by the Administrator. The State will be allowed 1 year (until the next annual evaluation) to implement the appropriate changes to the PAMS network.

(b) PAMS network requirements are mandatory only for serious, severe, and extreme O_3 nonattainment areas. When any such area is redesignated to attainment, the State may revise its PAMS monitoring program subject to approval by the Administrator.

7. Two new sentences are added before the last sentence in the first paragraph of section 2.2 of appendix A to read as follows:

Appendix A to Part 58—Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)

* * * * *

2.2 * * * Quality assurance guidance for meteorological systems at PAMS is contained in reference 3. Quality assurance procedures for VOC, NO_x (including NO and NO_2), O_3, and carbonyl measurements at PAMS must be consistent with EPA guidance. * * *

* * * * *

8. In the *References* section of appendix A redesignate references 5, 6, and 7 as references 6, 7, and 8, respectively, and a new reference 5 is added to read as follows:

References

* * * * *

5. Technical Assistance Document for Sampling and Analysis of Ozone Precursors.

Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8-91-215. October 1991.

* * * * *

9. Sections 4.0, 5.0 and 5.1 of appendix C are redesignated as sections 5.0, 6.0, and 6.1, respectively (reference 5.1 will become reference 6.1 of section 6.0), sections 4.0, 4.2, and 4.3 are added, and newly redesignated section 6.0 is revised to read as follows:

Appendix C—Ambient Air Quality Methodology

* * * * *

4.0 Photochemical Assessment Monitoring Stations (PAMS)

4.1 Methods used for O_3 monitoring at PAMS must be automated reference or equivalent methods as defined in § 50.1 of this chapter.

4.2 Methods used for NO, NO_2 and NO_x monitoring at PAMS should be automated reference or equivalent methods as defined for NO_2 in § 50.1 of this chapter. If alternative NO, NO_2 or NO_x monitoring methodologies are proposed, such techniques must be detailed in the network description required by § 58.40 and subsequently approved by the Administrator.

4.3 Methods for meteorological measurements and speciated VOC monitoring are included in the guidance provided in references 2 and 3. If alternative VOC monitoring methodology (including the use of new or innovative technologies), which is not included in the guidance, is proposed, it must be detailed in the network description required by § 58.40 and subsequently approved by the Administrator.

* * * * *

6.0 References

* * * * *

1. Pelton, D. J. Guideline for Particulate Episode Monitoring Methods, GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. EPA 450/4-83-005. February 1983.

2. Technical Assistance Document For Sampling and Analysis of Ozone Precursors. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8-91-215. October 1991.

3. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4-90-0003. August 1989.

10. The heading of appendix D is revised to read as follows:

Appendix D—Network Design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)

11. The second sentence of the first paragraph of section 1 of appendix D is revised to read as follows:

1. * * * It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS) and Photochemical Assessment Monitoring Stations (PAMS). These criteria will also be used by EPA in evaluating the adequacy of the SLAMS/NAMS/PAMS networks. * * *

* * * * *

Sections 4 and 5 of Appendix D [Redesignated as Sections 5 and 6]

12. Section 4 and section 5 of appendix D are redesignated as section 5 and section 6, respectively, and a new section 4 is added to read as follows:

* * * * *

4. Network Design for Photochemical Assessment Monitoring Stations (PAMS)

In order to obtain more comprehensive and representative data on O_3 air pollution, the 1990 Clean Air Act Amendments require enhanced monitoring for ozone (O_3), oxides of nitrogen (NO, NO_2, and NO_y), and monitoring for VOC in O_3 nonattainment areas classified as serious, severe, or extreme. This will be accomplished through the establishment of a network of Photochemical Assessment Monitoring Stations (PAMS).

4.1 *PAMS Data Uses.* Data from the PAMS are intended to satisfy several coincident needs related to attainment of the National Ambient Air Quality Standards (NAAQS), SIP control strategy development and evaluation, corroboration of emissions tracking, preparation of trends appraisals, and exposure assessment.

(a) *NAAQS attainment and control strategy development.* Like SLAMS and NAMS data, PAMS data will be used for monitoring O_3 exceedances and providing input for attainment/nonattainment decisions. In addition, PAMS data will help resolve the roles of transported and locally emitted O_3 precursors in producing an observed exceedance and may be utilized to identify specific sources emitting excessive concentrations of O_3 precursors and potentially contributing to observed exceedances of the O_3 NAAQS. The PAMS data will enhance the characterization of O_3 concentrations and provide critical information on the precursors which cause O_3, therefore extending the database available for future attainment demonstrations. These demonstrations will be based on photochemical grid modeling and other approved analytical methods and will provide a basis for prospective mid-course control strategy corrections. PAMS data will provide information concerning (1) which areas and episodes to model to develop appropriate control strategies; (2) boundary conditions required by the models to produce quantifiable estimates of needed emissions reductions; and (3) the evaluation of the predictive capability of the models used.

(b) *SIP control strategy evaluation.* The PAMS will provide data for SIP control strategy evaluation. Long-term PAMS data will be used to evaluate the effectiveness of these control strategies. Data may be used to evaluate the impact of VOC and NO_x emission reductions on air quality levels for O_3 if data is reviewed following the time period during which control measures were implemented. Speciation of measured VOC data will allow determination of which organic species are most affected by the emissions reductions and assist in developing cost-effective, selective VOC reductions and control strategies. A State or local air pollution control agency can therefore ensure that strategies which are implemented in their particular nonattainment area are those which are best suited for that area and achieve the most effective emissions reductions (and therefore largest impact) at the least cost.

(c) *Emissions tracking.* PAMS data will be used to corroborate the quality of VOC and NO_x emission inventories. Although a perfect mathematical relationship between emission inventories and ambient measurements does not yet exist, a qualitative assessment of the relative contributions of various compounds to the ambient air can be roughly compared to current emission inventory estimates to evaluate the accuracy of the emission inventories. In addition, PAMS data which are gathered year round will allow tracking of VOC and NO_x emission reductions, provide additional information necessary to support Reasonable Further Progress (RFP) calculations, and corroborate emissions trends analyses. While the regulatory assessments of progress will be made in terms of emission inventory estimates, the ambient data can provide independent trends analyses and corroboration of these assessments which either verify or highlight possible errors in emissions trends indicated by inventories. The ambient assessments, using speciated data, can gauge the accuracy of estimated changes in emissions. The speciated data can also be used to assess the quality of the VOC speciated and NO_x emission inventories for input during photochemical grid modeling exercises and identify potential urban air toxic pollutant problems which deserve closer scrutiny.

The speciated VOC data will be used to determine changes in the species profile, resulting from the emission control program, particularly those resulting from the reformulation of fuels.

(d) *Trends.* Long-term PAMS data will be used to establish speciated VOC, NO_x, and limited toxic air pollutant trends, and supplement the O_3 trends database. Multiple statistical indicators will be tracked, including O_3 and its precursors during the events encompassing the days during each year with the highest O_3 concentrations, the seasonal means for these pollutants, and the annual means at representative locations.

The more PAMS that are established in and near nonattainment areas, the more effective the trends data will become. As the spatial

distribution and number of O_3 and O_3 precursor monitors improves, trends analyses will be less influenced by instrument or site location anomalies. The requirement that surface meteorological monitoring be established at each PAMS will help maximize the utility of these trends analyses by comparisons with meteorological trends, and transport influences. The meteorological data can also help interpret the ambient air pollution trends by taking meteorological factors into account.

(a) *Exposure assessment.* PAMS data will be used to better characterize O_3 and toxic air pollutant exposure to populations living in serious, severe, or extreme areas. Annual mean toxic air pollutant concentrations will be calculated to help estimate the average risk to the population associated with individual VOC species, which are considered toxic, in urban environments.

4.2 *PAMS Monitoring Objectives.* Unlike the SLAMS and NAMS design criteria which are pollutant specific, PAMS design criteria are site specific. Concurrent measurements of O_3, NO_X, speciated VOC, and meteorology are obtained at PAMS. Design criteria for the PAMS network are based on selection of an array of site locations relative to O_3 precursor source areas and predominant wind directions associated with high O_3 events. Specific monitoring objectives are associated with each location. The overall design should enable characterization of precursor emission sources within the area, transport of O_3 and its precursors into and out of the area, and the photochemical processes related to O_3 nonattainment, as well as developing an initial, though limited, urban air toxic pollutant database. Specific objectives that must be addressed include assessing ambient trends in O_3, NO, NO_2, NO_X, VOC (including carbonyls), and VOC species, determining spatial and diurnal variability of O_3, NO, NO_2, NO_X, and VOC species and assessing changes in the VOC species profiles that occur over time, particularly those occurring due to the reformulation of fuels. A maximum of five PAMS sites are required in an affected nonattainment area depending on the population of the Metropolitan Statistical Area/Consolidated Metropolitan Statistical Area (MSA/CMSA) or nonattainment area, whichever is larger. Specific monitoring objectives associated with each of these sites result in four distinct site types. Note that detailed guidance for the locating of these sites may be found in reference 19.

Type (1) sites are established to characterize upwind background and transported O_3 and its precursor concentrations entering the area and will identify those areas which are subjected to overwhelming transport. Type (1) sites are located in the predominant morning upwind direction from the local area of maximum precursor emissions during the O_3 season and at a distance sufficient to obtain urban-scale measurements as defined in section 1 of this appendix. Typically, type (1) sites will be located near the edge of the photochemical grid model domain in the predominant morning upwind direction from the city limits or fringe of the urbanized area. Depending on the boundaries and size of the nonattainment area and the orientation of the grid, this site may be located outside of the nonattainment area. The appropriate predominant morning wind direction should be determined from historical wind data occurring during the period 7 a.m. to 10 a.m. on high O_3 days or on those days which exhibit the potential for producing high O_3 levels, i.e., O_3-conducive days as described in reference 25. Alternate schemes for specifying this morning wind direction may be submitted as a part of the network description required by §§ 58.40 and 58.41. Data measured at type (1) sites will be used principally for the following purposes:

- Future development and evaluation of control strategies,
- Identification of incoming pollutants,
- Corroboration of NO_X and VOC emission inventories,
- Establishment of boundary conditions for future photochemical grid modeling and mid-course control strategy changes, and
- Development of incoming pollutant trends.

Type (2) sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants. Type (2) sites are located immediately downwind of the area of maximum precursor emissions and are typically placed near the downwind boundary of the central business district to obtain neighborhood scale measurements. The appropriate downwind direction should be obtained similarly to that for type (1) sites. Additionally, a second type (2) site may be required depending on the size of the area, and should be placed in the second-most predominant morning wind direction as noted previously. Data measured at type (2) sites will be used principally for the following purposes:

- Development and evaluation of imminent and future control strategies,
- Corroboration of NO_X and VOC emission inventories,
- Augmentation of RFP tracking,
- Verification of photochemical grid model performance,
- Characterization of O_3 and toxic air pollutant exposures (appropriate site for measuring toxic emissions impact),
- Development of pollutant trends, particularly toxic air pollutants and annual ambient speciated VOC trends to compare with trends in annual VOC emission estimates, and
- Determination of attainment with the NAAQS for NO_2 and O_3.

Type (3) sites are intended to monitor maximum O_3 concentrations occurring downwind from the area of maximum precursor emissions. Locations for type (3) sites should be chosen so that urban scale measurements are obtained. Typically, type (3) sites will be located 10 to 30 miles downwind from the fringe of the urban area. The downwind direction should also be determined from historical wind data, but should be identified as those afternoon winds occurring during the period 1 p.m. to 4 p.m. on high O_3 days or on those days which exhibit the potential for producing high O_3 levels. Alternate schemes for specifying this afternoon wind direction may also be submitted as a part of the network description required by §§ 58.40 and 58.41. Data measured at type (3) sites will be used principally for the following purposes:

- Determination of attainment with the NAAQS for O_3 (this site may coincide with an existing maximum concentration O_3 monitoring site),
- Evaluation of future photochemical grid modeling applications,
- Future development and evaluation of control strategies,
- Development of pollutant trends, and
- Characterization of O_3 pollutant exposures.

Type (4) sites are established to characterize the extreme downwind transported O_3 and its precursor concentrations exiting the area and will identify those areas which are potentially contributing to overwhelming transport in other areas. Type (4) sites are located in the predominant afternoon downwind direction, as determined for the type (3) site, from the local area of maximum precursor emissions during the O_3 season and at a distance sufficient to obtain urban scale measurements as defined elsewhere in this appendix. Typically, type (4) sites will be located near the downwind edge of the photochemical grid model domain. Alternate schemes for specifying the location of this site may be submitted as a part of the network description required by §§ 58.40 and 58.41. Data measured at type (4) sites will be used principally for the following purposes:

- Development and evaluation of O_3 control strategies,
- Identification of emissions and photochemical products leaving the area,
- Establishment of boundary conditions for photochemical grid modeling,
- Development of pollutant trends,
- Background and upwind information for other downwind areas, and
- Evaluation of photochemical grid model performance.

States choosing to submit an individual network description for each affected nonattainment area, irrespective of its proximity to other affected areas, must fulfill the requirements for isolated areas as described in section 4 of appendix D, as an example, and illustrated by Figure 2. States containing areas which experience significant impact from long-range transport or are proximate to other nonattainment areas (even in other States) should collectively submit a network description which contains alternative sites to those that would be required for an isolated area. Such a submittal should, as a guide, be based on the example provided in Figure 2, but must include a demonstration that the design satisfies the monitoring data uses and fulfills the PAMS monitoring objectives described in sections 4.1 and 4.2 of appendix D. EPA recognizes that specific monitoring sites identified for one area may serve to fulfill the monitoring objectives for a different site in another area; for example, a downwind site for one area may suffice as an upwind site for another. These alternative network designs must also be reviewed and approved by the Administrator.

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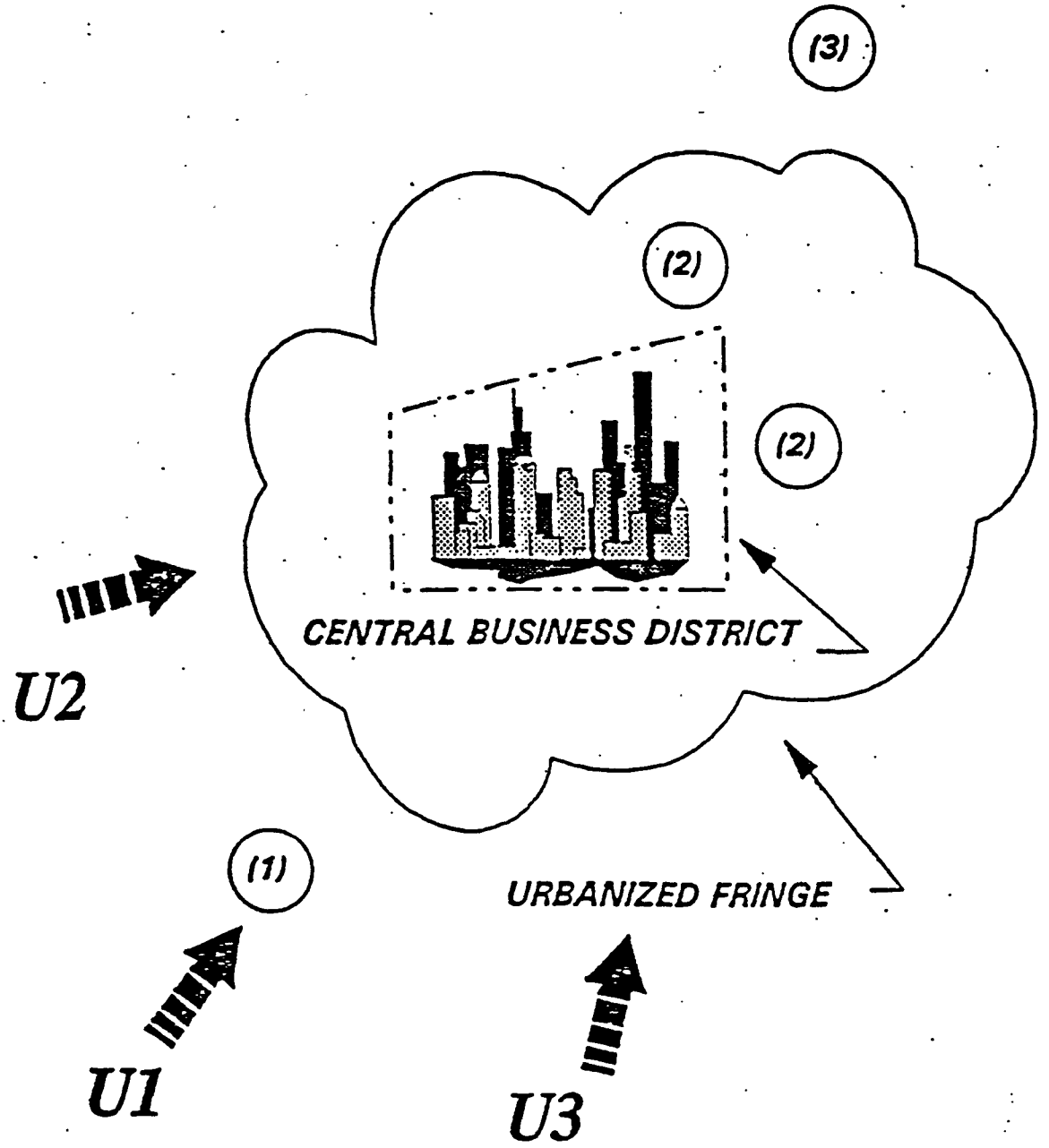
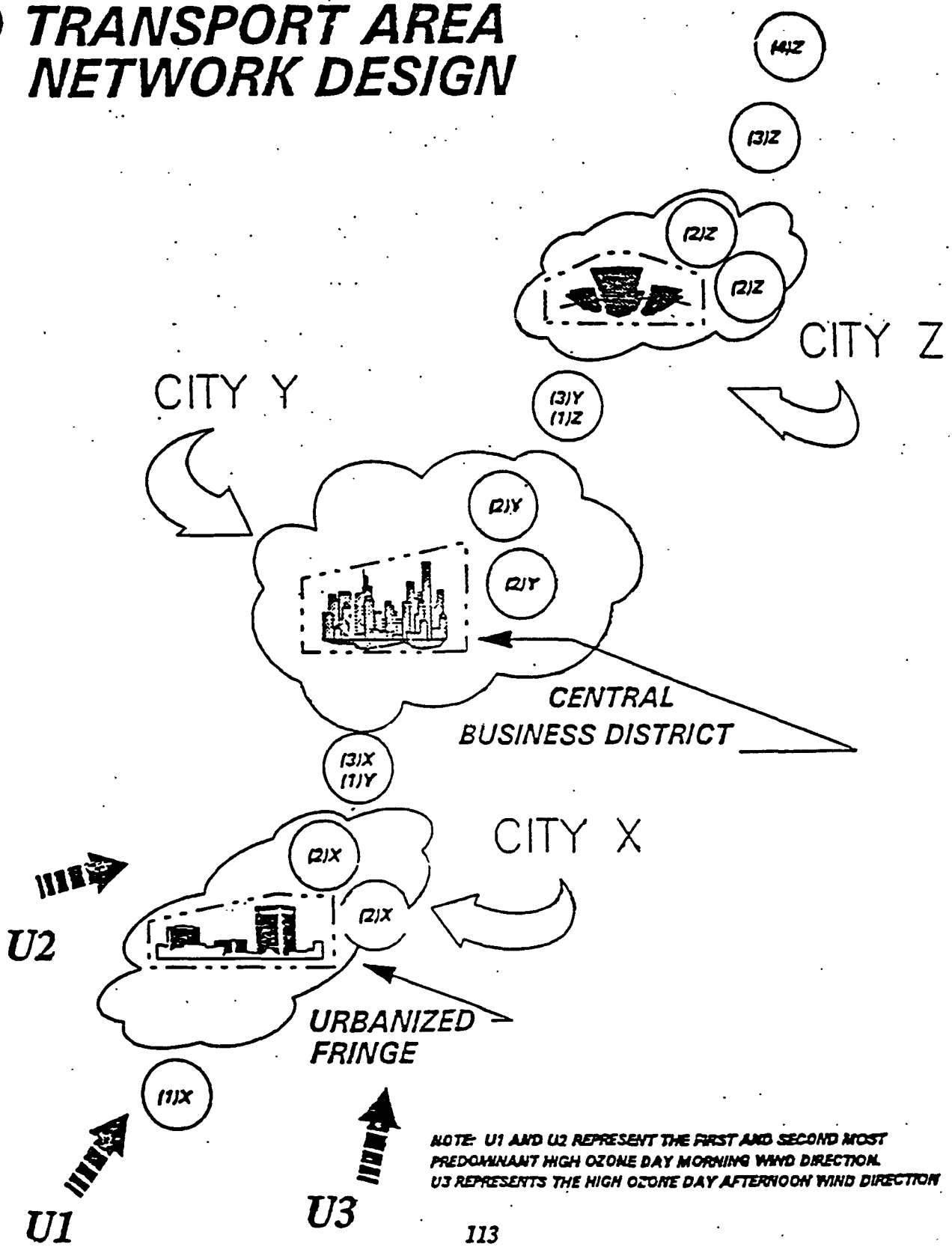
FIGURE 1 - ISOLATED AREA NETWORK DESIGN



NOTE: U1 AND U2 REPRESENT THE FIRST AND SECOND MOST PREDOMINANT HIGH OZONE DAY MORNING WIND DIRECTION. U3 REPRESENTS THE HIGH OZONE DAY AFTERNOON WIND DIRECTION.

FIGURE 2 - MULTI-AREA AND TRANSPORT AREA NETWORK DESIGN



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Alternative PAMS network designs should, on a site-by-site basis, provide those data necessary to enhance the attainment/nonattainment database for criteria pollutants and explain the origins of overwhelming O_3 transport. The alternative PAMS data should be usable for the corroboration and verification of O_3 precursor emissions inventories and should comprise a qualitative (if not quantitative) measure of the accuracy of RFP calculations. The data should be sufficient to evaluate the effectiveness of the implemented O_3 control strategies and should provide data necessary to establish photochemical grid modeling boundary conditions and necessary inputs including appropriate meteorological parameters, and provide measurements which can serve as model evaluation tools. Further, utilizing its PAMS database (alternative or not), a State should be able to draw conclusions regarding population exposure and conduct trends analyses for both criteria and non-criteria pollutants. Overall, the PAMS network should serve as one of several complementary means, together with modeling and analysis of other data bases (e.g., inventories) and availability of control technology, etc., for States to justify the modification of existing control programs, design new programs, and evaluate future courses of actions for O_3 control.

4.3 *Monitoring Period.* PAMS precursor monitoring will be conducted annually throughout the months of June, July and August (as a minimum) when peak O_3 values are expected in each area; however, precursor monitoring during the entire O_3 season for the area is preferred. Alternate precursor monitoring periods may be submitted for approval as a part of the PAMS network description required by § 58.40. Changes to the PAMS monitoring period must be identified during the annual SLAMS Network Review specified in § 58.20. PAMS O_3 monitors must adhere to the O_3 monitoring season specified in section 2.5 of appendix D. To ensure a degree of national consistency, monitoring for the 1993 season should commence as follows:

One in 3-day sampling—June 3, 1993.
One in 6-day sampling—June 6, 1993.

These monitoring dates will thereby be coincident with the previously-established, intermittent schedule for particulate matter. States initiating sampling earlier (or later) than June 3, 1993 should adjust their schedules to coincide with this national schedule.

4.4 *Minimum Monitoring Network Requirements.* The minimum required number and type of monitoring sites and sampling requirements are based on the population of the affected MSA/CMSA or nonattainment area (whichever is larger). The MSA/CMSA basis for monitoring network requirements was chosen because it typically is the most representative of the area which encompasses the emissions sources contributing to nonattainment. The MSA/CMSA emissions density can also be effectively and conveniently portrayed by the surrogate of population. Additionally, a network which is adequate to characterize the ambient air of an MSA/CMSA often must extend beyond the boundaries of such an area (especially for O_3 and its precursors); therefore, the use of smaller geographical units (such as counties or nonattainment areas which are smaller than the MSA/CMSA) for monitoring network design purposes is inappropriate. Various sampling requirements are imposed according to the size of the area to accommodate the impact of transport on the smaller MSAs/CMSAs, to account for the spatial variations inherent in large areas, to satisfy the differing data needs of large versus small areas due to the intractability of the O_3 nonattainment problem, and to recognize the potential economic impact of implementation on State and local government. Population figures must reflect the most recent decennial U.S. census population report. Specific guidance on determining network requirements is provided in reference 19. Minimum network requirements are outlined in Table 2.

TABLE 2.—PAMS MINIMUM MONITORING NETWORK REQUIREMENTS [1]

Population of MSA/CMSA or nonattainment area [2]	Required site type [3]	Minimum speciated VOC sampling frequency [4]	Minimum carbonyl sampling frequency [4]
Less than 500,000	(*)	A or C	
	(*)	A or C	D or F [5]
500,000 to 1,000,000	(*)	A or C	
	(*)	B	E
	(*)	A or C	
1,000,000 to 2,000,000	(*)	A or C	
	(*)	B	E
	(*)	B	E
	(*)	A or C	
More than 2,000,000	(*)	A or C	
	(*)	B	E
	(*)	B	E
	(*)	A or C	
	(*)	A or C	

[1] O_3 and NO_x (including NO and NO_2) monitoring should be continuous measurements.
[2] Whichever area is larger.
[3] See Figure 1.
[4] Frequency Requirements are as follows: A—Eight 3-hour samples every third day and one additional 24-hour sample every sixth day during the monitoring period; B—Eight 3-hour samples, every day during the monitoring period and one additional 24-hour sample every sixth day year-round; C—Eight 3-hour samples on the 5 peak O_3 days plus each previous day, eight 3-hour samples every sixth day, and one additional 24-hour sample every sixth day, during the monitoring period; D—Eight 3-hour samples every third day during the monitoring period; E—Eight 3-hour samples every day during the monitoring period; F—Eight 3-hour samples on the 5 peak O_3 days plus each previous day and eight 3-hour samples every sixth day during the monitoring period. (NOTE: multiple samples taken on a daily basis must begin at midnight and consist of sequential, non-overlapping sampling periods.)
[5] Carbonyl sampling frequency must match the chosen speciated VOC frequency.
Note that the use of Frequencies C or F requires the submittal of an ozone event forecasting scheme.

For purposes of network implementation and transition, EPA recommends the following priority order for the establishment of sites:

- The type (2) sites which provides the most comprehensive data concerning O_3 precursor emissions and toxic air pollutants,
- The type (3) site which provides a maximum O_3 measurement and total conversion of O_3 precursors,
- The type (1) site which delineates the effect of incoming precursor emissions and concentrations of O_3 and provides upwind boundary conditions,
- The type (4) site which provides extreme downwind boundary conditions, and
- The second type (2) site which provides comprehensive data concerning O_3 precursor emissions and toxic air pollutants in the second-most predominant morning wind direction on high O_3 days.

Note also that O_3 event (peak day) monitoring will require the development of a scheme for forecasting such high O_3 days or will necessitate the stipulation of what meteorological conditions constitute a potential high O_3 day; monitoring could then be triggered only via meteorological projections. The O_3 event forecasting and monitoring scheme should be submitted as a part of the network description required by §§ 58.40 and 58.41 and should be reviewed during each annual SLAMS Network Review specified in § 58.20.

4.5 *Transition Period.* A variable period of time is proposed for phasing in the operation of all required PAMS. Within 1 year after (1) February 12, 1993, (2) or date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme, or (3) the designation of a new area and classification to serious, severe, or extreme O_3 nonattainment, a minimum of one type (2) site must be operating. Operation of the remaining sites must, at a minimum, be phased in at the rate of one site per year during subsequent years as outlined in the approved PAMS network description provided by the State.

4.6 *Meteorological Monitoring.* In order to support monitoring objectives associated with the need for various air quality analyses, model inputs and performance evaluations, meteorological monitoring including wind measurements at 10 meters above ground is required at each PAMS site. Monitoring should begin with site establishment. In addition, upper air meteorological monitoring is required for each PAMS area. Upper air monitoring should be initiated as soon as possible, but no later than 2 years after (1) February 12, 1993, (2) or date of redesignation or reclassification of any existing O_3 nonattainment area to serious, severe, or extreme, or (3) the designation of a new area and classification to serious, severe, or extreme O_3 nonattainment. The upper air monitoring site may be located separately from the type (1) through (4) sites, but the location should be representative of the upper air data in the nonattainment area. Upper air meteorological data must be collected during those days specified for monitoring by the sampling frequencies in Table 2. of section 4.4 of this appendix D in accordance with current EPA guidance.

* * * * *

Section 6 of Appendix D [Amended]

13. References 19 through 32 are added to section 6 of appendix D to read as follows:

6. References

* * * * *

19. Enhanced Ozone Monitoring Network Design and Siting Criteria Guideline Document. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 450/4–91–033. November 1991.

20. Technical Assistance Document For Sampling and Analysis of Ozone Precursors. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8–91–215. October 1991.

21. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4–90–0003. August 1989.

22. Criteria for Assessing the Role of Transported Ozone/Precursors in Ozone Non-attainment Areas. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA–450/4–91–015. May 1991.

23. Guideline for Regulatory Application of the Urban Airshed Model. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA–450/4–91–013. July 1991.

24. Ambient Air Monitoring Data Quality Objectives (DQOs) for the Photochemical Assessment Monitoring Stations (PAMS) Program. Guideline Document. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Draft Report. July 1992.

25. Shao-Hung Chu, "Using Windrose Data to Site Monitors of Ozone and Its Precursors", Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Draft Report. June 1992.

26. Lewis, Charles W., and Teri L. Conner, "Source Reconciliation of Ambient Volatile Organic Compounds Measured in the Atlanta 1990 Summer Study: The Mobile Source Component", Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. September 1991.

27. Fujita, Eric M., Bart E. Croes, Charles L. Bennett, Douglas R. Lawson, Frederick W. Lurmann, and Hilary H. Main, "Comparison of Emission Inventory and Ambient Concentration Ratios of CO, NMOG, and NO_x in California's South Coast Air Basin", J. Air and Waste Management Association 42:264–276. March 1992.

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29. Mayrsohn, H. and J. H. Crabtree, "Source Reconciliation of Atmospheric Hydrocarbons", Atmospheric Environment Vol 10. 1976.

30. Mayrsohn, Henry, James H. Crabtree, Mutsuo Kuramoto, Ray D. Sothern, and Henry Mano, "Source Reconciliation of Atmospheric Hydrocarbons 1974", Atmospheric Environment Vol 11. 1977.

31. Analysis of the Ambient VOC Data Collected in the Southern California Air Quality Study, State of California Air Resources Board—Research Division, 1800 15th Street, Sacramento, CA 95814, Final Report, Contract No. A832–130. February, 1992.

32. Purdue, Larry J., "Summer 1990 Atlanta Ozone Precursor Study", presented at the 84th Annual Meeting and Exhibition of the Air and Waste Management Association, Vancouver, British Columbia, Canada. June 1991.

14. Appendix E is amended by adding a new paragraph after the first paragraph in section 9, redesignating sections 10, 11, and 12 as sections 11, 12, and 13, and adding a new section 10, redesignating Table 5 as Table 6 in newly redesignated section 12, and adding a new Table 5 in new section 10, amending the last sentence in newly redesignated section 11 to add reference to PAMS, and amending newly redesignated section 12 by adding an entry to the bottom of Table 6 for VOC to read as follows:

Appendix E—Probe Siting Criteria for Ambient Air Quality Monitoring

* * * * *

*9. * * **

For VOC monitoring at those SLAMS designated as PAMS, FEP teflon is unacceptable as the probe material because of VOC adsorption and desorption reactions on the FEP teflon. Borosilicate glass, stainless steel, or its equivalent are the acceptable probe materials for VOC and carbonyl sampling. Care must be taken to ensure that the sample residence time is 20 seconds or less.

* * * * *

10. Photochemical Assessment Monitoring Stations (PAMS)

10.1 *Horizontal and Vertical Probe Placement.* The height of the probe inlet must be located 3 to 15 meters above ground level. This range provides a practical compromise for finding suitable sites for the multipollutant PAMS. The probe inlet must also be located more than 1 meter vertically or horizontally away from any supporting structure.

10.2 *Spacing from Obstructions.* The probe must be located away from obstacles and buildings such that the distance between the obstacles and the probe inlet is at least twice the height that the obstacle protrudes above the sampler. There must be unrestricted airflow in an arc of at least 270° around the probe inlet. Additionally, the predominant wind direction for the period of greatest pollutant concentration (as described for each site in section 4.2 of appendix D) must be included in the 270° arc. If the probe is located on the side of the building, 180° clearance is required.

10.3 *Spacing from Roads.* It is important in the probe siting process to minimize destructive interferences from sources of nitrogen oxide (NO) since NO readily reacts with O_3. Table 5 below provides the required minimum separation distances between roadways and PAMS (excluding upper air measuring stations):

TABLE 5.—SEPARATION DISTANCE BETWEEN PAMS AND ROADWAYS

[Edge of Nearest Traffic Lane]

Roadway average daily traffic vehicles per day	Minimum separation distance between roadways and stations in meters[1]
<10,000	>10
15,000	20
20,000	30
40,000	50
70,000	100
>110,000	>250

[1] Distances should be interpolated based on traffic flow.

Type (1), (3) and (4) sites are intended to be regionally representative and should not be unduly influenced by nearby roadways. Similarly, a nearby roadway should not act as a local depressor of O_3 concentrations for type (2) and (3) sites.

10.4 *Spacing from Trees.* Trees can provide surfaces for adsorption and/or reactions to occur and can obstruct normal wind flow patterns. To minimize these effects at PAMS, the probe inlet should be placed at least 20 meters from the drip line of trees. Since the scavenging effect of trees is greater for O_3 than for the other criteria pollutants, strong consideration of this effect must be given in locating the PAMS probe inlet to avoid this problem. Therefore, the samplers must be at least 10 meters from the drip line of trees that are located between the urban city core area and the sampler along the appropriate wind direction.

10.5 *Meteorological Measurements.* The 10-meter meteorological tower at each PAMS site should be located so that measurements can be obtained that are not immediately influenced by surrounding structures and trees. It is important that the meteorological data reflect the origins of, and the conditions within, the air mass containing the pollutants collected at the probe. Specific guidance on siting of meteorological towers is provided in references 31 and 32.

11. Waiver Provisions

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For those SLAMS also designated as NAMS or PAMS, the request will be forwarded to the Administrator.

12. Discussion and Summary

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TABLE 6.—SUMMARY OF PROBE SITING CRITERIA

Pollutant scale	Height above ground, meters	Distance from supporting structure, meters		Other spacing criteria
		Vertical	Horizontal[a]	
VOC	3–15	>1	>1	1. Should be >20 meters from the dripline and must be 10 meters from the dripline when the tree(s) act as an obstruction. 2. Distance from probe inlet to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted air flow in an arc of at least 270° around the probe inlet and the predominant wind direction for the period of greatest pollutant concentration (as described for each site in section 4.2 of appendix D) must be included in the 270° arc. If probe located on the side of a building unrestricted air flow must be 180°. 4. Spacing from roadways (see Table 5).

[a]When probe is located on rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof.

* * * * *

Section 13 of Appendix E [Amended]

15. References 31, 32, and 33 are added to section 13 of appendix E to read as follows:

13. References

* * * * *

31. Technical Assistance Document For Sampling and Analysis of Ozone Precursors. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8–91–215. October 1991.

32. Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/4–90–0003. August 1989.

33. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 450/4–87–013. June 1987.

[FR Doc. 93–3072 Filed 2–11–93; 8:45 am]

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APPENDIX B

METEOROLOGICALLY ADJUSTED OZONE TRENDS IN URBAN AREAS

Meteorologically Adjusted Ozone Trends in Urban Areas: A Probabilistic Approach

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ABSTRACT

A method has been developed that explicitly accounts for the effect of meteorological fluctuations on the annual distribution of ground level ozone in urban areas. The model includes a trend component that adjusts the annual rate of change in ozone for concurrent impacts of meteorological conditions, including surface temperature and wind speed. The model was applied using available data from 25 eastern U.S. urban areas where ozone levels frequently exceed the National Ambient Air Quality Standard. The results suggest that the meteorologically adjusted 99th percentile of ozone is decreasing in most urban areas over the period from 1981 through 1990. The median rate of change was -1.1 percent per year, indicating that ozone levels have decreased approximately 10 percent over this time period. Trends estimated by ignoring the meteorological component appear to underestimate the rate of improvement in ozone primarily because of the uneven year-to-year distribution of meteorological conditions favorable to ozone.

INTRODUCTION

Meteorological conditions, including daily temperature and wind speed, are known[1-3] to play an important role in determining the severity of ground-level ozone concentrations. Because annual variations in meteorological conditions can be substantial, year-to-year fluctuations in annual ozone statistics can also be quite large. The effect of such variations is to mask any long-term trends[4-6] in ozone that might reasonably be related to changes in precursor emissions (VOC, NO_x).

A method has been developed that explicitly accounts for the effect of yearly meteorological fluctuations on the annual frequency distribution of ground-level ozone levels. The method is based on a probability model in which the frequency distribution of ozone is described in terms of daily meteorological parameters and a trend component. The parameters are estimated using the method of maximum likelihood in which measured daily maximum ozone levels are quantitatively related to daily maximum temperature and other daily weather conditions.

The method has been applied to data collected in 25 urban areas in the eastern portion of the U. S. Trends in ozone concentrations over the 10-year period from 1981-1990 are estimated for each city. In addition, the model has been used to calculate expected annual ozone air quality statistics estimated using annual meteorological data that have been adjusted to a reference period. The bootstrap method is used to determine standard errors associated with the parameter estimates and to calculate confidence limits for the annual adjusted ozone concentrations statistics.

DATA BASE

Hourly average concentrations of ozone were obtained from EPA's AIRS data base for all available monitoring stations within each of the 25 Metropolitan Statistical Areas (MSA) where ozone levels have been historically high. The data were selected for the time period 1981 through 1990 and include the months during which daily maximum ozone levels were likely to be near or above EPA's National Air Quality Standard (120 ppb). Typically these months spanned from June through September in more northerly areas (e.g., Chicago, New York, Boston) and from April through October in more southerly areas (e.g., Houston and Miami). For each day, the maximum hourly average ozone value was selected from all available station-hours.

The meteorological data base was assembled from hourly average data obtained from the National Weather Service. Both surface and upper air data were used to create approximately 100 daily meteorological parameters' that might be potentially important predictors of daily ozone levels. These parameters encompass many of those that have been previously identified with high ozone levels such as daily maximum surface temperature, relative humidity, mixing height, and cloud cover. Daily maximum ozone values for each urban area were paired with corresponding meteorological data at the nearest surface and upper air station.

The data were screened using graphical and regression methods to determine which meteorological parameters seemed to be most strongly associated with day-to-day fluctuations in daily maximum 1-hour ozone. Generally, it was found that 6 meteorological parameters explained most of the variability in daily ozone concentrations. These 6 variables were (1) daily maximum surface temperature (positive association), (2) morning average wind speed (negative), (3) afternoon average wind speed (negative), (4) relative humidity (negative), (5) opaque cloud cover (negative) and, (6) morning mixing height (negative).

Figure 1 shows box plots of the annual distributions for each of the 6 meteorological parameters in the Chicago urban area. Median and upper percentiles of daily maximum temperatures were higher in 1983 and 1988 than for any of the other years. Since temperature shows a strong positive association with ozone, ozone levels in these 2 years would be expected to be higher. Also, relative humidity and cloud cover for 1988 was significantly lower than for any other year during the 10 year span. Since relative humidity and cloud cover are generally negatively related to ozone, ozone levels in 1988 would be expected to be higher as a result. Although wind speeds and mixing height are important predictors of day-to-day changes in ozone, the annual distribution of wind speeds and mixing height across the 10 year period is relatively flat. Thus, annual variations in these 3 parameters appear to be less important in terms of accounting for year-to-year changes in ozone levels in Chicago.

While a qualitative link was evident between meteorology and daily ozone, a more quantitative association is desirable. Such a quantitative link is established by modeling the probability distribution of daily maximum ozone levels as a function of daily meteorological parameters.

PROBABILISTIC MODELING

A probability model is proposed that incorporates the effects of daily meteorological conditions on the probability distribution of ozone concentration levels. The probability model is based on the Weibull distribution in which the scale parameter is allowed to vary from day to day in response to changes in meteorological conditions favorable to ozone. With this model structure, annual ozone statistics may be computed by simply combining daily ozone distributions fitted from the model. Thus, it is possible to quantitatively explain how shifts in the annual distribution of say, temperature, affect the annual distribution of ozone. Conversely, the distribution of ozone under more typical conditions may be predicted simply by substituting meteorological conditions into the model and recomputing the distribution of ozone. The basic form of the probability model is:

$$Prob\,[y > Y]_i = Exp\left\{-\left(\frac{Y}{\sigma_i}\right)^{\lambda}\right\} \qquad (1)$$

where Prob = Probability that daily ozone exceeds Y
σ_i = Scale Parameter for day i
λ = Shape Parameter

The scale parameter for any given day is allowed to vary as a function of the meteorological conditions in the following manner:

$$\sigma_i = Exp\left\{\sum \beta_j * M_{ij} + \xi * T\right\} \qquad (2)$$

where β_j = Regression coefficient for parameter j
M_{ij} = Meteorological parameter j on day i
ξ = Annual Trend Rate
T = Year (T=1,2,...10)

This model is designed to account for the effects of daily variations in meteorological conditions and slowly changing trends that may take place over a number of years. The advantage is that meteorological and trend effects are estimated simultaneously to avoid potential confounding between the 2 types of effects. The model was applied using the data base assembled for the Chicago MSA. Maximum Likelihood Estimates of the parameters were obtained from code prepared using the SAS Interactive Matrix Language[8] (IML). Results shown in Table 1 include the parameter estimates, standard errors and t ratio. The 6 meteorological parameters represent the most significant predictors of ozone over the geographic region containing the 25 urban areas used in this analysis. The interaction term formed between temperature and morning average wind speed was included to account for the combined effects of these parameters. The trend component was positive and marginally significant (t=2.2).

Because the scale parameter is expressed exponentially, the parameter estimates represent a fractional change per unit change in the independent variable. For example, the afternoon wind speed coefficient is -0.021 which means that each 1 meter per second increase in afternoon wind speed produces a 2.1 percent decrease in the scale parameter. The linear trend parameter was estimated at 0.0074 which means that on average, ozone is estimated to be increasing at slightly less than 1 percent per year over the ten-year period.

To assess the validity of the model, the measured- and model-predicted 95th and 99th percentiles of daily maximum ozone levels were compared for each of the 10 years. Predicted values were obtained by substituting parameter estimates and solving for the value of Y such that the sum of the probabilities given in equation (1) is equal to the product N*P, where N is the number of ozone measurements in a year and P is the percentile expressed as a fraction. For 95th percentiles, the model fits the observed data fairly well for each of the

10 years. For 99th percentiles, the predicted values were underestimated (approximately 10 percent) in 1988 and slightly overestimated (approximately 5 percent) in 1989 and 1990.

ADJUSTED OZONE STATISTICS

While the meteorologically adjusted annual trend rate is estimated at approximately +0.7 percent per year, it is visually more appealing to display the meteorologically adjusted ozone percentiles for each of the years. Meteorologically adjusted ozone percentiles are computed by using typical meteorological data in place of the actual meteorological conditions for each year. For convenience, a reference meteorological period is defined in terms of meteorological conditions that occur over at least a 10 year period. The reference period is characterized in terms of averages and standard deviations of meteorological parameters that are found to be important ozone predictors. For example, the mean relative humidity for the reference period is computed as the mean of the daily relative humidities across the 10 year period from 1981 through 1990. Similarly, the standard deviation for the reference period is computed as the average of the 10 yearly standard deviations of daily relative humidity.

The method used to adjust the meteorological data involves translation of meteorological parameters such that each parameter has the same mean and standard deviation as the reference period. Effectively, data values within each year are scaled such that they become centered over the distribution of meteorological parameters corresponding to the reference period. Notationally, the calculation of scaled meteorological data is as follows:

$$Y = Mr + (Xb - Mb)*(Sr/Sb).$$

where

Mb	=	Mean value for the given period
Sb	=	Standard deviation for the given period
Mr	=	Mean value for the reference period
Sr	=	Standard deviation for the reference period
Xb	=	Daily meteorological parameters for the given year
Y	=	Scaled meteorological parameters for the given year

As before, model-predicted values of ozone are obtained by substituting parameter estimates and solving for the value of Y such that the sum of the probabilities given in equation (1) is equal to the product N*P, where N is the number of ozone measurements in a year and P is the percentile expressed as a fraction. The meteorology used in this calculation is the scaled meteorology such that it has the same mean and standard deviation as the reference period.

Figure 2 shows the result of this adjustment for Chicago along with the original 99th percentiles. The adjusted result for any given year may be interpreted as the expected value for the ozone statistic if the distribution of meteorology in that year had resembled the long term (10-year) average. Overall, the year-to-year changes in the adjusted 99th percentiles are much less abrupt and convey a smoother sense of trends over the 10 year period. Upper and lower 95 percent confidence bounds on the 99th percentile were obtained using the bootstrap technique which is described below.

BOOTSTRAP ESTIMATE OF ERRORS

One of the important assumptions associated with maximum likelihood estimation is that the individual observations (days) are independent. Because of meteorological persistence, this is usually not the case. The effect of non-independence among the daily values is to bias the estimate of standard errors associated with the parameter estimates. Because of the positive association among daily values, the effect is to cause the asymptotic standard errors to be underestimated. A more realistic estimate of the standard error of the parameters can be obtained using a resampling scheme such as the Bootstrap or Jackknife[9,10]. Because of its simplicity, the blocked bootstrap is used as the procedure to estimate the sampling errors. The sampling strategy involved first partitioning the days into consecutive 3-day blocks. This was done to preserve the dependence that usually exists among meteorological conditions and, of course, resulting ozone levels.

Next, annual bootstrap samples were chosen by randomly selecting (with replacement) data in 3-day blocks until a complete annual (ozone season) sample had been formed. For each annual sample (ozone and accompanying meteorological data) the parameter estimates were obtained along with the adjusted meteorological data and adjusted ozone statistics. This step was repeated until 100 annual samples had been constructed. The standard errors of parameter estimates (Table 1 and Table 2) were computed as simply the standard deviation of the bootstrap estimates of the parameters. Typically, the bootstrap estimates of the standard error were 30 to 40 percent larger than the asymptotic results.

URBAN AREA RESULTS

The model was applied using data for 25 urban areas (Table 2) located throughout the eastern portion of the U.S. The same 6 meteorological parameters, including wind speed and temperature interaction, were included in the model. Model performance showed some variation among the urban areas. Model performance is typically good in all areas except for southern coastal cities including Miami, Tampa, and Jacksonville, Florida. For these areas, source/receptor alignment and meso-scale meteorological effects (land/sea breezes) not accounted for may be related to poorer model performance.

Table 2 shows the estimated trend parameter along with the bootstrap adjusted standard error and t ratio. The urban areas are sorted such that cities at the top of the list show the most marked improvements while cities near the bottom of the list show the least improvements over time. The t ratio statistic provides a measure of the significance of the trend rate. Absolute values of the t ratio greater than 2.0 indicate significance at approximately the 95 percent level.

Three of the urban areas displayed improvements that exceeded 2 percent per year (Houston, Louisville, and Dallas) while another 10 urban areas had rates of improvement

better than 1 percent per year. Several cities listed near the bottom of the list actually showed slight increases in ozone over the 10-year period. The median rate of change among the 25 urban areas indicates a 1.1 percent per year decrease in ozone which is equivalent to an improvement of approximately 10 percent over the 10-year period.

For comparison purposes, ozone trends in the 25 urban areas were recomputed using the Weibull probability model with only the linear trend component included in the scale parameter. The purpose for this calculation was to contrast the difference between estimated trend rates with and without consideration of annual meteorological fluctuations. For 21 of the 25 urban areas, the adjusted trend rate was lower than the unadjusted rate. The median rate of change for the unadjusted trends was a 0.5 percent decrease per year indicating that improvements after adjustment are substantially greater than before adjustment. Clearly, the adjusted ozone trends provide an indication that national efforts to reduce the severity of the urban ozone problem have been more productive than would otherwise be suggested from the data.

CONCLUSIONS

A statistical model has been developed for describing day-to-day changes in the probability distribution of ground level ozone as a function of meteorological conditions. The model includes a long-term trend component such that meteorological effects are accounted for directly in the estimation procedure. The model was applied to data available from 25 urban areas for the summer period covering 1981 through 1990. The performance of the model was evaluated by comparing measured- and model-predicted 95th and 99th percentiles. Overall, the measured- and model-predicted percentiles tracked closely in the northern latitudes but performed less well in southern coastal areas where meso-scale meteorological conditions are suspected to dominate.

Generally, the adjusted 99th percentiles have considerably less year-to-year variability than do the unadjusted 99th percentiles. The median rate of change in daily maximum 1-hour ozone levels among the 25 Eastern U.S. urban areas reflected a 1.1 percent per year decrease over the period from 1981 through 1990. Since annual changes in meteorological conditions are directly considered, the method produces adjusted trend rates that are less influenced by meteorology than those produced without consideration of meteorological fluctuations.

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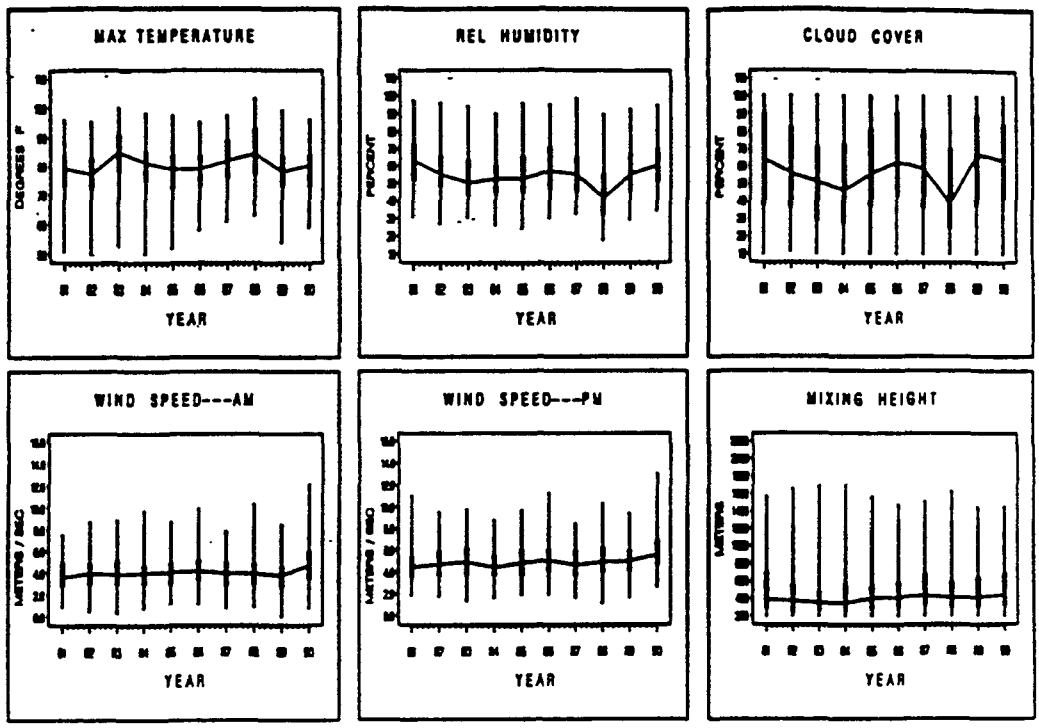

FIGURE 1. Chicago Meteorclogical Data

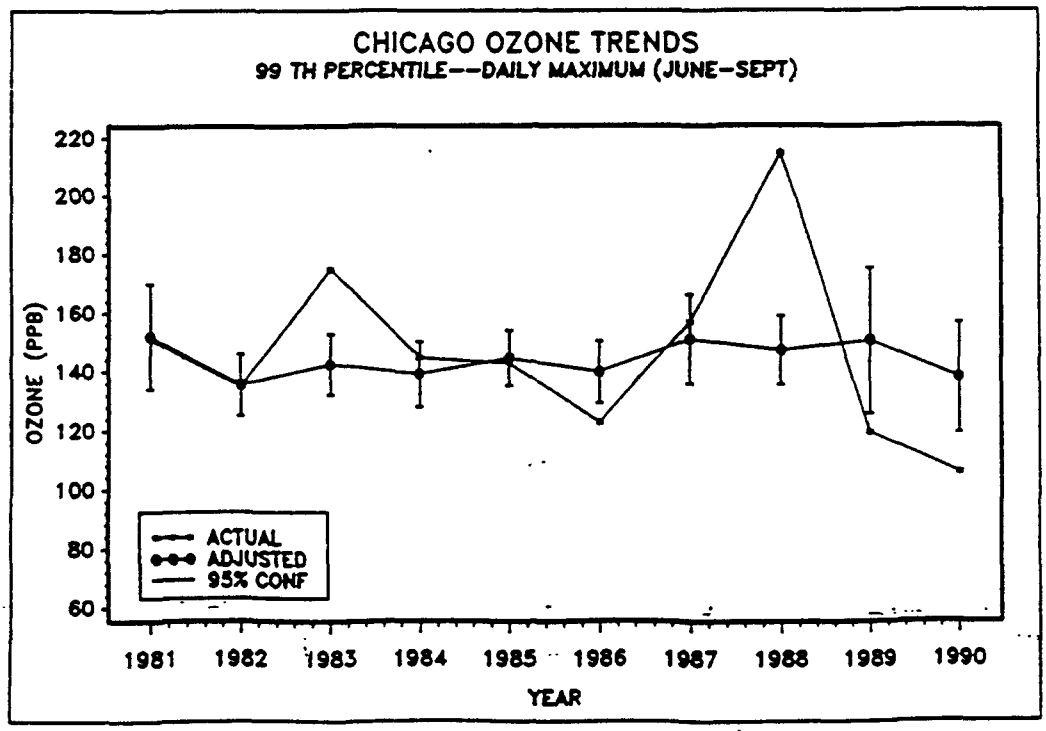

FIGURE 2. Ozone Trend Statistics with 95% Confidence Limits

TABLE 1

Parameter Estimates and Standard Errors (Chicago)

Variables	Parameter Estimates	Standard Errors	T Ratio
Lambda	4.3800	0.1780	24.6
Constant	1.2126	0.2000	6.1
Maximum Sfc Temperature	0.0433	0.0023	18.8
Wind Speed (7-10 AM)	0.2513	0.0468	5.9
Temp X Wind Speed (AM)	-0.0038	0.0006	-6.8
Wind Speed (1-4 PM)	-0.0213	0.0070	-3.0
Relative Humidity (10-4PM)	-0.0010	0.0011	-0.9
Opaque Cloud Cover	-0.0004	0.0003	-1.3
Mixing Height (AM)	-0.00009	0.00005	-1.8
Year	0.0074	0.0034	2.2

Note: Standard Errors are based on 100 bootstrap replications. They are approximaely 30 to 40 percent larger than asymptotic results.

TABLE 2

OZONE TRENDS ADJUSTED FOR METEOROLOGY EASTERN U.S URBAN AREAS--1981 THROUGH 1990

	TREND RATE (PERCENT/YEAR)	STANDARD ERROR	T-RATIO
HOUSTON	-2.8	0.43	-6.5
LOUISVILLE	-2.6	0.57	-4.6
DALLAS	-2.3	0.29	-7.9
NEW YORK	-1.9	0.39	-4.9
PITTSBURGH	-1.7	0.32	-5.3
ST LOUIS	-1.6	0.27	-5.9
TAMPA	-1.5	0.32	-4.7
BIRMINGHAM	-1.4	0.28	-5.0
CLEVELAND	-1.3	0.37	-3.5
DETROIT	-1.3	0.31	-4.1
CINCINNATI	-1.2	0.45	-2.7
PHILADELPHIA	-1.0	0.31	-3.9
BALTIMORE	-1.1	0.34	-3.2
MILWAUKEE	-0.7	0.40	-1.8
KANSAS CITY	-0.7	0.39	-1.8
WASHINGTON	-0.4	0.37	-1.1
BATON ROUGE	-0.4	0.38	-1.1
CHARLOTTE	-0.4	0.21	-1.9
BOSTON	-0.2	0.38	-0.5
TULSA	-0.1	0.23	-0.4
COLUMBIA	0.2	0.24	0.8
JACKSONVILLE	0.6	0.38	1.6
MIAMI	0.6	0.44	1.4
CHICAGO	0.7	0.34	2.1
ATLANTA	0.8	0.26	3.1

Note: Dark lines separate cities with downward trends (top) no change (middle) or upward trends (bottom)

APPENDIX C

GUIDELINE FOR THE INTERPRETATION OF OZONE AIR QUALITY STANDARDS

United States
Environmental Protection
Agency

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

EPA-450/4-79-003
OAQPS No. 1.2-108
January 1979

Air

EPA

Guideline Series

Guideline for the Interpretation of Ozone Air Quality Standards

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Guideline for the Interpretation of Ozone Air Quality Standards

Monitoring and Data Analysis Division

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

January 1979

OAQPS GUIDELINE SERIES

The guideline series of reports is being issued by the Office of Air Quality Planning and Standards (OAQPS) to provide information to state and local air pollution control agencies, for example, to provide guidance on the acquisition and processing of air quality data and on the planning and analysis requisite for the maintenance of air quality. Reports published in this series will be available - as supplies permit - from the Library Services Office (MD-35), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a nominal fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

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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 occassional "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:

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

(* 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 stabiity 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 it 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-

dard 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 arbitary 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

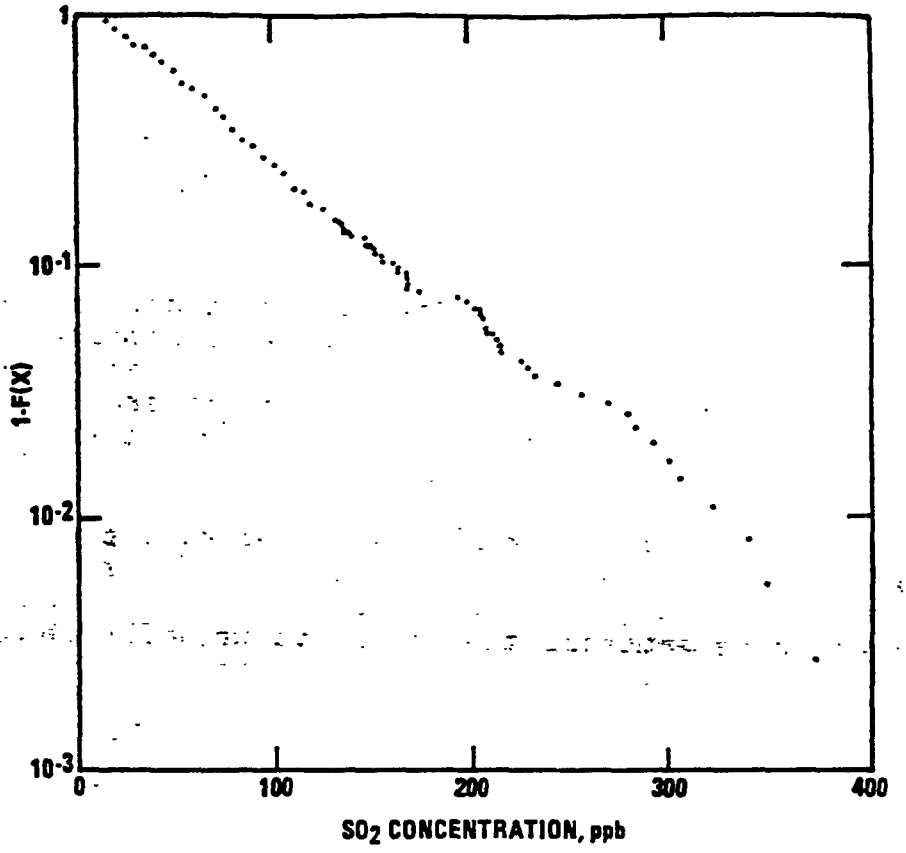

Figure 1. Sulfur dioxide measurements for 1968 (24-hour) at CAMP station in Philadelphia, Pa., plotted on semi-log paper.

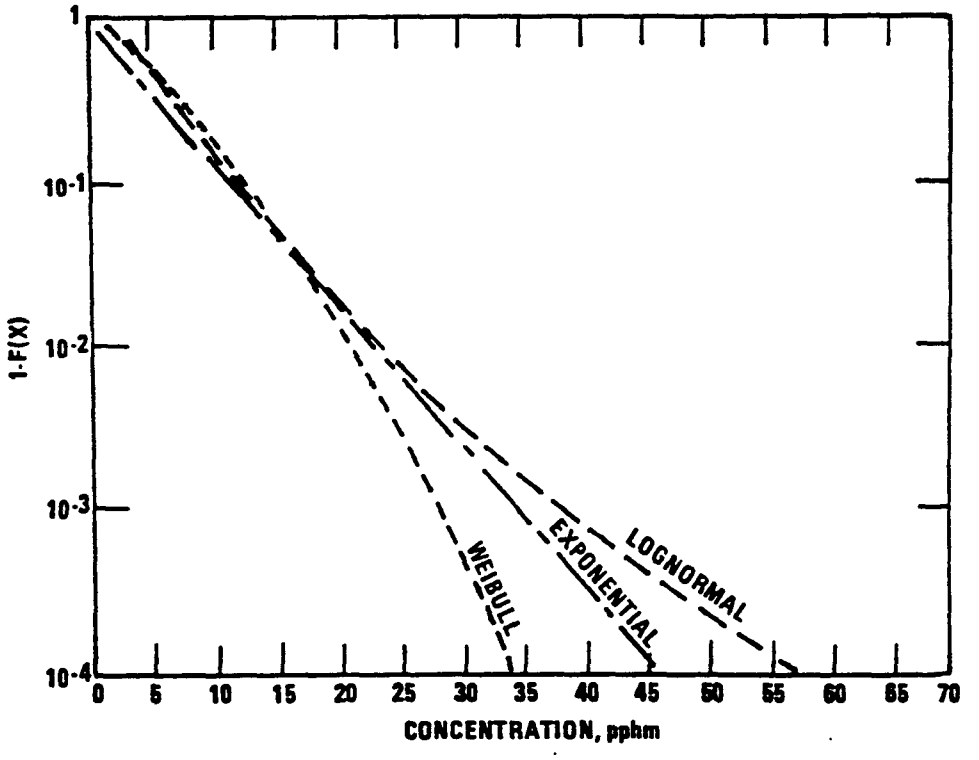

Figure 2. Examples of lognormal, exponential, and Weibull distributions plotted on semi-log paper. A Weibull distribution may also curve upward for certain parameter values.

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 Fi(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:

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

where Fi 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:

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

In general it may not be possible to explicity 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

$$F1(x) = 1 - EXP(-43.4x) \quad \text{and}$$
$$F2(x) = 1 - EXP(-37.6x).$$

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

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

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.

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

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:

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

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.

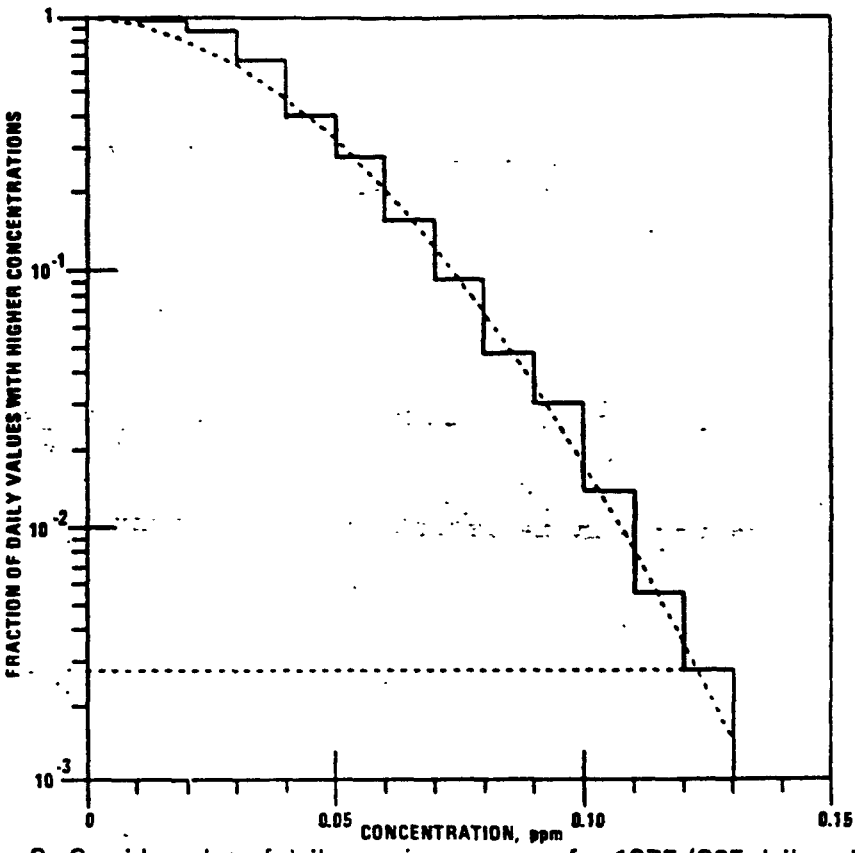

Figure 3. Semi-log plot of daily maximum ozone for 1975 (365 daily values).

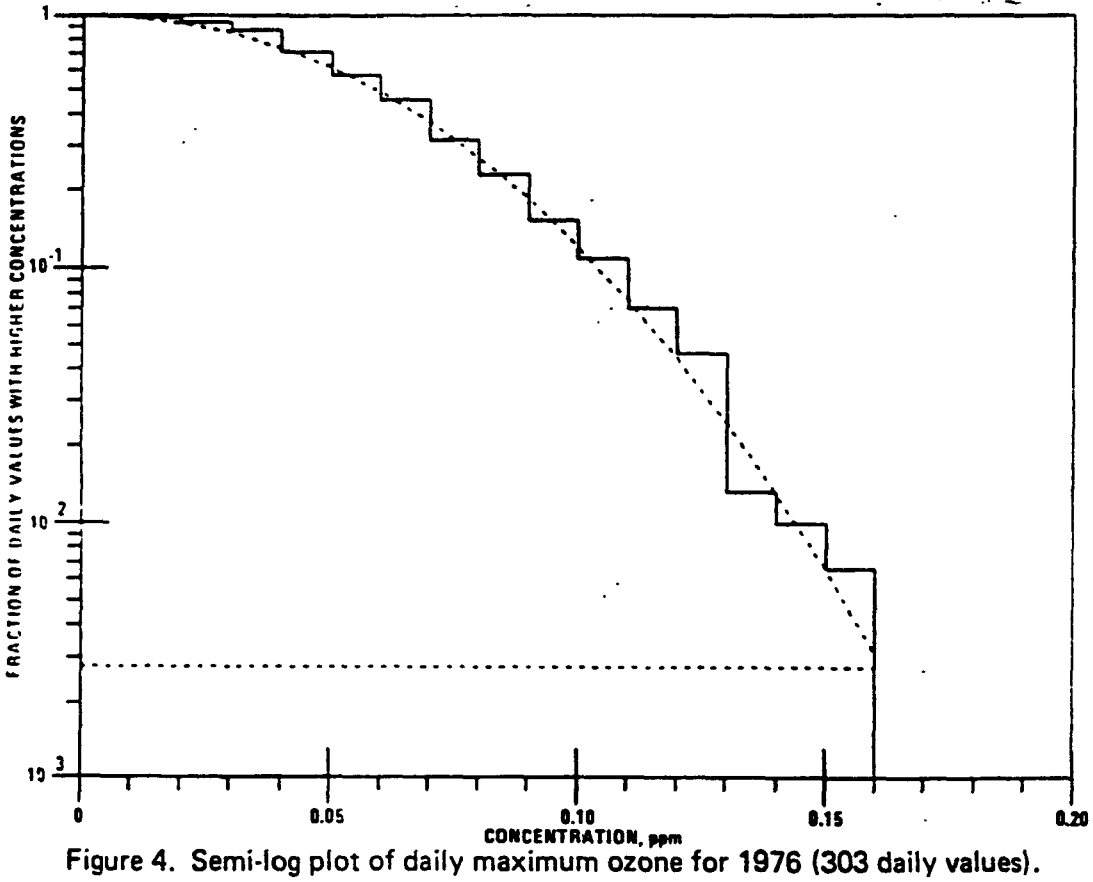

Figure 4. Semi-log plot of daily maximum ozone for 1976 (303 daily values).

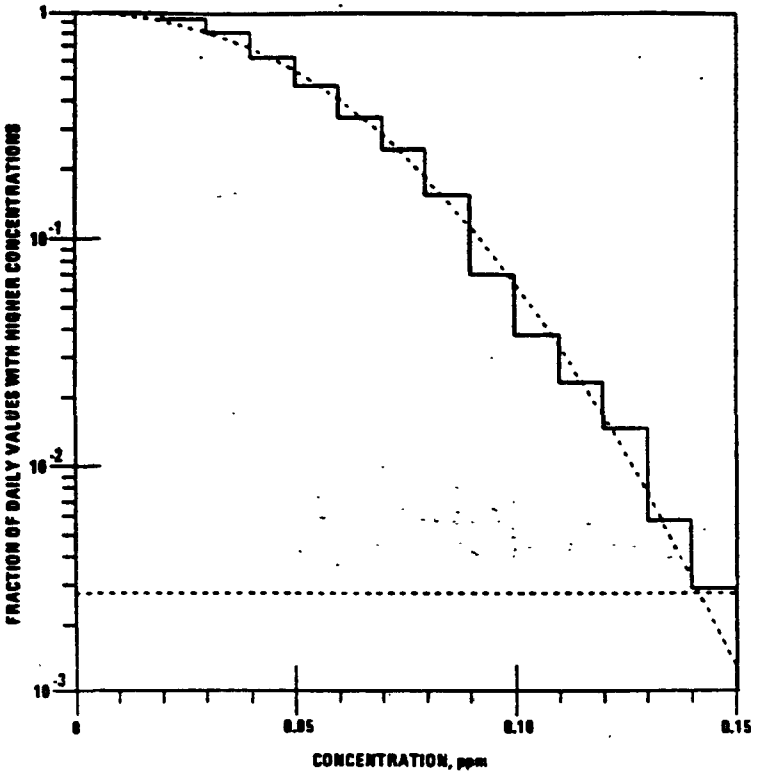

Figure 5. Semi-log plot of daily maximum ozone for 1977 (349 daily values).

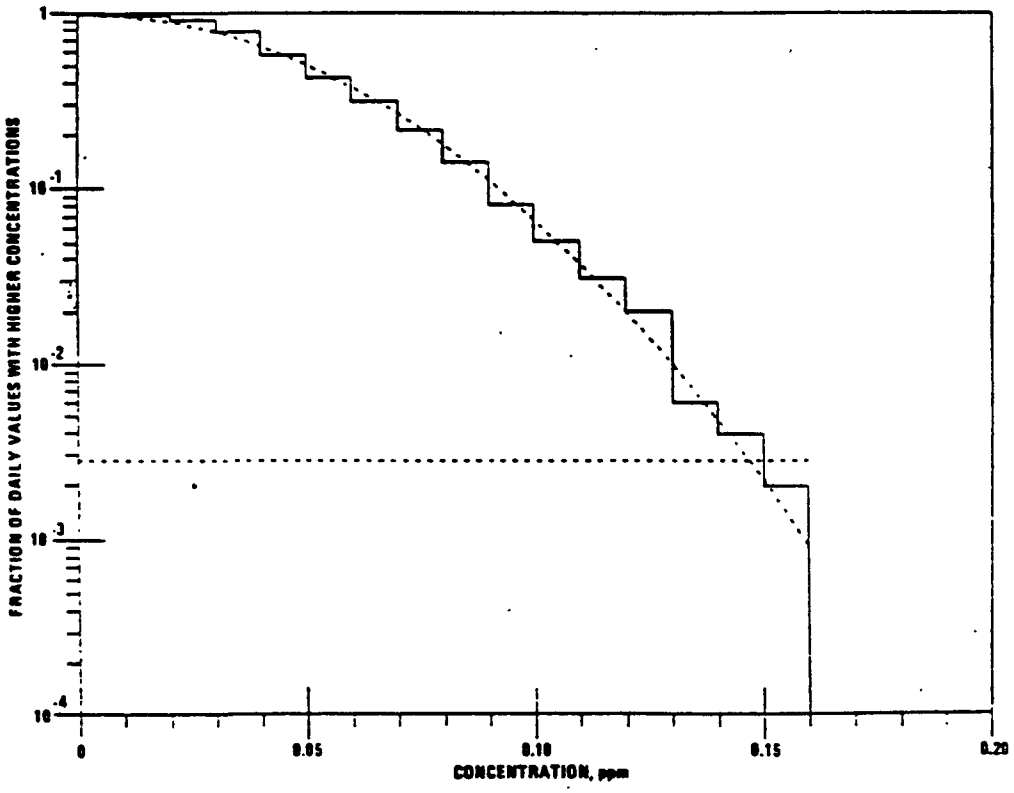

Figure 6. Semi-log plot of daily maximum ozone for three years: 1975, 1976, 1977 (1,017 daily values).

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:

$$1/365 = 1/3\ \mathrm{EXP}\{-(d/.0467)^{1.835}\} + 1/3\ \mathrm{EXP}\{-(d/.0705)^{2.139}\} + 1/3\ \mathrm{EXP}\{-(d/.0629)^{2.180}\}$$

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.

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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.

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APPENDIX D

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

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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 NO_2 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 "conducive 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 NO_2 and SO_2 have also been made. An advantage of the system for NO_2 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 CO_2 management? Any problems, solutions, or expectations?

Answer:

CO_2 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 CO_2 plugging the column. In such cases, water removal is important and should be done. Whether or not there are ways of taking CO_2 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 CO_2.

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 conceptional 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 C_2 and C_3 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 C_2 compounds have too much potential for contributing a significant amount to the total VOC. Also, some of the C_2 compounds are reactive.

The principal interest in monitoring the C_2 and C_3 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 NO + 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 ±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, NO_2, 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 Baldridge 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.

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

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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 Base[3] or the Interim Data Base for State and Local Air Toxic Volatile Organic Chemical Measurements[4] The trace metal data were obtained from the National Aerometric Data Bank's new Aerometric Information Retrieval System[5] (AIRS) while the benzo(a)pyrene data came from U.S. Environmental Protection Agency's (EPA) Atmospheric Research and Exposure Assessment Laboratory[6] (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 $\mu g/m^3$ 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:

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

where r = unit risk value

$\overline{\overline{VOC}}_{UA}$ = estimated VOC grand mean concentration for urban areas from Table 3.

pop_{UA} = urban area U.S. population (185 million).

$\overline{\overline{VOC}}_{NUA}$ = 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 $\mu g/m^3$ 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 $\mu g/m^3$, while most of the averages were less than 0.1 $\mu g/m^3$.

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:

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

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 $1.8x10^{-6}$ for styrene to a high of $3.0x10^{-4}$ for formaldehyde. Several of the VOC have risks in the $1x10^{-4}$ to $9.9x10^{-4}$ range. These include chloroform ($2.1x10^{-4}$) benzene ($1.7x10^{-4}$), 1,3 butadiene ($1.3x10^{-4}$) ethylene dichloride ($1.1x10^{-4}$), and formaldehyde ($3.0x10^{-4}$).

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.

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TABLE 1

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

POLLUTANT	PREVIOUSLY USED UNIT RISK ESTIMATES $(ug/m^3)^{-1}$	CURRENT UNIT RISK ESTIMATE $(ug/m^3)^{-1}$
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}
[illegible]ylene dibromide[c]	5.1×10^{-4}	2.2×10^{-4}
[illegible]ylene 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. Methyl 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 2 URBAN AREAS WITH VOC DATA

URBAN AREA	BENZ	BUTA	CCL4	CHLOR	EDC	EDB	FORM	MC	STRY	PERC	TCE	VC	VDC
BIRMINGHAM							•						
PHOENIX													•
BAKERSFIELD	•	•	•	•		•		•		•	•		
CONCORD		•											
FREMONT		•											
FRESNO	•	•	•	•		•		•		•	•		
LOS ANGELES-LONG BEACH	•		•	•	•	•		•		•	•		•
MERCED	•	•	•	•		•		•		•	•		
MODESTO	•	•	•	•	•	•		•		•	•		
OAKLAND	•		•	•	•	•		•		•	•	•	•
OXNARD-VENTURA	•		•	•		•		•		•	•		
RICHMOND		•											
RIVERSIDE-SAN BERNARDINO	•		•	•		•		•		•	•		•
SACRAMENTO	•	•	•	•		•		•		•	•		•
SAN DIEGO	•		•	•		•		•		•	•		
SAN FRANCISCO	•	•	•	•	•	•		•		•	•	•	
SAN JOSE	•	•	•	•	•	•		•		•	•	•	
SANTA BARBARA	•	•	•	•		•		•		•	•		
STOCKTON	•	•	•	•	•	•		•		•	•		
VALLEJO-NAPA	•		•	•	•	•		•		•	•	•	
DENVER										•			•
WASHINGTON	•												
JACKSONVILLE							•						
MIAMI							•						
ATLANTA							•						
CHICAGO	•		•				•			•	•		•
EAST ST LOUIS							•						
INDIANAPOLIS	•												
LOUISVILLE							•						
BATON ROUGE	•		•	•		•	•	•		•	•	•	
LAKE CHARLES	•												
BOSTON	•						•			•	•		
BALTIMORE	•			•	•					•	•		
PORTLAND	•												
DETROIT	•						•						
LANSING							•						
MIDLAND							•						
PORT HURON							•						
KANSAS CITY	•												
ST LOUIS	•											•	•
LAS VEGAS	•		•	•	•				•	•	•	•	
CAMDEN	•		•			•		•	•	•	•		
NEWARK	•		•	•		•		•	•	•	•		
NEW YORK CITY										•			
CHARLOTTE	•												
AKRON	•												
CLEVELAND	•						•						
PORTLAND							•						
PHILADELPHIA	•		•	•	•	•	•	•		•	•		
CHATTANOOGA	•												
BEAUMONT	•												
SALT LAKE	•												
DALLAS	•		•				•						
EL PASO	•												
FORT WORTH	•												
HOUSTON	•		•	•	•		•	•	•	•	•		•
TEXAS CITY	•					•							
BURLINGTON							•						
RICHMOND	•												
CHARLESTON(INSTITUTE)	•		•	•	•			•		•	•	•	•
TOTALS		12	24	22	13	19	19	21		26	25	7	10

BENZ=BENZENE, BUTA=1,3 BUTADIENE, CCL4=CARBON TETRACHLORIDE, CHLOR=CHLOROFORM, EDC=ETHYLENE DICHLORIDE, EDB=ETHYLENE DIBROMIDE, FORM=FORMALDEHYDE

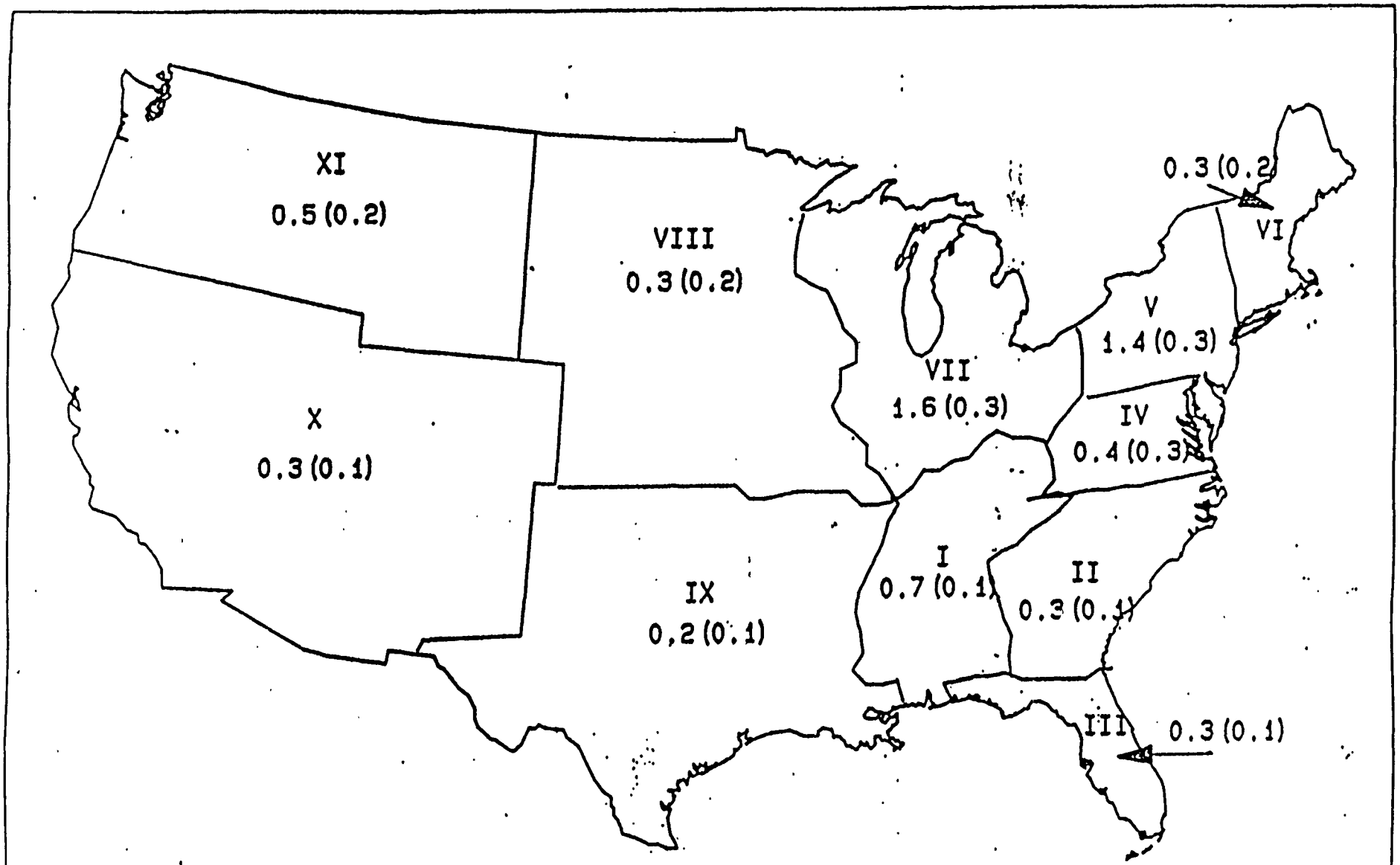


Figure 1 Regional urban and nonurban area benzo(a)pyrene average concentrations in ng/m^3, 1986-87

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
VINYLIDENE 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	POPUALATION 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	113a.	0.47
NICKEL(SUBSULFIDE)	161	91	4.8E-4	0b.	0.00
BAP	35	47	1.7E-3	4	0.02
PICc.	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

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
VINYLIDENE 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
PIC	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 ASJUSTED TO CHROMIUM+6 INCIDENCE BY MULTIPLING 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	124
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) HIGHEST ANNUAL MEAN (UG/M3)	LOS ANGELES(1987) IND. RISK	BATON ROUGE(1986) HIGHEST ANNUAL MEAN (UG/M3)	BATON ROUGE(1986) IND. RISK	BOSTON(1986 D1986) HIGHEST ANNUAL MEAN (UG/M3)	BOSTON(1986 D1986) IND. RISK	CHICAGO(1986) HIGHEST ANNUAL MEAN (UG/M3)	CHICAGO(1986) IND. RISK
NIC	4.3E-03	0.007	3.0E-5	0.004	1.7E-5	0.003	1.3E-5	0.010	4.3E-5
ENE	8.3E-06	11.15	9.3E-5	8.63	7.2E-5	4.27	3.5E-5	4.45	3.7E-5
	1.7E-03	0.30a.	5.1E-7	0.20a.	3.4E-7	0.46a.	7.8E-7	7.13a.	1.2E-5
	4.2E-01	0.30a.	1.3E-4	0.20a.	8.4E-5	0.46a.	1.9E-4	7.13a.	3.0E-3
LIUM	2.4E-03	0.00003	7.2E-8	0.00003	7.2E-8	0.00003	7.2E-8	0.00052	1.2E-6
UTADIENE	2.8E-04	-	-	-	-	-	-	-	-
IUM	1.8E-03	0.002	3.6E-6	0.001	1.8E-6	0.001	1.8E-6	0.003	5.4E-6
ON TETRACHLORIDE	1.5E-05	0.67	1.0E-5	0.04	6.0E-7	-	-	0.000	-
ROFORM	2.3E-05	0.44	1.0E-5	1.08	2.5E-5	-	-	-	-
MIUM +6	1.2E-02	0.004	4.8E-5	0.002	2.4E-5	0.002	2.4E-5	0.006	7.2E-5
LENE DIBROMIDE	2.2E-04	0.05	1.1E-5	-	-	-	-	-	-
LENE DICHLORIDE	2.6E-05	0.40	1.0E-5	4.19	1.1E-4	-	-	-	-
LDEHYDE	1.3E-05	23.30b.	3.0E-4	2.66	3.5E-5	2.59	3.4E-5	3.24	4.2E-5
LENE CHLORIDE	4.7E-07	5.94	2.8E-6	0.48	2.3E-7	-	-	5.77c.	2.7E-6
L	4.8E-04	0.000	0.0E-0	0.000	0.0E-0	0.000	0.0E-0	0.000	0.0E-0
NE	5.7E-07	-	-	-	-	-	-	-	-
ACHLOROETHYLENE	5.8E-07	6.94	4.0E-6	0.50	2.9E-7	1.84	1.1E-6	2.12	1.2E-6
HLOROETHYLENE	1.7E-06	1.54	2.6E-6	0.03	5.1E-8	1.53c.	2.6E-6	2.20	3.7E-6
L CHLORIDE	4.1E-06	-	-	1.28	5.2E-6	-	-	-	-
IDENE CHLORIDE	5.0E-05	0.20d.	1.0E-6	-	-	-	-	0.09d.	4.5E-6
		TOTALS	6.6E-4		3.8E-4		3.0E-4		3.2E-3

NOGRAMS/M3
ATA REPRESENTS RIVERSIDE,CA. IN 1980
985 DATA
DATA 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/M3)	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	477	3.3E-3	0.020	6.6E-5
PIC	477	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/M3)	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	6.80	1.2E-5
VINYL CHLORIDE	13	4.1E-6	2.44	1.0E-5
VINYLIDENE CHLORIDE	37	5.0E-5	0.34	1.7E-5

APPENDIX F

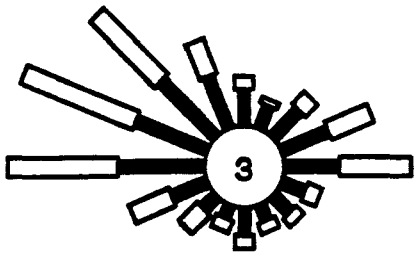
SAMPLE WIND ROSES FOR THE PAMS PROGRAM

conducive days

Atlanta GA

10 years

observed highs



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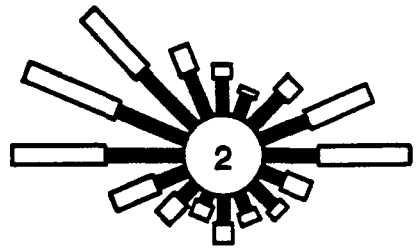
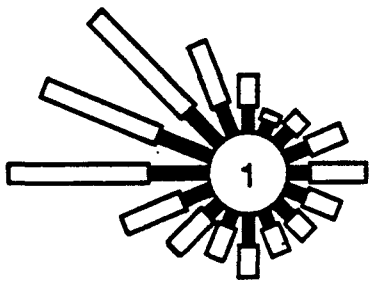
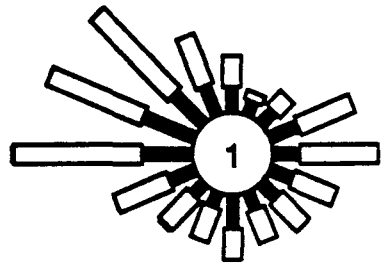
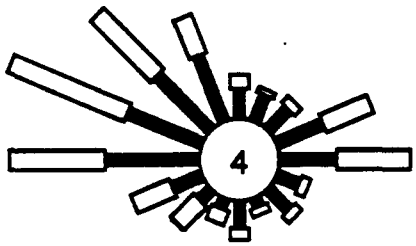




PM



5 years



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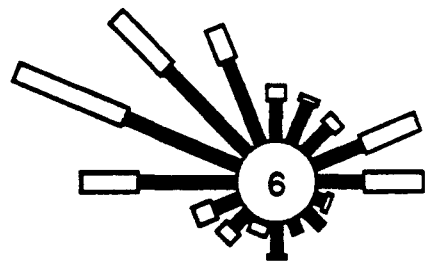

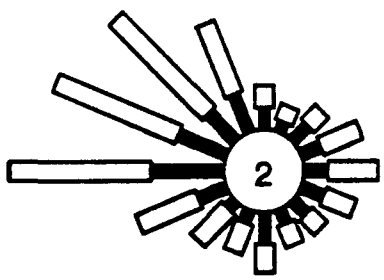

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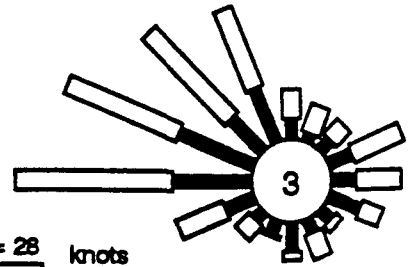
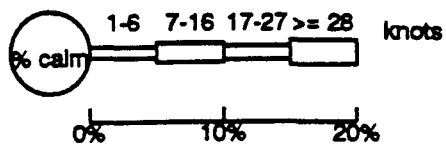


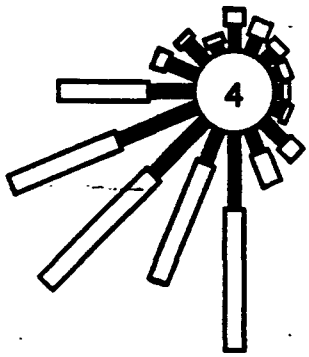


conducive days

Chicago IL

10 years

observed highs



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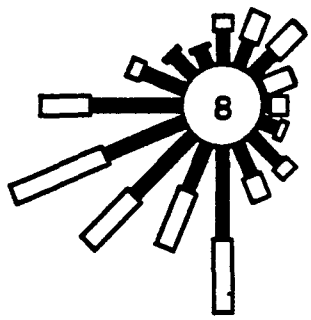

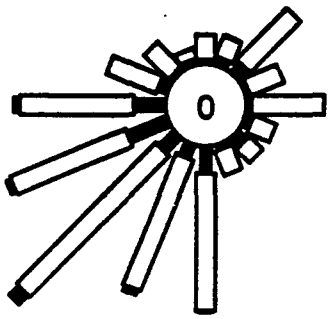

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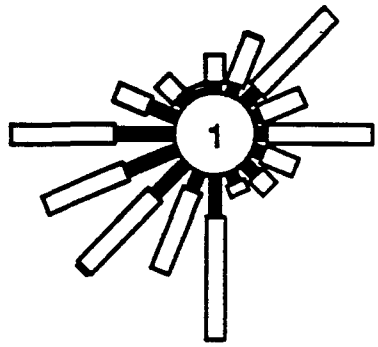
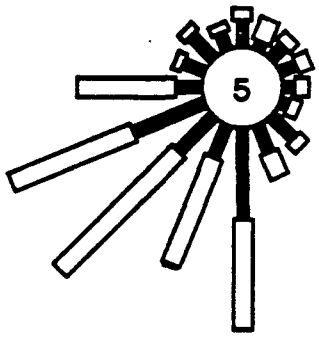


5 years



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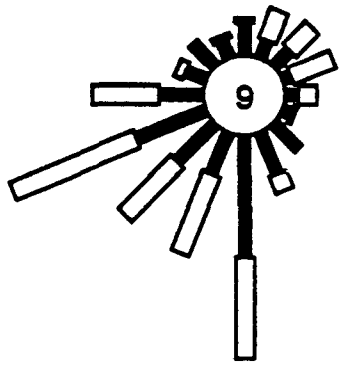

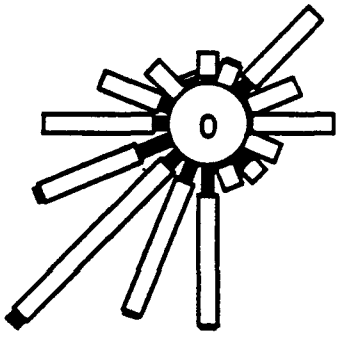

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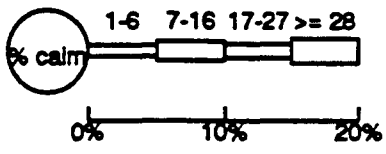
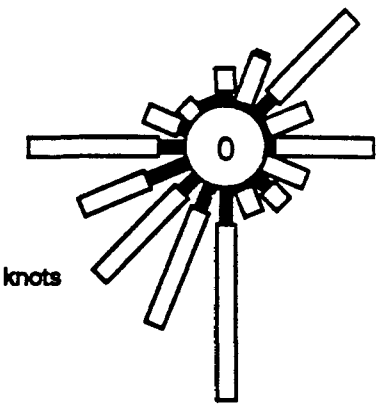


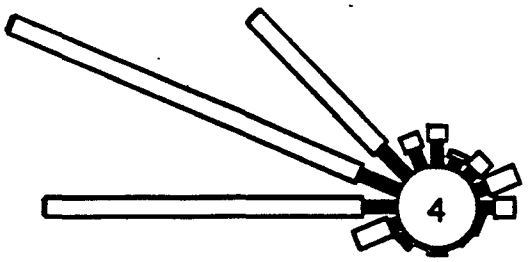


conducive days

SE Desert (Daggett)

10 years

observed highs



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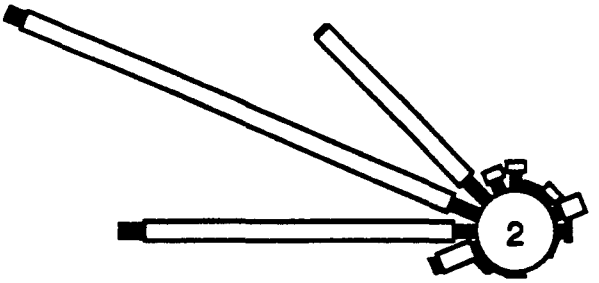

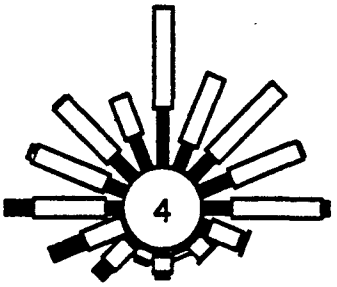

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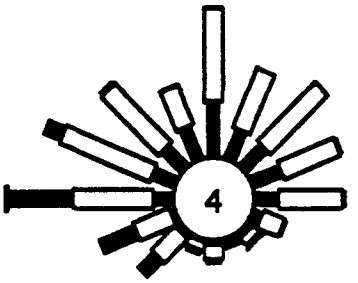
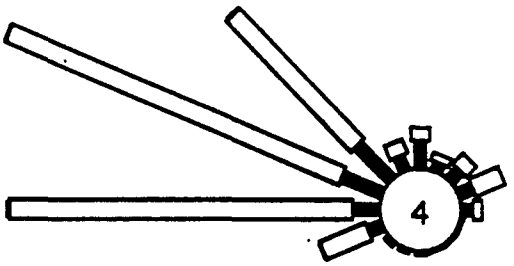
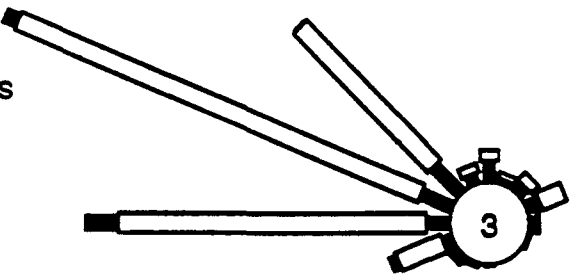
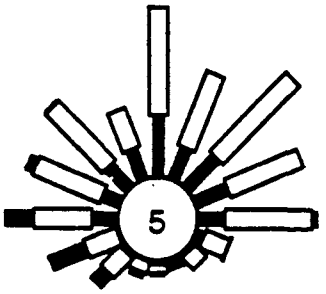




5 years

AM





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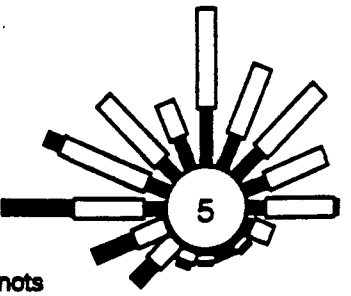
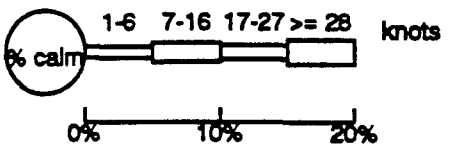
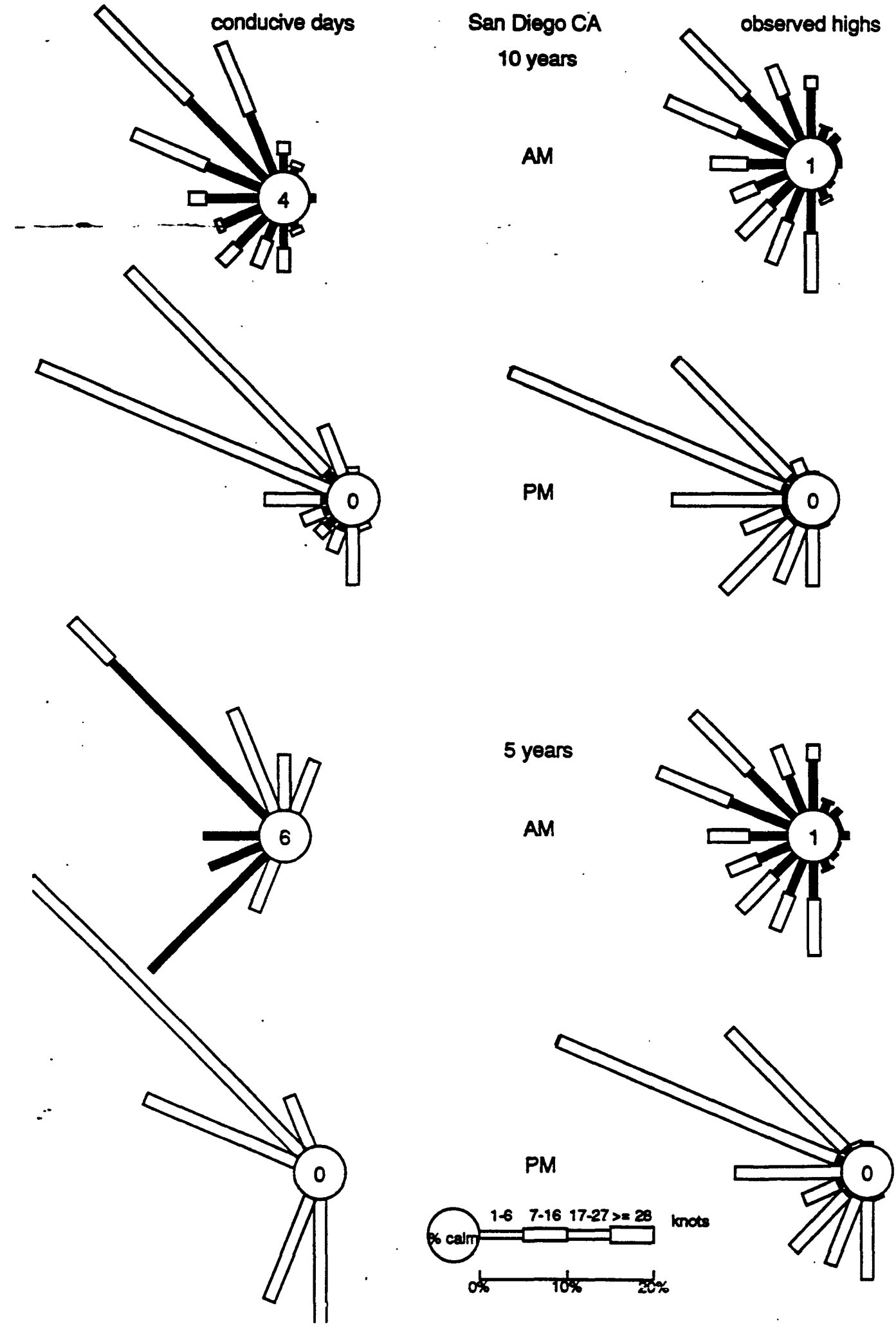





conducive days
San Diego CA
10 years
observed highs
AM
4
1
0
PM
0
5 years
6
AM
1
PM
0
1-6 7-16 17-27 >= 28 knots
% calm
0%
10%
20%

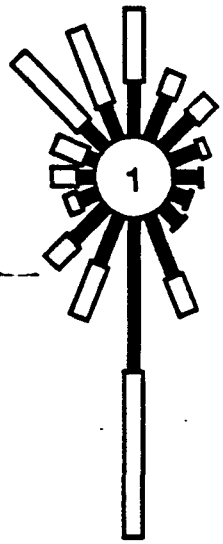
conducive days

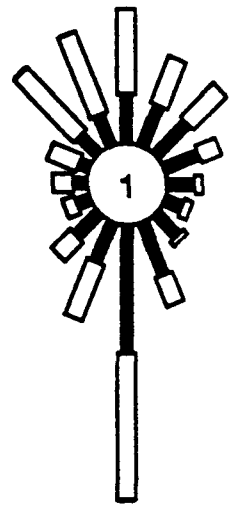
Washington DC

10 years

observed highs

AM





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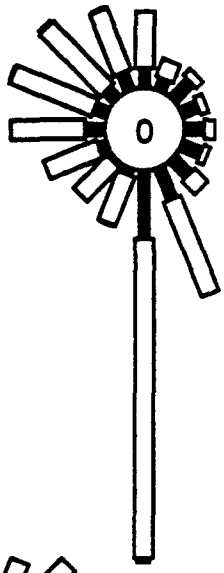
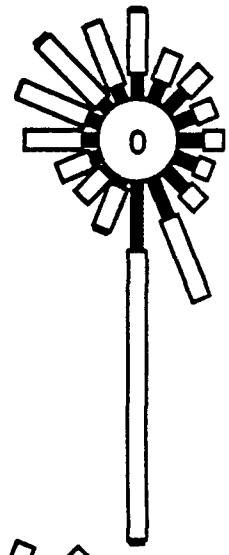
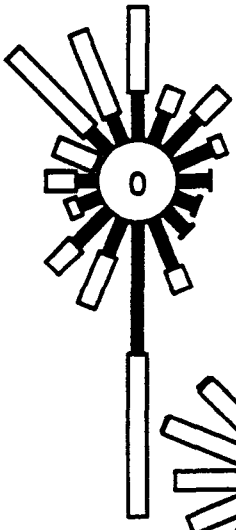
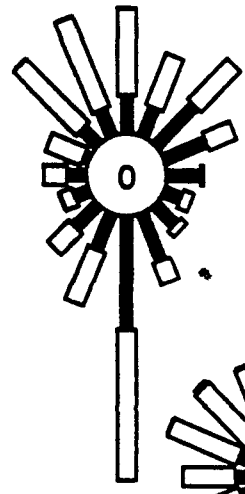




5 years

AM





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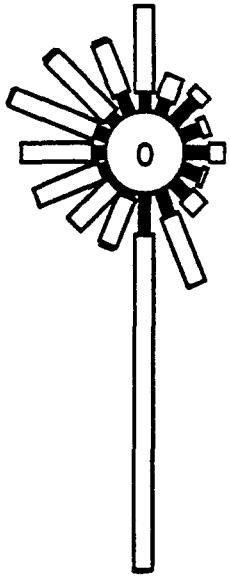
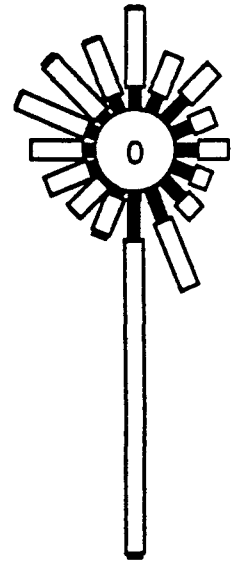
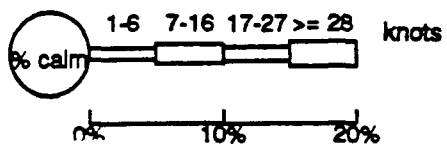




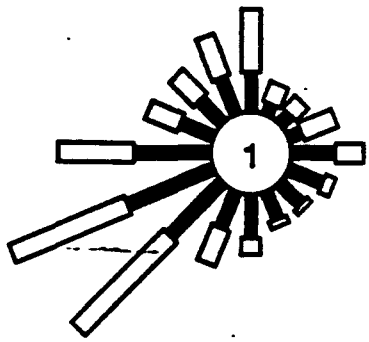


conducive days

Philadelphia PA

10 years

observed highs



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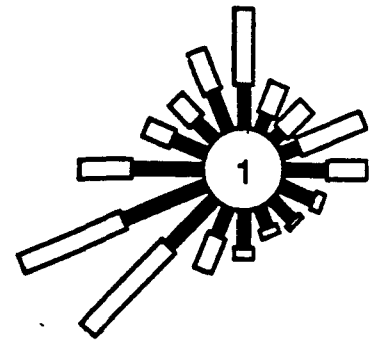

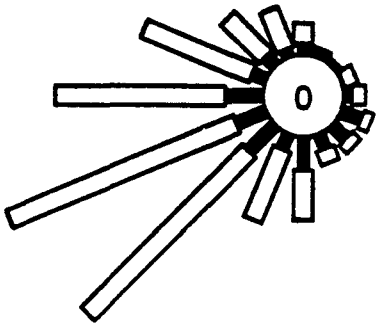

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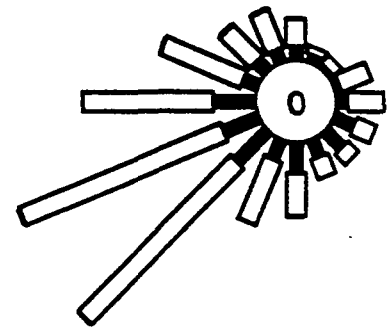
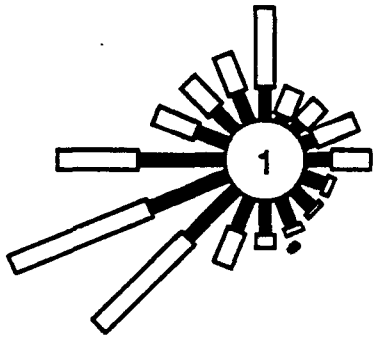


5 years



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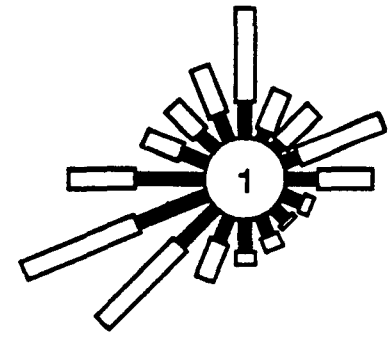

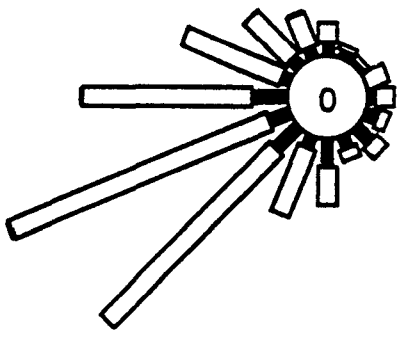

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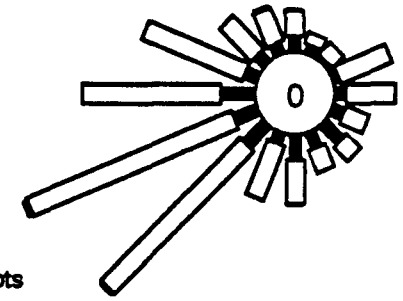
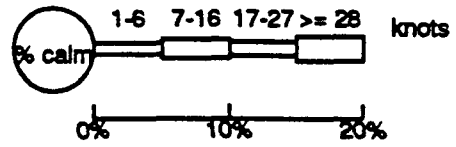


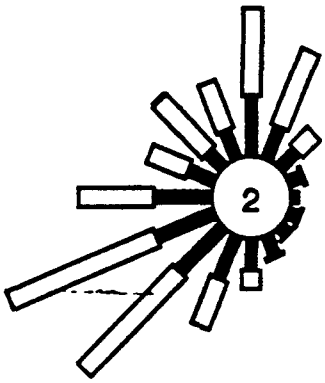


conducive days

New York, NY

10 years

observed highs



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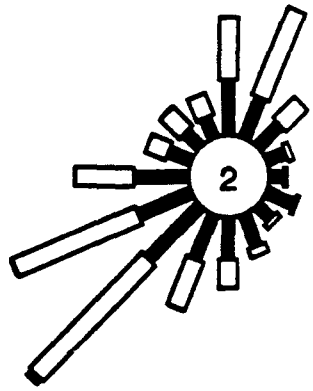

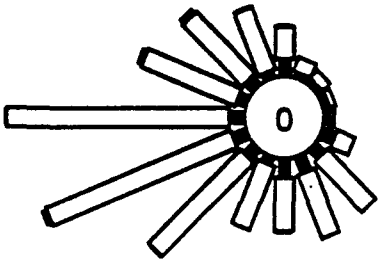

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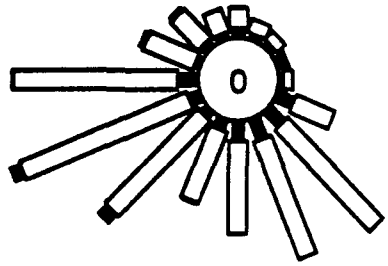
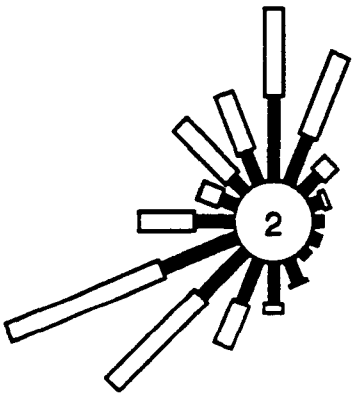


5 years



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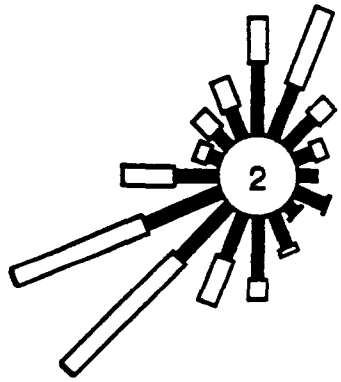

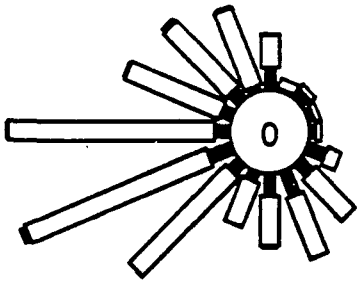

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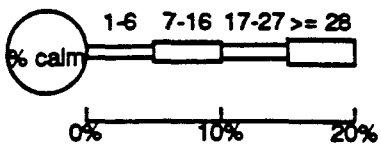
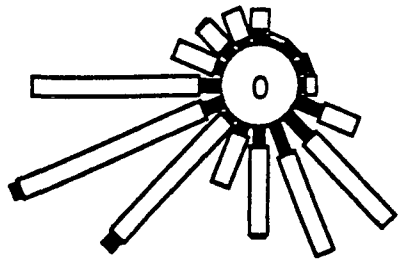


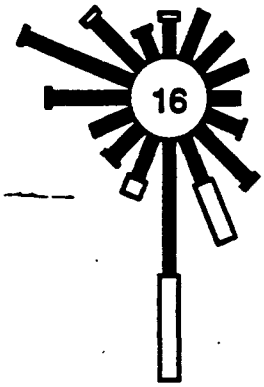


conducive days

Los Angeles CA

observed highs

10 years



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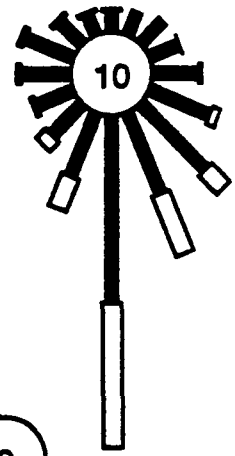
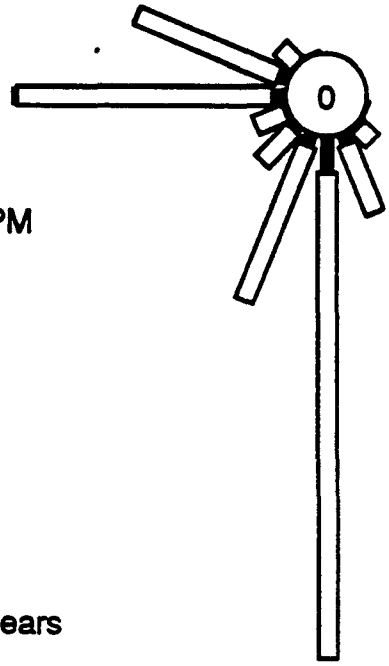
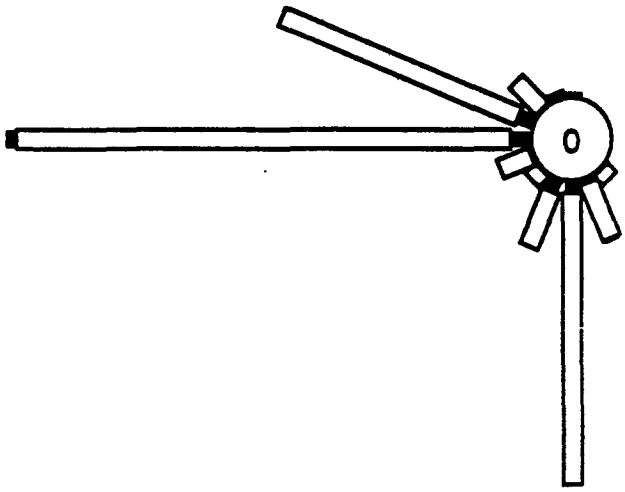
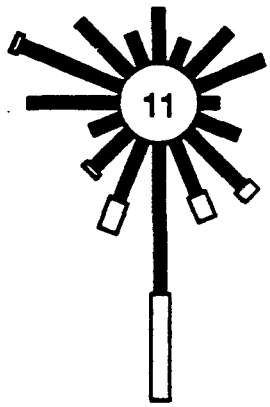






PM

5 years



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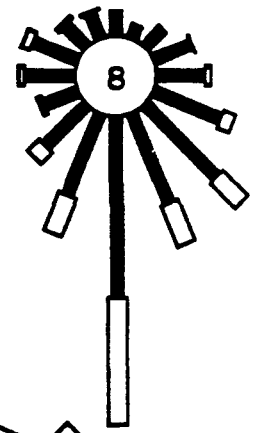

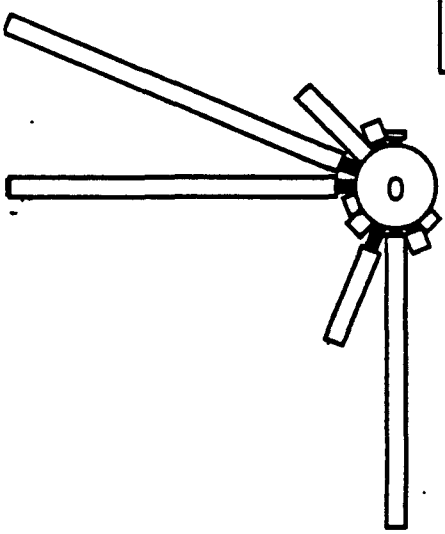

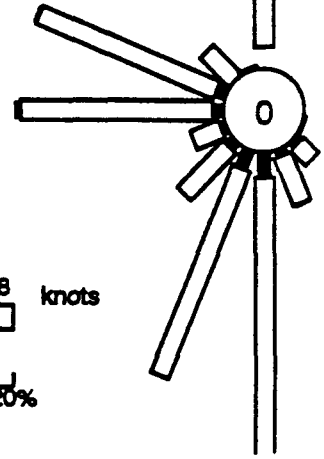

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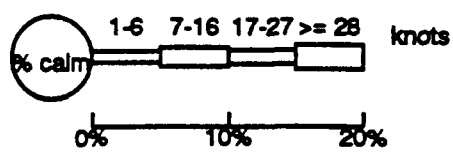
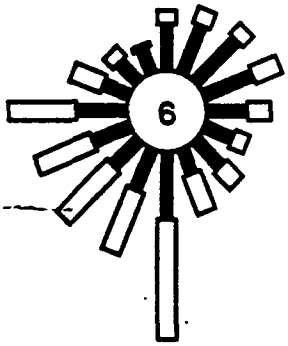


conducive days

Houston TX

10 years

observed highs



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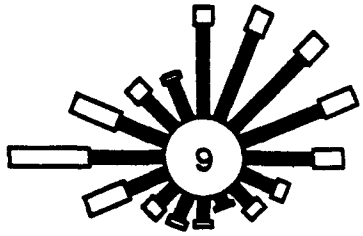

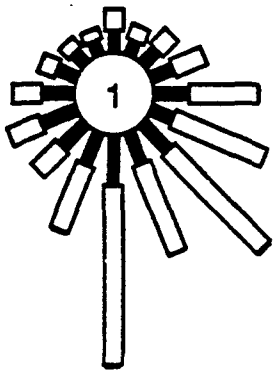

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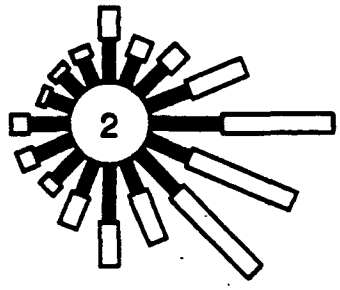
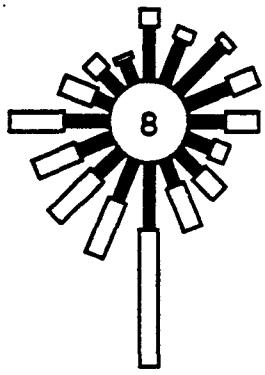


5 years



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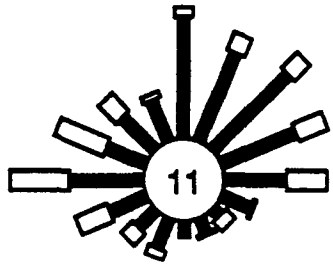

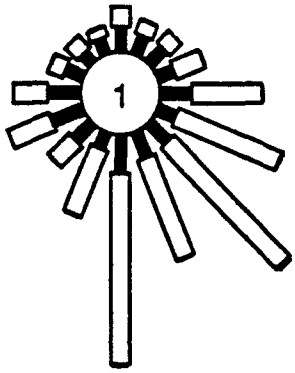

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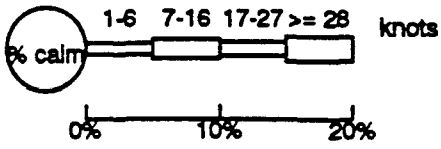
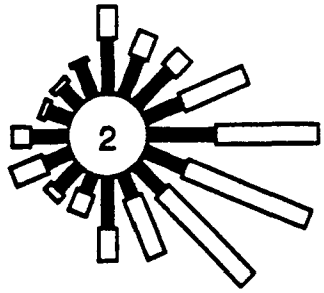


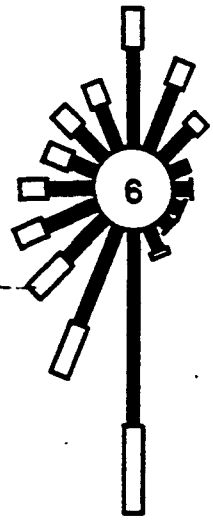


conducive days

Hartford CT

10 years

observed highs



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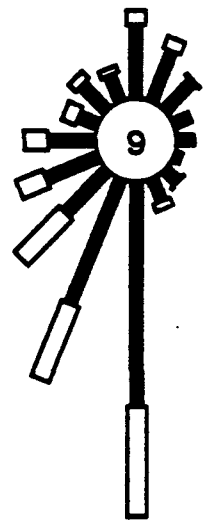

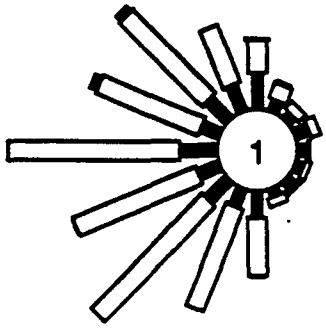

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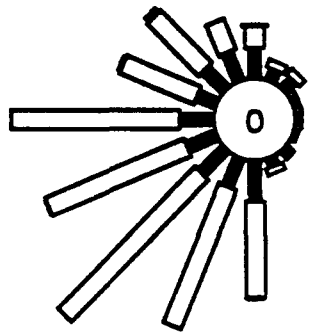
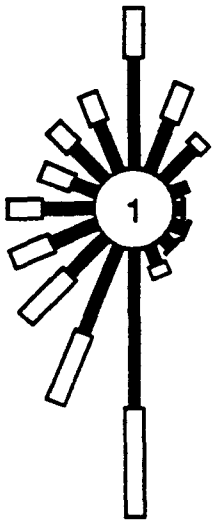


5 years



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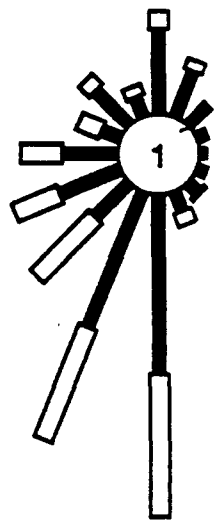

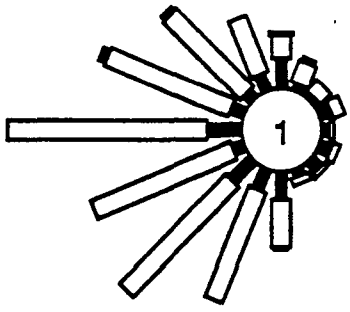

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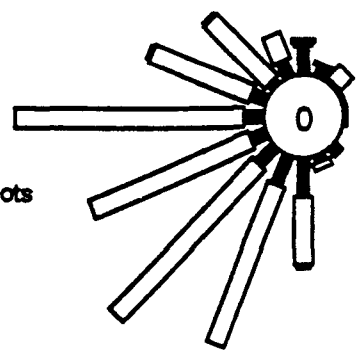
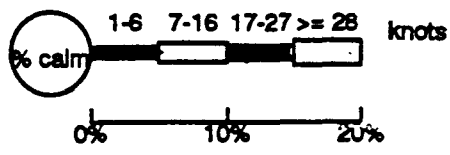


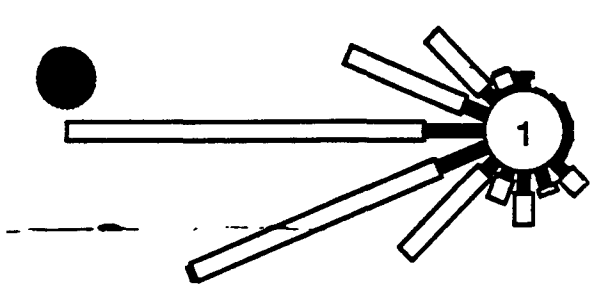


conducive days

Boston MA

10 years

observed highs



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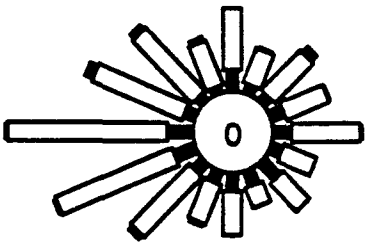

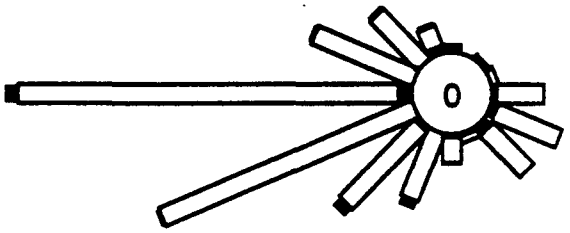

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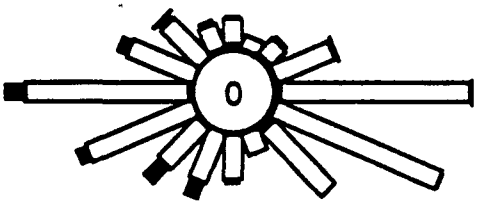
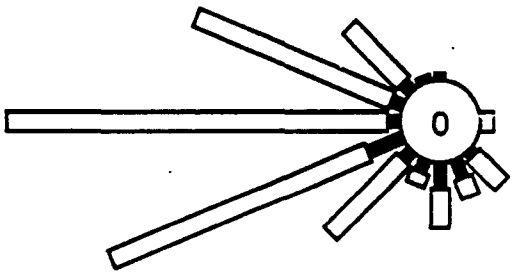


5 years



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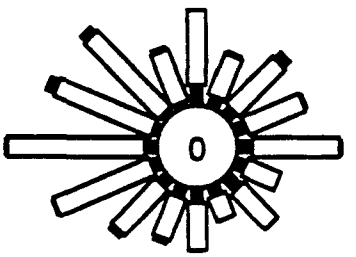

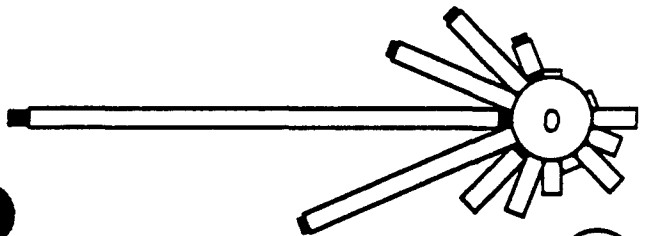

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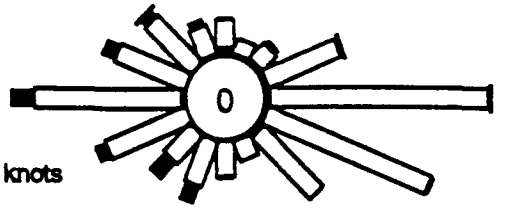
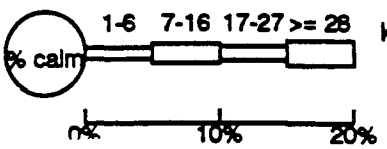


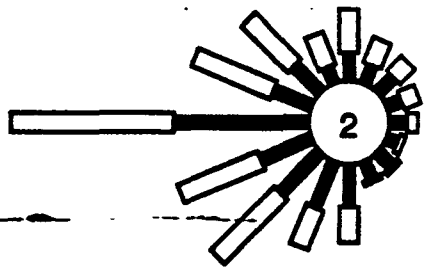


conducive days

Baltimore MD

10 years

observed highs



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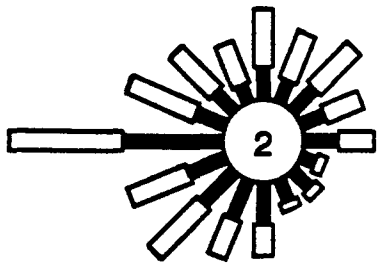

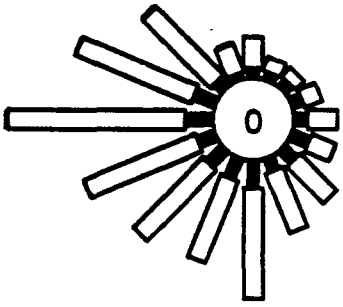

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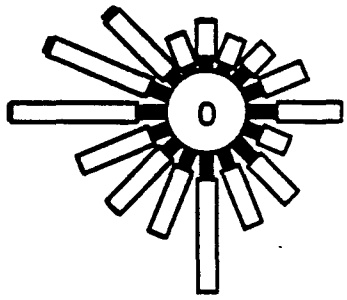
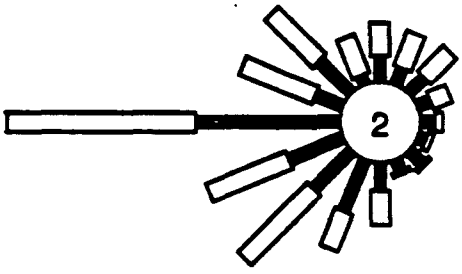


5 years



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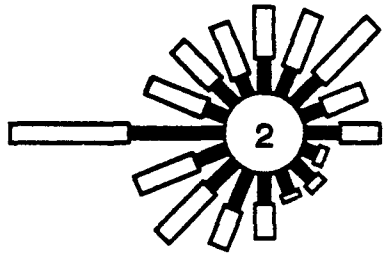

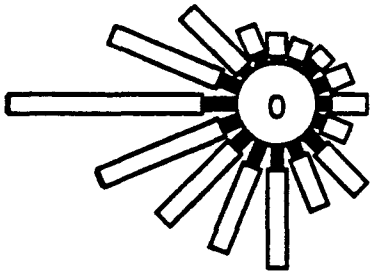

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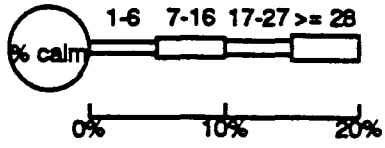
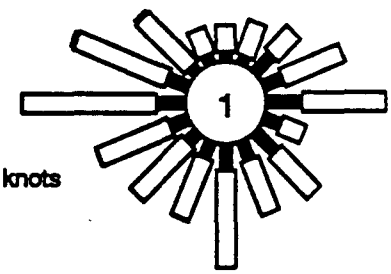




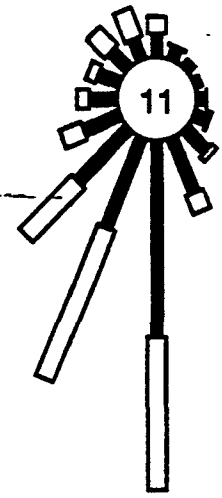
conducive days

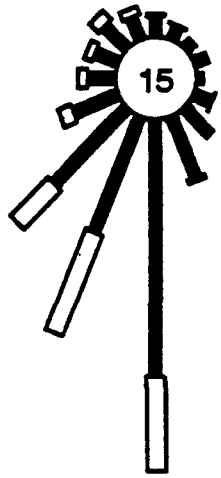
Sacramento CA

observed highs

10 years

AM





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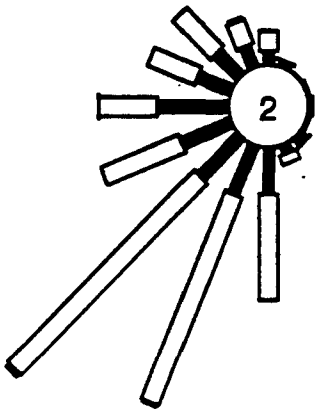
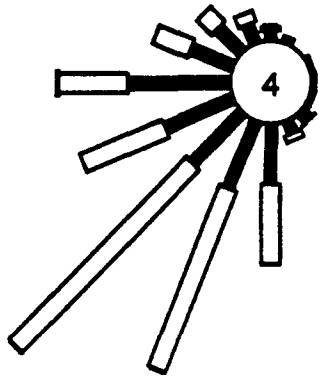
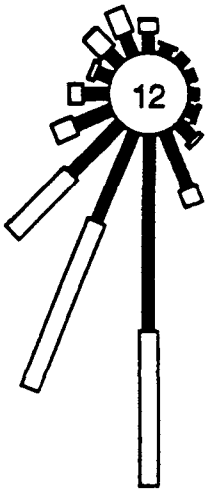
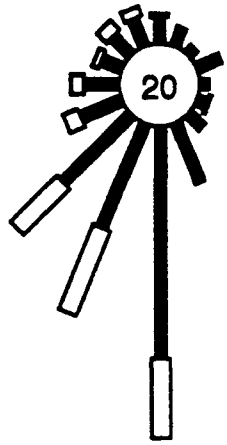




5 years

AM





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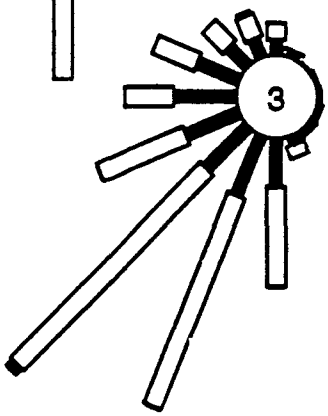
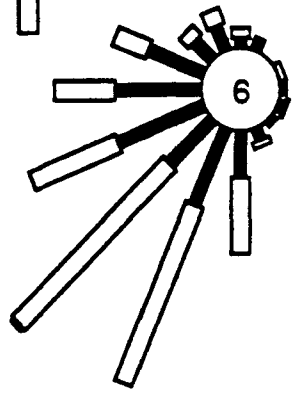
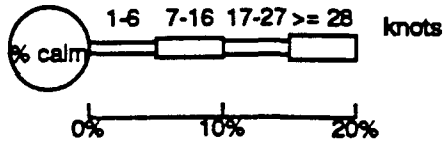




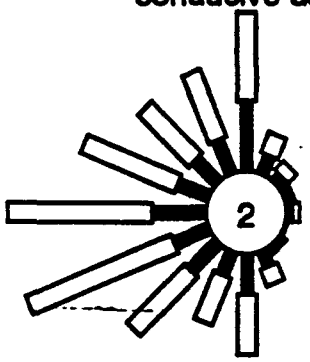


conducive days

Providence RI

10 years

observed highs



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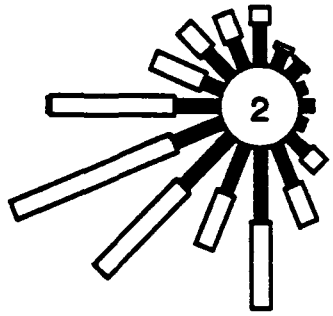

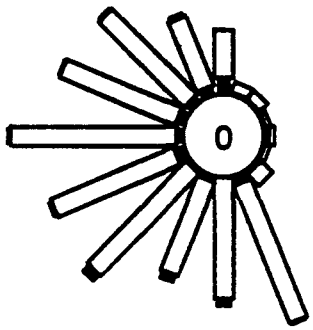

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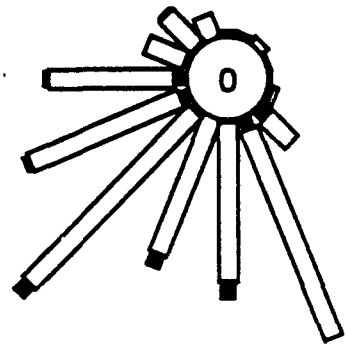
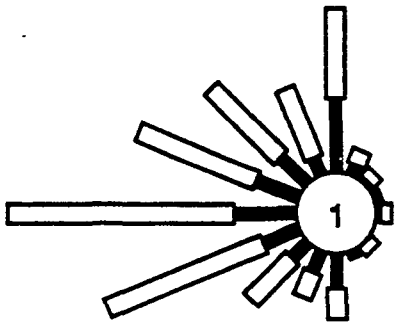
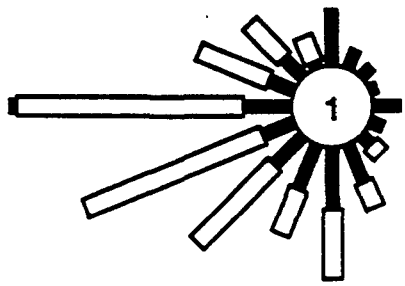
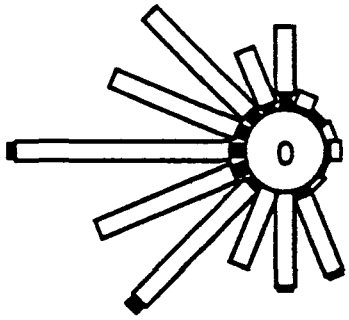




5 years

AM





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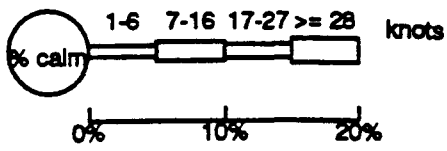
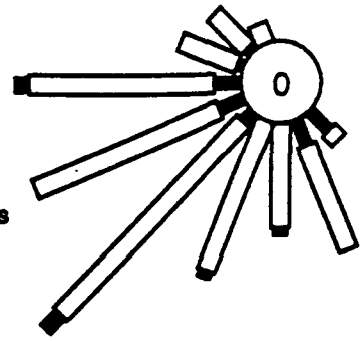


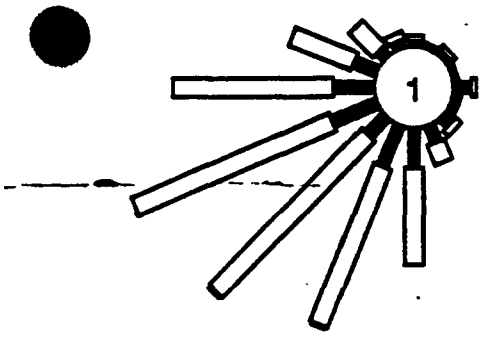


conducive days

Milwaukee WI

10 years

observed highs



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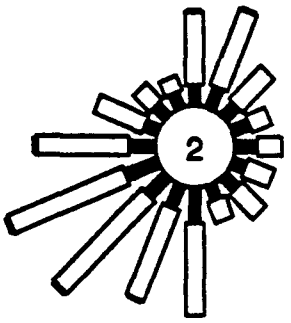

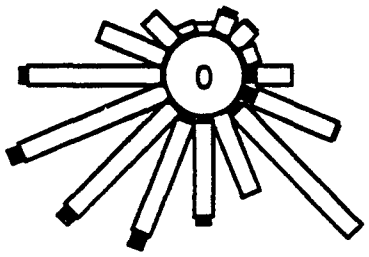

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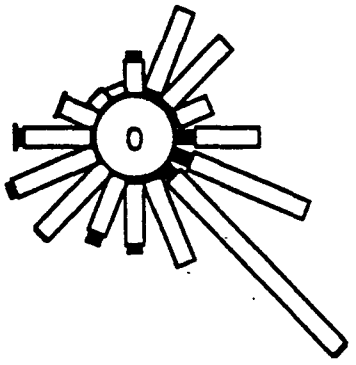
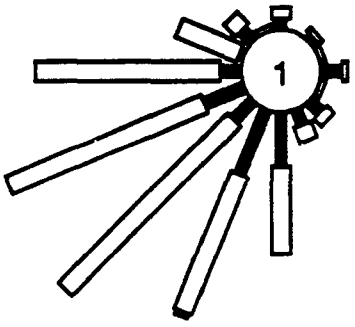


5 years



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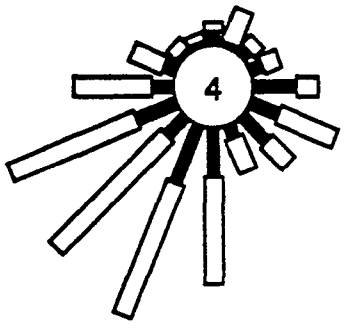

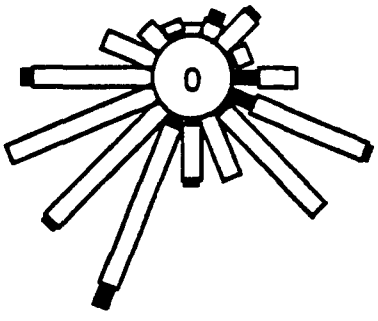

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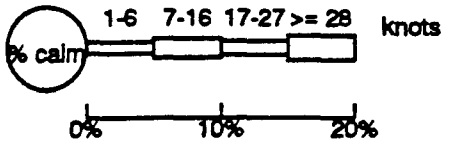
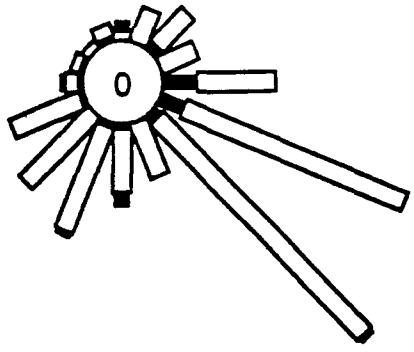


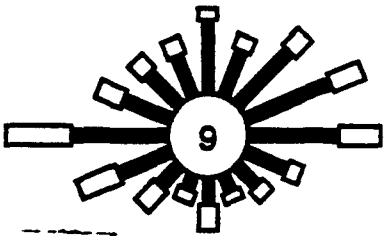


conducive days

Baton Rouge LA

10 years

observed highs



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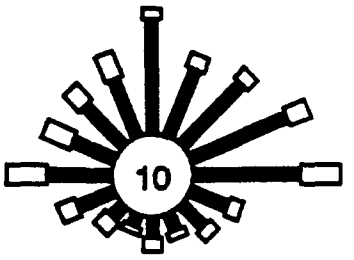

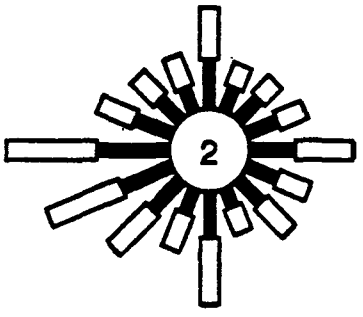

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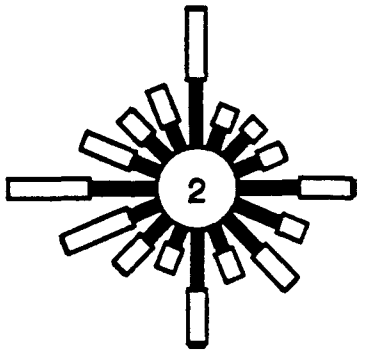
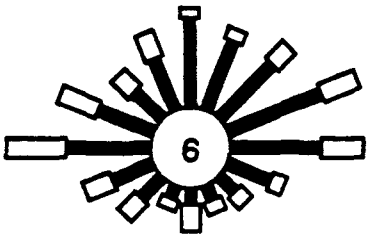


5 years



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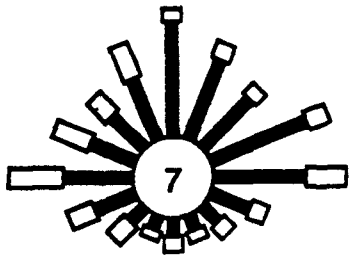

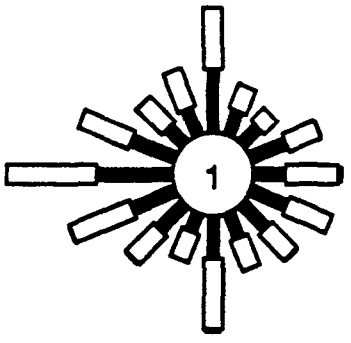

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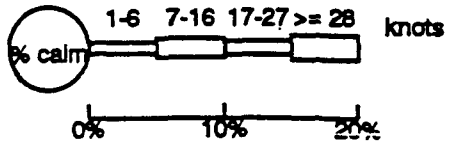
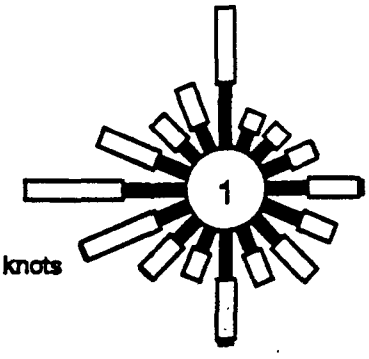


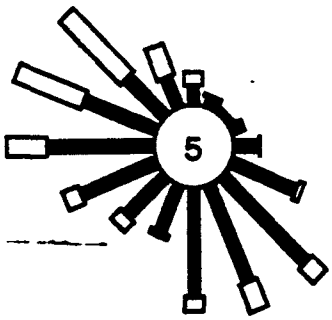


conducive days

San Joaquin (Bakersfield)

observed highs

10 years



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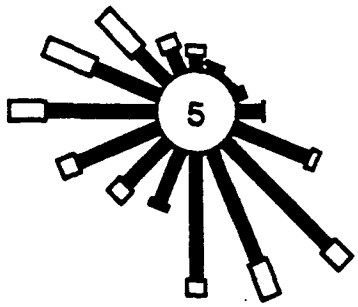

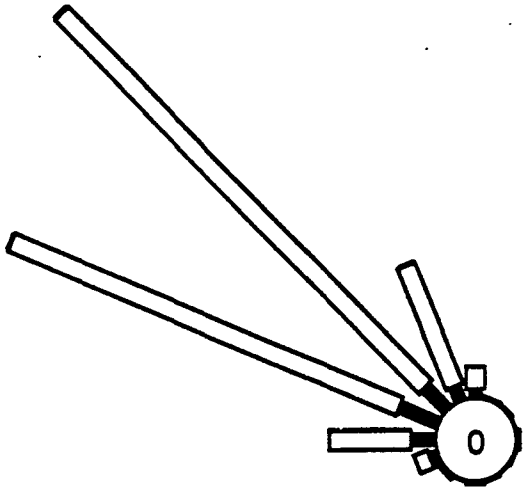

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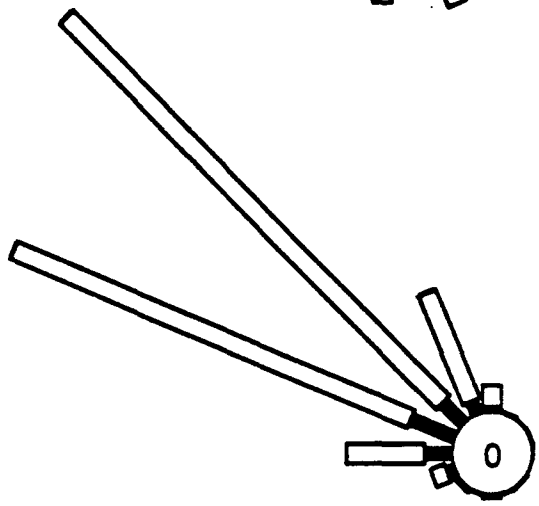
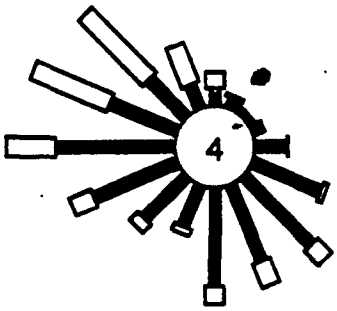


5 years



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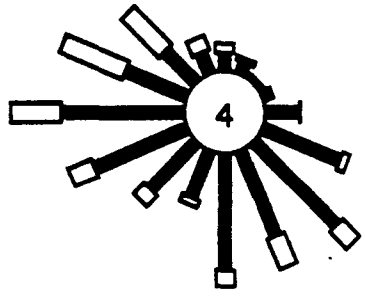

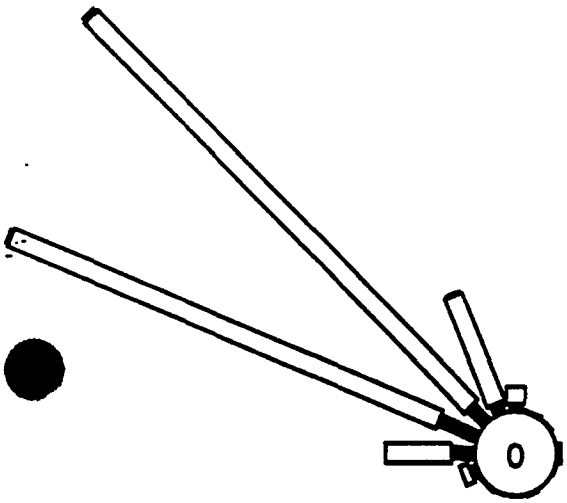

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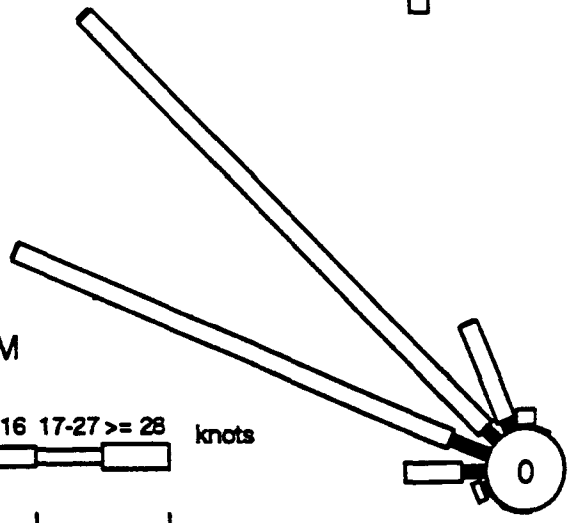
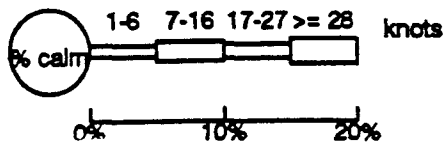


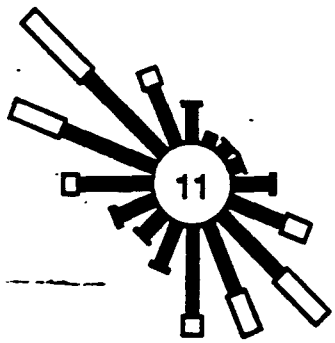


conducive days

San Joaquin (Fresno)

10 years

observed highs



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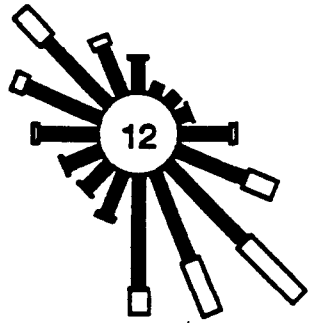

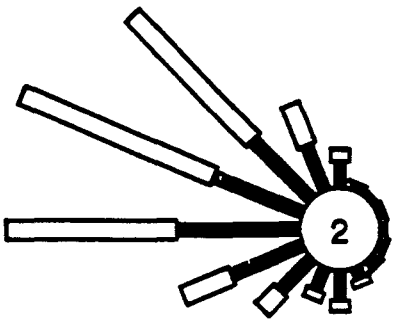

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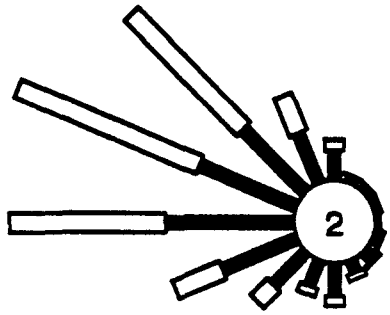
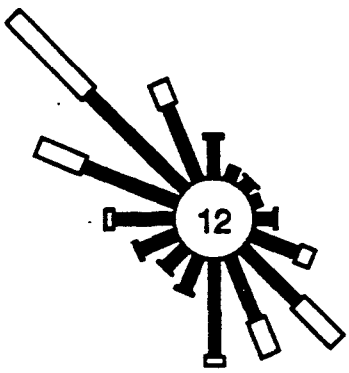
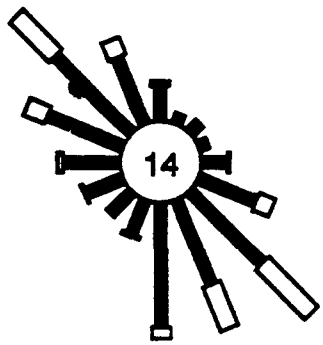
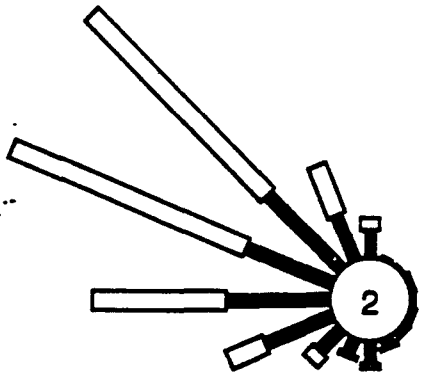




5 years

AM





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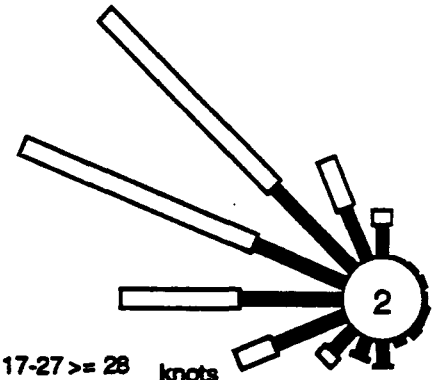
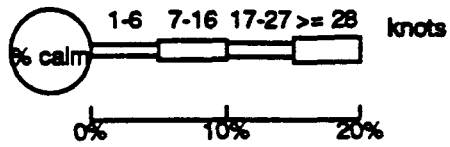
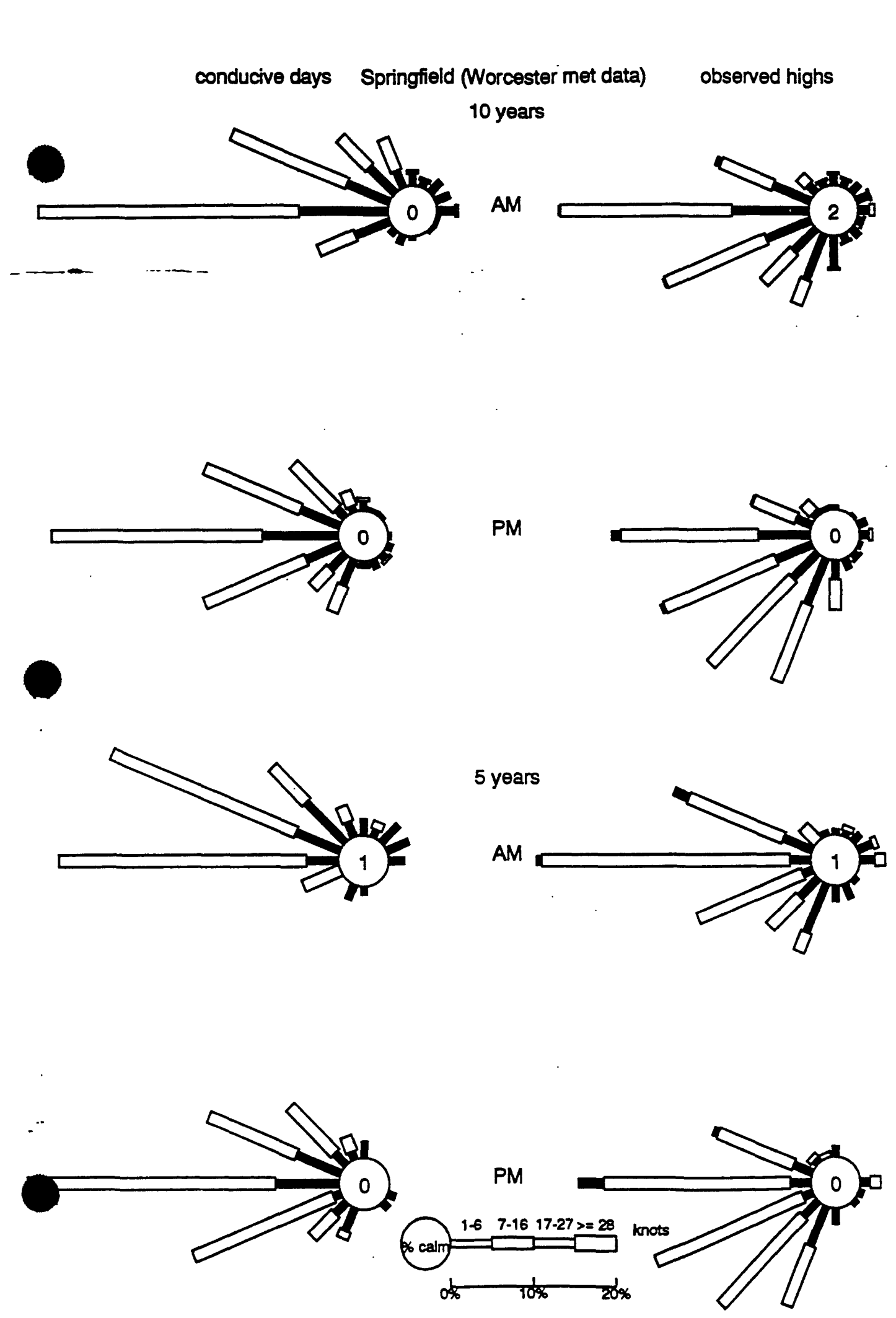
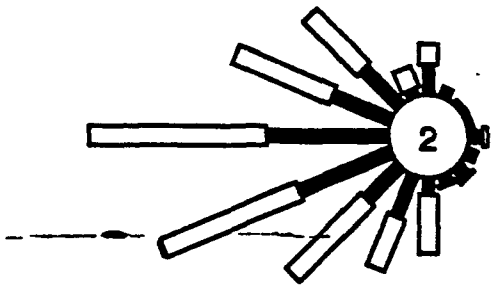





conducive days
Springfield (Worcester met data)
observed highs
10 years
0
AM
2
0
PM
0
5 years
1
AM
1
0
PM
0
1-6
7-16
17-27
>= 28
knots
% calm
0%
10%
20%

conducive days Portsmouth with Portland Met data observed highs

10 years



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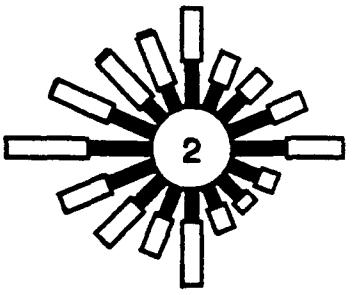

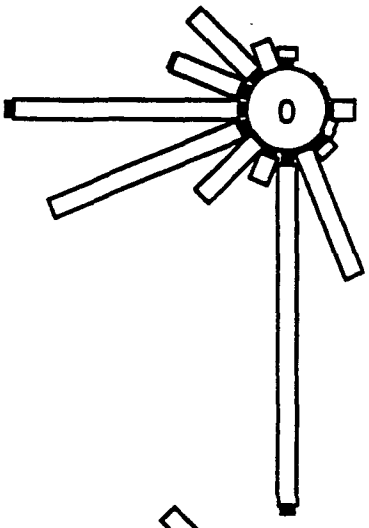

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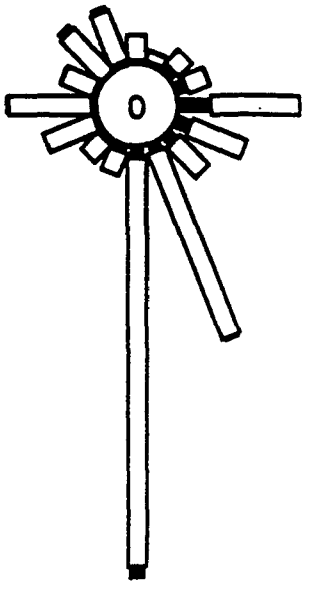
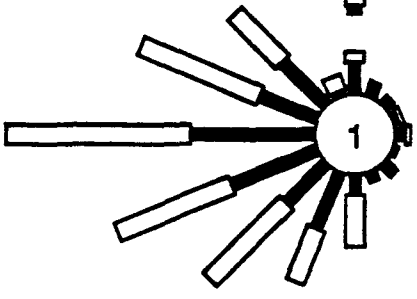


5 years



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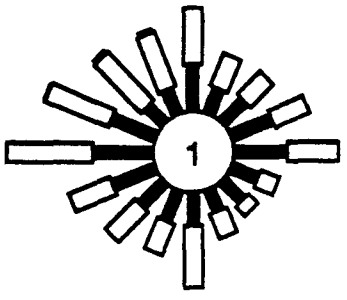

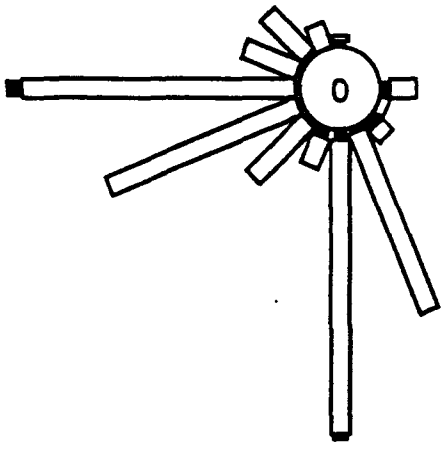

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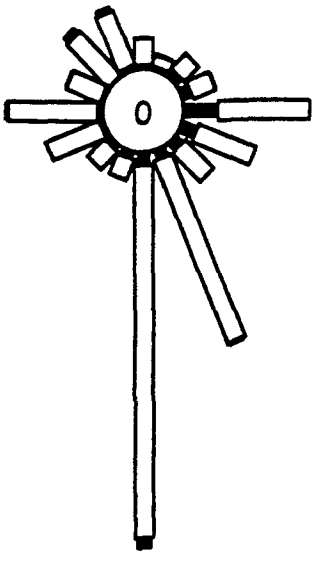
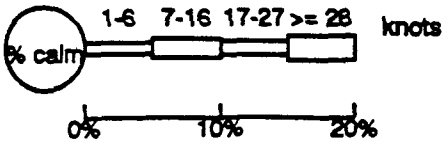
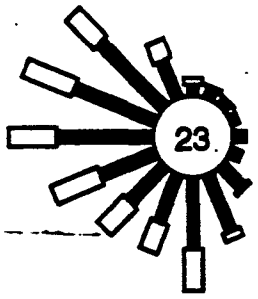




conducive days Portsmouth with Concord Met data observed highs

10 years



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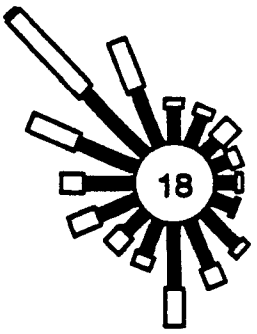

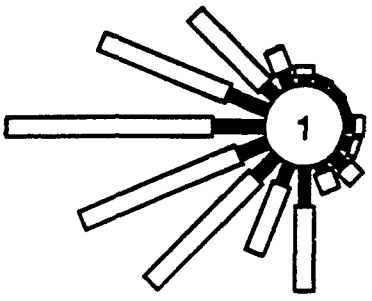

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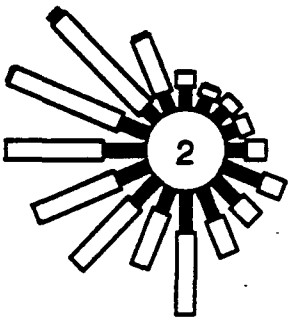
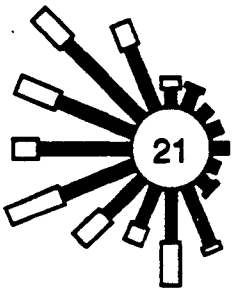


5 years



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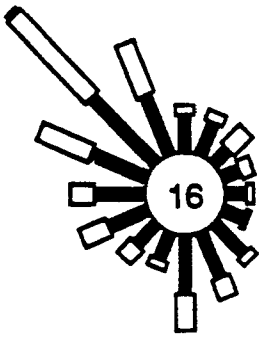

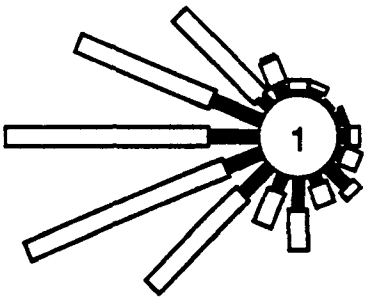

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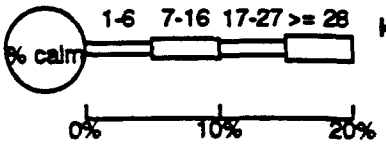
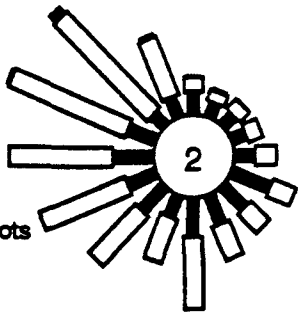


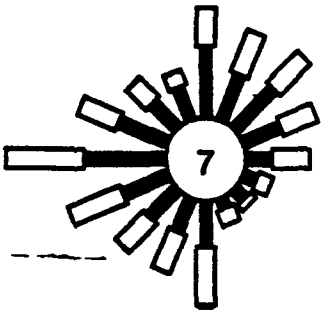


conducive days

Beaumont-Port Arthur TX

10 years

observed highs



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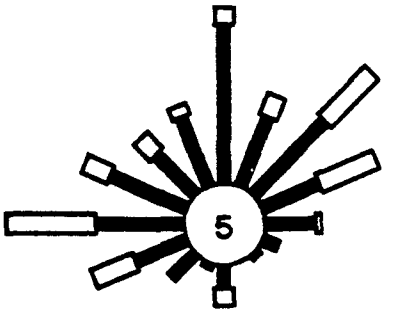

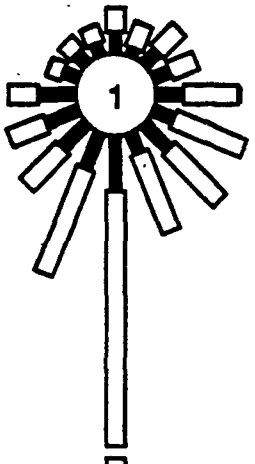

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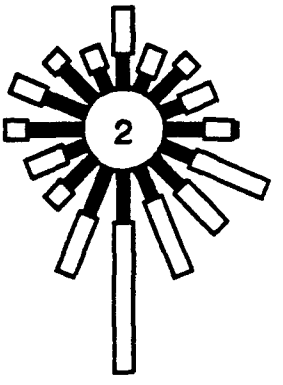
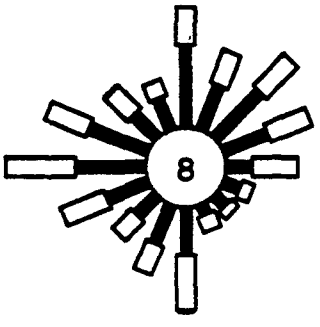


5 years



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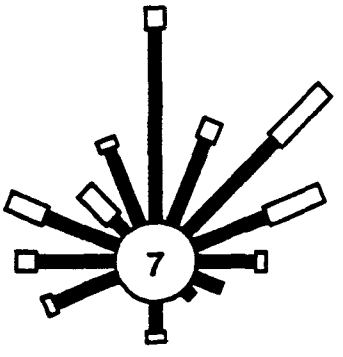

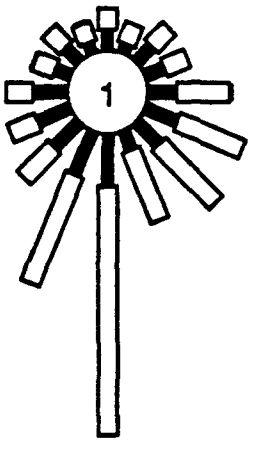

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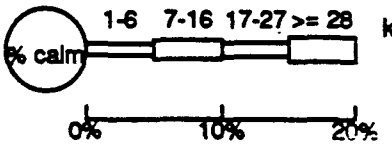
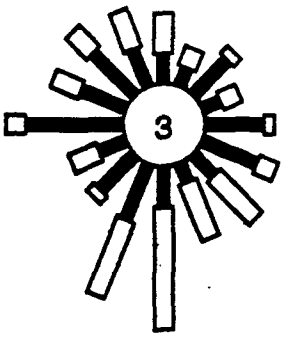
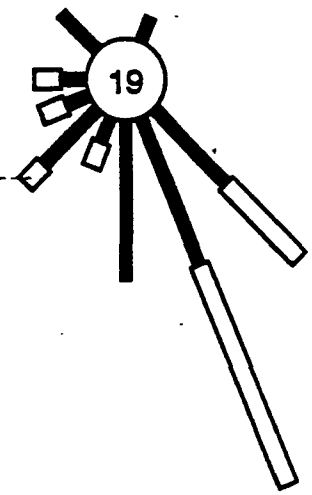




conducive days Ventura (Santa Barbara) observed highs

10 years



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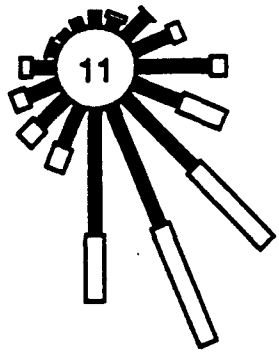

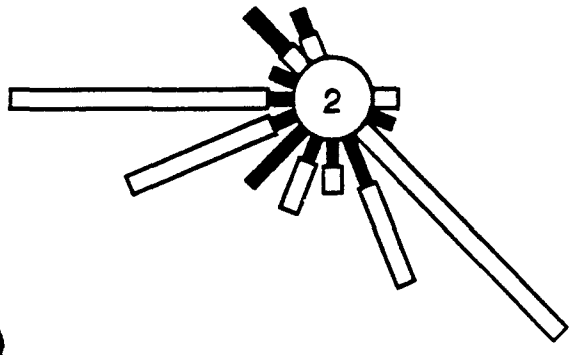

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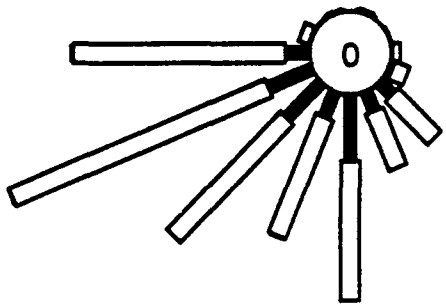

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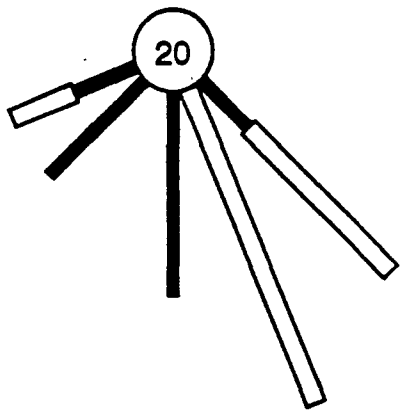

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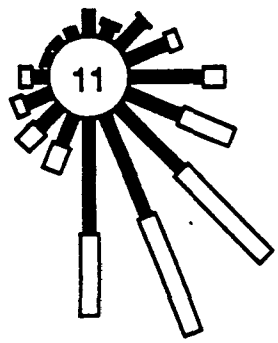

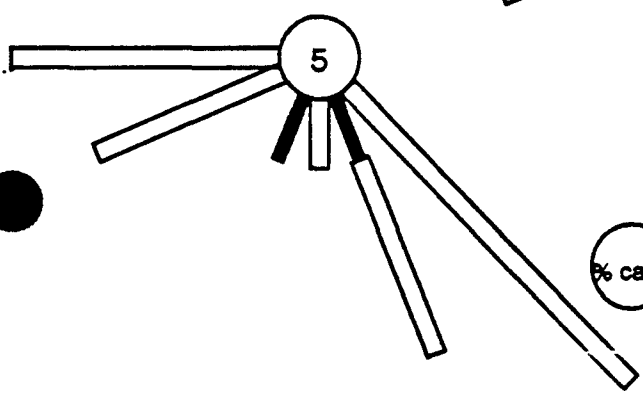

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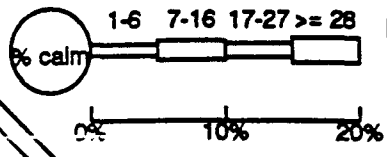
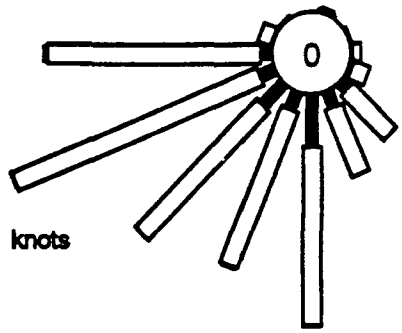


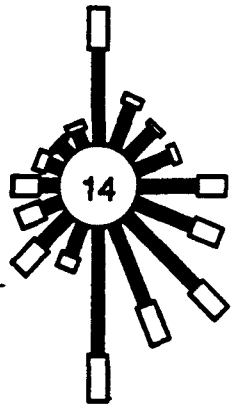


conducive days

El Paso, TX

10 years

observed highs



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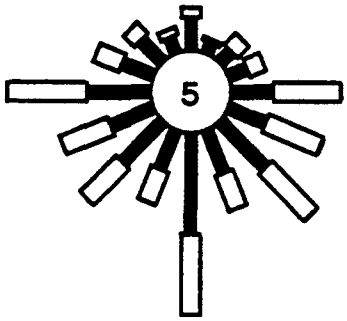

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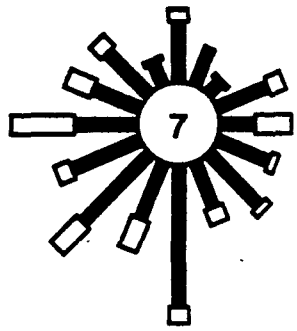

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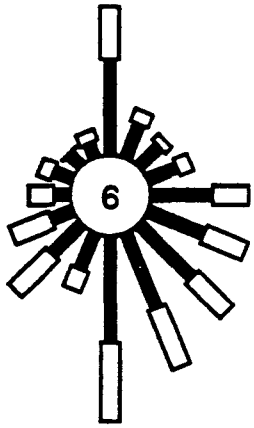

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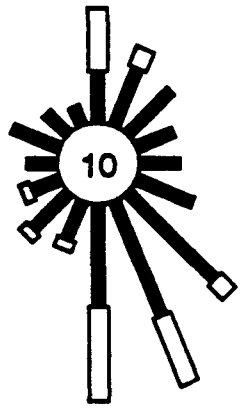

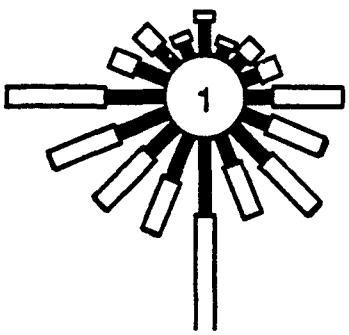

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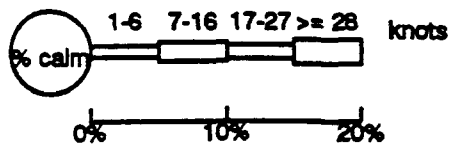
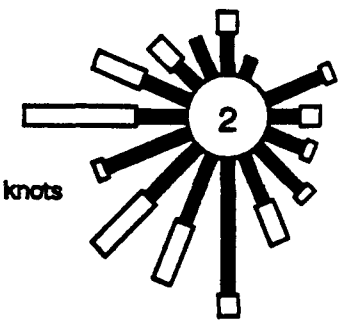


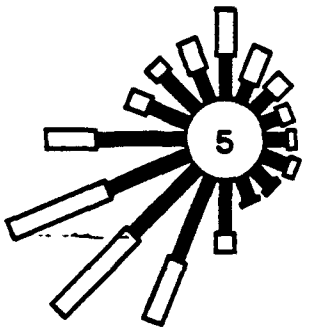


conducive days

Raleigh-Durham NC

10 years

observed highs



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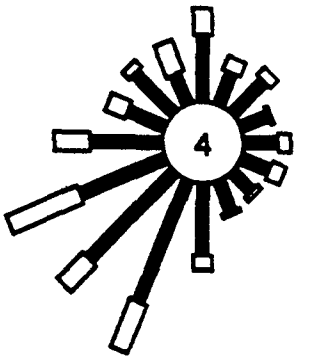

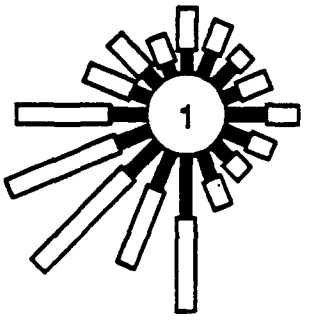

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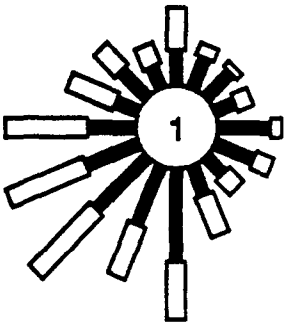
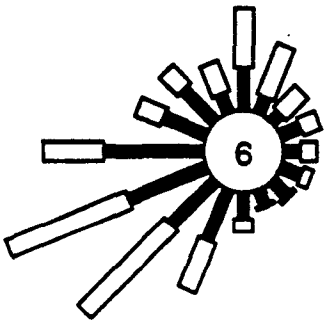


5 years



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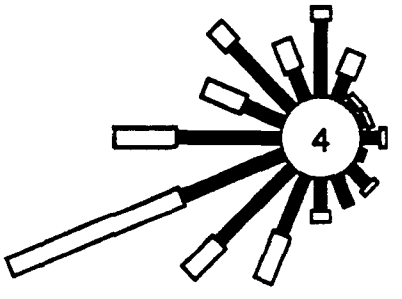

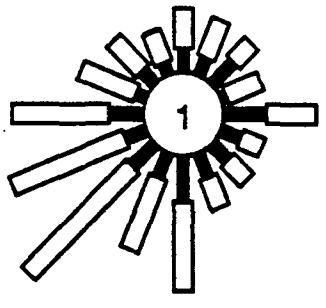

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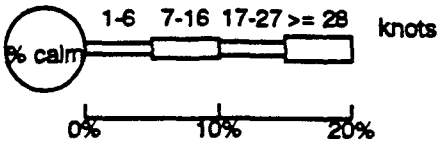
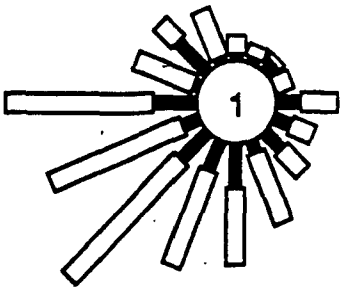


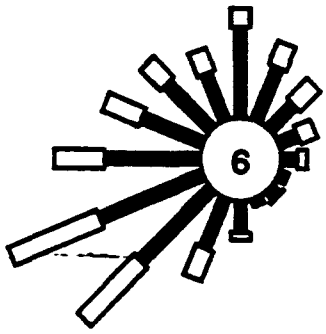


conducive days

Greensboro-Winston-Salem

observed highs

10 years



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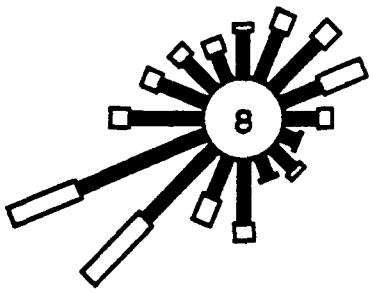

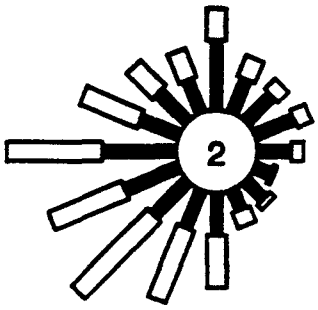

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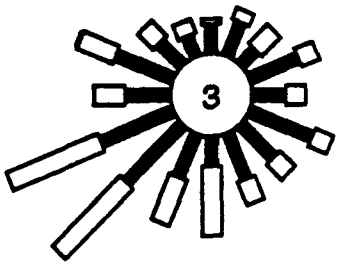
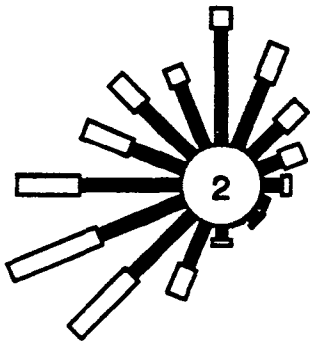


5 years



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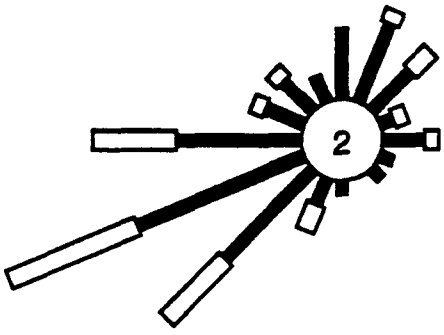

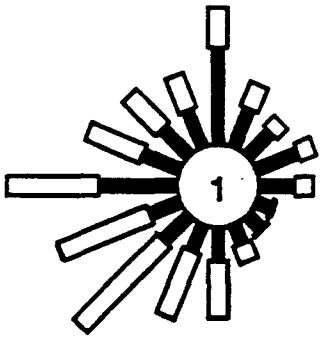

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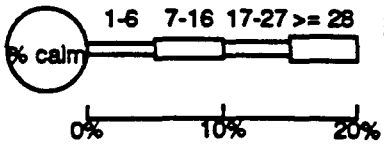
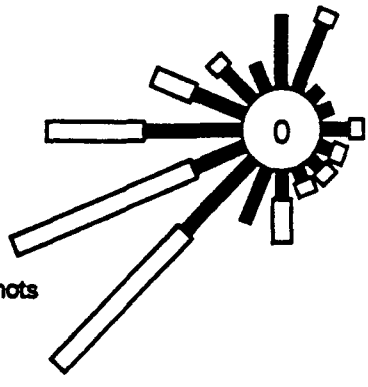


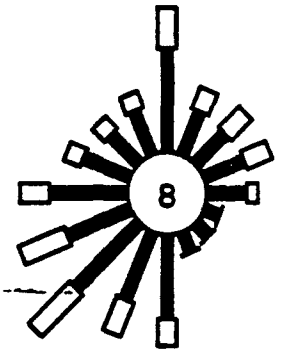


conducive days

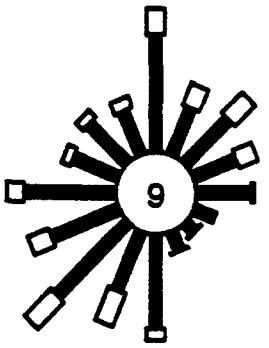
Charlotte NC

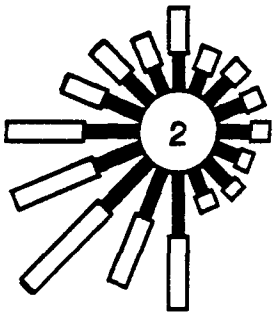
10 years

observed highs

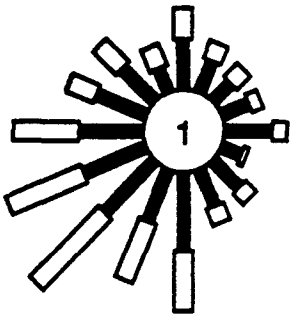


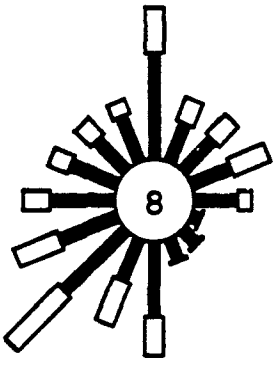
AM





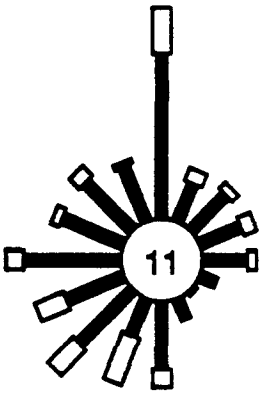
PM

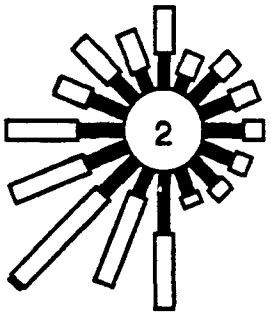




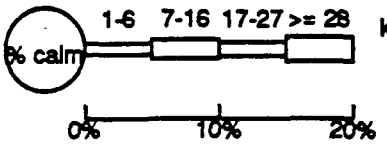
5 years

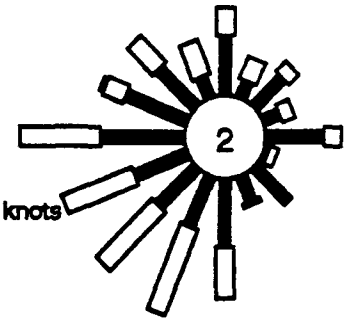
AM





PM





APPENDIX G

OUTPUTS FROM THE SCREEN MODEL

02/23/94
13:59:49

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

NT 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)	DWASH
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

 [illegible]ASH=   MEANS NO CALC MADE (CONC = 0.0)
 [illegible]ASH=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         MAX CONC     DIST TO    TERRAIN
  PROCEDURE         (UG/M**3)     MAX (M)     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      CONC                 U10M    USTK  MIX HT    PLUME    SIGMA    SIGMA
   (M)   (UG/M**3)    STAB     (M/S)   (M/S)     (M)   HT (M)   Y (M)    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          MAX CONC     DIST TO    TERRAIN
  PROCEDURE          (UG/M**3)     MAX (M)     HT (M)
--------------      -----------   -------    -------
SIMPLE TERRAIN        1058.          100.         0.


**************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
**************************************************
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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

Issue Date: November 12, 1993

Previous Revision: February 8, 1993

New Designations:

Advanced Pollution Instrumentation, Inc
Model 300 Gas Filter Correlation CO Analyzer

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 PM_{10} samplers sold as reference or equivalent methods must carry a label or sticker identifying them as designated methods. For analyzers or PM_{10} 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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		PARTICULATE MATTER - TSP					
******	Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)	40 CFR Part 50, Appendix B	Manual	Ref.	47 48	54912 17355	12/06/82 04/22/83
		PARTICULATE MATTER - PM_{10}					
******	Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere	40 CFR Part 50, Appendix J	Manual	Ref.	52 52	24664 29467	07/01/87 08/07/87
RFPS-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
RFPS-1287-063	"Sierra-Andersen or General Metal Works Model 1200 PM_{10} High-Volume Air Sampler System," consisting of a Sierra-Andersen or General Metal Works Model 1200 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 Cleves, OH 45002	Manual	Ref.	52 53	45684 1062	12/01/87 01/15/88

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		PARTICULATE MATTER - PM_{10} (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, 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 Cleves, OH 45002	Manual	Ref.	52 53	45684 1062	12/01/87 01/15/88
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, 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 Cleves, OH 45002	Manual	Ref.	52 53	45684 1062	12/01/87 01/15/88

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		PARTICULATE MATTER - PM_{10} (Continued)					
RFPS-0389-071	"Oregon DEQ Medium Volume PM_{10} Sampler" NOTE: This method is not now commercially available.	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
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, pneumatic constant flow controller, total and coarse flow rotameters and vacuum gauges, pressure switch (optional), 24-hour flow/event recorder, digital 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 Cleves, 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 an observing time of 60 minutes, the calibration factor set to 2400, a glass fiber filter tape, an automatic filter advance after each 24-hour sample period, and with or without either of the following options: FH0P1 Indoor Cabinet FH0P2 Outdoor Shelter Assembly	Andersen Instruments, Inc. 4801 Fulton Industrial Blvd. Atlanta, GA 30336	Auto	Equiv.	55	38387	09/18/90

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		PARTICULATE MATTER - PM_{10} (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 mass rate/mass concentration 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

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE					
******	Reference Method for the Determination of Sulfur Dioxide in the Atmosphere (Pararosaniline Method)	40 CFR Part 50, Appendix A	Manual	Ref.	47 48	54899 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 41 42 45	3893 32946 13044 1147	01/27/76 08/06/76 03/08/77 01/04/80

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE (Continued)					
EQSA-1275-006	"Meloy 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 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 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	Auto	Equiv.	41 43	3893 38088	01/27/76 08/25/78
EQSA-0276-009	"*Thermo Electron Model 43 Pulsed Fluorescent* SO_2 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	Equiv.	41 41 42 44 45 45	8531 15363 20490 21861 2700 32419	02/27/76 04/12/76 04/20/77 04/12/79 01/14/80 05/16/80

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE (Continued)					
EQSA-0676-010	"Philips PW9755 SO_2 Analyzer," consisting of the following components: PW9755/02 SO_2 Monitor with: PW9741/00 SO_2 Source PW9721/00 Filter Set SO_2 PW9711/00 Electrolyte SO_2 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 PW9752/00 Air Sampler Manifold PW9753/00 Mounting Rack For Accessories PW9750/41 Control Clock 60 Hz PW9754/00 Air Distributor	Philips Electronic Instruments, Inc. 85 McKee Drive Mahwah, NJ 07430	Auto	Equiv.	41 41 42	26252 46019 28571	06/25/76 10/19/76 06/03/77
EQSA-0876-011	"Philips PW9700 SO_2 Analyzer," consisting of the following components: PW9710/00 Chemical Unit with: PW9711/00 Electrolyte SO_2 PW9721/00 Filter Set SO_2 PW9740/00 SO_2 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.	Philips Electronic Instruments, Inc. 85 McKee Drive Mahwah, NJ 07430	Auto	Equiv.	41	34105	08/12/76
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 IZS Internal Zero/Span Module V Zero/Span Valves CLO Current Loop Output TF TFE Sample Particulate Filter VT Zero/Span Valves And Timer DO Status Remote Interface	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	41 44	36245 33476	08/27/76 06/11/79

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE (Continued)					
EQSA-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.) NOTE: This method is not now commercially available.	ASARCO Incorporated 3422 South 700 West Salt Lake City, UT 84119	Auto	Equiv.	42 44	44264 67522	09/02/77 11/26/79
EQSA-0678-029	"Beckman Model 953 Fluorescent Ambient SO_2 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
EQSA-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 H_2S 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	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE (Continued)					
EQSA-1078-032	"Meloy Model SA285E Sulfur Dioxide Analyzer," operated on the following ranges and time constant switch positions: 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-14B Line Transmitter Board S-18 Rack Mount Conversion S-18A Rack Mount Conversion S-21 Front Panel Digital Meter S-22 Remote Zero/Span Control And Status (Timer) S-22A Remote Zero/Span Control S-22B Remote Zero/Span Control And Status (Pulse) S-23 Auto Zero Adjust S-23A Auto/Manual Zero Adjust S-25 Press To Read S-26 Manual Zero And Span S-27 Auto Manual Zero/Span S-28 Auto Range And Status S-30 Auto Reignite S-32 Remote Range Control And Status S-35 Front Panel Digital Meter With BCD Output S-37 Temperature Status Lights S-38 Sampling Mode Status	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Equiv.	43	50733	10/31/78
EQSA-0779-039	"Monitor Labs Model 8850 Fluorescent SO_2 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: 03A Rack 03B Slides 05A Valves Zero/Span 06A IZS Internal Zero/Span Source 06B,C,D NBS Traceable Permeation Tubes 08A Pump 09A Rack Mount For Option 08A 010 Status Output W/Connector 013 Recorder Output Options 014 DAS Output Options 017 Low Flow Option 018 Kicker	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	44	44616	07/30/79

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		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 FS-2B Rack Mount Conversion FS-3 Front Panel Mounted Digital Meter FS-5 Auto/Manual Zero/Span With Status FS-6 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.	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Equiv.	45	31488	05/13/80
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	Equiv.	45 46	79574 9997	12/01/80 01/30/81

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		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 0-0.2ppm*, 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 006 Internal Permeation Span Source 007 Remote Activation of Zero/Span Valves 008 RS-232 Interface (Model 43B) 009 Pressure/Temperature Compensation (Model 43B) *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.	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Equiv.	51	12390	04/10/86
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 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.	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	Equiv.	51	32244	09/10/86
EQSA-0390-075	"Monitor Labs Model 8850S SO_2 Analyzer," operated on a range of either 0-0.5 or 0-1.0 ppm.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	55	5264	02/14/90

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE 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 *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.	Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Equiv.	55	38149	09/17/90
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 RS-232-C Interface	Environnement S.A. 111, bd Robespierre 78300 Poissy, France	Auto	Equiv.	57	5444	02/14/92

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		SULFUR DIOXIDE (Continued)					
EQSA-0193-092	"Lear Siegler 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 (EZS) Rack Mount Assembly Internal Floppy Disk Drive.	Lear Siegler 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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		OZONE					
RFOA-1075-003	"Meloy 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	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Ref.	40	54856	11/26/75
RFOA-1075-004	"Meloy 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	Auto	Ref.	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	Auto	Ref.	41 45	5145 18474	02/04/76 03/21/80
RFOA-1076-014 RFOA-1076-015 RFOA-1076-016	"MEC Model 1100-1 Ozone Meter," "MEC Model 1100-2 Ozone Meter," "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	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Ref.	41 42	46647 30235	10/22/76 06/13/77

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		OZONE (Continued)					
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: DO 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
EQOA-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 Vycor-Jacketed U.V. Source Lamp 0-10 mV, 0-100 mV, 0-1 V, or 0-10 V Analog Output	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
EQOA-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 PW9750/30 Frame For MTT PW9752/00 Air Sampler Manifold PW9750/41 Control Clock 60 Hz	Philips Electronic Instruments, Inc. 85 McKee Drive Mahwah, NJ 07430	Auto	Equiv.	42 42	38931 57156	08/01/77 11/01/77

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		OZONE (Continued)					
RFOA-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.	Columbia Scientific Industries 11950 Jollyville Rd. Austin, TX 78759	Auto	Ref.	44	10429	02/20/79
EQOA-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	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Equiv.	45	57168	08/27/80
EQOA-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 10 Particulate Filter 15 through 20 DAS/REC Output	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	46	52224	10/26/81
EQOA-0382-055	"PCI Ozone Corporation Model LC-12 Ozone Analyzer," operated on a range of 0-0.5 ppm.	PCI Ozone Corporation One Fairfield Crescent West Caldwell, NJ 07006	Auto	Equiv.	47	13572	03/31/82

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		OZONE (Continued)					
EQOA-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 RS232 Interface Vycor-Jacketed U.V. Source Lamp Teflon-based Solenoid Valve 4-20 mA, Isolated, or Dual Analog Outputs 20 Second Update Software	Auto	Equiv.	48	10126	03/10/83
EQOA-0990-078	"Environics 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 = *On*; and with or without the RS-232 Serial Data Interface.	Environics, Inc. 165 River Road West Willington, CT 06279	Auto	Equiv.	55	38386	09/18/90
EQOA-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) — Rack Mount With Slides — Zero/Span Valves IZS Reference Adjustment — RS-232 With Status Outputs *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.	Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Equiv.	57	44565	09/28/92

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		OZONE (Continued)					
EQOA-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 *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 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 (EZS) 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.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Equiv.	58	6964	02/03/93

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	FED. REGISTER VOL.	FED. REGISTER PAGE	NOTICE DATE
		CARBON MONOXIDE					
FCA-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 C External Sample Pump	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 Bench Mounting Kit Linearizer Circuit	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 0-1, 5, 20, or 50 mA Output 0-10 or 100 mV Output Remote Zero And Span Controls 1-5, 4-20, or 10-50 mA Output 0-1, 5, or 10 Volt Output	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

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		CARBON MONOXIDE (Continued)					
RFCA-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 07A Zero/Span Valve Power Supply 08A Calibration Valves 9A,B,C,D Input Power Transformer	Lear Siegler Measurement Controls Corporation Englewood, CO 80112-5189 74 Inverness Drive East	Auto	Ref.	44 45	54545 2700	09/20/79 01/14/80
RFCA-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. *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".)	Horiba Instruments, Inc. 17671 Armstrong Avenue Irvine, CA 92714-5727	Auto	Ref.	45	72774	11/03/80
RFCA-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 NOTE: This method is not now commercially available.	Commonwealth of Massachusetts Department of Environmental Quality Engineering Tewksberry, MA 01876	Auto	Ref.	45	81650	12/11/80

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 3-007 Zero/Span Module Panel	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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* 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, Rack Mount Assembly, Valve Assembly For External Zero/Span (EZS), 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.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	57	44565	09/28/92
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, Zero/Span Valves, RS-232 With Status Outputs *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.	Advanced Pollution Instrumentation, Inc. 8815 Production Avenue San Diego, CA 92121-2219	Auto	Ref.	58	58166	10/29/93

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE					
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 018A Ozone Dry Air 018B Ozone Dry Air - No Drierite	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	42 42 46	37434 46575 29986	07/21/77 09/16/77 06/04/81
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 the sample inlet line.	Combustion Engineering, Inc. Process Analytics P.O. Box 831 Lewisburg, WV 24901	Auto	Ref.	42	37435	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 951-0112 Remote Zero/Span Sample Control 951-0114 Recorder Output, 5 V 951-0115 External Pump (115 V, 60 Hz) 951-8072 Molybdenum Converter Assembly (Horizontal) 951-8074 Copper Converter Assembly (Horizontal) 951-8079 Copper Converter Assembly (Vertical) 951-8085 Molybdenum Converter Assembly (Vertical)	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Ref.	42	46574	09/16/77

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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
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

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
RFNA-1078-031	"Meloy Model NA530R Nitrogen Oxides Analyzer," operated on the following ranges and time constant switch positions:	Columbia Scientific Industries 11950 Jollyville Road Austin, TX 78759	Auto	Ref.	43 44	50733 8327	10/31/78 02/09/79

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 cm^3/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.

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
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 14-004 Indicating Temperature Controller 14-005 Sample Flowmeter 14-006 Air Filter	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref.	44 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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
RFNA-0879-040	"Philips 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 PW9011/00 Remote Control Set	Philips Electronic Instruments, Inc. 85 McKee Drive Mahwah, NJ 07430	Auto	Ref.	44	51683	09/04/79
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 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	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	45 46	9100 29986	02/11/80 06/04/81

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
RFNA-1289-074	"Thermo Environmental Instruments Inc. Model 42 $NO/NO_2/NO_x$ 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 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.	Thermo Environmental Instruments, Inc. 8 West Forge Parkway Franklin, MA 02038	Auto	Ref.	54	50820	12/11/89
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 356 Level One Spares Kit 357 Level Two Spares Kit PE5 Permeation Tube for IZS	Advanced Pollution Instrumentation, Inc 8815 Production Avenue San Diego, CA 92121-2219	Auto	Ref.	56	27014	06/12/91

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
RFNA-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. *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.	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	56	47473	09/19/91
RFNA-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: switch 1 position open (down) function Recorder outputs are NO & NO_2 switch 5 position open (down) function 3 minute time constant switch 6 position closed (up) function 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; Three-Channel Recorder Output RS-232 Interface; 4-20 mA Output	Dasibi Environmental Corporation 515 West Colorado Street Glendale, CA 91204-1101	Auto	Ref.	57	55530	11/25/92

DESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		NITROGEN DIOXIDE (Continued)					
RFNA-1292-090	"Lear Siegler Measurement Controls Corporation 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 (EZS)	Lear Siegler Measurement Controls Corporation 74 Inverness Drive East Englewood, CO 80112-5189	Auto	Ref.	57	60198	12/18/92

*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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		LEAD					
******	Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air	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

ESIGNATION NUMBER	IDENTIFICATION	SOURCE	MANUAL OR AUTO	REF. OR EQUIV.	*FED.* VOL.	*REGISTER* PAGE	NOTICE DATE
		LEAD (Continued)					
QL-0783-058	"Determination of Lead Concentration in Ambient Particulate Matter by Energy-Dispersive X-Ray Fluorescence Spectrometry (Texas Air Control Board)"	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-0888-068	"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
EQL-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 OR AUTO	REF. OR EQUIV.	*FED. REGISTER* VOL.	PAGE	NOTICE DATE
		LEAD (Continued)					
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

February 8, 1993

METHOD CODES

Method	Designation Number	Method Code
SO_2 Manual Methods		
Ref. method (pararosaniline)	–	097
Technicon I (pararosaniline)	EQS-0775-001	097
Technicon II (Pararosaniline)	EQS-0775-002	097
SO_2 Analyzers		
Advanced Pollution Instr. 100	EQSA-0990-077	077
Asarco 500	EQSA-0877-024	024
Beckman 953	EQSA-0678-029	029
Bendix 8303	EQSA-1078-030	030
Dasibi 4108	EQSA-1086-061	061
Environnement S.A. AF21M	EQSA-0292-084	084
Lear Siegler AM2020	EQSA-1280-049	049
Lear Siegler SM1000	EQSA-1275-005	005
Lear Siegler ML9850	EQSA-0193-092	092
Meloy SA185-2A	EQSA-1275-006	006
Meloy SA285E	EQSA-1078-032	032
Meloy SA700	EQSA-0580-046	046
Monitor Labs 8450	EQSA-0876-013	513
Monitor Labs 8850	EQSA-0779-039	039
Monitor Labs 8850S	EQSA-0390-075	075
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_3 Analyzers		
Advanced Pollution Instr. 400	EQOA-0992-087	087
Beckman 950A	RFOA-0577-020	020
Bendix 8002	RFOA-0176-007	007
CSI 2000	RFOA-0279-036	036
Dasibi 1003-AH,-PC,-RS	EQOA-0577-019	019
Dasibi 1008-AH	EQOA-0383-056	056
Environics 300	EQOA-0990-078	078
Lear Siegler ML9810	EQOA-0193-091	091
McMillan 1100-1	RFOA-1076-014	514
McMillan 1100-2	RFOA-1076-015	515
McMillan 1100-3	RFOA-1076-016	016
Meloy OA325-2R	RFOA-1075-003	003
Meloy OA350-2R	RFOA-1075-004	004
Monitor Labs 8410E	RFOA-1176-017	017
Monitor Labs 8810	EQOA-0881-053	053
PCI Ozone Corp. LC-12	EQOA-0382-055	055
Philips PW9771	EQOA-0777-023	023
Thermo Electron 49	EQOA-0880-047	047
CO Analyzers		
Advanced Pollution Instr. 300	RFCA-1093-093	093
Beckman 866	RFCA-0876-012	012
Bendix 8501-5CA	RFCA-0276-008	008
Dasibi 3003	RFCA-0381-051	051
Dasibi 3008	RFCA-0488-067	067
Horiba AQM-10, -11, -12	RFCA-1278-033	033
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

Method	Designation Number	Method Code
NO_2 Manual Methods		
Sodium arsenite (orifice)	EQN-1277-026	084
Sodium arsenite/Technicon II	EQN-1277-027	084
TGS-ANSA (orifice)	EQN-1277-028	098
NO_2 Analyzers		
Advanced Pollution Instr. 200	RFNA-0691-082	082
Beckman 952A	RFNA-0179-034	034
Bendix 8101-B	RFNA-0479-038	038
Bendix 8101-C	RFNA-0777-022	022
Dasibi 2108	RFNA-1192-089	089
CSI 1600	RFNA-0977-025	025
Lear Siegler ML9841	RFNA-1292-090	090
Meloy NA530R	RFNA-1078-031	031
Monitor Labs 8440E	RFNA-0677-021	021
Monitor Labs 8840	RFNA-0280-042	042
Monitor Labs 8841	RFNA-0991-083	083
Philips PW9762/02	RFNA-0879-040	040
Thermo Electron 14B/E	RFNA-0179-035	035
Thermo Electron 14D/E	RFNA-0279-037	037
Thermo Environmental Inst. 42	RFNA-1289-074	074
Pb Manual Methods		
Ref. method (hi-vol/AA spect.)	–	803
Hi-vol/AA spect. (alt. extr.)	EQL-0380-043	043
Hi-vol/Energy-disp XRF (TX ACB)	EQL-0783-058	058
Hi-vol/Energy-disp XRF (NEA)	EQL-0589-072	072
Hi-vol/Flameless AA (EMSL/EPA)	EQL-0380-044	044
Hi-vol/Flameless AA (Omaha)	EQL-0785-059	059
Hi-vol/ICAP spect. (EMSL/EPA)	EQL-0380-045	045
Hi-vol/ICAP spect. (Kansas)	EQL-0592-085	085
Hi-vol/ICAP spect. (Montana)	EQL-0483-057	057
Hi-vol/ICAP spect. (NE&T)	EQL-1188-069	069
Hi-vol/ICAP spect. (N. Hampshr)	EQL-1290-080	080
Hi-vol/ICAP spect. (Pennsylva)	EQL-0592-086	086
Hi-vol/ICAP spect. (Rhode Is.)	EQL-0888-068	068
Hi-vol/ICAP spect. (S.V. Labs)	EQL-1288-070	070
Hi-vol/WL-disp. XRF (CA A&IHL)	EQL-0581-052	052
PM_{10} Samplers		
Oregon DEQ Med. vol. sampler	RFPS-0389-071	071
Sierra-Andersen/GMW 1200	RFPS-1287-063	063
Sierra-Andersen/GMW 321-B	RFPS-1287-064	064
Sierra-Andersen/GMW 321-C	RFPS-1287-065	065
Sierra-Andersen/GMW 241 Dichot	RFPS-0789-073	073
Wedding & Assoc. high volume	RFPS-1087-062	062
PM_{10} 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) 8501-5CA (50) 2. Beckman 866 (50) 3. MSA 202S (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. Dasibi 3003 (50) 9. TEII 48 (50) 10. Monitor Labs 8830 (50) 11. Dasibi 3008 (50) 12. Lear Siegler ML 9830 (5-100) 13. API 300 (10-50)	
NO_2	1. Sodium Arsenite 2. Sodium Arsenite/Technicon II 3. TGS-ANSA		1. Monitor Labs 8440E (.5) 2. CE (Bendix) 8101-C (.5) 3. CSI 1600 (.5) 4. Meloy NA30R (.1,.25,.5,1.0) 5. Beckman 952-A (.5) 6. TEII 14 B/E (.5) 7. TEII 14 D/E (.5) 8. Bendix 8101-B (.5) 9. Philips PW9762/02 (.5) 10. Monitor Labs 8840 (.5, 1.0) 11. TEII 42 (.05, .1, .2, .5, 1.0) 12. API 200 (.5, 1.0) 13. Monitor Labs 8841 (.05, .1, .2, .5, 1.0) 14. Dasibi 2108 (.5) 15. Lear Siegler 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. Dasibi 1003-AH,PC,RS (.5,1.0) 2. Philips PW9771 (.5) 3. TEII 49 (.5, 1.0) 4. Monitor Labs 8810 (.5, 1.0) 5. PCI Ozone Corp. LC-12 (.5) 6. Dasibi 1008-AH,PC,RS (.5,1.0) 7. Environics 300 (.5) 8. API 400 (.1-1.0) 9. Lear Siegler 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 (ARL, 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 (SVL) 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 1200 3. SA/GMW 321-B 4. SA/GMW 321-C 5. Oregon DEQ MV Special Sampler 6. SA/GMW 241 & 241M Dichot Sampler			1. Andersen Inst. FH62I-N PM_{10} Beta Attenuation Monitor 2. Rupprecht & Patashnick TEOM® Series 1400 and 1400a PM-10 Monitors 3. Wedding & Associates' PM-10 Beta Gauge Automated Particle Sampler
SO_2	Pararosaniline Method	1. Technicon I 2. Technicon II		1. Lear Siegler SM1000 (.5) 2. Meloy SA185-2A (.5, 1.0) 3. TEII 43 (.5, 1.0) 4. Philips PW9755 (.5) 5. Philips PW9700 (.5) 6. Monitor Labs 8450 (.5, 1.0) 7. ASARCO 500 (.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 Siegler AM2020 (.5,1.0) 14. TEII 43A (.1, .2, .5, 1.0) 15. Dasibi 4108 (.1, .2, .5, 1.0) 16. Monitor Labs 8850S (.5, 1.0) 17. API 100 (.5) 18. Environnement S.A. AF21M (.5) 19. Lear Siegler 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

ATTACHMENT A - SAMPLE SUBMITTAL MATERIALS

Including the following:

- AMP380 report
- Site ID forms
- Monitor ID form
- Sample MSA monitoring network design map
- Sample 2km radius map
- Sample 1/4 mile radius map
- Land use information

DATE 06/24/93
AMP380

EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999 ADDRESS: 123 PAMS TEST LANE STATE/LOCAL ID:
CITY POPULATION : 1 CITY (00000): NOT IN A CITY DIST CITY: 999 K UTM ZONE : 19
AQCR POPULATION : 3,196,520 COUNTY (001): ADJUNTAS CO DIFF GMT : UTM NORTH: 2004041
DATE ESTABLISHED: 1992/01/01 ELEV MSL : 999 M UTM EAST : 728975
MET SITE: DATE TERMINATED : / / COMP SECT: NW LATITUDE : +18:06:51
SITE ID : - - DATE LAST UPDATE: 1993/06/24 LONGITUDE: -066:50:10
DISTANCE SITE : M HQ EVAL DATE : / / METHOD (MAP): MAP INTERPOLATION, VIA DI
DIRECTION SITE: REGN EVAL DATE : / / SCALE (15840): 1:15,840
TYPE SITE (1): ON-SITE MET EQUIP DATUM (27): NAD 27
EST OF ACCURACY : 5.00000SEC

AQCR (244): PUERTO RICO
CMSA LOCATED IN (0000): ** DESCRIPTION UNKNOWN **
LAND USE (1): RESIDENTIAL
LOCATION DESCRIPTION : TEST PAMS SITE FOR PUERTO RICO
LOCATION SETTING (1): URBAN AND CENTER CITY
MSA LOCATED IN (0000): NOT IN AN MSA
SITE COMMENT 1 : SITE COMMENTS-1
SITE COMMENT 2 : SITE COMMENTS-2
SUPPORTING AGENCY (001): PUERTO RICO ENVRIONMENTAL QUALITY BOARD
URBAN AREA REPRESENTED (5601): NEW YORK, NY-NORTHEASTERN NJ

TANGENT STREET:

STREET #	TRAFFIC FLOW	YR TRAFFIC	DIR	STREET NAME	TYPE ROAD
1	999999	1990	NW	PAMS TEST MAIN ST	(1): ARTERIAL

SITE TYPE:
SITE LOCATION TYPE MSA OR CMSA REPRESENTED
(1): UPWIND BACKGROUND 61 ********** DESCRIPTION UNKNOWN **********
(0): ********** DESCRIPTION UNKNOWN **********
(0): ********** DESCRIPTION UNKNOWN **********

PARAMETER : 42602 DATE SAMPLING BEGAN: 1992/01/01 SITE CRITERIA MET : Y DATE SITE CRITERIA MET: 1992/01
POC : 1 DATE SAMPLING ENDED: / / REF MTHOD USED : Y REF METHOD USED DATE : 1992/01
MONITOR TYPE : 6 DATE TYPE EFFECTIVE: 1992/01/01 QA PLAN : QA EFFECTIVE DATE : /
REPORTING ORGANIZ : 001 RO EFFECTIVE DATE : 1992/01/01 ACTION TYPE : APP ACTION TYPE REASON : 01
COLLECTING LAB : 001 AUDIT DATE : / / MONITOR OPEN PATH NUM : PROJECT CLASS :
ANALYZING LAB : 001 PROBE LOCATION (1): TOP OF BUILDING
UNRESTRIC AIR FLOW: Y PROBE HEIGHT : 9 M HORIZONTAL DISTANCE : 0 M VERTICAL DISTANCE : 1 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

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AMP380 Report
A-2

DATE 06/24/93
AMP380

EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

CH-93-58

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999 PARAMETER: 42602 POC: 1
ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR NO2
MONITOR COMMENTS 2: COMMENTS-2 FOR NO2

PARAMETER	: 43104	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	N	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

PROBE OBSTRUCTION:

TYPE OBSTRUCTION	DIRECTION FROM MONITOR	DISTANCE FROM INLET	HEIGHT OF OBS
(1): BUILDINGS	NW	99 M	99 M

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	99 M

MONITOR COMMENTS 1: MONITOR COMMENTS-1 FOR VOC
MONITOR COMMENTS 2: MONITOR COMMENTS-2 FOR VOC

PARAMETER	: 43502	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: AAP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 1 M	VERTICAL DISTANCE	: 0 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: MONITOR COMMENTS-1 FOR FORMALDEHYDE
MONITOR COMMENTS 2: MONITOR COMMENTS-2 FOR FORMALDEHYDE

DATE 06/24/93
AMP380

EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999

PARAMETER	: 43503	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 1 M	VERTICAL DISTANCE	: 0 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR PARAMETER 43503
MONITOR COMMENTS 2: COMMENTS-2 FOR PARAMETER 43503

PARAMETER	: 43551	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: MONITOR COMMENTS-1 FOR ACETONE
MONITOR COMMENTS 2: MONITOR COMMENTS-2 FOR ACETONE

PARAMETER	: 44201	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/03
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999 PARAMETER: 44201 POC: 1
DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR OZONE
MONITOR COMMENTS 2: COMMENTS-2 FOR OZONE

PARAMETER	: 61102	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 1 M	VERTICAL DISTANCE	: 0 M

DOMINANT SOURCE (1): POINT
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9 M

MONITOR COMMENTS 1: COMMENTS-1 FOR WIND DIRECTION
MONITOR COMMENTS 2: COMMENTS-2 FOR WIND DIRECTION

PARAMETER	: 62101	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 1 M	VERTICAL DISTANCE	: 0 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR TEMPERATURE
MONITOR COMMENTS 2: COMMENTS-2 FOR TEMPERATURE

DATE 06/24/93
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EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999

PARAMETER	: 62201	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	Y	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR HUMIDITY
MONITOR COMMENTS 2: COMMENTS-2 FOR HUMIDITY

PARAMETER	: 63301	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	N	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR SOLAR RADIATION
MONITOR COMMENTS 2: COMMENTS-2 FOR SOLAR RADIATION

PARAMETER	: 64101	DATE SAMPLING BEGAN:	1992/01/01	SITE CRITERIA MET	: Y	DATE SITE CRITERIA MET:	1992/01
POC	: 1	DATE SAMPLING ENDED:	/ /	REF MTHOD USED	: Y	REF METHOD USED DATE	: 1992/01
MONITOR TYPE	: 6	DATE TYPE EFFECTIVE:	1992/01/01	QA PLAN	:	QA EFFECTIVE DATE	: /
REPORTING ORGANIZ	: 001	RO EFFECTIVE DATE	: 1992/01/01	ACTION TYPE	: APP	ACTION TYPE REASON	: 01
COLLECTING LAB	: 001	AUDIT DATE	: / /	MONITOR OPEN PATH NUM	:	PROJECT CLASS	:
ANALYZING LAB	: 001	PROBE LOCATION (1):	TOP OF BUILDING				
UNRESTRIC AIR FLOW:	N	PROBE HEIGHT	: 9 M	HORIZONTAL DISTANCE	: 0 M	VERTICAL DISTANCE	: 1 M

DATE 06/24/93
AMP380

EPA AEROMETRIC INFORMATION RETRIEVAL SYSTEM (AIRS)
AIR QUALITY SUBSYSTEM
SITE DESCRIPTION INVENTORY

CH-93-58

EPA REGION: 02 STATE (72): PUERTO RICO

SITE ID: 72-001-9999 PARAMETER: 64101 POC: 1
DOMINANT SOURCE (1): POINT
MEASUREMENT SCALE (3): NEIGHBORHOOD - 500 M TO 4KM
MONITOR TYPE OBJECTIVE (3): BACKGROUND
PAMS REQ SAMPLE FREQ (S): SEASONAL

PROBE OBSTRUCTION:

TYPE OBSTRUCTION	DIRECTION FROM MONITOR	DISTANCE FROM INLET	HEIGHT OF OBS
(2): TREES/BRUSH	NW	9 M	9 M
(3): RIDGES	NE	9 M	9 M

ROAD DESCRIPTION:

STREET NUMBER	DISTANCE FROM ROAD
1	9999 M

MONITOR COMMENTS 1: COMMENTS-1 FOR BAROMETRIC PRESSURE
MONITOR COMMENTS 2: COMMENTS-2 FOR BAROMETRIC PRESSURE

OMB No. 2060-0084
Approval Expires 01/31/96

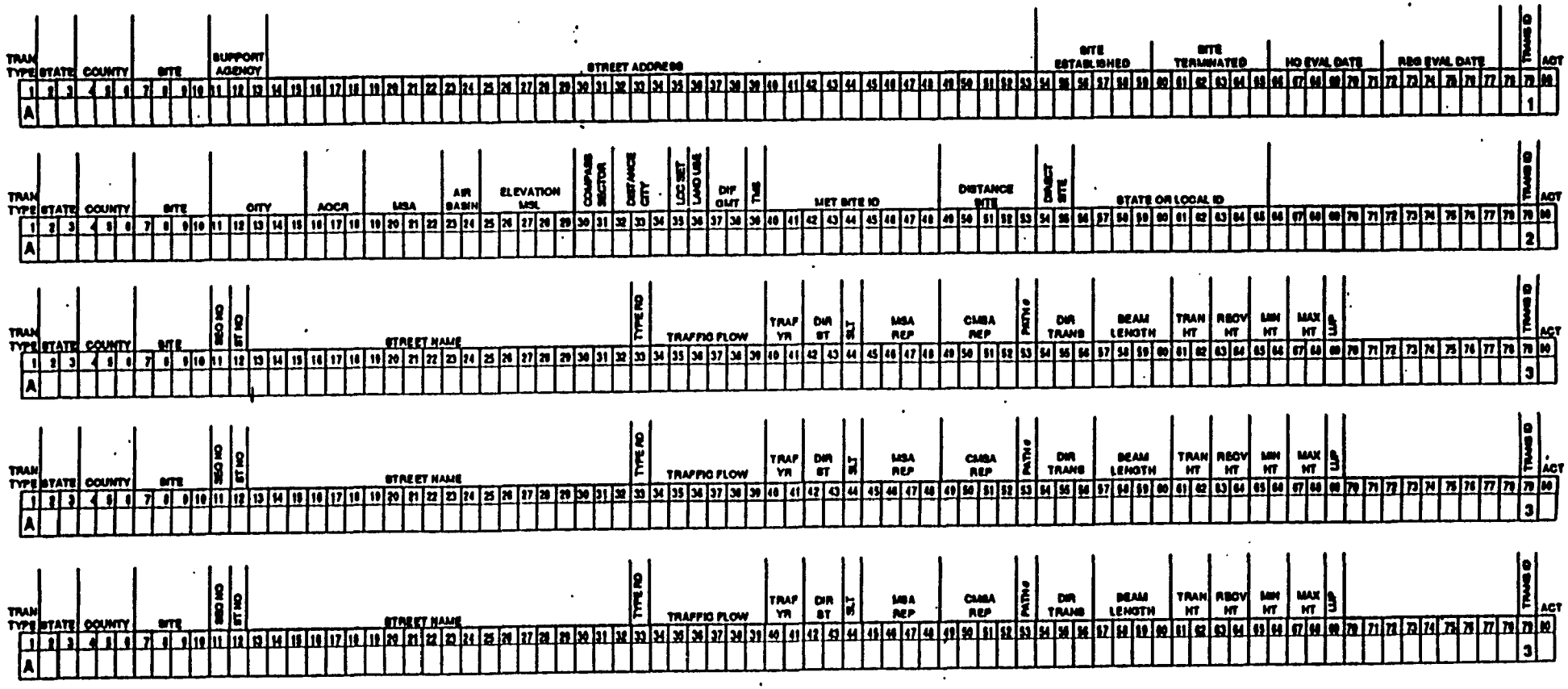
SITE IDENTIFICATION FORM

EPA
AEROMETRIC INFORMATION RETRIEVAL SYSTEM
RESEARCH TRIANGLE PARK, NC 27711

FORM COMPLETED BY _____

DATE _____

STATE _____ CITY _____ COUNTY _____



NOTES:

Card A1–A3	TRAN TYPE:	Transaction Type
Card A1–A3	TRANS ID:	Transaction-ID
Card A1	DATE:	YYMMDD Format
Card A1	HQ EVAL:	Headquarters Evaluation
Card A1	ACT:	Action Code (Delete = D)
Card A1–A3	ACT:	Action Code (Insert = I, Modify = M)
Card A2	DIF GMT:	Difference Greenwich Mean Time
Card A2	LOC SET:	Location Setting
Card A2	TMS:	Type Met Site
Card A2	DIRECT SITE:	Direction to Site
Card A3	SEQ NO:	Sequence Number
Card A3	ST NO:	Street Number
Card A3	TYPE RD:	Type Road
Card A3	TRAF YR:	Year of Traffic Flow
Card A3	DIR ST:	Direction to Street
Card A3	SLT:	Site Location Type
Card A3	MSA REP:	MSA Represented
Card A3	CMSA REP:	CMSA Represented
Card A3	PATH #:	Open Path Number
Card A3	DIR TRANS:	Direction to Transmitter
Card A3	TRANS HT:	Transmitter Height
Card A3	RECV HT:	Receiver Height
Card A3	MIN HT:	Min Beam Height
Card A3	MAX HT:	Max Beam Height
Card A3	LUP:	Land Use Under Path

Session 3

OMB No. 2060-0084
Approval Expires 01/31/99

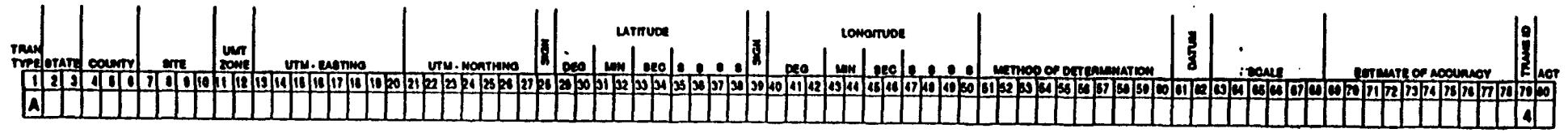
EPA
AEROMETRIC INFORMATION RETRIEVAL SYSTEM
RESEARCH TRIANGLE PARK, NC 27711

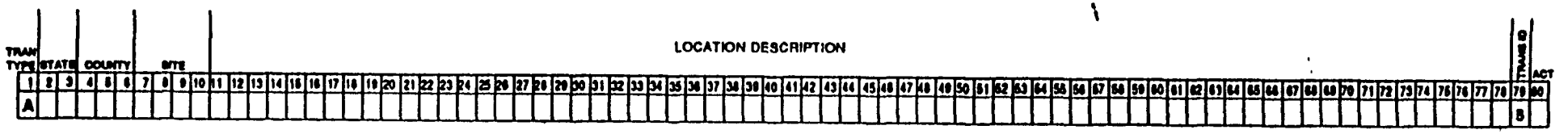
SITE IDENTIFICATION FORM

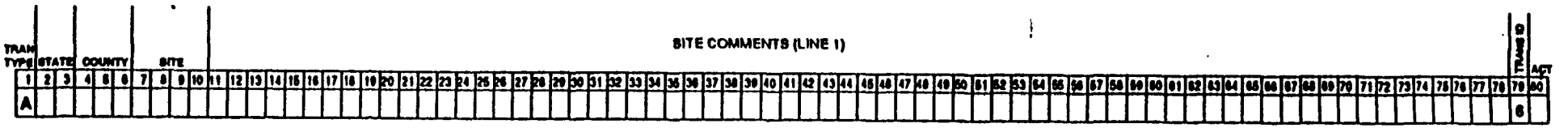
FORM COMPLETED BY_____

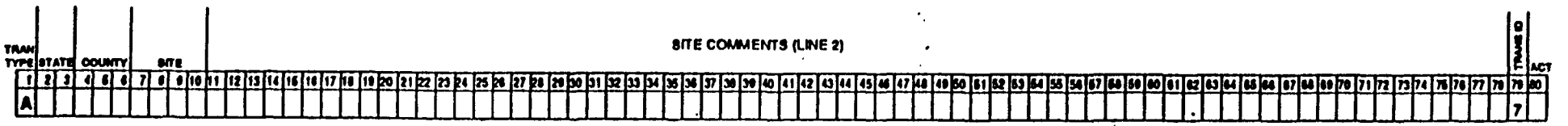
DATE_____

STATE_____ CITY_____ COUNTY_____









NOTES:

Card A4	SIGN:	"+" or "-"
Card A4	SSSS:	Decimal Portion of Field
Card A4–A7	TRAN TYPE:	Transaction Type
Card A4–A7	TRANS ID:	Transaction ID
Card A4–A7	ACT:	Action Code (Insert = I, Modify = M)

Site ID Form
A-9

OMB No. 2060-0084
Approval Expires 01/31/96

MONITOR IDENTIFICATION FORM

EPA
AEROMETRIC INFORMATION RETRIEVAL SYSTEM
RESEARCH TRIANGLE PARK, NC 27711

FORM COMPLETED BY_____

DATE_____

STATE_____ CITY_____ COUNTY_____

MONITOR-ID | DATE | ANALYZE LAB | COLLECT LAB | REPORT ORG | REPORT ORG EFFECTIVE DATE | SAMPLING BEGAN | SAMPLING ENDED | LAST EPA AUDIT | PROJECT CLASS | ACTION TYPE | ACT REASON | DOM SRC | M SCALE | MTO | NONATTAIN AREA | URBAN AREA REP | PRSF | MOPN | TRANS ID | ACT

MONITOR-ID | STREET INFORMATION | OBSTRUCTION DESCRIPTION | DATE SITE CRITERIA MET | QA PLAN | QA EFFECTIVE DATE | PLC | PROBE HEIGHT | H DIST | V DIST | URAF | TYPE OB | DIR MON | DIST INL | HT OBS | TYPE OB | DIR MON | DIST INL | HT OBS | TYPE OB | DIR MON | DIST INL | HT OBS | TRANS ID | ACT

MONITOR-ID | NUMBER OF SCHEDULED SAMPLES PER MONTH | RSF | RSF EFF DATE | STSS | STCD | FEC | TRANS ID | ACT

MONITOR-ID | MONITOR COMMENTS (LINE 1) | TRANS ID | ACT

TRAN TYPE | MONITOR-ID | MONITOR COMMENTS (LINE 2) | TRANS ID | ACT

NOTES:

Card F1–F5	TRAN TYPE:	Transaction Type
Card F1–F5	TRANS ID:	Transaction-ID
Card F1–F5	POC:	Parameter Occurrence Code
Card F1	MON TYPE:	Monitor Type
Card F1	DATE TYPE EFF:	Date Type Effective
Card F1	REPORT ORG:	Reporting Organization
Card F1, F3	DATE:	YYMMDD Format
Card F1	AT REASON:	Action Type Reason
Card F1	M SCALE:	Measurement Scale
Card F1	MTO:	Monitor Type Objective
Card F1	DOM SRC:	Dominant Source
Card F1	PRSF:	Parm Req Sampling Freq
Card F1	MOPN:	Monitor Open Path Number
Card F1	ACT:	Action Code (Delete = D)
Card F1–F5	ACT:	Action Code (Insert = I, Modify = M)
Card F2	MSN:	Monitor Street Number
Card F2	DISTANCE:	Distance from Road
Card F2	RM:	Reference Method
Card F2	STCR:	Siting Criteria Met
Card F2	QA PLAN:	Quality Assurance Plan
Card F2	QA EFFECTIVE DATE:	QA Plan Effective Date
Card F2	PLC:	Probe Location Code
Card F2	H DIST:	Horizontal Distance
Card F2	V DIST:	Vertical Distance
Card F2	URAF:	Unrestricted Air Flow
Card F2	TYPE OB:	Type Obstruction
Card F2	DIR MON:	Direction from Monitor
Card F2	DIST INL:	Distance from Inlet
Card F3	HT OBS:	Height of Obstruction
Card F3	MON AREA:	Monitoring Area
Card F3	WS:	Worst Site
Card F3	SFLAG:	Surrogate Flag
Card F3	RSF:	Required Sampling Frequency
Card F3	RSF EFF DATE:	Required Sampling Frequency Effective Date
Card F3	STSS:	Short Term Scheduled Satisfied
Card F3	SCTD:	Short Term Completion Date
Card F3	FEC:	First Exceedance Correction

Session 8

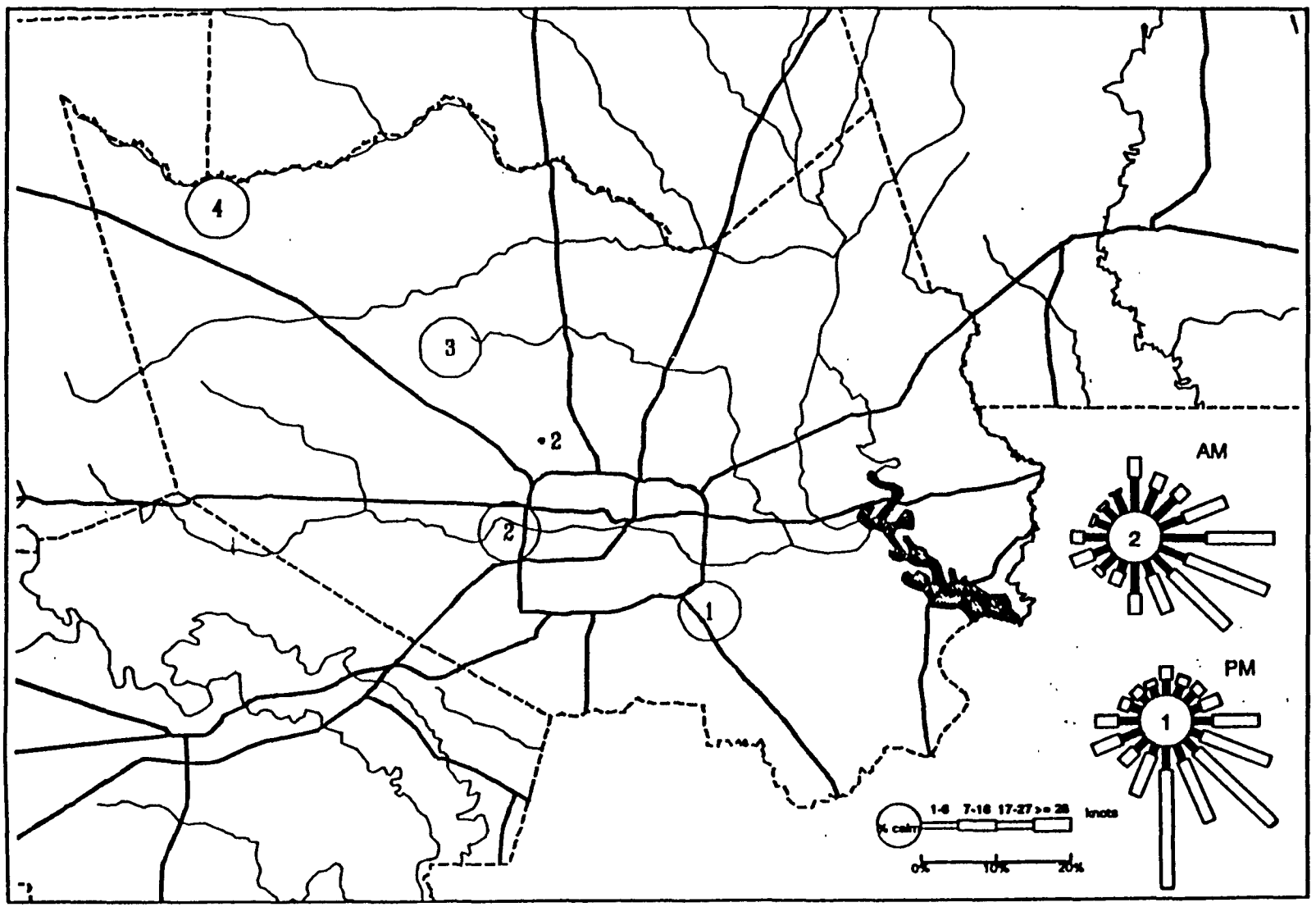


Figure A-1. Sample MSA Network Design Map

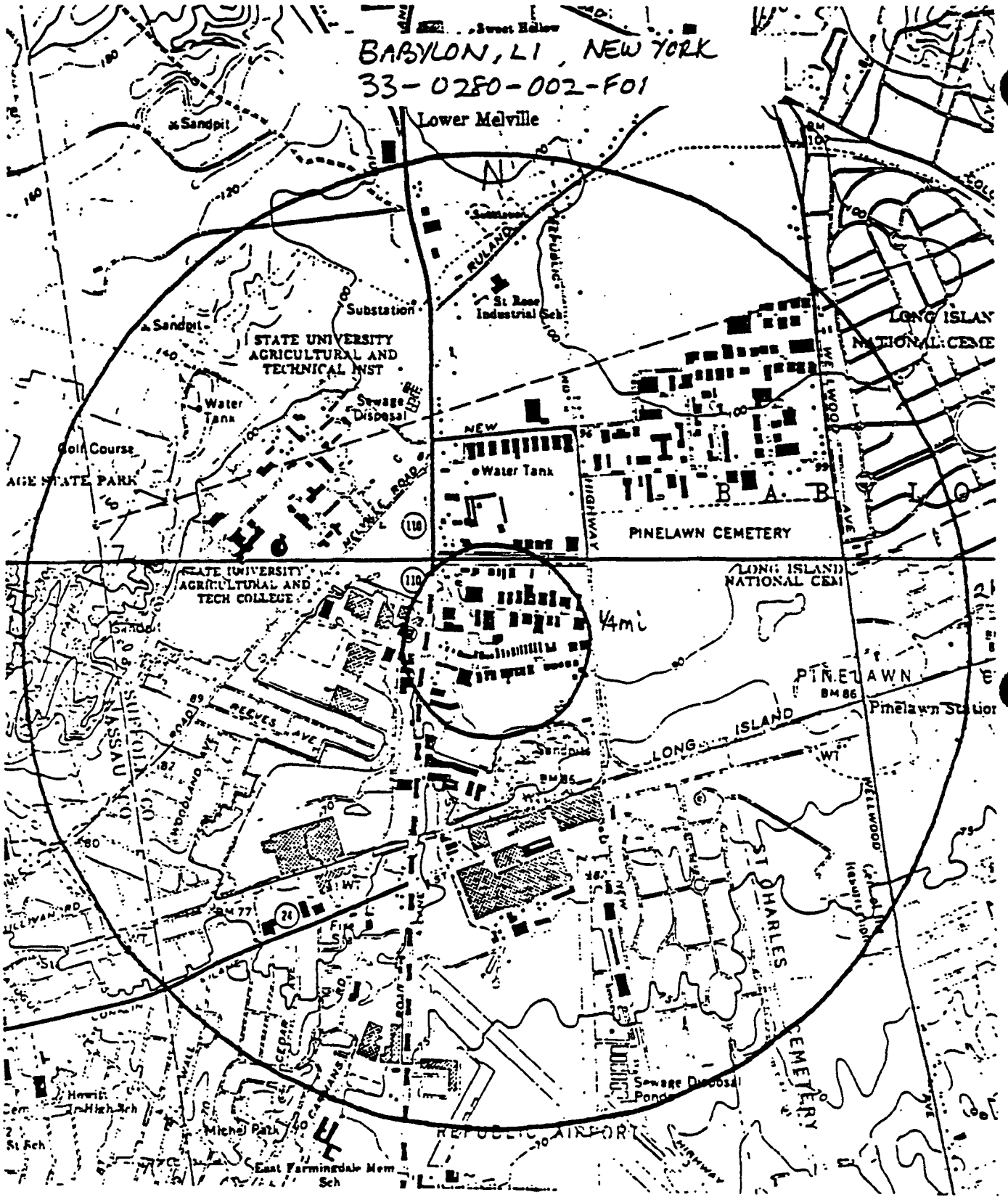


Figure A-2. Sample 2 Km Radius Map

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Sketch a map to document the environment within a 1/4 mile radius of the site. Include the following information on the drawing where applicable.

PAMS Location on Drawing	Residences
Roadways with Names (paved and unpaved)	Trailer Parks
Parking Areas (paved and unpaved)	Recreation Parks
Stationary Sources	Recreation Fields
Buildings (number of stories)	Railroad Yards
Undeveloped Land (ground cover)	Bodies of Water
Tree Lines or Clusters	North Direction
Small Area Sources (dry cleaners, gas stations, etc.)	

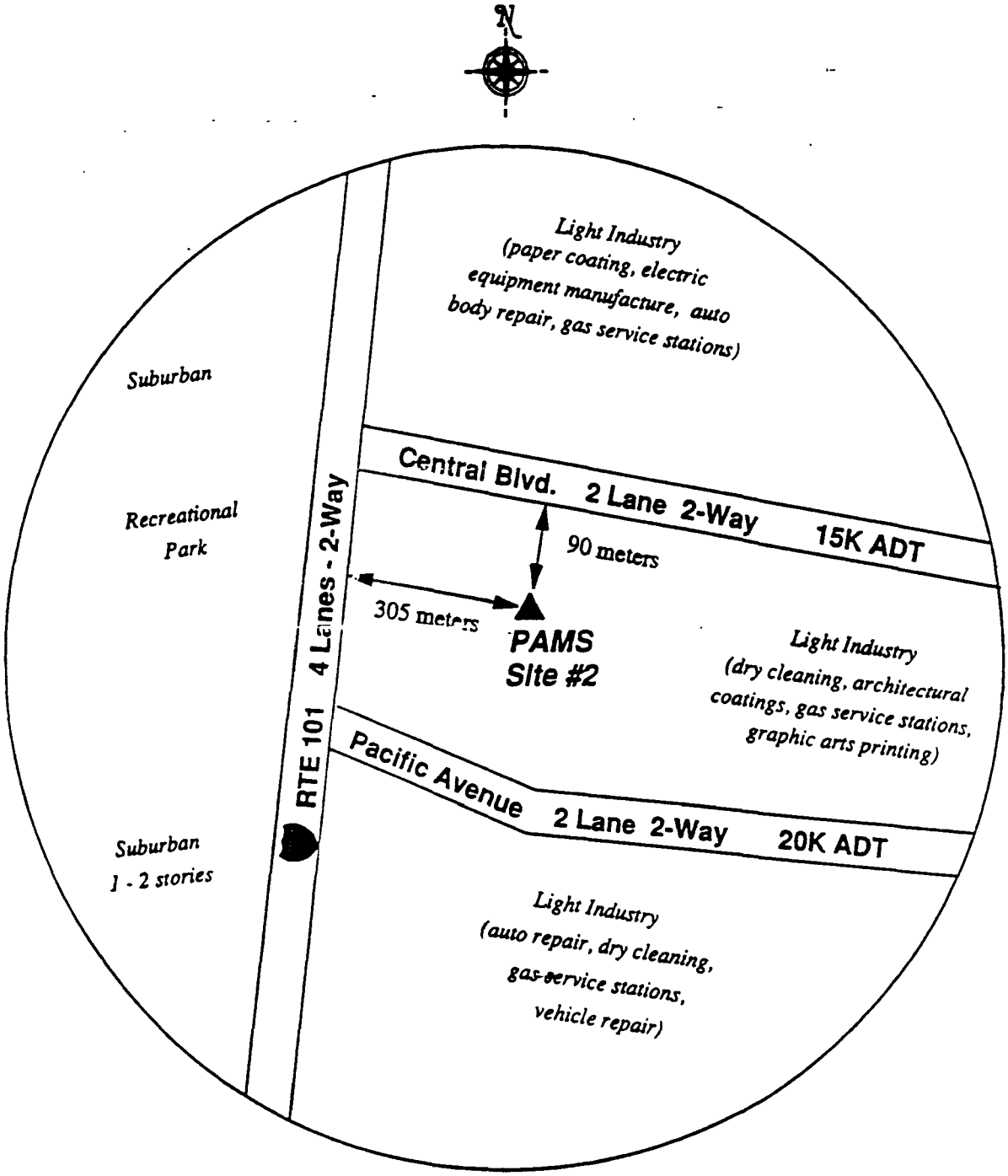


Figure A 3. Sample 1/4 Mile Radius Map

LAND USE INFORMATION

As noted in Section 2 of this document, land use information is quite useful in determining the appropriate locations for ambient monitoring stations.

Land use information availability varies across the country. Differing State and local land use regulations generate similar differences in land use data. Federal data sources also vary in the availability of detailed data on electronic media.

Land use is defined differently by the many public and private data vendors, as well as data customers. Land use can simply describe the degree of urbanization of an area and the nature of this man-made development, or it can describe the purpose served by the development (*e.g.*, residential, commercial, institutional, open space) as well as the transportation systems serving these areas.

The primary land use data sources in the federal government are the United States Geological Survey (USGS) and the Bureau of the Census. The USGS produces topographic maps on paper, electronic tape/disk, and optical disk. These maps are relatively inexpensive and dense with information, but land use information must be distilled from the maps' structure types, development densities, and transportation networks rather than simply being read as pre-marked zones. Topographic maps are available in a variety of scales and media for many areas of the country. Aerial photographs are available at 1:24,000 scale. These photographs offer literal images of the surface features photographed from aircraft. Trained readers can classify types of development and vegetation from these monochrome prints. Pilot projects have yielded orthophotoquad maps on optical disk for a few areas. The Bureau of the Census provides demographic and socioeconomic data capable of supporting land use analysis.

State, regional, and local governments maintain varying amounts of land use data. Data maintained often vary with the planning requirements mandated by State or local legislation. An advantage of sub-state level data is the presence of projected land use maps. Comprehensive development plans often include current land use and projected land use, the latter typically being in the form of zoning maps which reflect policies steering development.

With the development of satellite technology and image processing computer systems, remote sensing has become a viable source of land cover, topographic, and interpretive data such

as land use. Remote sensing is the process of deriving information through systems not in direct contact with the objects or phenomena of interest: image processing describes the manipulation of this raw data yielded by remote sensing systems. The combination of these technologies can yield a variety of spatial data.

There are two main providers of primary remote sensing data. The Earth Observation Satellite Observation Company (EOSAT) is the operator of the Landsat remote sensing satellite system and the distributors of the primary data (and some interpreted data) from this system. The information from this system is read with a pixel size of 30m x 30m. The French company Systéme Probatoire de la Observation de la Terre (SPOT) has a satellite in orbit and a distribution office in the United States. SPOT data are available with a 20m x 20m pixel size for color data and a 10m x 10m black and white pixel size. SPOT is also the only supplier of global Digital Terrain Modeling information. Both companies offer data for a variety of sizes of databases and a variety of media (digital/tape, paper, or film/transparency). The cost for digital system corrected map sheet information is $0.49 per square km for EOSAT data and $0.68 per square km for SPOT data.

The National Oceanic and Atmospheric Administration (NOAA) has used the Nimbus series of satellites to gather Advanced Very High Resolution Radiometer (AVHRR) data since 1978. AVHRR data are only sensed at 1.1 kilometer resolution, but offer the advantage of semidiurnal readings. The private vendor handling public access to AVHRR data notes that this information is not archived and contains encoded meteorological data; no land cover/land use information is available through AVHRR.

Remote sensing data can directly provide information on land use and land cover. Digital processing can enhance the satellite data to interpret this physical evidence to describe physical and cultural processes.

ATTACHMENT B - SAMPLE WIND ROSES

(Prepared by OAQPS/MRB)

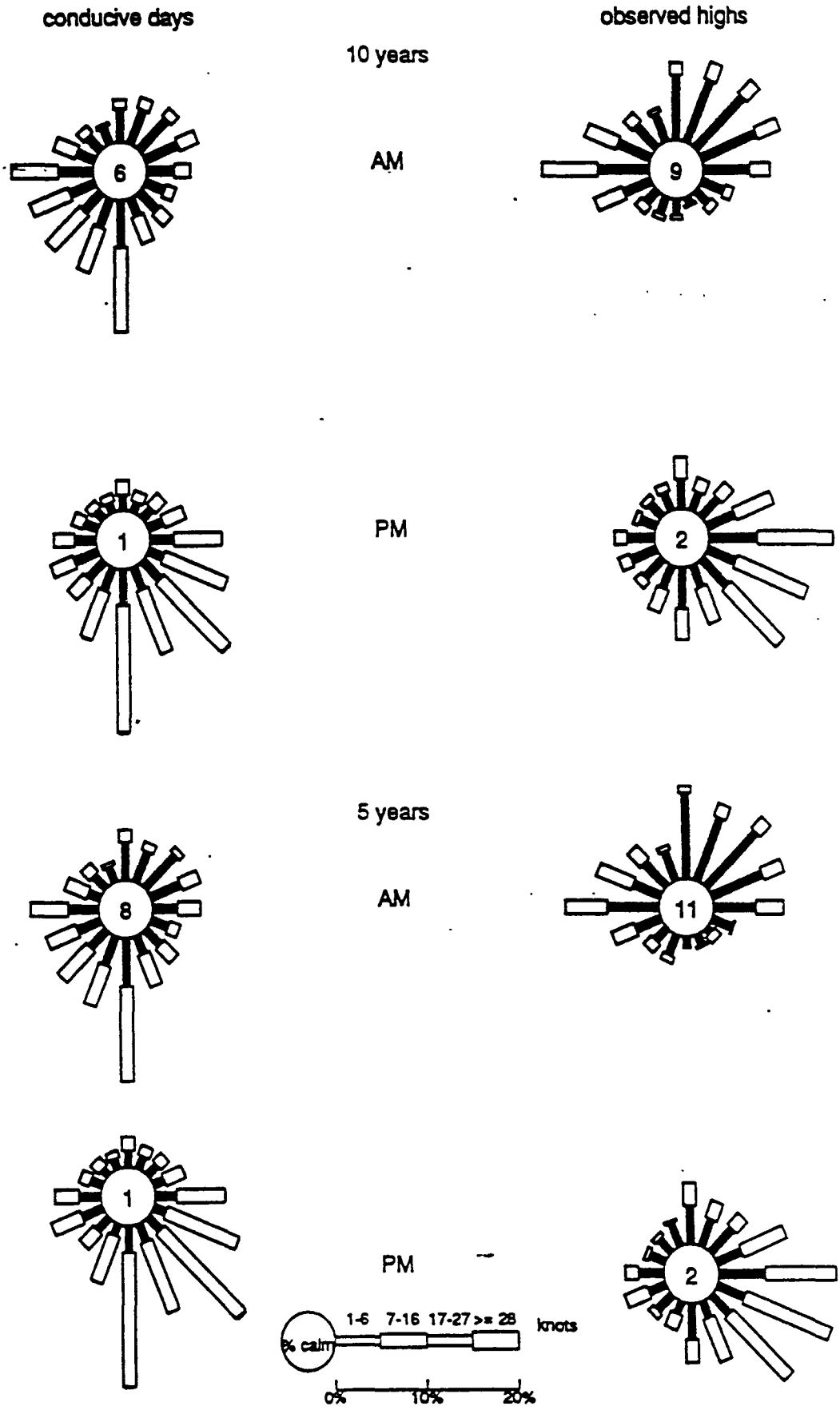


Figure B-1. Sample Wind Roses

ATTACHMENT C - GUIDANCE FOR SUBMITTAL OF EMISSIONS INFORMATION

- Introduction
- Point Source Emissions
- Area Source Emissions
- Mobile Source Emissions

ATTACHMENT C
PAMS MONITOR SITING - USE OF EMISSIONS RELATED DATA AND SURROGATES

1.0 INTRODUCTION

Presentation of a summary of the available SIP base year (1990) VOC and NO_x emissions by the predominant major source categories will provide an initial indication of the relative magnitudes of the source categories for which geographic distribution may be relevant to the selection of PAMS Site #2. Appropriate data for this highly aggregated level of summary should exist in the documentation of current SIP inventory submittals for the nonattainment area of concern and should be available directly from State personnel responsible for inventory preparation.

The primary purpose of obtaining and presenting emissions data summaries is to provide perspective on the relative distribution of the area's emissions across source types. This information will make it possible to develop priorities as to the sources for which geographical distributions are important in the process of locating PAMS Site #2. At a minimum, VOC and NO_x emissions totals should be presented for the following categories: (1) point sources, broken down into combustion and non-combustion sources; (2) area sources, broken down into population-related and industrial source types; and (3) mobile sources, with separate totals for highway and non-road sources (see Table C-1).

For most purposes related to PAMS station siting, the ideal form of geographic emissions information is a set of emissions density displays at a small grid scale, such as that which can be produced by emissions preprocessors for urban scale photochemical models. Where these types of presentations of emissions data are not available or where the resolution provided is not adequate for specific monitor siting considerations, alternatives are discussed below.

TABLE C-1. EXAMPLE AREA-WIDE EMISSIONS SUMMARY

	Ozone Season Weekday Emissions (tons/day)			
	VOC		NO_x	
	tons/day	percentage	tons/day	percentage
POINT SOURCE				
Combustion	1	< 0.1	78	22.4
Non-combustion	9	1.5	1	< 0.1
AREA SOURCE				
Population-related	115	19.1	16	4.6
Industry-related	160	26.6	14	4.0
MOBILE SOURCE				
Highway vehicles	195	32.4	231	66.4
Non-road	22	3.7	8	2.3
BIOGENICS	100	16.6		
TOTALS	602	100*	348	100*

* Due to rounding percentages do not total 100.

2.0 POINT SOURCE EMISSIONS

Site #2 monitoring sites should be selected in areas that will allow accurate assessment of representative amounts of point source emissions (*i.e.*, emissions from facilities that generate 10 tons per year (tpy) VOC emissions or greater, or from facilities that generate 100 tpy or greater NO_x emissions. Smaller sources should be included if such data are available. A map identifying point emissions sources and monitoring sites is the best way to concisely present the required data. Maps should be generated at two levels of resolution: (1) a *macro* level, showing the entire SIP and monitoring area; and (2) a *micro* level, representing a neighborhood-level view of the monitoring sites and nearby point sources. VOC emissions are generated from many point source mechanisms (*e.g.*, combustion, evaporation, waste disposal) and therefore are

generated at many emissions points. In comparison, NO_x is primarily a combustion byproduct, generated at a smaller number of emissions points. This fundamental difference in emission generation, coupled with the tendency of NO_x emission sources to mask VOC emissions, results in the need for separate maps identifying VOC and NO_x point emission sources.

2.1 MACRO-LEVEL MAPPING

Two macro-level maps should be submitted supporting Site #2 monitoring sites. One map will summarize the monitoring locations and VOC emissions levels, the other will relate monitoring sites to NO_x emission points.

2.1.1 VOC Map

Point source emissions should be presented on a map that indicates VOC emissions on a zip code level (see Figure C-1). In areas where the geographic areas represented by zip codes are too small to be clearly represented on a macro-level map, the sources could be identified by latitude/longitude. VOC emissions in each zip code may be identified by cross-hatching, color, or gray scale, and should be resolved into quartiles or higher resolution. VOC emissions for each facility in the SIP area should be available from EPA's Aerometric Information Retrieval System (AIRS) Facility Subsystem (AFS). Zip codes are typically included for AFS facilities[1]; in absence of zip codes, an approximation may be made using the latitude/longitude or Universal Transverse Mercator (UTM) data typical in AFS. Wind roses should be presented on the same page, in the same orientation, as the emissions map. Including wind roses will make evaluating potential site locations easier and more consistent. Software and climatological data for generating wind roses are available in the Support Center for Regulatory Air Models (SCRAM) on EPA's Technology Transfer Network bulletin board service (TTN).

---

[1]AFS includes zip codes for both *street* and *mailing* addresses. Care should be taken to use *street* addresses. This avoids inaccuracies caused when a facility submits the mailing address of a remotely located home office or when a rural facility maintains an in-city post office box.

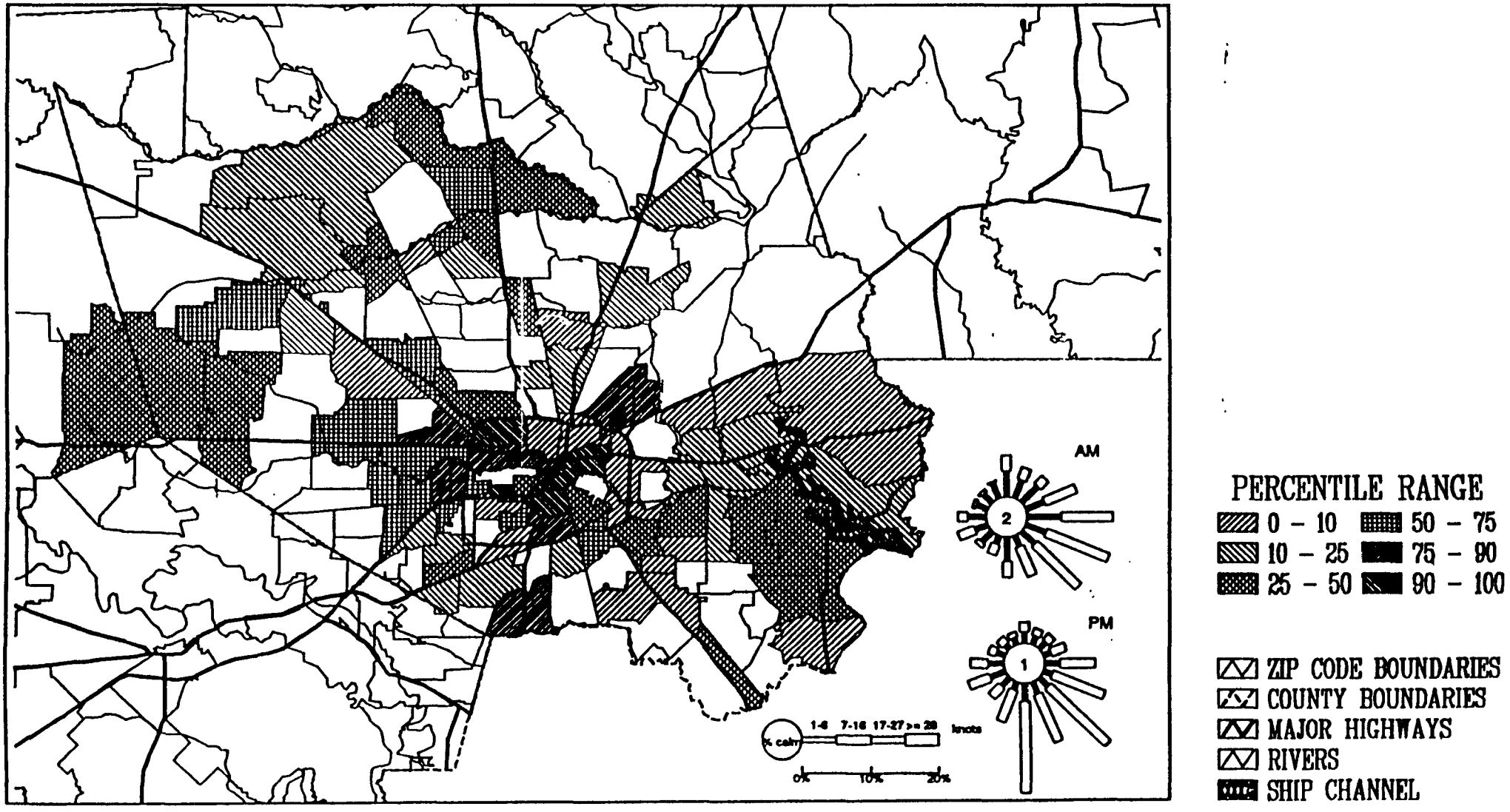


Figure C-1 VOC emission densities by ZIP code

2.1.2 NO_x Map

As stated earlier in this section, NO_x is a combustion byproduct and therefore is produced in a number of sources. Because the NO_x resulting from a source may react with, and therefore mask, ambient VOC levels, NO_x emissions points should be located and identified individually rather than aggregated to a zip code level so that the VOC measurements are not unduly influenced by a single source. NO_x emissions may be identified from AFS; facility location is typically reported using latitude/longitude or UTM data. The relative emissions from each source may be reported on the map by indicating the location of each facility with an indicator (circle, dot or spike) sized in proportion to its NO_x emissions. As in the case of the VOC maps, wind roses should be presented along with the maps.

2.2 MICRO-LEVEL MAPS

Micro-level maps show, on a neighborhood level, the location of the monitoring sites. Micro-level maps generally show a 4-5 km radius around the monitoring station (see Figure C-2). One micro-level map should be submitted for each monitoring location to be implemented within the next ozone monitoring season.

All point sources in the neighborhood of the monitoring site should be indicated on this map. As suggested for the NO_x macro map, the relative emissions from each source may be reported on the map by indicating the location of each facility with an indicator (circle, dot or spike) sized in proportion to its NO_x emissions. Color or shape may be used to indicate pollutant (VOC or NO_x). AFS may be consulted to determine emissions, pollutant and location (using plant address, latitude/longitude, or UTM code).

Wind roses should be printed on the same sheet as the map, oriented consistently with the map to facilitate evaluation.

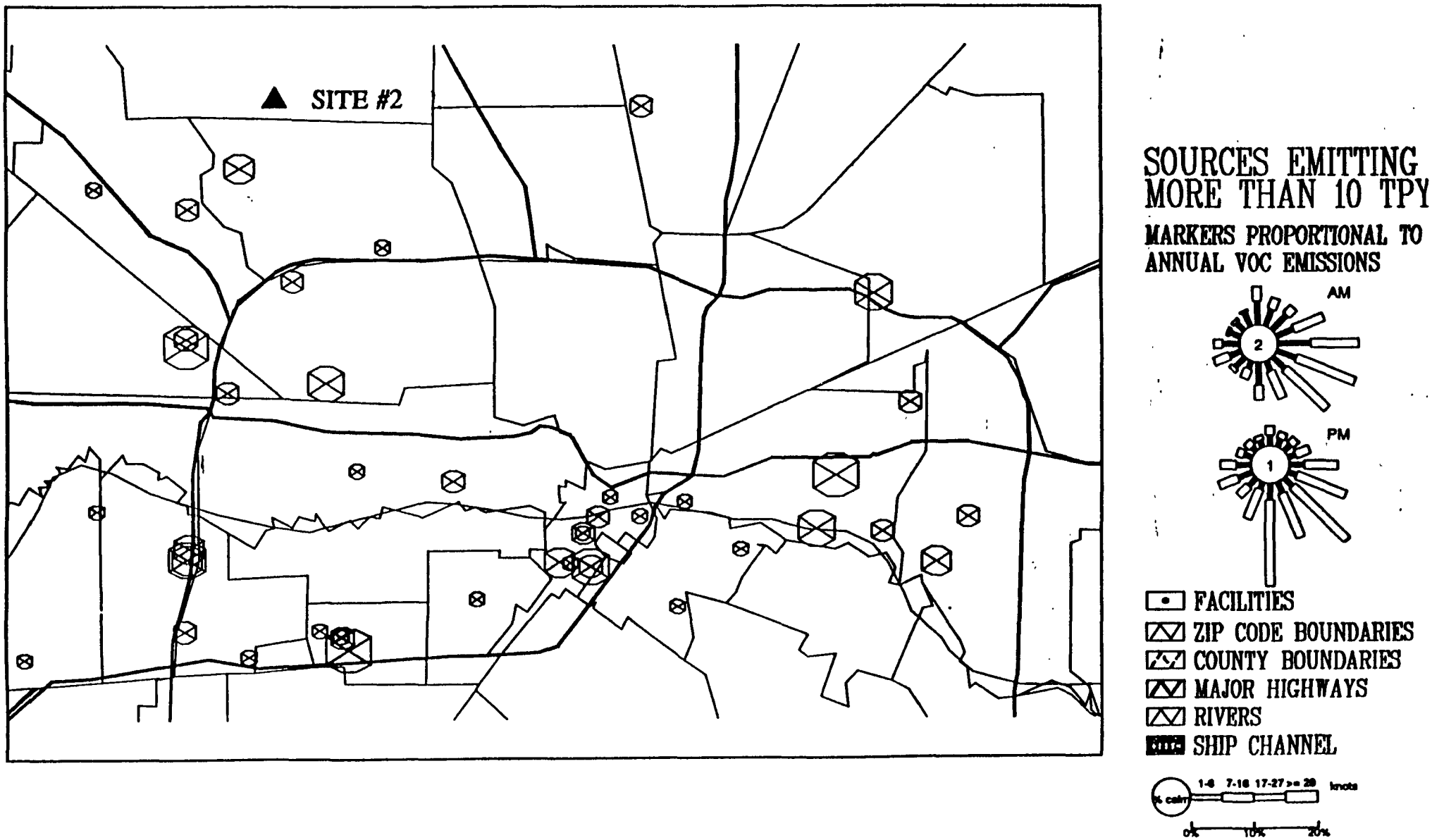


Figure C-2 Point source VOC emission intensities

3.0 AREA SOURCE EMISSIONS

Many types of emission sources are too small or too prevalent to be inventoried as point sources. Area source classifications allow estimation of emissions from such sources by using emission factors based upon substituting data descriptive of activity throughout a neighborhood or county for facility-specific data. While indicators of the distribution of area sources include varied data such as population, housing, land cover, land use, and sales of relevant commodities or products, surrogates for the area sources responsible for VOC emissions are most closely paralleled with population distribution. Therefore, maps representing the population distribution of a nonattainment region will indicate neighborhoods with the highest area source emission potential.

A work of caution is given, however, because the use of population as a surrogate activity level indicator is true for activities such as dry cleaning, architectural surface coating, small degreasing operations, and solvent evaporation from household and commercial products. However, per capita factors should not be used for sources whose emissions do not correlate well with population. In some instances, it might be better to use employment rather than population as a surrogate activity level indicator. Such factors are usually appropriate to estimate emissions for source categories which have an SIC code and for which employment data at the local level are available. Because large fractions of VOC emissions are covered by point source procedures, the emissions-per-employee factor is a secondary procedure to cover emissions from sources that are below the point source cutoff level.

There are several public sources of population and demographic data. The U.S. Department of Commerce, Bureau of the Census provides population data on paper, magnetic tape/disk, and optical disk. The data may be resolved to a variety of levels down to the size of the typical city block. Data at the census tract level, a region containing approximately 2,500 to 8,000 people, is sufficient for most area source estimates. Local and regional planning departments also maintain population data. Though the source of this data may also be the federal census, it may be aggregated into regions more relevant to the development and urbanization patterns of the metropolitan area.

4.0 MOBILE SOURCE EMISSIONS

Mobile sources consist of on-road sources (often referred to as "highway vehicles") and off-road sources, which include aircraft, railroads, vessels, and "non-road" sources such as farm and construction equipment, utility engines, lawnmowers, etc. While on-road mobile sources are expected to be a dominant source category in all PAMS areas, the importance of off-road sources may vary.

4.1 ON-ROAD MOBILE SOURCES

Potential sources of information on the geographic distribution of on-road mobile source emissions include:

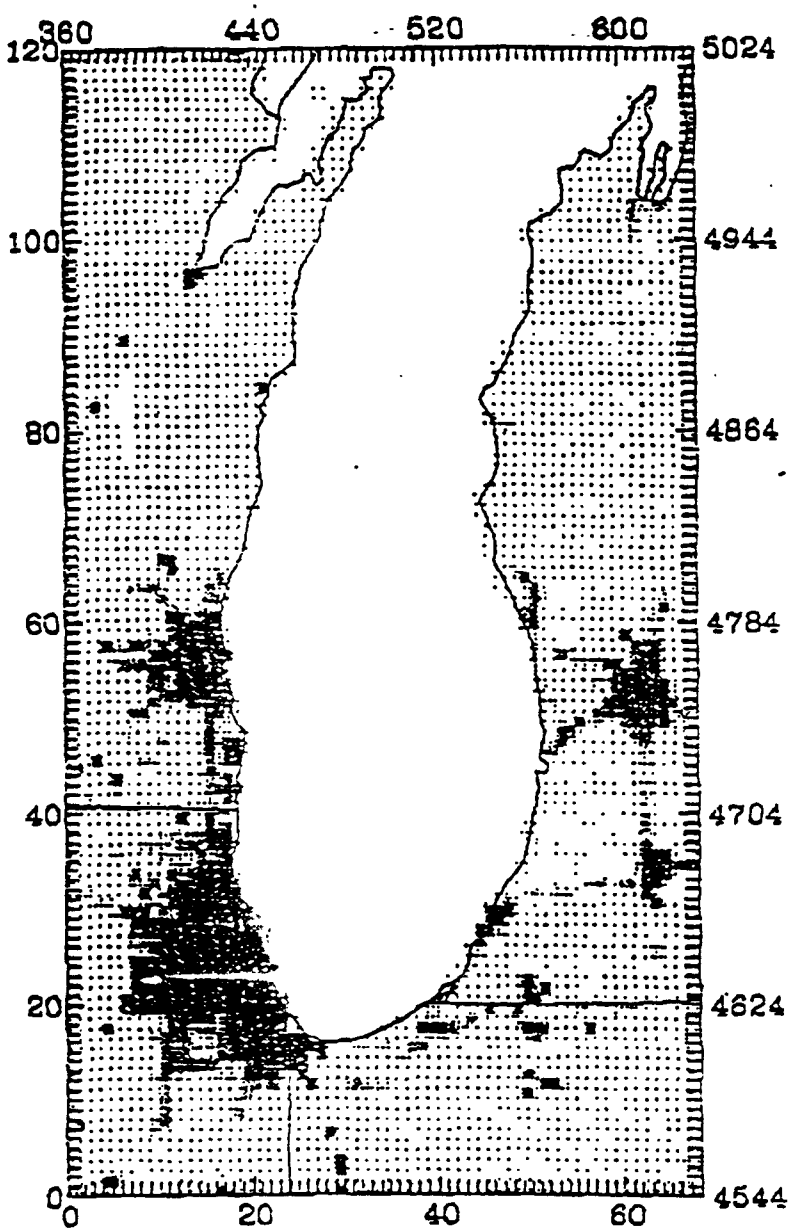
- Highly resolved grid-based on-road mobile source emissions data such as that which would be prepared for photochemical oxidant model input (gridded emission densities) (see Figure C-3)
- Emissions estimates by road system links and traffic generation and destination areas, resulting from the use of a calibrated travel demand model in combination with the EPA MOBILE on-road mobile source emission factor model
- Link- and area-based transportation activity estimates (vehicle miles travelled, trip starts and trip ends) from a calibrated travel demand model
- Traffic count maps indicating the level of traffic on the area's road system. (see Figure C-4)

Traffic flow maps may be available from the local organization(s) charged with performing traffic counts. Some of these maps use bandwidths to indicate the relative level of traffic on individual roads, while others feature the transportation grid system with actual traffic counts written in numerically at the counted locations. The level of detail of these maps will vary with the intensity of the local counting program, but typically includes only the larger roads in the area (such as major arterials and expressways).

4.2 OFF-ROAD MOBILE SOURCES

The level of effort and detail appropriate for development of geographic distributions for off-road mobile sources is a function of the magnitude of these emissions in the area of concern, which would be shown by emissions summaries. The highly disparate nature of the individual off-road source types complicates geographical allocation of this category. If the off-road category represents a critical or significant portion of the overall emissions of a given pollutant, and locations of these emissions have not already been characterized for air quality modeling, investment of some effort in geographical allocation for PAMS purposes may be justified. The basic steps would include (1) obtaining a detailed listing of emissions from individual off-road source types, (2) assigning priorities based on their emission levels, (3) developing reasonable surrogates or logical locational characteristics for each source type, and (4) graphically depicting the distribution of emissions represented by these surrogates or characteristics.

Max value:	9379.1 (kg/day) at (22, 24)
Avg value:	123.9 (kg/day), non-zero cells only.



4 km, 68 x 120, 6/26 Motor Vehicle emissions (Revised inventory)
RHC
Total: 654868 (Kg/day)

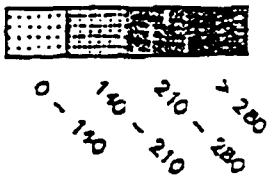


Figure C-3 Grid-based mobile emissions data map

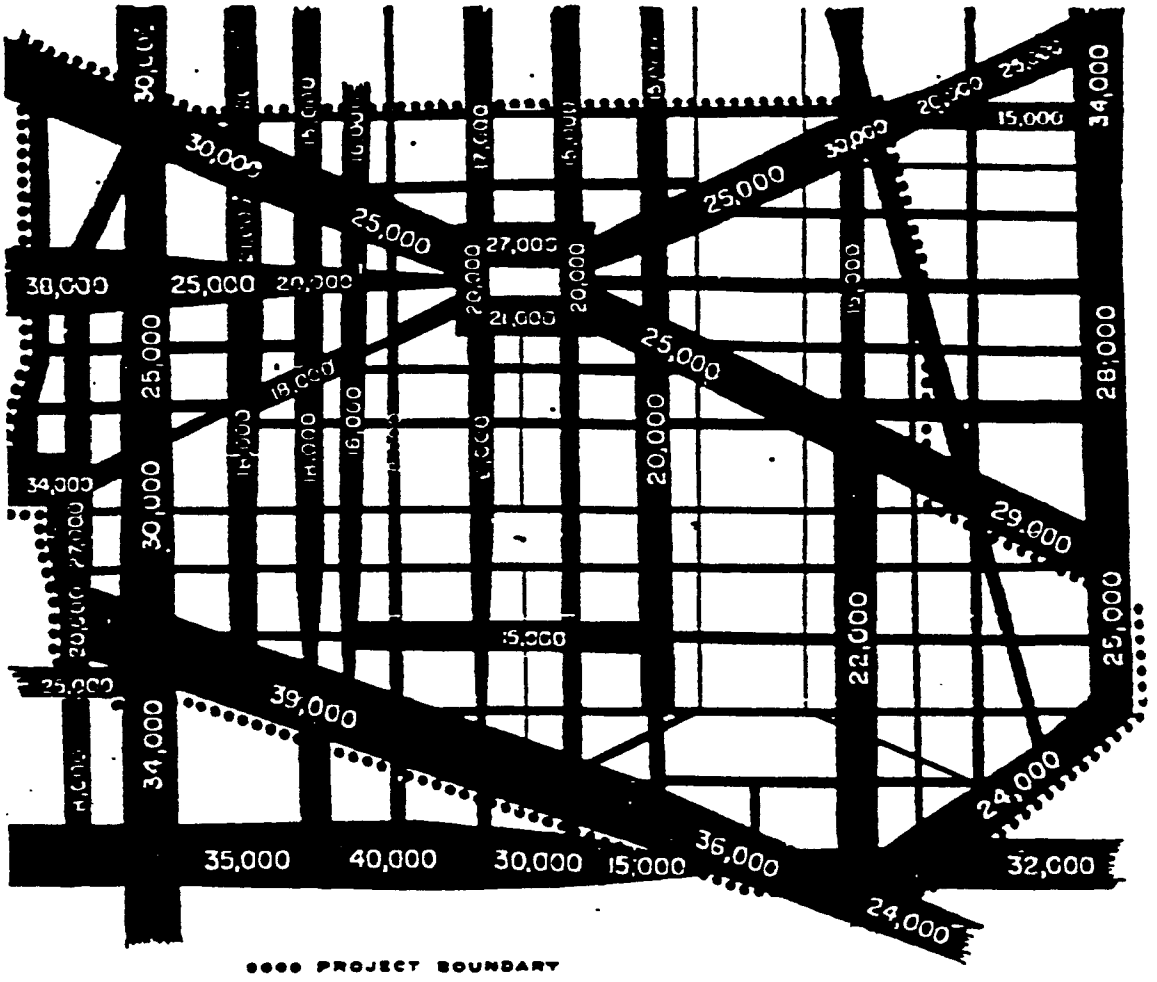


Figure C-4 Sample traffic density map for a downtown area

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ATMOSPHERIC RESEARCH AND EXPOSURE ASSESSMENT LABORATORY
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27711

September 15, 1993

MEMORANDUM

SUBJECT: Requirements and Guidance for PAMS Meteorological Station in New Brunswick, New Jersey

FROM: Jerry H. Crescenti, Physical Scientist
Human Exposure Modeling Branch (MD-56)

TO: N. Ogden Gerald
Office of Air Quality and Planning Standards (MD-14)

This memo is in response to your request for information about the requirements and incorporation of a 30 meter meteorological tower and upper air profilers into the Photochemical Assessment Monitoring System (PAMS) which will be located at Rutgers University in New Brunswick, New Jersey. There are two categories of data needed to fulfill PAMS meteorological requirements - surface and upper air.

The variables which are required from a ground-based system include wind speed, wind direction, air temperature, relative humidity, barometric pressure and incident solar radiation. Most of the guidance summarized below is taken from the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements (1983, revised 1989, EPA-600/4-82-060) and the On-Site Meteorological Program Guidance for Regulatory Modeling Applications (1987, EPA-450/4-87-013).

The primary objective of instrument siting (horizontal and vertical probe placement) and exposure (spacing from obstructions) is to place the sensor in a location where it can make precise measurements that are representative of the general state of the atmosphere in that region under study. The choice of a site must be made with a complete understanding of the regional geography, the sources being investigated, and the potential uses of the data being collected. Ideally, the 30 meter tower should be located in an open level area. In terrain with significant topographic features, different levels of the tower may be under the influence of different meteorological regimes at the same time. If this is the case, such conditions should be well documented.

The standard exposure of a wind sensor over level, open terrain is 10 meters above the ground. Open terrain is defined as an area where the horizontal distance between the instrument

and any obstruction is at least ten times the height of that obstruction. An obstruction may be man-made (e.g., building) or natural (e.g., trees). The wind sensor should be mounted on a mast at the top of the tower or on a boom projecting horizontally out from the tower. If the sensor is mounted on a boom, then it should be located at a horizontal distance at a minimum of twice the maximum diameter or diagonal of the tower away from the nearest point on the tower. The boom should project in the direction which provides the least distortion for the predominant wind direction. For example, the boom should be aligned in a northwesterly or southeasterly direction if the predominant wind is from the southwest.

Air temperature and humidity sensors should be mounted over a plot of open level ground at least 9 meters in diameter. The ground surface should be covered with non-irrigated or unwatered short grass or, in areas which lack a vegetation cover, natural earth. The surface must not be concrete, asphalt or oil-soaked. If there is a large paved area nearby, these sensors should be at least 30 meters away from it. These sensors should be located at a distance from any obstructions of at least four times their height. Areas of standing water should also be avoided as well as steep slopes, ridges or hollows. The standard heights are 2 and 10 meters, but additional levels may frequently be required in air quality studies. These sensors must be housed in well ventilated solar radiation shields (forced aspiration is preferable) at a horizontal distance from the nearest point on the tower of at least the diameter of the tower.

As for the barometric pressure sensor, there is no particular siting guidance available since the data is seldom utilized in EPA studies. However, the barometric pressure is needed when computing variables such as specific humidity, potential temperature and air density. I would suggest that the sensor be place indoors with the data acquisition system. One end of a rubber tube should be attached to the sensor's pressure port and the other ended vented to the outside of the trailer or shelter so that pressurization due to the air conditioning or heating system is avoided.

Solar radiation measurements should be taken in a location free from any obstruction which can either cast shadows or reflect sunlight on to sensor. This means that there should be no object above the horizontal plane of the sensing element that could possibly cast a shadow on it (including the tower). In addition, the pyranometer should not be placed near light colored walls or artificial sources of radiation. Usually, a tall platform or a roof make suitable locations for sensor placement. However, since it is not desirable to have a large obstruction such as a building in the vicinity of the tower, then the best strategy is to place the pyranometer directly south of the tower and its guy wires. There is no height requirement for this sensor.

The variables required for upper air monitoring to support PAMS include profiles of horizontal wind velocity, vertical wind velocity, and air temperature. Also needed is an estimate of the mixing layer height and stability class of the atmospheric boundary layer. However, temporal and spatial density of these variables have not been clearly defined. Rather, the amount of data to be acquired is a function of the field study objectives and numerical model input requirements.

There are two types of wind profiling systems. The first type is a RADAR which transmits a 915 MHz electromagnetic signal and has a range of approximately 90 to 3000 meters. The second type is a SODAR which transmits a 2 to 5 KHz acoustic signal and has a range of about 60 to 600 meters. Both systems transmit their respective signals in pulses. Each pulse is both reflected and absorbed by the atmosphere as it moves upwards. The height range of each pulse is determined by how high it can go before the signal becomes so weak that the energy reflected back to the antenna can no longer be detected. That is, as long as the reflected pulses can be discerned from background noise, meaningful wind velocities can be obtained. The attenuation of the pulses are functions of signal type, signal power, and atmospheric conditions. A Radio Acoustic Sounding System (RASS) utilizes a combination of electromagnetic and acoustic pulses to derive an air temperature profile in the range of about 90 to 1200 meters.

For upper air monitoring, remote sensing is quickly becoming the method of choice. However, while these profiling systems have been approved and used to develop meteorological databases required as input for dispersion models, there is a distinct void in terms of guidance needed to help potential users and the regulatory community. Because of their unique nature and constant evolution, the available EPA guidance for SODARs is more generic than that which already exists for many well established in-situ meteorological sensors. Almost no guidance is currently available on RADAR and RASS systems.

Since SODARs utilize sound transmission and reception to determine the overlying wind field, a clear return signal with a sharply defined atmospheric peak frequency is required. Thus, consideration of background noise may put limitations on where a SODAR can be located. External noise sources can be classified as active or passive, and as broad-band (random frequency) or narrow-band (fixed frequency). General background noise is considered active and is broad-band. If loud enough, it can cause the SODAR software to reject data because it can not find a peak or because the signal-to-noise ratio is too low. The net effect is to lower the effective sampling rate due to the loss of many transmission pulses. Radian (assuming that this company is providing the profiling systems) should be consulted as to what noise level would be acceptable for the SODAR. A qualitative survey should be conducted to identify any potential noise sources. A quantitative noise survey may be necessary to determine if noise levels are within the instrument's minimum requirements.

Examples of active, broad-band noise sources include highways, industrial facilities, power plants, and heavy machinery. Some of these noise sources have a pronounced diurnal, weekly or even seasonal pattern. A noise survey should at least cover diurnal and weekly patterns. Examination of land-use patterns and other sources of information may be necessary to determine if any seasonal activities may present problems.

Examples of active, fixed-frequency noise sources include rotating fans, a back-up beeper on a piece of heavy equipment, birds and insects. If these noise sources have a frequency component in the SODAR operating range, they may be misinterpreted as good data by the SODAR. Some of these sources can be identified during the site selection process. One approach to reducing the problem of fixed frequency noise sources is to use a coded pulse, i.e.,

the transmit pulse has more than one peak frequency. A return pulse would not be identified as data unless peak frequencies were found in the return signal the same distance apart as the transmit frequencies. Radian can provide information on whether or not the SODAR is capable of such a task.

Passive noise sources are objects either on or above the ground (e.g., tall towers, power transmission lines, buildings, trees) that can reflect a transmitted pulse back to the SODAR antenna. While most of the acoustic energy is focused in a narrow beam, side-lobes do exist and are a particular concern when antenna enclosures have degraded substantially. Side-lobes reflecting off stationary objects and returning at the same frequency as the transmit pulse may be interpreted by the SODAR as a valid atmospheric return with a speed of zero. It is not possible to predict precisely which objects may be a problem. Anything in the same general direction in which the antenna is pointing and is higher than 5 to 10 meters may be a potential reflector. It is therefore important to construct an "obstacle vista diagram" prior to SODAR installation that identifies the direction and height of potential reflectors in relation to the SODAR. This diagram can be used after some data have been collected to assess whether or not reflections are of concern at some SODAR height ranges. Note that reflections from an object at distance X from an antenna will show up at height $X\cos(\alpha)$, where α is the tilt angle of the antenna from the vertical.

The RADAR, SODAR and RASS antennas should be aligned and tilted carefully as small errors in orientation or tilt angle can produce unwanted biases in the data. True North should also be established for antenna alignment. Installation of the antennas should not be permanent since problems are very likely to arise in siting the profilers in relation to the tower and other objects that may be in the area. One final consideration is the effect of the instrument on its surroundings. The sound pulse from a SODAR and RASS is quite audible and could become a nuisance to residents who might happen to live near the installation site.

A joint effort is currently underway between EPA's Atmospheric Research and Exposure Assessment Laboratory in Research Triangle Park, North Carolina and NOAA's Wave Propagation Laboratory in Boulder, Colorado to further develop QA and QC guidance for wind and temperature profiling systems. Once established, this information will provide standard and consistent operating procedures which will lead to the acquisition of high quality, interpretable, and scientifically defensible data sets.

cc: Alan H. Huber
William F. Hunt
Robert G. Kellam
Dale A. Pahl
Larry J. Purdue
Brian D. Templeman

APPENDIX J

AIR QUALITY INDICATORS

United States
Environmental Protection
Agency

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

EPA-450/4-81-015
February 1981

Air

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY INTRA-AGENCY TASK FORCE REPORT ON AIR QUALITY INDICATORS

EPA-450/4-81-015
February 1981

U.S. Environmental Protection Agency Intra-Agency Task Force Report on Air Quality Indicators

by

W.F. Hunt, Jr. (chairman), G. Akland, W. Cox, T. Curran, N. Frank, S. Goranson, P. Ross, H. Sauls, and J. Suggs

U.S. Environmental Protection Agency
Office of Air, Noise, and Radiation
Office of Research and Development
Office of Planning and Management
Region 5

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

February 1981

This report is issued by the Environmental Protection Agency to report technical data of interest to a limited number of readers. Copies are available - in limited quantities - from the Library Services Office (MD-35), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

Publication No. EPA-450/4-81-015

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1. OVERVIEW

The Intra-Agency Task Force on Air Quality Indicators was established to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends in national publications. As a first step, the members of the task force identified topics of concern and prepared a series of issue papers on these topics; these papers discuss the background and current status of each issue, develop recommendations, and identify areas that need additional work. These individual papers make up the remaining sections of this document.

To put the activities of the task force in perspective, it should be noted that on May 10, 1979, EPA promulgated regulations for ambient air quality monitoring and data reporting. These regulations were a result of the groundwork of the Standing Air Monitoring Work Group (SAMWG), and reflect EPA's concerns about data quality, timeliness, and consistency from one area to another. Specific provisions in these regulations instituted the routine reporting of precision and accuracy information to aid in characterizing data quality, the designation of specific sites in state and local agency monitoring networks to be used in national trends analyses, and the increased standardization of siting criteria to ensure greater uniformity. All ambient air quality data received by EPA should reflect these changes by 1981; the data bases currently used in EPA's analyses are in transition. In a sense, the monitoring community has identified and begun to implement improvements in the air quality data bases, and now those responsible for analyzing the data must ensure that the best use is made of these improvements.

1.1 RECOMMENDATIONS

In developing recommendations, two common concerns were apparent. The first involved data bases that do not yet exist (e.g., precision and accuracy information). Since it is premature to recommend how these data should be used in reporting air quality, the Task Force has simply identified the group

that should take the initiative in developing methods for using the information. The second concern involved the relative merits of standardization. The data from a given air quality study can be analyzed by a wide variety of statistical techniques. In many cases, different approaches are equally acceptable. In fact, in certain cases, there are statistical techniques that are recommended but seldom applied. The important point here is that an emphasis on standardization should not discourage the development and application of new techniques. Consequently, these recommendations should be viewed as a set of general principles rather than a set of inflexible rules. If a particular approach satisfies the intent of these recommendations, it is satisfactory; if it does not, an explanation should be included in the analysis to say why alternative techniques were used.

The recommendations are grouped in four categories: data base, data analysis, data interpretation, and data presentation. In each category, both general and specific points are presented.

1.1.1 Data Base

In general, each analysis should indicate what data were used. For small studies, specific sites can be named; for large studies, it will suffice to indicate the data source (e.g., the National Air Data Branch, NADB) and the selection criteria used to choose sites. Specific recommendations are listed below.

1. Precision and Accuracy (Section 2) - EPA does not require the submission of precision and accuracy information until 1981; therefore no guidance on its use will be given at this time. It is recommended that ORD/EMSL take the lead in developing procedures for using this information.

2. Data Screening (Section 3) - Statistical procedures for detecting outliers are available, and some have been incorporated into SAROAD. Under the new monitoring regulations and management plan for the National Air Monitoring Stations (NAMS), users will eventually be able to assume that NAMS data quality has been verified. In the interim, however, the user should apply appropriate screening procedures to the data for any small-scale analysis; for large-scale analyses, the user may rely on robust statistical techniques that will minimize the potential impact of anomalous data.

3. Site Selection (Sections 4 & 5) - The NAMS will provide a usable, quality assured, standardized data base for trends--particularly national trends. Composite values of NAMS data will provide a

useful index for national trends assessment. In the interim, the user must select sites on the basis of specific criteria which ensure adequate completeness and seasonal balance. The criteria should be stated clearly in the analysis.

1.1.2 Data Analysis

The analysis should be structured so that results are stated in terms of statistical significance. Analyses that have no statistical basis should indicate that they do not and why they do not. Those analyses with a statistical basis should indicate the statistical approach used. More specific recommendations concerning data analysis follow.

1. Choice of Summary Statistics (Section 6) - Summary statistics should reflect the appropriate air quality standard and not be biased due to sample size. If an analysis requires the use of a statistic that is biased with sample size, care must be taken to ensure that comparisons over time or across sites are not affected by differences in sample sizes.

2. Comparability of the Data Base (Sections 5 & 6) - Any trends analysis should be structured so that results are not attributable to the data base varying with time. Interpolated data may be used for the visual presentation of trends, but trend statistics should be based on actual data unless the effect of interpolation can be quantified.

3. Trend Techniques (Section 6) - Standard statistical techniques such as Chi-square, nonparametric regression, aligned-rank tests, analysis of variance, and time series are all acceptable means of assigning probability statements to trends analyses. The primary concern is that the tests used are statistical in nature, not which tests are used. However, EPA groups need to take a more active role in applying various techniques to air data to assess the relative merits of different procedures.

1.1.3 Data Interpretation

An analyst can facilitate the interpretation of air quality monitoring data from the existing NAMS network by using other sources of information that help explain why an air quality trend has or has not taken place or why there are significant differences between sets of air quality data. To better assess the effectiveness of EPA's emission control program, the agency should collect data on all variables that impact air quality in at least two major urban areas.

1.1.4 Data Presentations

Data presentations should be consistent with the analysis, and should be adequately labeled so that they can stand alone.

1. Choice of Scales - Distortion of scales should be avoided. In general, the pollutant concentration axis should start at zero concentration.

2. Distinguish No-Data Cases - Presentations involving shading (e.g., maps) should clearly indicate cases with no data as a distinct category.

1.2 FUTURE WORK

In view of the transition occurring in the air quality data bases, it is recommended that this task force be continued during 1981, when NAMS data and precision and accuracy data will be received initially by EPA. During this time, the following tasks should be performed:

1. Assessment of Statistical Manpower - To ensure that the task force recommendations can actually be implemented and are not merely idealized goals, it will be necessary to appraise the available and planned technical resources. A breakdown of resources needed should be provided, with particular attention to the in-house resources needed to provide continuity and technical guidance.

Lead Group: OPM

Target Date: March 81

2. Use of Precision and Accuracy Information - The eventual use of precision and accuracy information needs to be better defined. Although these data are not currently being received by EPA, similar preliminary information is available to EMSL. These data should be examined, and a plan should be developed on how this type of information can be incorporated into EPA's use of air quality data. Consideration should be given to the feasibility of eventually establishing national performance standards for precision and accuracy data.

Lead Group: ORD/EMSL

Target Date: July 81

3. Use of Site Information in Trends Analyses - An important feature of the NAMS data base is the detailed information available describing individual sites. To routinely make efficient use of this information, it will be necessary to identify the relevant site parameters and to develop computer software to link the site information with the air quality information. Attention should be given to stratifying the data into broad classifications needed for more refined data analysis.

Lead Group: OAQPS/MDAD

Target Date: September 81

4. Assessment of Statistical Software - Several statistical software packages are available that could be used for air quality data analysis. To ensure that EPA statistical manpower is efficiently utilized an assessment should be made of what statistical software is applicable. In particular, this assessment should determine: (1) what statistical packages are being used and to what extent and (2) if the best statistical packages are being employed and if not, why not.

Lead Group: ORD/EMSL/RTP

Target Date: September 81

5. Presentation of Data - Because the Task Force is recommending specific types of data presentations a pilot study should be initiated to ensure that these recommendations are feasible to implement on a routine basis. Attention should be given to identifying computer programs that would facilitate these presentations and if gaps exist to develop the necessary programs to the extent possible with existing resources.

Lead Group: Region V

Target Date: September 81

2. KNOWN MEASURES OF DATA UNCERTAINTY (Precision and Accuracy)

Concepts of precision and accuracy have been the subject matter for many presentations and publications. ASTM Committee E-11 on quality control of materials discussed definitions and implications of these two ideas over a 10-year period.[1] Complete agreement on the meanings of precision and accuracy is unlikely to be found in the literature on scientific measurement systems. In assessments of the quality of ambient air data, EPA uses estimates of precision to characterize the relative capability of the monitoring system to repeat its results when measuring the same thing and estimates of accuracy to characterize the closeness of an observation to the "truth."[2]

Beginning January 1, 1981, EPA will require all state and local reporting agencies to calculate precision and accuracy estimates in a prescribed manner and to qualify all data entered into the EPA data bank with quarterly precision and accuracy estimates. Some, but not all, of the components necessary for estimating precision and accuracy (Appendix A, 40-CFR-58)[3] are available. Currently, collocated samplers and single concentration precision checks provide data which can be used to estimate the precision of manual and automated samplers, while audits of flow rates and laboratory analytical measurements provide data which can be used for estimating accuracy. Perhaps improved methods for estimating these parameters will be developed as a result of the increased attention to assessing air quality data.

Table 1 presents the types and frequencies of special checks for precision and accuracy by pollutant measurement method; Table 2 displays the concentration range for each audit level.[3]

2.1 NEED FOR QUALIFYING AIR POLLUTION DATA

Over many years, the air pollution data bank has grown into a gigantic body of computerized records of concentrations of pollutants measured at sites across the Nation at points in time. Necessarily, great amounts of attention and expense have been devoted to devising systems to process the data into a

TABLE 1. SPECIAL CHECKS AND AUDITS FOR ESTIMATION OF PRECISION AND ACCURACY

	Precision	Accuracy (local audit)*	
Automated analyzers (SO_2, CO, NO_2, O_3)			
Type check	One concentration	Three or four concentrations	
Frequency	Biweekly	25% of the analyzers each quarter; at least one per quarter	
Scope	All monitoring instruments	All analyzers each year	
Manual methods		Type of audit	
Type check		Flow	Analytical
SO_2	Collocated samplers at two sites	NA	Three levels
NO_2		NA	Three levels
TSP		One level	NA
Frequency	Each monitoring day	25% of the sites each quarter; at least once per quarter	Each analysis-day; at least twice per quarter
Scope	Two sites (of high concentration)	All sites each year	NA

*See Table 2 for audit levels.

TABLE 2. CONCENTRATION RANGES FOR AUTOMATED ANALYZER AUDITS

	Concentration range, ppm	
Audit level	SO_2, NO_2, O_3	CO
1	0.03-0.08	3-8
2	0.15-0.20	15-20
3	0.40-0.45	40-45
4	0.80-0.90	80-90

computerized retrievable form. Also, high priority has been given to the development and refinement of a system for collecting data from state and local agencies and sending the data through EPA Regional Offices to the NADB computer system. Inevitably, air pollution control administrators and affected industries are concerned about the quality of the data that result from this great expenditure of resources, especially pollutant measurements that may represent exceedances of National Ambient Air Quality Standards (NAAQS) or that have other serious implications.

As a result of continued programs of quality assurance and technological improvements in monitoring and analysis, today's ambient air data are doubtlessly more representative of true concentrations than those of some years ago. However, these improvements in data quality cannot be quantified because no routine, standardized data assessment program has been in effect. Implementation of the program described above should provide the means to evaluate progress in measuring and recording ambient air data and should give managers a higher level of confidence in making decisions based on air pollutant measurements.

2.2 SCHEDULE FOR IMPLEMENTING THE PRECISION AND ACCURACY PROGRAM

All designated NAMS sites are to begin operation January 1, 1981 (Appendixes A and E, 40-CFR-58). On July 1, 1981, the first quarterly report is due into EMSL; the first quarterly summary report from EMSL to the EPA Regional Offices is due September 1, 1981; and the first annual report is scheduled for July 1, 1982. The remaining State and Local Air Monitoring Stations (SLAMS) are to be phased into the Precision and Accuracy Reporting System as soon as possible after January 1, 1981. The distinction of SLAMS and NAMS is of little relevance here, since precision and accuracy data relate only to agencies.

2.3 USES OF PRECISION AND ACCURACY DATA

Confidence in conclusions concerning air quality trends will be more scientifically defensible with the precision and accuracy data because of the increased capability to test for statistical significance in trends analyses. Also, additional interpretive insights may be gained; for example, if accuracy does not change significantly, the quality assurance program may be ruled out as a factor affecting trends.

For many trends study purposes, the analyst must set an arbitrary limit (e.g., ±15%) on sites to be included in an analysis. The analyst must make judgments in light of the purpose and the user requirements. In all cases, the analyst should test to determine any effect of precision and accuracy information on conclusions.

It is premature at this time to attempt to develop definitive criteria for using precision and accuracy data in determining trends, nonattainment status, and so forth. Inclusion of precision and accuracy data in analyses may appear to add to the overall levels of uncertainty, but experience over time is needed to establish criteria for setting limits on the data to be used in a particular situation.

Precision and accuracy data will permit comparisons of data quality within and between monitoring networks and within and between States and regions. Also, precision and accuracy data together with data from EPA's Ambient Air Performance Audit Program should provide the means for effective evaluations of analytical laboratories hired by State and local agencies.

A great deal of interest centers on the possible uses of precision and accuracy data to report probability intervals about peak and mean estimates of air quality data. If the peak value is not an outlier, there is no problem with the probability interval. Long-term (3 years) studies may be required to verify the assumptions that the sample of precision and accuracy information is representative and that extreme values are within the population. There should be no problem in reporting probability intervals for mean values. In any case, the assessed quality of air pollution measurements should be included in all relevant reports and publications.

2.4 REFERENCES

1. Precision Measurement and Calibration, Statistical Concepts and Procedures. National Bureau of Standards Special Publication 300. Volume 1. February 1969.

2. Rhodes, R. C. Precision and Accuracy Data for State and Local Air Monitoring Networks: Meaning and Usefulness. Paper presented at the 73rd APCA Annual Meeting, Montreal, Canada, June 1980.

3. Appendix A. Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS). FR Vol. 44, No. 92, pp. 24574-27581, May 10, 1979.

3. DETECTING AND REMOVING OUTLIERS

An outlier is an observation that does not conform to the pattern established by other observations. This pattern may be a scatter plot, frequency histogram, time series, or simple listing. The parent population from which the observations are drawn is usually assumed to behave according to a certain probabilistic model, and the observations are usually assumed to be drawn at random or at least independently. The agreement between the observations and the parent population depends both on the correctness of the underlying assumptions and on certain aspects governing the selection process. Outliers should not be isolated from other problems of statistical analysis; they should be included among anomalies such as nonadditivity, nonconstant variance, bias, temporal drift, or wrong model specification. A correction in another problem can often solve the outlier problem.

3.1 CAUSES OF OUTLIERS

Three basic ways an outlier can occur are (1) mistakes in readings, (2) wrong model specification, and (3) rare deviation.[1]

Mistakes in readings can occur during any stage of data processing, but the more common mistakes (e.g., transcription errors) usually occur early in the processing; during data coding or key punching, transcription errors often go unnoticed. Unusual readings from instruments may be caused by power failure or surges, improper calibration, breakdowns, torn filters, contamination, chemical interaction, leaks, and so forth. Not adhering to an experimental plan or design can affect recorded data. Mistakes occur both in totally automated data gathering processes and in those that rely on human consideration or intervention.

With the exception of glaring mistakes that have obvious explanations, model specification usually is the basis for deciding if a discordant observation is an outlier. In fact, most tests currently being used routinely by EPA to detect outliers are actually testing some type of nonnormality.[2] For example, the null hypothesis of all the tests listed in Table 3, with the

exception of the gap test, is that the population from which the observations are being drawn is specified by a normal distribution model. References 3 and 4 describe additional tests which specify normal, lognormal, or Weibull models. Detection of an outlier by any one of these tests is paramount to declaring the parent population has a different distribution than was originally assumed. Of course, the final conclusion would be that the observation is an outlier.

In any parent population, some observable events have a low probability of occurring. These events are usually associated with the extremes (tails) of the distribution. Although the probability of obtaining one of these observations is small, it is possible for such an event to occur. Being a rare occurrence, the observation is almost always treated as an outlier.

3.2 STATISTICAL PROCEDURES FOR IDENTIFYING OUTLIERS

Statistical procedures for identifying outliers are used for different reasons. One reason is to justify what would have been done anyway (i.e., to reject observations that an experienced investigator would intuitively reject). Another reason for using statistical tests is to provide algorithms to the computer[2,5] for scanning large sets of data that would be impractical to scan by visual inspection. At present, 5122 SLAMS, 1269 NAMS, and 68 Inhalable Particulate Network (IPN) sites are producing data which require validation. In addition, special studies such as the Philadelphia IP Study, the National Forest Ozone study, and the Across Freeway Study (LACS) are collecting large quantities of continuous and 24-hour data. Whether the data are collected routinely or for special studies, a procedure for detecting outliers is necessary to strengthen the validity of conclusions reached during data analysis.

Table 3 lists several statistical tests for objectively screening a set of data and identifying possible outliers. These tests are currently being applied to routine data storage systems within EPA. These tests, except for the studentized range, the studentized t-test, and the Shewhart control chart require no external or independent parameter estimates; conclusions are based solely on the data at hand. Except for the Gap Test,[2] these tests for outliers are tests for normality. All tests are aimed at high values relative to some measure of spread based on the sample. Where routine screening of data is necessary, a battery of several tests is advisable.

The Dixon ratio test[6] was the first of many standard statistical procedures which have been found to work well in air data screening. Some work better

than others, depending on sampling frequencies and durations. For example, the Shewhart control chart was found superior to the Dixon ratio in screening 24-hour measurements.[2] These and other screening procedures constitute the Air Data Screening System (ADSS), which is now being implemented in 27 States through the Air Quality Data Handling System.[2]

In another screening program, several statistical procedures are currently being applied to SAROAD data.[2] With the exception of the gap test, these tests have one thing in common--they all assume that the observations are samples from a single normal population with specific location and shape parameters. Tables and charts are used to identify values that have a low probability of occurring if all observations were taken from the same population; these values are flagged for further investigation.

To demonstrate how outliers can be identified, several tests, in Table 3 are applied to the following set of mass data in the 0-15 micron size range gathered over a 5-month period in Birmingham, Alabama, using a dichotomous sampler.

24-hour samples		Monthly values	
Date	$\mu g/m^3$	Average ($\bar{x}$)	Range (R)
08/01/79	43.8		
08/07/79	66.7		
08/25/79	17.8		
08/31/79	45.3	43.4	48.9
09/06/79	92.6		
09/12/79	34.8		
09/30/79	38.4	55.3	57.8
10/06/79	47.5		
10/12/79	64.7		
10/18/79	36.2		
10/24/79	30.6		
10/30/79	16.9	39.2	47.8
11/05/79	36.6		
11/23/79	15.3	26.0	21.3
12/05/79	101.8		
12/11/79	35.0	68.4	66.8

Dixon Ratio[2,3]

Calculated: $R_{22} = \frac{X_n - X_{n-2}}{X_n - X_3} = \frac{101.8 - 66.7}{101.8 - 17.8} = 0.418.$

Tabulated: $r_{0.90}$ (i.e., $\alpha = 0.10$) = 0.454 for n = 16.

Thus: $R_{22} < r_{0.90}$.

Shewhart Control Chart[2,3]

Range: $LCL_R = D_3\bar{R} = (0)(43.95) = 0.$

$UCL_R = D_4\bar{R} = (2.57)(53.95) = 112.95.$

In this example, the largest integer less than the average was used (n = 3).

Average: $LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R} = 40.95 - (1.02)(43.95) < 0$ (use $LCL_{\bar{X}} = 0$ in this case).

$UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R} = 40.95 + (1.02)(43.95) = 85.78.$

Thus the monthly average (68.4) and range (66.8) for December are not considered outliers.

Chauvenet's Criterion[9]

$\bar{X} = 45.25$

$S = 25.00$

$C = \frac{X_n - \bar{X}}{S} = \frac{101.8 - 45.25}{25.00} = 2.26.$

The critical value of C for sample size n = 16 is 2.154 with an α-level of 0.016 for a one-tailed test, thus 101.8 is an outlier. Chauvenet's criterion is not recommended for samples of $n < 7$ for a two-tailed test and for samples of $n < 4$ for a one-tailed test because it tends to flag too many valid observations.

Grubbs Test[7,8]

Calculated: $SS = 9372.26$, $SS_{16} = 5961.16$, and $SS_{15,16} = 3161.25$.

Thus: $L_1 = \frac{SS_{16}}{SS} = 0.64$ and $L_2 = \frac{SS_{15,16}}{SS} = 0.34$

Tabulated: $L_1 = 0.576$ and $L_2 = 0.405$ for n = 16.

Therefore, at the $\alpha = 0.05$ significance level, only the highest value (101.8) can be rejected as an outlier.

Coefficient of Skewness[10]

$$\text{Calculated: } B = \frac{n \sum_{i=1}^{n} (X_i - \bar{X})^3}{\sum_{i=1}^{n} (X_i - \bar{X})^2 \; ^{3/2}} = 1.0$$

Normally, this test for skewness is not used for n small (say < 25); however, the value of B exceeds the tabulated value 0.71 for n = 25 (the tabulated value for n = 16 will be < 0.71) and therefore, normality is rejected at the $\alpha = 0.05$ significance level.

After excising 101.8 and 92.6, normality can no longer be rejected; both values are outliers based on this test.

Studentized T-Test[9]

The standard deviation (S) required for testing studentized deviates was estimated from the August, September, and October data to be 21.52. November and December data are grouped together because there are only two observations in each month. The suspected outlier is 101.8 $\mu g/m^3$.

$$T = \frac{X_n - \bar{X}}{S} = \frac{101.8 - 47.18}{21.52} = 2.54.$$

The critical value ($\alpha = 0.05$) for examining one outlier among four samples, relative to the prior S based on 11 degrees of freedom, is $t_{0.05}(4,11) = 2.24$. Thus 101.8 $\mu g/m^3$ is an outlier.

Studentized Range[9]

The S required for the studentized range test was estimated from the same set of data as the studentized t-test. November and December data are grouped together as before, and the suspected outlier is again 101.8 $\mu g/m^3$.

Calculated: $W = X_n - X_1 = 101.8 - 15.3 = 86.5.$

Tabulated: $W = q_{0.05}(4,11)S = 4.26(21.52) = 91.68$

Thus: 101.8 is not an outlier.

Some tests are more suited to hourly than to 24-hour data. Table 3 summarizes the recommended applications of the commonly used tests. For examples of how other tests are applied, consult the references.

References 3 and 4 describe nonparametric tests for comparing two or more data sets to aid in identifying a data set that does not conform to the pattern established by the other data sets. Reference 4 also discusses the use of nonparametric tests for a single sample. However, identifying an outlier by a nonparametric test is inconsistent with our definition of an outlier; an outlier is an atypical observation because it does not conform to a model which we hypothesize to describe the data. If we have no model in mind, it is difficult to describe what we mean by an outlier. Hence, nonparametric techniques are recommended only for the comparison of data sets.

3.3 RECOMMENDED TREATMENT OF OUTLIERS

No observation should be rejected solely on the basis of statistical tests, since there is always a predictable risk (i.e., the α-level) of rejecting "perfectly good" data. Compromises and tradeoffs are sometimes necessary, especially in routinely scanning large amounts of data; in these situations, no statistical rule can substitute for the knowledge and judgement of an experienced analyst who is thoroughly familiar with the measurement process.

In any data-collecting activity, all data must be recorded along with any notes that may aid in statistical analysis. Gross mistakes should be corrected if possible before performing calculations in the final analysis; if a mistake cannot be explained or corrected, it is <u>not</u> always wise to discard the reading as though it had never occurred. Further experimental work may be needed, since a gross error in the observations can bias the analysis in all but the most robust statistical procedures. In addition, data collected under differing conditions should not be combined for identifying outliers unless the experiment was designed (e.g., factorial design) to handle such data with an appropriate model during final analysis.

In performing the calculations in the final statistical analysis, the question of what weight, if any, to assign a discordant value is difficult to answer in general terms. An acceptable explanation for an outlier should preclude any further use of the value. Sometimes it is obvious that an observation does not belong even though there is no explanation for its existence. Although the value should not be used in further calculations, it should be mentioned in the final report.[7]

Experienced investigators differ greatly on these matters.[9] Excluding "good" data may not be as serious as including "bad" data and then excluding

any questionable observations in further calculations at the risk of losing information on estimates and introducing some bias. Reducing sample variation (increasing precision) may be preferred over introducing a slight bias, especially if the bias is theoretically estimable. Using robust air quality indicators that are not strongly influenced by outliers may avoid many argumentative, subjective decisions.

3.4 CONCLUSIONS

The data analyst should not assume that all outliers represent erroneous values. Some outliers occur because the analyst has used the wrong probabilistic model to characterize the data. For example, outlier tests based on assumptions of normality may be inappropriate for nonnormal data sets. In addition, there is always a finite chance that an extreme value will occur naturally. The analyst should carefully investigate these possibilities before discarding outliers. The use of robust air quality indicators is recommended since they decrease the need for detecting outliers. Reference 4 discusses several outlier tests, their performance, and provides a brief summary of comparative information for each test, including pertinent references.

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TABLE 3. OUTLIER TESTS

Test name	Test criterion	Definition of terms	Basis for test	Critical values	Recommended application
Dixon ratio[2,3,11]	$r_{10} = (X_n - X_{n-1})/(X_n - X_1)$, $3 \le n \le 7$ $r_{11} = (X_n - X_{n-1})/(X_n - X_2)$, $8 \le n \le 10$ $r_{21} = (X_n - X_{n-2})/(X_n - X_2)$, $11 \le n \le 13$ $r_{22} = (X_n - X_{n-2})/(X_n - X_3)$, $14 \le n \le 25$	X_n = maximum value of n samples, X_{n-1} = second maximum value, X_1 = minimum value, other subscripts indicate order from lowest to highest	A value too large compared to other values in the sample; underlying distribution is normal	Special tables for r_{ij}[3,11]	24-h samples on a monthly basis; values may be individuals or averages of individuals
Shewhart control chart[2,3,10,11]	Range : $LCL_R = D_3\bar{R}$, $UCL_R = D_4\bar{R}$ Average: $LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R}$, $UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}$	$\bar{R}$ = average range of several groups of samples, $\bar{\bar{X}}$ = overall average, LCL = lower control limit, UCL = upper control limit, A_2, D_3, D_4 are constants used to calculate 3σ control limits for $\bar{X}$ and R, depending on sample size	A value outside control limits based on average and range of previous samples taken in a time sequence and assuming an underlying normal distribution	Special tables[10,11] for D_3, D_4, and A_2 to calculate 3σ control limits depending on sample size	Monthly averages and ranges of 24-h samples
Chauvenet's criterion[9]	$C = \frac{(X_n - \bar{X})}{S}$	X_n = largest value in a set of n samples, S = standard deviation, i.e., $S = \left[\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}\right]^{1/2}$ $\bar{X}$ = average of n samples, $\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$	A value too large compared to the sample average, underlying distribution is normal and that a mistake occurs on the average once in 2n samples	Special tables with α-levels for two-tailed tests given as 1/2n, and 1/4n for 1-tailed tests	1-h values on a daily basis; not recommended for n<4 for a 1-tailed test

(continued)

TABLE 3 (continued)

Test name	Test criterion	Definition of terms	Basis for test	Critical values	Recommended application
Coefficient of skewness[10]	$B = \frac{\sum_{i=1}^{n} (X_i-\bar{X})^3}{\left[\sum_{i=1}^{n} (X_i-\bar{X})^2\right]^{3/2}}$	X_j = value of the jth sample. n = total number of samples	"Tail effect" of an unknown number of observations; underlying distribution is normal	Special tables[10] for 0.05 & 0.01 points of the distribution of B assuming normality	1-h values on a daily basis; may be applied sequentially to several outliers
Studentized t-test[9]	$T_n = \frac{(X_n - \bar{X})}{S}$	X_n = largest value in a group samples. $\bar{X}$ = average. S = standard deviation, estimated from prior or concurrent samples (i.e. independent of the numerator	A value too large compared to the mean, relative to the standard deviation; underlying normal distribution	Special tables[9] of percentage points of critical values $t_\alpha(n,v)$	1-h values on a daily basis
Studentized range[9]	$W = X_n - X_1$	X_n = maximum value in a set of n samples. X_1 = minimum value. W = range of a set of n samples	Extreme values too far apart; underlying distribution is normal	Special tables[9] for relative range distribution percentage points; an independent estimate of the standard deviation is required	1-h values on a daily basis
Sequential difference[3]	1-h: $D_i = X_i - X_{i-1}$ 24-h: $D_i = X_i - X_{i-24}$	X_i = ith sample where i refers to the hour. X_{i-1} = sample taken in the hour preceding i. X_{i-24} = sample taken on the previous day corresponding to the ith hour of the present day	A value in a time series being significantly larger than the previous hour's sample under assumption of normality. A value in a time series being larger than the previous day's sample during the same hour under assumption of normality	3σ limits based on previous data & assumption of normality	1-h values 24-h values

(continued)

TABLE 3 (continued)

Test name	Test criterion	Definition of terms	Basis for test	Critical values	Recommended application
Grubbs test[7,8]	$L_2 = \frac{SS_{n-1,n}}{SS}$	$SS_{n-1,n}$ = sum of squares corrected for the avg of the samples where the two highest values have been excluded, SS_n = sum of squares corrected for the avg and excluding the highest value, SS = sum of squares corrected for the avg excluding no values	One or more values too large compared to the avg; normal distribution	Special tables[7,8] for L_1 and L_2 percentage points; F-tables may be used if mean squares are used in place of sums of squares	1-h values on a daily basis; multiple outliers in a univariate case; better than sequential application of other tests in preventing the "masking effect"; NOTE: Tietjen & Moore[8] expand tables to cover more than two outliers at a time
Gap test[2]	$p = e^{-n\lambda k}$	k = length of a gap in a frequency distribution to the right of which n values lie, λ = parameter of the exponential distribution based on the 50th and 95th percentile of each data set, p = probability that n values will lie to the right of a gap of length k	One or more values lying to the right of a gap too large compared to the other observations; assuming independent samples from an exponential distribution	Special software; identifies gaps with probabilities of less than 0.01 of having values greater than the gap	1-h values for any length of time; multiple outliers in a univariate case; NOTE: Another gap test not currently being routinely used was developed by Tietjen & Moore[8]; this test is based on Grubbs type statistics where the largest gap to the right of the mean is first identified & the number of observations above the gap are tested

4. AREA OF COVERAGE AND REPRESENTATIVENESS

4.1 BACKGROUND

Over the decade of the 1970's the number of ambient air pollutant monitors increased dramatically from approximately 1800 in 1970 to approximately 8000 in 1979.[1] The lack of uniform criteria for station locations, probe siting, sampling methodology, quality assurance practices, and data handling procedures resulted in data of unknown quality. In preparing "national" air quality trends data bases for the major pollutants, the number of monitoring sites changed constantly, reflecting the growth in State monitoring networks during this period. A conglomeration of different types of sites--rural, industrial, residential, commercial, etc--evolved with no national plan. Some urban areas of the country had extensive monitoring while others did not.

In October 1975, at the request of the Deputy Administrator of EPA, a Standing Air Monitoring Work Group (SAMWG) was established. The Work Group was to critically review and evaluate current air monitoring activities and to develop air monitoring strategies which would be more cost effective, would help to correct identified problems, would improve overall current operations, and would adequately meet projected air monitoring goals. Members of the Work Group represent State and local air pollution control agencies and EPA program and regional offices.

SAMWG's review indicated that the current ambient monitoring program is basically effective in providing information for support of State Implementation Plan (SIP) activities. Several areas were identified where deficiencies existed, however. The principal areas where corrections are needed are summarized below.

1. Lack of uniformity in station location and probe siting, sampling methodology, quality assurance practices, and data handling procedures have resulted in data of unknown quality.

2. Existing regulations coupled with resource constraints do not allow State and local agencies sufficient flexibility to conduct special purpose monitoring studies.

3. Resource constraints and the diversity of data needs frequently result in untimely or incomplete reporting of air quality data. Adequate air quality data for national problem assessments and routine trend analyses are in some cases not available to agency headquarters until 12-18 months after each calendar quarter.

4. In some cases, data are being reported to the EPA central data bank from more stations than are absolutely necessary for adequate assessment of national control programs and analysis of pollutant trends.

The recommendations of SAMWG later became the basis for the Federal monitoring regulations promulgated on May 10, 1979.[2] These regulations require EPA to:

- set stringent requirements for a refined national monitoring network in areas with high population and pollutant concentrations to provide a sound data base for assessing national trends;
- give the States flexibility to use resources freed from SIP monitoring work to meet their own needs;
- establish uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States;
- establish a standard national pollutant reporting index and require its use for major metropolitan areas; and
- require the submission of precision and accuracy estimates with air quality data to enable better interpretation of data quality.

These regulations should produce a streamlined, high-quality, more cost-effective national air monitoring program.

The States are required to establish a network of stations to monitor pollutants for which National Ambient Air Quality Standards (NAAQS) have been established. Each network is to be designed so that stations are located in all areas where the State and the EPA Regional Office decide that monitoring is necessary. The stations in the network are termed State and Local Air Monitoring Stations (SLAMS).

Data summaries from the network are to be reported annually to EPA. Data from a subset of SLAMS to be designated as National Air Monitoring Stations (NAMS) are to be reported quarterly to EPA.

4.2 NETWORK DESCRIPTION

4.2.1 The SLAMS Network

The SLAMS network should be designed to meet a minimum of four objectives:

1. To determine the highest concentrations expected in each area covered by the network;

2. To determine representative concentrations in areas of high population density;

3. To determine the impact of ambient pollution levels from significant sources or source categories; and

4. To determine background concentrations.

Each monitoring site is required to be identified by location and type of surroundings as well as by monitoring objective and spatial scale of representativeness. The spatial scale of representativeness is described in terms of the physical dimensions of the air parcel sampled by the monitoring station throughout which actual pollutant concentrations are reasonably similar; the scale adjectives are micro, middle, neighborhood, urban, regional, national, and global.

4.2.2 The NAMS Network

The NAMS stations are selected from the SLAMS network to emphasize urban and multisource areas. The primary objective for NAMS is to monitor areas where pollutant levels and population exposure are expected to be highest, consistent with the averaging time of the NAAQS. Accordingly, NAMS fall into two categories:

1. Stations in area(s) of expected maximum concentrations; and

2. Stations with poor air quality and high population density but not necessarily in area(s) of expected maximum concentrations.

For each urban area where NAMS are required, both categories of stations must be established. If only one NAMS is needed to monitor suspended particulates (TSP) and sulfur dioxide (SO_2), the first category must be used. The NAMS are expected to provide superior data for national policy analyses, for trends, and for reporting to the public on major metropolitan areas. Only continuous instruments will be used at NAMS to monitor gaseous pollutants.

Siting requirements and definitions vary with pollutant, but NAMS are required only in urban areas with populations of at least 50,000 where pollutant concentrations are known to exceed the secondary NAAQS. The number of urban areas monitored will vary with pollutant, as indicated below.

Pollutant	Urban areas	NAMS monitors
Total suspended particulates (TSP)	212	636
Sulfur dioxide (SO_2)	160	244
Carbon monoxide (CO)	77	121
Ozone (O_3)	85	208
Nitrogen dioxide (NO_2)	33	65

The NAMS network is being selected on the basis of experience with past monitoring data and primarily attempts to measure the highest pollutant levels associated with each urban area. The word "associated" indicates that, with transport-effected pollutants such as O_3 or TSP, the highest levels may occur in areas of low population densities. The location selection should be periodically reviewed, based on historical monitoring data, meteorological conditions, and changes in emission patterns. For example, there is definite evidence that the highest O_3 levels in the Los Angeles basin have been moving upwind in the last few years, probably because of the changing composition of tailpipe pollutants. Changing fuel usage and new construction may have also contributed to this shift.

4.3 REPRESENTATIVENESS

The question has often been asked as to what constitutes a "national" trend? In previous National Air Quality, Monitoring and Emission Trends Reports,[3,4,5] all sites with data available in the National Aeromatic Data Bank (NADB), that could meet an historical data completeness criteria, were selected for the national trend. In the case of total suspended particulate (TSP) as many as 3000 sites could meet an historical completeness criteria. These sites come from a variety of networks representing urban areas, rural areas, and large point sources. Geographical coverage was largely weighted by population; that is, the more populated areas generally had more monitoring sites. In analyzing the national trend each site was weighted equally.

In contrast to TSP, the automotive related pollutants--carbon monoxide (CO) and ozone (O_3)--had less than 250 trend sites meeting historical completeness criteria as late as 1977.[5] Although California had a disproportionate

number of these trend sites, each site was weighted equally in developing the national trend.

In each of the three cases, the sites used for analyzing the national trend represented a mixture of siting criteria. Consequently, it was difficult to determine what the resulting trend really represented.

The major difficulty in selecting sites that define a "national" trend is determining what mix of sites represents national air quality. How should geographic distribution be determined--by population or by land mass? What types of sites--center city, suburban, residential, commercial, industrial, rural, remote, etc.--should be in the national trend and what proportions are appropriate?

4.3.1 The NAMS Solution

A partial solution to this dilemma lies in the NAMS network. Part of the problem with a "national" trend is a semantic one--how is it defined? The NAMS can resolve this problem because they can be defined. For each of the criteria pollutants, NAMS are located in either the areas of expected maximum concentration or the areas of high population density. Consequently, the NAMS lend themselves to stratification into these two site populations. Additional siting information is available through the NAMS management information system, which will allow for the use of covariate data (such as traffic counts in the case of CO) for the first time.

The NAMS are particularly appropriate for characterizing national trends for urban sites located in areas of expected maximum concentration or high population density. For example, the CO NAMS located in areas of expected maximum concentration make up a clearly defined population and could serve as a good indicator of the success (or failure) of the automotive emission control program.

4.3.2 The SLAMS and Detailed Urban Area Analyses

While the NAMS can be used to define national urban trends in areas of expected maximums or high population density, the SLAMS can be used for detailed urban area analyses. If one is trying to determine changes in air quality in an urban area, then an examination of both spatial and temporal change is in order. The SLAMS networks lend themselves to these types of analyses. EPA has published several guidelines useful in determining spatial and temporal trends; they should be consulted before initiating these types of analyses.[6,7]

4.4 REFERENCES

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5. DATA COMPLETENESS AND HISTORICAL CONTINUITY

Data completeness for summary statistics and historical continuity for trend data are two concerns of the data analyst. In both cases, the quantity of data available affects the uncertainty of the analytical results. In current practice, criteria are invoked in the data screening steps to select minimally acceptable data sets. This section explores the effect of missing data on the uncertainty of analytical results, and discusses criteria for ensuring adequate data completeness and historical continuity.

5.1 DATA COMPLETENESS

5.1.1 Background and Purpose

The number of air quality values produced by ambient monitors is usually fewer than the maximum number possible. Missing values result from the intermittent sampling schedules for manual methods, instrument failure, downtime for calibration, or human error. The temporal balance and the sample size of the resultant data set can seriously affect the validity of the sample and the uncertainty of its summary statistics.

Published criteria have been used by EPA to establish the validity of data sets for summarizing and analyzing air quality data. Such criteria should minimize the uncertainty associated with air quality summary statistics. Unfortunately, for each pollutant the same completeness criteria are used for all summary statistics; despite the fact that the uncertainty associated with a summary statistic varies with the type of statistic and its variance properties.

In a sense, validity criteria provide a capability for identifying data produced by poorly operating instruments and for screening data samples that may otherwise yield misleading or incorrect estimates of air quality levels. Data requirements defined by the criteria should involve the type of summary statistic (e.g., annual mean or maximum daily average) as well as its intended application (e.g., trends analysis or status assessment with respect to the standard). In general, fewer data are needed to determine an annual average

than a short-term statistic, and fewer data per year are needed to estimate a long-term trend than a yearly status.

Currently, the NADB uses different validity criteria[1] for different time periods and sampling approaches, as shown in Table 4. The criteria for each sampling approach are intended to consider both the characteristics in the data collection and the primary objective of the monitoring; however, for specific applications there are inconsistencies in the criteria for different approaches. This section discusses only the criteria for summary statistics for periods of 3 to 12 months.

TABLE 4. NADB VALIDITY CRITERIA[1]

Continuous Sampling (1-h, 2-h, and 4-h data)
Quarterly statistics - 75% or 1642 hours
Annual statistics - 75% or 6570 hours
Intermittent Sampling (24-h data)
Quarterly statistics
Five samples per quarter
If 1 month has no values, at least two values in other months
Annual statistics - four valid quarters

5.1.2 Origin of NADB Criteria

Criteria for intermittent sampling were formulated on the basis of a bi-weekly sampling schedule which was used by the National Air Surveillance Network (NASN) up to 1972. Nehls and Akland recommended that more stringent criteria be applied when the sampling schedule is every 3rd or 6th day.[2]

For continuous sampling, the origin of the 75 percent criteria is not clear. Early Federal Air Quality Publications[3] used a 50 percent criterion to report summary statistics. Nehls and Akland suggested 75 percent completeness and a more structured basis for summary statistics, as shown in Table 5; these criteria require as few as 3402 hourly observations, or 39 percent of the possible hours.

TABLE 5. CONTINUOUS MEASUREMENT SUMMARY CRITERIA[2]

Time interval	Minimum requirement
3-h running average	3 consecutive hourly values
8-h running average	6 hourly values
24-h	18 hourly values
Monthly	21 daily averages
Quarterly	3 consecutive monthly averages
Yearly	9 monthly averages with at least 2 monthly averages per quarter

5.1.3 Characteristics of Air Quality Sampling

Intermittent 24-hour sampling generally follows a fixed systematic or pseudo-random schedule which is intended to provide representative coverage of a time period with only a fraction of the total possible observations. By design, data from intermittent sampling can provide good estimates of an annual mean, but may severely underestimate the peak values. Trying to improve the estimate of the peak observation by intensifying the sampling during periods of high pollution levels is known as episode monitoring. When these unscheduled episode data are combined with the scheduled data, bias can be introduced into summary statistics.

Early intermittent sampling for TSP and other pollutants by the NASN was biweekly on a modified random schedule which yielded 20 samples a year. Later the schedule was modified to ensure equal representation for each day of the week. After 1972, samples were collected every 12th day yielding a maximum of 30 to 31 samples a year. EPA's current recommended sampling schedule for TSP is once every 6 days. Most agencies seem to follow this schedule. Among 2882 sites with 1978 data that meet the NADB validity criteria, over 60 percent produced 40 to 60 samples, and less than 10 percent sample more often than 1 in 3 days.

Continuous hourly monitoring, by providing a more complete representation of air quality, should provide much better estimates of the true annual mean and short-term peak values. In reality, continuous monitoring is often incomplete, and can yield biased estimates of long-term behavior. Missing data often occur in blocks of consecutive days or weeks. Sometimes a pollutant such as O_3 is monitored during only part of the year; only seasonal statistics are appropriate in these cases.

TABLE 6. DATA COMPLETENESS FOR CONTINUOUS SO_2 MONITORING, 1973

Minimum quarterly completeness (%)	Number of sites: Annual completeness <75%	Number of sites: Annual completeness ≥75%	Number of sites: Total
25	41	--	41
26-32	11	--	11
33-49	40	4	44
50-66	14	18	32
67-74	2	10	12
75-100		84	84
Total	108	116	224

As an example of actual monitoring performance, data completeness for 1973 SO_2 data is presented in Table 6. Of 224 sites, only 116 reported 75 percent of the total hourly observations. According to the percentage of completeness for 1973, 56 of the 108 sites not meeting the 75 percent annual completeness criterion had at least one-third of the total observations in each calendar quarter.

5.1.4 Characteristics of Air Quality Data

Air quality data are known to exhibit temporal components generally in the form of diurnal, weekly, or seasonal cycles. The variances for each component may be different, thus an arbitrarily selected sample of the entire series may not yield unbiased, minimum variance statistical estimates if the sample does not represent each portion of each time component equally.

For example if a diurnal pattern always shows the highest concentrations between 0800-1200 hours, but the sampling does not include any observations during these hours, simple sample statistics will have a negative bias. A sample requires temporal balance to be representative.

With a seasonal pattern of nonuniformly distributed data, the more extreme the seasonal variation, the larger the potential bias. In addition, the larger the sampling imbalance across the seasons, the larger the potential bias. If a seasonal pattern shows one quarter with concentrations twice those of the other three quarters, the range of possible bias in a mean is 88 percent to 136 percent if one-tenth of the total observations are in a single quarter.

Temporal balance is essential only if simple unweighted statistics are used. Unbiased estimates can be obtained from unbalanced samples by using appropriate sample stratification and by applying weighting factors. This method is particularly effective in determining unbiased estimates for a given sample size when the variance components are different within sampling strata.

The problems of unbalanced samples were considered in the establishment of the original validity criteria for TSP and other 24-hour data. The recommendations of Nehls and Akland for continuous data also considered these problems. Unfortunately, the current criteria for intermittent sampling do not ensure balance when sampling more frequently than once in 2 weeks; more stringent criteria or weighting factors need to be considered. In addition, the current NADB criteria for continuous sampling may not ensure balance while requiring more observations than necessary. Fewer observations could provide better estimates if the sampling recommendations were adopted.[2]

5.1.5 Estimates of Air Quality

The variation in a statistical estimate of air quality depends on the temporal variation of the data, the size of the data sample, the temporal distribution of the sample within the year, and how the data are combined in developing the estimate.

Data completeness has varying impacts on different sample statistics. In general, the more data available, the better the estimate. For a given level of uncertainty, however, fewer observations will be needed to estimate a mean than, say, a maximum value. For data with cyclical components, temporally balanced samples with less data will yield better estimates than unbalanced samples with more data. With the use of weighted averages, more data will usually yield better estimates, even if they are not balanced.

Intermittent Data - Nehls and Akland investigated the accuracy of annual means estimated from systematic samples. Table 7 shows how accuracy degrades with decreasing sampling frequency based on particulate data collected almost continuously in Philadelphia over 9 years. As expected, the percent error increases with decreasing sampling frequency. For a given sampling frequency, the error for a quarterly mean is approximately twice that for the annual mean.

TABLE 7. ACCURACY OF PARTICULATE SAMPLING FREQUENCIES AND AVERAGING INTERVALS

Sampling frequency (k) days	Percent error compared to daily sampling		
	Yearly	Quarterly	Monthly
2	1.4	2.3	3.9
3	1.7	3.2	6.5
4	2.3	4.6	8.7
5	2.7	6.0	10.3
6	3.2	6.5	12.0
7	8.7	10.7	15.1
8	3.8	8.1	14.9
9	5.0	8.9	16.0

Empirical evidence of the effect of sample frequency on summary statistics is presented in Table 8, based on TSP data from 14 sites monitoring continuously for 3 years, 1976-78. Estimates of annual averages and annual maximums when sampling every other day, every 3rd day, every 6th day, and every 12th day are compared with the averages and maximums obtained from daily sampling. Errors of the estimates for the annual maximum are typically 4 to 6 times larger than the errors in the mean. Even sampling every other day, the sample maximum underestimates the annual maximum by 9 percent.

TABLE 8. DEVIATION OF OBSERVED ANNUAL MEAN AND MAXIMUM FROM TRUE VALUES AMONG 42 TSP SITES, 1976-78

Sampling frequency	Average percentage error, (%)	
	Mean	Maximum
1 in 12	7.1	30.1
1 in 6	4.1	22.0
1 in 3	2.1	13.6
1 in 2	1.9	8.9

Continuous Data - The variability of an annual mean derived from continuous data can be examined by assuming that the data consist of 1 or 2 months of complete data in each calendar quarter. This assumption corresponds to the extreme situations in which the quarterly completeness is 33 percent or 67 percent.

Variance of the annual mean $Var(\bar{x})$ based on complete months of data is expressed as

$$Var(\bar{x}) = \frac{\sigma^2}{4n} (1-f) = \frac{\sigma^2}{4} (\frac{1}{n} - \frac{1}{3}), \quad (1)$$

where f is the fraction of months sampled in each quarter ($f = n/3$ and $1-f$ is the finite population correction), n is the number of months in a quarter, and σ^2 is the variance among true monthly means within a quarter. For simplicity, the number of days in a month and the number of months sampled per quarter are assumed to be equal. To generalize this approach, this model could be constructed to consider subsamples of any number of discrete blocks of consecutive days within each calendar quarter.

The variance of an annual mean based on monthly data defined by Equation 1 depends on the variability among monthly means within a quarter and on the number of months sampled in a quarter. Thus, for 1 month of data per quarter, the standard deviation (SD) of the mean is 0.41 times the SD of monthly means. For 2 months of data per quarter, the SD of the mean is 0.2 times the SD of monthly means.

The model based on monthly data was evaluated by comparing the empirical distribution of annual means (based on 1 or 2 months of actual data) with the theoretical distribution defined by Equation 1. Complete SO_2 measurements observed at the NYC laboratory site during 1973 were used to generate all 81 possible subsamples and corresponding annual means. Using the average quarterly estimate of variance among months equal to $(21.4)^2$, the estimates of variance for the sample means using 1 month or 2 months of data per quarter are $(8.8)^2$ and $(4.4)^2$ respectively. Normal distributions corresponding to these variance estimates were compared to the histogram based on all 81 possible annual averages; there was good agreement, as indicated in Figure 1. This example demonstrates that data with one-third of the observations in each calendar quarter can produce reasonable sample estimates.

The analysis above assumes that the variance is the same in each sampling strata (quarter). If variances are different, the sampling period with the highest variability should have the best sampling representation.

5.1.6 Summary and Recommendations

Data completeness criteria for producing summary statistics are desirable to ensure representative estimates of air quality. Ideally, different criteria

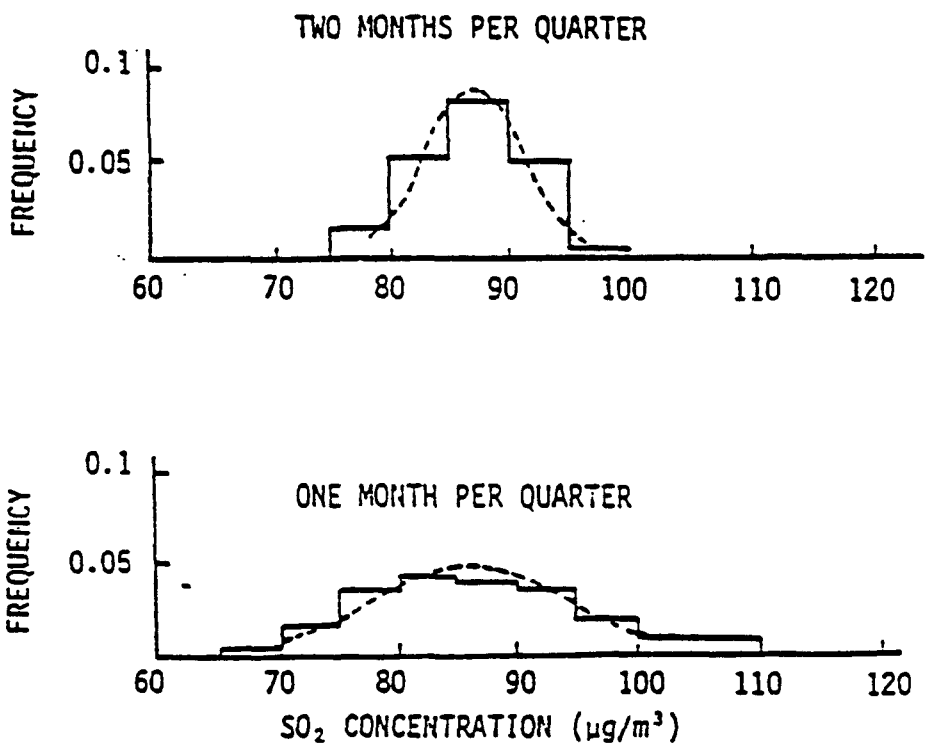

Figure 1. Empirical histograms of all possible annual averages based on one or two months of data per quarter compared with theoretical frequency distributions defined by statistical model for 1973 SO_2 at the New York City laboratory site.

should be used to screen data for different uses; however from a practical point of view, a single criterion specifying minimum data completeness for one statistic (e.g., a mean) will probably be used for all applications. The current NADB criteria for summarizing data need to be revised. The recommendations of Nehls and Akland appear reasonable for intermittent data; the existing criteria are reasonable as long as weighted statistics are used to correct for the potential sampling imbalance. Methods for specifying the required strata and numbers of observations should be resolved in future work.

5.2 HISTORICAL COMPLETENESS

5.2.1 Background and Purpose

Important to trend analysis is data base preparation. If one is analyzing the trend at only one monitoring site, all data from that monitor can be considered. When analyzing a group of monitors, a specific time frame represented by the group should be used, and the historical data completeness of each candidate monitoring site should be examined to determine suitability for trends analysis within the time frame.

Since air quality trend analysis focuses on year-to-year variation (as opposed to within-year variation), emphasis is usually on comparison of annual statistical indicators derived from complete or "valid" data sets. Thus, the number and temporal distributions of the annual statistical indicators are important; this characteristic is termed "historical completeness."

The data series should be as complete as possible, but missing values are permissible. Air quality monitoring does not always produce complete data records. Instrument failure and data processing problems are two of the many reasons for missing data. In many cases, emphasis is on compliance assessment rather than long-term monitoring. Historical completeness criteria are used during the data screening process to identify the largest possible data base from which a representative sample can be drawn for trend analysis.

5.2.2 Characteristics of Missing Data in Trend Analysis

The number of missing values permitted depends on the objective of the trend analysis, the trend technique, and the variance components of the data. In this context, variance components include error due to incomplete sampling, instrument error, meteorological fluctuations, and departures of the observed

trend from an assumed underlying pattern. The sensitivity of a trend technique improves with more data; thus the analyst desires the maximum amount of data at the largest number of sites. The sensitivity also depends on the variability of the trend. If, for example, a monotonic trend were to exist at a group of sites, a minimum of two observations selected at random from each site would be sufficient to categorize the trend. Similarly, if the analysis objective were to detect a long-term shift without the need to categorize the year-to-year pattern, a few widely spaced data points would be adequate. If, however, the temporal patterns were more complex or were masked by high data variability, more data would be needed to separate the trend from other variance components, and more complete temporal records would be needed to obtain an accurate year-by-year trend.

5.2.3 Historical Completeness Criteria

At a minimum, each site in the trend analysis must have two data points representing the time series. To ensure that these data points are widely spaced, the time period may be divided into two segments. For example, if the 6-year period 1972-77 were divided into 1972-74 and 1975-77, a site could be selected if it produced one valid year of data in the first and in the second time segments; this procedure ensures that data from the start and end of the time period are represented.

A data selection approach often used by EPA is based on the historical completeness of quarterly data. A criterion commonly used in the analysis of national trends is four consecutive calendar quarters with valid data in each of 2 time segments. Because the last one or two quarters of data can be missing from the most recent years due to late reporting, this approach can yield more current estimates than the approach based on complete annual data. In addition, using quarterly data to derive annual summary statistics minimizes the bias caused by within-year sampling imbalance (Section 5.1).

Using historical completeness criteria can increase the number of candidate monitors many fold, and thus help obtain a more geographically representative sample. Of the 4000 TSP monitors reporting data to the NADB between 1972 and 1977, 2661 met the aforementioned criteria based on valid annual data, and 2737 met the criteria based on valid quarterly data. The trend period was divided into two time segments--1972-74 and 1975-77. Using three 2-year time

segments and valid annual estimates, 1737 would qualify, but only 417 had valid annual data in each year between 1972 and 1977..

If a representative sample of stations with valid data for all years is available, additional sites with missing data may not be needed or may only be needed to improve the detectability of trends or to confirm the existence of trends by using a larger population.

5.2.4 Historical Completeness in Data Presentation

Historical completeness of data is particularly important for graphical presentations of trend results. Trend lines based on a group of monitoring stations are commonly used in air quality analysis. Such an aggregate trend line must be based on the same number of sites for each data point (e.g., year) to minimize bias caused by a changing data base; this requirement is satisfied by using every-year stations or by estimating all missing values. Estimating missing values is not necessary for trend assessment, but it is for data presentation.

In general, EPA characterizes the air quality trend in a defined geographic region using data for n years from m monitors. These data can be arranged in the matrix:

	Year 1	Year 2	. . .	Year n
Monitor 1	x_{11}	x_{12}	. . .	x_{1n}
Monitor 2	x_{21}	x_{22}	. . .	x_{2n}
. . .	. . .	. . .	x_{ij}	. . .
Monitor m	x_{m1}	x_{m2}	. . .	x_{mn}

where value x_{ij} occurs at monitor i in year j. The presentation of trends requires an average regional value of x for each year. If the matrix is complete, a reasonable estimate of the average value for year j is the arithmetic mean of each column,

$$\hat{\mu}_j = \frac{1}{m} \sum_{i=1}^{m} x_{ij}. \qquad (2)$$

However, this estimate may be biased if the matrix has missing values.

Two methods have proved useful in estimating yearly means when the data matrix is incomplete. In the one method, missing values are estimated by linear interpolation before the column means are calculated. This method

produces reasonable estimates when the underlying trend is linear. The other method assumes each cell in the matrix can be characterized by a general linear model:

$$x_{ij} = \mu + M_i + Y_j + e_{ij} \qquad (3)$$

where

μ is a constant--the grand mean of all the responses which would be obtained if there were no errors;

M_i is a term peculiar to the ith monitor, and is independent of year;

Y_j is a term peculiar to the jth year, and is independent of monitor; and

e_{ij} denotes the experimental error associated with x_{ij}, and it is assumed to be a normal random variable with standard deviation σ_e.

Computer programs can be used to generate least squares estimates of these parameters regardless of the number of missing values in the data matrix. Each yearly mean is estimated as

$$\hat{\mu}_j = \hat{\mu} + \hat{Y}_j. \qquad (4)$$

Statistical methods are available for determining confidence intervals for the yearly means and for the differences between yearly means.

One advantage of the generalized linear model is that it explicitly relates the number of missing yearly values to the uncertainty of the estimates of the yearly means. Working backwards through the model, the analyst can specify a desired confidence interval, calculate the number of permissible missing values, and adjust the data base accordingly.

5.2.5 Effect of Historical Completeness on Trends Analysis

The impact of missing data on trends analysis is empirically examined by sampling from a group of 30 SO_2 sites with 75 percent complete data each year of 1974-78. Theoretical 90 percent and 50 percent probability intervals based on sampling one-third of the annual means in each of the first 3 years and one-half in each of the last 2 years are shown in Figure 2. This method of sampling is analogous to selecting sites independently for each year, and the intervals show the distribution of means in each year.

The smallest variability is in the last 2 years because of the larger number of observations used to calculate those means. The distribution of means

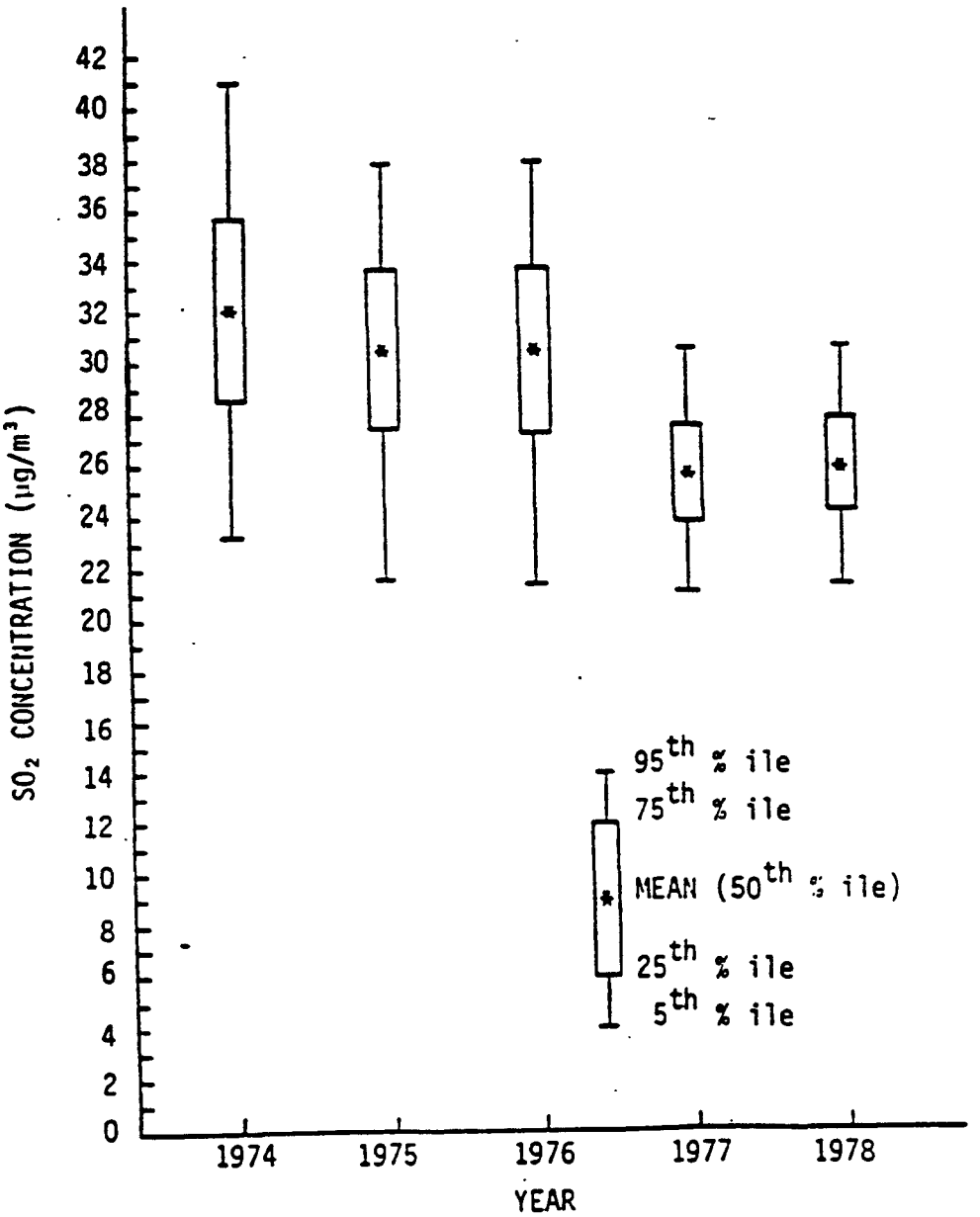

Figure 2. Theoretical probability distribution of annual mean - SO_2 with 10 sites in each year 1974-1976 and 15 sites in 1977 and 1978.

is sufficiently variable for a subsample of means to show an incorrect upward trend. The extremes occur when a site effect exists and when different sites are used at the start and end of the time period. The highest and lowest annual means from the aforementioned subsamples are shown in Table 9.

TABLE 9. ANNUAL MEANS

	1974	1975	1976	1977	1978
Lowest	14.5	21.4	11.3	12.9	14.5
Highest	56.9	56.8	58.7	35.5	37.3

The situation is less ominous if an additional constraint--that the same sites be used in the first 3 years and in the last 2 years--is imposed as a requirement for historical continuity.

Sampling from a finite population dictates that the distribution of means for each year of the first 3 years will be independent of the distribution of means for 1 of the last 2 years. If there is a site effect, other combinations will be dependent. The most extreme results will occur if the distribution of means in the first and last years are independent; for example, there is a 25 percent chance that the subsample-derived mean of the first year will be less than the true value and that the subsample-derived mean for the last year will be greater than the true value. The extreme value for the first year could be 14.5 and that for the last year could be 37.3, but values for the intermediate years would counterbalance the extremes at the end years because of the site effect. Example values for the three intermediate years are 33.7, 42.2, and 14.9, respectively. Thus, historical continuity minimizes the chances of an incorrect result, but this rare combination of missing values may still prevent the detection of the true downward trend.

5.2.6 Conclusions and Recommendations

Historical completeness criteria are useful screening tools for selecting sites for trend analysis. Historical data should be as complete as the environmental data base will permit in order to establish a representative sample which is large enough to detect trends. Trend analysis should keep track of the extent of the historical completeness, and should report separate findings accordingly. Techniques such as linear interpolation and the generalized linear model

should be applied to trend data with missing values to minimize bias due to site effects for the purpose of displaying graphical results.

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6. STATISTICAL INDICATORS AND TREND TECHNIQUES

This section attempts to answer two commonly asked questions: What is the air quality? How is it changing? Throughout the section, it is assumed that the principles and procedures of the previous sections have been followed; that is, the data sets have been screened for outliers and the sites have been examined to ensure representativeness. Separate subsections are devoted to each topic--statistical indicators and trend techniques, but a certain amount of interplay is involved between the two. For example, when a particular statistical indicator is used to summarize the data, a natural followup concern is how this indicator has changed over time.

6.1 STATISTICAL INDICATORS

The term "statistical indicator" is used in this section in a fairly general sense to include any statistic which summarizes air quality data for a particular time period. Technically, a statistic is a "summary value calculated from a sample of observations."[1] For some air quality applications, we may have not merely a sample but also the entire population; therefore, the computed value is not technically a statistic. For the purposes of this section, statistical indicator is used in either case.

This subsection discusses the background and purpose of statistical indicators for air quality, the types of indicators frequently used, what properties are desirable, and the relative merits of various indicators as well as future needs.

6.1.1 Background and Purpose

A continuous air quality monitor can produce a pollutant measurement for each hour of the day every day of the year. This means as many as 8760 concentration values for a single pollutant at a single site. The volume of data is further increased by the number of pollutants measured at a site and by the number of sites within an area. Such a quantity of data requires some type of data reduction to conveniently summarize the data. A wide variety of summary

statistics could be used. The proper choice depends on the intended purpose of the information and on an awareness of the characteristics of the data.

While many specific purposes could be listed for air quality statistical indicators, for most practical applications there are basically two: (1) indicating status with respect to standards and (2) evaluating trends. An air quality standard is an absolute frame of reference for an indicator. If an air quality statistic is not compared to a standard, it is usually compared to a value from some other time period under the general heading of trend analysis. A third purpose is using the statistic as a basis of comparison with data from other sites or cities; however, most remarks that apply to choosing an indicator for trend analysis also apply to these comparisons.

An important point in any discussion of statistical indicators is that many air quality standards are structured in terms of concentration limits not to be exceeded more than once a year. This places a premium on information in the upper tail of the distribution. Accordingly, the average and median values commonly used as summary statistics in many fields are often of little interest in air quality data analyses. In fact, only the extreme values may be of interest for comparisons with standards.

6.1.2 Types of Statistical Indicators

A wide variety of statistical indicators are being used in air quality data analyses. Some reflect standard statistical choices such as means or percentiles. The highest or second highest value or the number of times the level of the standard is exceeded is often used due to the importance of the higher concentration values in air quality management. For example, the 1-hour NAAQS for CO specifies a level of 9 ppm not to be exceeded more than once a year. Thus, the second highest hourly value or the number of hourly values greater than 9 ppm would equivalently indicate whether or not the site meets the standard.

Other statistical indicators represent a compromise between focusing on the peak concentrations and introducing more stability into the indicator. These indicators may use either upper percentiles or knowledge of typical pollutant patterns to construct a useful index for trends. Examples include the average of daily maximum O_3 measurements for the O_3 season or the number of times a level (other than the standard) is exceeded.

Although the previously discussed indicators are typically used to summarize data for one pollutant at one site, they can be adapted to accommodate data for one pollutant at several sites within an area. A further generalization is to incorporate data for several pollutants into a single index. To do this requires some method of normalizing the individual pollutant measurements so that there is some basis for scaling their relative contributions to the index value. The Pollutant Standards Index (PSI) is a method for doing this.[2,3]

An ideal indicator would incorporate both air quality data and population data to provide a measure of population exposure to various air pollution levels. Efforts have been made in developing such measures, but the degree of spatial and temporal resolution required for both data sets makes these beyond the current state of the art. However, simplifying assumptions may be introduced to obtain rough approximations for these types of measures.[4]

6.1.3 Desirable Properties

Certain properties are desirable for a statistical air quality indicator. Some properties are desirable on a purely intuitive basis; others involve technical or practical considerations.

Clarity - Because the purpose of an indicator is to convey information, there is an advantage in using an indicator that is easily understood. Although understanding is partially a function of the intended audience, simple data presentations should use more easily understood indicators than those appropriate for a detailed examination of alternative control strategies if the more detailed analysis requires a more complicated indicator. Clarity does not necessarily mean that the indicator is simple to compute. For example, the computations for evaluating the PSI require linear segmented functions, but the final result is relatively easy to comprehend.

Independence of Sample Size - Another desirable property, on an intuitive basis, is that the indicator be independent of sample size. For example, sampling TSP every 6th day commonly results in approximately 60 measurements a year. Sampling every day of the year may result in 365 (or 366) measurements. Use of the maximum value, the second maximum, or the number of times the standard level is exceeded creates a problem with different sample sizes. A site that samples once every 6th day has only a 1-in-6 chance of measuring the annual maximum; a site that samples every day obviously measures the maximum. Any indicator that does not account for varying sample sizes can be misleading.

Robustness - A property that should be mentioned is robustness--that is, the indicator is not unduly influenced by a few outliers. How desirable this property is for air quality data analysis depends on the type of study. In air pollution work, the higher concentrations are often the most important; therefore, the median concentration may be robust but irrelevant. If the purpose of the study is to examine trends resulting from an overall emission reduction, the robustness of the indicator may be desirable.

Precision and Accuracy - A statistical indicator can have all of the above properties and yet fail to adequately summarize the data. Therefore, precision and accuracy must be included as desirable properties. Accuracy implies that the indicator is unbiased; precision measures the variability of the estimate. A recent paper by Johnson[5] discusses these properties for certain air quality indicators.

Feasibility - A practical evaluation of potential indicators must consider the feasibility of implementing a particular choice. An indicator may be highly desirable but not feasible to implement due to the present state of the art or to lack of information in the air quality data bases. This does not mean that a promising indicator should be ignored because it is difficult to implement; such a situation can highlight where additional work is needed.

Relevance - After all of the above properties have been considered, the final test of an air quality indicator is its relevance to the purpose of the study. Does the indicator sufficiently characterize the data so that the results may be easily translated into a clear statement of the information in the air quality data?

6.1.4 Discussion of Candidate Indicators

Consideration of all possibilities is not practical when discussing candidate indicators. It is more convenient to delineate certain classes of indicators: peak values (highest and second highest measurements), mean values (arithmetic and geometric), percentiles, exceedance statistics, design value statistics, multisite indicators, multipollutant indicators, and seasonal indicators.

Peak Value Statistics - This class includes indicators such as the maximum and the second highest concentrations which have been used because they are consistent with the "once per year" type of air quality standard. These

are not independent of sample size. For less than everyday sampling, they have a negative bias because they underestimate the true value. Therefore it is difficult to recommend this class of statistics unless an adjustment is made for sample size. A possible alternative approach is the use of expected peak values estimated by fitting distributions to the data;[6] this approach yields statistics independent of sample size.

Mean Values - TSP, SO_2, and NO_2 have NAAQS's involving annual means (arithmetic for SO_2 and NO_2; geometric for TSP), so the use of an annual mean for these pollutants is fairly natural. For CO and O_3, the annual mean is not particularly useful for assessing status. Because the primary CO control strategy involves motor vehicle emission reductions, the annual mean may be adequate for trend analyses; nevertheless, changes in higher concentrations, should be examined. The typical diurnal and seasonal patterns for O_3 suggest that the annual mean is of little value.

Percentiles - Use of percentiles is one means of adjusting for differences in sample sizes and affording a degree of protection against a few extreme values. If higher concentrations are of interest, little will be gained by using lower or midrange percentiles. Upper percentiles are more useful; the 90th, 95th, and 99th percentiles provide an adequate range for trends analyses.

Exceedance Statistics - This class of statistics includes both the frequency and the relative frequency that an air quality level (NAAQS or other) was exceeded. This type of statistic is intuitively appealing, and is relatively easy to understand. If the level of the standard is used, the results relate directly to status assessment. Statistics involving the recorded number of exceedances (rather than the percentage of exceedances) depend on the sample size; with less than complete sampling, they underestimate the true value. As with peak value statistics, it would be advisable to use an adjustment to account for incomplete sampling. This type of correction was incorporated into EPA's recently revised O_3 standard.[7,8]

A change from one to two exceedances does not mean that the air quality has become 100 percent worse. Caution is needed in interpreting this type of statistic because it exaggerates percentage changes. Johnson[5] considered the relative precision of exceedances and the 90th percentile for O_3 data, and concluded that the 90th percentile was more desirable for trend analyses.

Design Value Statistics - For a site that fails to meet a standard, the design value is the concentration that must be reduced to the level of the standard for site compliance. Design values computed for sites that meet the standard would be less than or equal to the standard. The design value is a convenient summary statistic, but it is not easy to compute because it may involve factors other than the actual air quality concentrations.[8] Although informative, these statistics are difficult to recommend for general use because of the complexities of their estimations.

Multisite Indicators - An indicator that combines data from several sites (e.g., PSI) can be useful. A recent paper by Cox and Clark[9] suggests areawide indicators for examining trends for regional-scale pollutants such as O_3. A potential problem with multisite indicators is that data from cleaner sites can mask higher concentrations at other sites. The seriousness of this problem depends on the purpose of the study.

Multipollutant Indicators - An indicator that combines data for several pollutants should scale the measurements so that the contribution of each pollutant is appropriate. The PSI was developed for this purpose, and is recommended as the standard indicator for these types of applications.[2,3] It provides a convenient air quality indicator for daily reporting. A multipollutant indicator is not recommended for characterizing trends because of the difficulty of interpreting the results; for example, improvement in one pollutant may mask degradation in another. The logical step in interpreting the results is to examine trends for each pollutant.

6.1.5 Conclusions

When the purpose of the analysis is to compare standards, an indicator that relates directly to the standard is needed. For pollutants with annual mean standards, the annual mean also suffices for trend analyses. For pollutants with only peak value standards, peak value and exceedance statistics are acceptable for trends if adjusted for sample size; upper percentiles (90th, 95th, and 99th) should also be considered. For pollutants (e.g., O_3) with clear seasonal peaks, statistics based on data for only the peak season are acceptable. In all cases, the data should be summarized for an averaging time that corresponds to the averaging time of the standard.

Multisite indicators may warrant further study, particularly for areawide pollutants. In national trend assessments, data are available for hundreds of

sites; but because many subsets of these sites are correlated, interpretation of the results is complicated. Multisite indicators could be used to aggregate the data for appropriate subregions as an intermediate step in evaluating trends.

Another area that warrants further attention is the development of population exposure indicators. Such indicators could provide not only a useful technical tool but also an effective means of conveying information to the general public.

6.2 TREND TECHNIQUES

A question of interest is whether air quality has changed over time. The search for the answer results in a variety of analyses categorized as trend assessment. Air quality trends analyses can vary in complexity from a simple numerical comparison of statistics from two time periods to a detailed time-series analysis incorporating the effects of meteorology and emission control programs.

This subsection is a general discussion of trend techniques for air quality data. More detailed information on certain techniques is contained in EPA's *Guidelines for the Evaluation of Air Quality Trends*.[10] Another useful report, *Methods for Classifying Changes in Environmental Conditions*, has recently been prepared in conjunction with the development of EPA's environmental profiles effort.[11]

6.2.1 Background and Purpose

Because of the general public's interest in air pollution, questions concerning air quality are fairly common. Air pollution summaries in units such as micrograms per cubic meter need a useful frame of reference to make the result more meaningful. The NAAQS's are one basis of comparison; another is how air quality values have changed over time, which is a convenient practical way to provide a perspective on what the numbers mean.

Both the general public and the technical community have a vested interest in air pollution control programs, and trends analyses are frequently used to evaluate the effectiveness of these programs. These analyses can be quite sophisticated. For example, ambient CO trends during the mid-1970's in New Jersey were the result of both the Federal Motor Vehicle Control Program (FMVCP) and an Inspection/Maintenance (I/M) Program instituted by the State; this result was further complicated by the residual impact of the gasoline shortage in 1974-75.

These factors, in addition to the possible influence of varying meteorology, rapidly escalated the level of detail needed in an analysis--not only with respect to the trend techniques used but also with respect to the types of data needed.

Another consideration in air quality trends analyses is the scope of the study. The study may involve data from a single site, or it may involve a national data sample from hundreds or thousands of sites. A technique that may be reasonable for an individual site may not be feasible for a more extensive data set.

6.2.2 Types of Trend Techniques

A wide variety of trend techniques have been used for air quality trends analyses. This section briefly discusses nonstatistical and statistical approaches.

Nonstatistical - The usefulness of graphs (discussed in more detail in Section 8) in any data analysis should not be underrated. At its simplest level, the purpose of a trend analysis is to determine what patterns are present in the data. Box-plots,[12] time-series plots, histograms, and so forth--all serve as convenient guides to the data analyst. In many cases, a careful choice of the proper graphical technique suffices to indicate trends (e.g. Whittaker Henderson,[13] Box-plots,[14,15] and two-way tables[16,17,18]).

A second nonstatistical approach is a simple numerical comparison between summary statistics for two time periods. This is sometimes modified so that trends are categorized as "no change" if the change fails to exceed some specified limit. This seemingly arbitrary cutoff may involve an underlying statistical rationale and an assumed variance component.

Statistical - The statistical technique may merely be a comparison of two annual means by using a standard t-test. When a sequence of data values is available, regression analysis may be used. This may be either parametric[19] or nonparametric.[14,15] Trends analysis using regression basically assumes a linear trend over time. In many practical situations, this assumption may not be reasonable, so alternative procedures (e.g., analysis of variance (ANOVA)) may provide a more flexible framework for indicating change. Because of the time dependencies in sequences of air pollution data, time-series models have been used for air quality trends analyses. Intervention analysis is one of the techniques used to examine control strategies.[20]

The above techniques apply to a single series of data points. For analyses of data from several sites, the results at each site may be summarized as either up or down, and then analyzed as a contingency table; this technique assumes that the sites are independent.

6.2.3 Desirable Properties

From a practical viewpoint, a desirable trend technique would be one which is intuitively easy to understand, feasible to implement, based on reasonable assumptions, and capable of providing results that are easily interpreted.

Intuitively Easy to Understand - People are more comfortable if the rationale for the analytical technique is intuitively understandable. A technique may always be implemented on a "black box" basis: the user submits the required input data, and the answer appears as the output. For the result to be useful, however, the user must be confident that the technique will work. This does not necessarily mean that the technique itself must be simple; it means that the underlying concepts must be easily explained. For example, an autoregressive, integrated, moving average model can be presented with a barrage of notations involving forward and backward difference operators. Yet, the need for a model that incorporates seasonal and diurnal patterns and dependencies from one hour to the next is more easily understood.

Feasible to Implement - It is a truism to state that the best trend technique available will be ignored unless it is feasible to implement. For air quality analyses, several considerations are involved in evaluating feasibility. Because there are limited data histories in many practical situations, the technique must be applicable to relatively short time periods (e.g., 2 to 5 years). For an analysis of data from a few sites, one may compute many types of summary statistics; for national analyses, choices must be limited to those readily available from NADB, which essentially limits the selection to certain standard quarterly or annual statistics. (Monthly statistics are not stored, and would have to be computed from raw data.) The number of sites involved also places practical constraints on the amount of computer time and analyst time available per site.

Based on Reasonable Assumptions - Every statistical procedure has an underlying model requiring that certain assumptions be satisfied. These assumptions should be met by the air quality data for a test to be useful; therefore,

the stipulations should be structured so that the air quality data can reasonably be expected to meet them.

Results Easily Interpreted - After the analysis is complete, the success of a technique depends on whether the results can be easily interpreted. This is one advantage of a statistical technique, as opposed to a nonstatistical technique, for assessing change. The probability assigned by the statistical procedure is an aid in interpreting the results; it also affects the type of statistical technique that should be used. For instance, if the annual rate of change is the variable of practical interest, a procedure such as regression should be used since this is the type of information it produces.

6.2.4 Discussion of Candidate Techniques

Important in any discussion of candidate trend techniques for air quality data is the interpretation of the final result. Because of the strong seasonality of certain pollutants (e.g., O_3), the question of interest often involves trends for a particular season. From a practical viewpoint, if the effectiveness of a control strategy is of concern, only the peak months of the year may be of interest. Because the NAAQS's are stated in terms of annual status assessments (with the exception of Pb, which is quarterly), analyses are often in terms of annual summary statistics. Use of an annual summary statistic reduces the number of data points available for the analysis; but if the trend in this summary statistic is the item of interest, the analysis should be structured around the statistic.

The remainder of this subsection briefly discusses broad classes of trend techniques, and indicates comparative strengths or weaknesses.

Graphical Procedures - Graphical presentations (discussed in more detail in Section 8) are included here to emphasize that they are a useful first step in any data analysis, not merely a final step for presentation purposes.

Numerical Comparisons - A simple comparison of summary statistics from two time periods is of minimal use in most cases because it provides no frame of reference for what is a normal change from one year to the next. Any underlying statistical rationale for categorizing changes as up, down, or as no change should be stated in the analysis. If the results of these comparisons are aggregated over many sites for a contingency table analysis, they are acceptable.

Statistical Comparisons - Statistical comparisons may be made using either parametric or nonparametric techniques. A typical parametric technique

would be a t-test to compare 2 years of data, although the presence of seasonality may artificially inflate the error term and reduce the sensitivity of the test. Nonparametric tests may be used to avoid the assumptions that the errors are normally distributed. The Wilcoxon signed-rank test allows for seasonality, and is therefore a useful nonparametric technique. Aligned-rank tests have been suggested for assessing changes in environmental data;[11] however, experience with these tests for ambient air quality trends is limited at this time.

Regression - Both parametric and nonparametric regressions provide an estimate of the rate of change as well as a statistical significance test. In assessing air quality trends, the rate of change is often important because it relates directly to the effectiveness of a control strategy rather than simply stating whether an increase or decrease has occurred. Because of seasonal patterns in the data, regression is normally applied to an annual statistic or a summary statistic for the peak season; this is a disadvantage since only one value a year is used. Regression also tests for a linear trend, which is useful either when the user is interested in a linear trend or in a relative measure of net change over the time period; but if a finer resolution of the pattern is desired, regression may not be adequate.

Analysis of Variance - The general class of analysis of variance (ANOVA) models offers considerable flexibility for trends analysis. The user can introduce month, season, and year terms into the model if a single site is being examined. For an areawide analysis, a site-effect term can be added as well as interactions and even covariates. ANOVA is not restricted to linear trend assumptions, and multiple comparison tests are available to test for significant differences among effects of interest.

Time-Series Analysis - A basic assumption in many statistical techniques is that successive measurements are independent--that is, the value of a particular measurement does not depend on past measurements. In view of the diurnal and seasonal patterns often present in air quality data, one may use time-series techniques for these problems. Applications of time-series techniques for air quality analyses have used Box-Jenkins techniques,[20] Fourier analysis,[21] and polynomials to remove the seasonal components.[22] Intervention analysis techniques seem appropriate for examining control strategies and other types of intervention.[20] While these techniques have the advantage of producing more information, they are also more difficult to apply; consequently, it

is difficult to recommend them for routine large-scale analyses.

6.2.5 Conclusions

At the present time, it does not seem feasible to recommend specific trend techniques. Since trends analyses are done for different purposes, the level of resolution required in the answer may vary from a simple up-down classification to an actual determination of the percentage improvement associated with a specific control strategy. However, it does seem advisable to encourage the use of statistical tests as an objective means of classifying trends.

Areas that warrant further examination include the intervention/time-series approach to see if the implementation of this type of analysis can be simplified so that its use can become more routine. Also, more experience is needed in applying the aligned-rank test to air quality data.

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7. INFERENCES AND CONCLUSIONS

This section focuses on the problem of identifying cause-and-effect relationships after a statistically significant trend or difference between data sets has been determined. Previous sections have discussed the problems of data completeness, historical trends criteria, precision and accuracy of data, screening data for outliers, siting and representativeness, statistics for analyzing air quality data, and trend techniques. Assuming that all of these problems can be resolved in a particular analysis, the problem of interpretation remains.

7.1 BACKGROUND

At the present time, most air quality data available for analysis are submitted to NADB. The major enhancement to this system is the current designation of NAMS--a refined national monitoring network in areas with large populations and high pollutant concentrations. Each NAMS will meet uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States.[1] Precision and accuracy data will be available with the air quality data for the first time.

Though the enhancements achieved through the monitoring regulations will provide a much sounder national air quality data base for decisionmakers, the data are still seriously deficient in determining cause-and-effect relationships between air quality, emission changes, meteorology, and the impact of unanticipated events such as fuel shortages. Explaining the causes of air quality changes is difficult without information to supplement basic air quality data. For example, what is the impact of a local, regional, or national gasoline shortage on ambient air pollution levels? What is the probable impact of fuel switching or tampering with automotive emission control devices on air quality levels?

A case in point is the recent controversy over O_3 trends in Los Angeles. A significant increase was observed in O_3 levels between 1977 and 1978. An

attempt was made by the South Coast Air Quality Management District[2] to determine how much of the increase was due to meteorology; they used a meteorological index developed by Zeldin;[3] stated that a significant increase in O_3 levels remained after they had adjusted the data for meteorology; and speculatively attributed it to the breakdown of catalytic control devices. What was needed was concomitant information on emission changes; independent estimates of fuel switching, tampering, and so forth; and more complete meteorological data.

The problem in making inferences and conclusions is largely the lack of supplemental information needed to interpret air quality data analysis and trends. This lack could be improved in two ways: (1) the data analyst could try to find concomitant information (e.g., weather data collected at airports by the National Oceanic and Atmospheric Administration), or (2) a long-term solution would be to apply the principles of experimental design and enhance the NAMS in two or more major urban areas with supplemental information on meteorology and emission changes. The first approach is discussed in the following section on case studies, and the second is discussed in the section on long-term solutions.

7.2 CASE STUDIES

Over the years, a number of attempts have been made to explain ambient air quality trends in terms of changes in emissions, meteorological conditions, or instrument measurement practices (e.g., changes in laboratory procedures or calibration). The approach can best be illustrated by examples, as in the following four case studies.

7.2.1 Comparison of SO_2 Trends and the %S Content Regulations in Distillate and Residual Fuel Oil in Bayonne, N.J.

The impact of regulations for controlling the sulfur content of fuels on ambient SO_2 levels was illustrated in Bayonne, N.J., by comparing ambient SO_2 levels with the effective dates of regulations limiting the sulfur content[4] (Figure 3). The EPA report[4] which presented the analysis stated that the improvement in SO_2 air quality at this site can be attributed primarily to regulations which became effective in New Jersey and New York during 1968-72. The trend at the Bayonne site is consistent with the national trend in SO_2 during this time period,[4] and is probably due to changes in the allowable sulfur content of fuel.

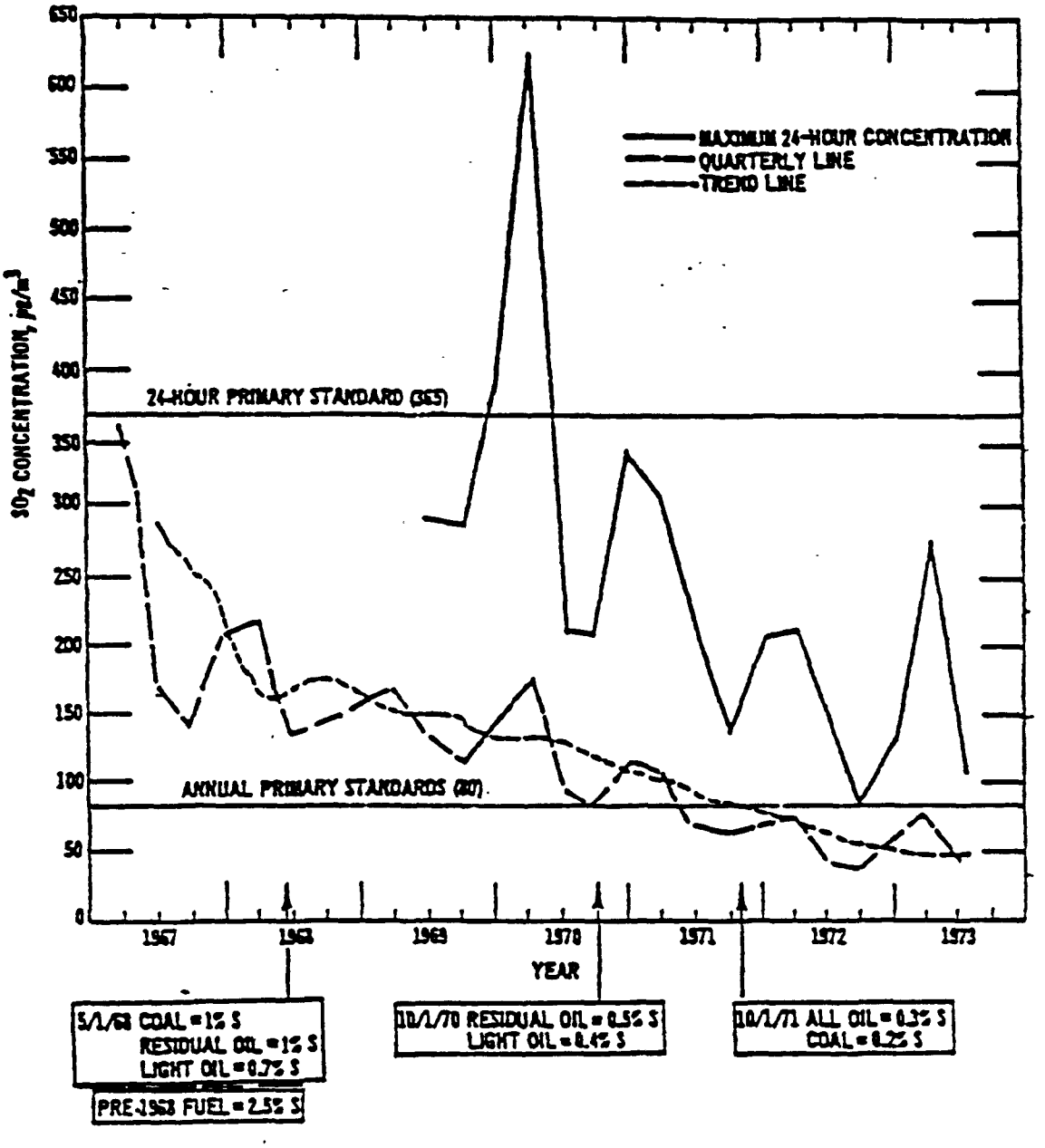

Figure 3. Comparison of SO_2 trends at Bayonne, N.J., with regulations governing % sulfur content in fuel.

The analysis could have been improved, and the conclusions strengthened if appropriate meteorological data had been available to be treated as a covariate. As it stands, however, the graphical presentation suggests a reasonable cause-and-effect relationship between the decreasing levels of SO_2 and the increasing restrictiveness of regulations limiting the sulfur content of fuel.

7.2.2 Impact of Gasoline Shortage on CO in Richmond, Va.

An analysis of CO data in Richmond, Va., illustrates the problem of interpreting ambient data. In 1974, an EPA analysis[5] was undertaken to evaluate the effect, if any, of the energy crisis on CO levels. The CO monitoring site in downtown Richmond was representative of the influence of commuter traffic patterns.

The period of time chosen for the analysis was the last 4 weeks (28 days) of January and the 4 weeks of February. This time period was expected to reflect the most severe period of the gasoline shortage and to minimize the potential anomalies in traffic patterns associated with the Thanksgiving, Christmas, and New Year's holidays. The windspeed data recorded at the R. E. Byrd International Airport served as an approximate indicator of the windspeed at the site. The data were presented as weekly averages to compensate for the differences in daily traffic patterns (Table 10).

TABLE 10. WEEKLY AVERAGE CO CONCENTRATIONS (ppm) AND WINDSPEEDS (mph) IN RICHMOND, VA, JANUARY 4-FEBRUARY 28, 1974

Week	Hourly average	Daily 8-h max.	6 to 9 a.m. and 4 to 7 p.m. average	Average daily windspeed
1/04-1/10	2.92	4.45	4.50	5.90
1/11-1/17	1.94	3.13	3.18	7.87
1/18-1/24	3.07	4.79	4.52	6.63
1/26-1/31	2.88	4.56	4.20	6.21
2/01-2/07	2.28	3.54	3.56	7.24
2/08-2/14	2.31	3.76	3.40	8.06
2/15-2/21	2.08	3.09	3.00	9.13
2/22-2/28	1.73	2.81	2.82	9.67

The CO data showed a downward trend during this 8-week period; however, the average windspeed increased during this period (Figure 4). The decline

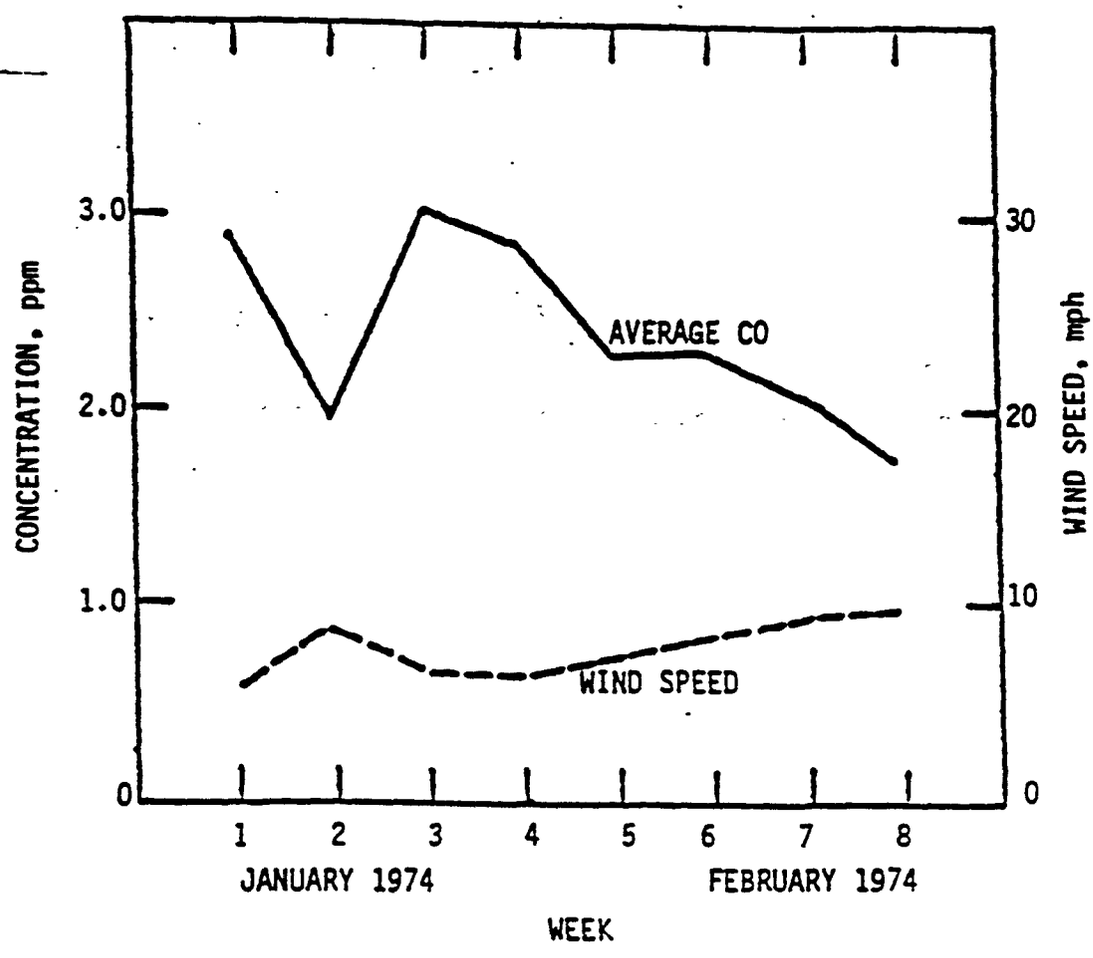

Figure 4. Weekly average CO and wind speed in Richmond, VA from January 4 to February 28, 1974.

in CO levels may, therefore, have been due to the increase in average windspeeds, which is indicative of greater dilution.

The interdependence was seen in the statistical analysis of the data. If the change in windspeed was ignored, four parameters--daily average, maximum 8-hour average, rush-hour average, and nonrush-hour average--showed statistically significant decreases, although the rush-hour decrease was less apparent in the averages. These findings were based on ANOVA. When windspeed was introduced into the analysis as a covariate, using analysis of covariance, none of the changes in the above parameters were significant. Therefore, although the data at this site indicated a decline in CO levels during this period, the associated increase in windspeeds made the cause of the decline difficult to assess.

Failure to detect significant trends after adjusting for windspeed is not entirely unexpected. The variability associated with CO measurements and the relatively brief duration of the gasoline shortage make it possible for the effect to go unnoticed, unless the monitoring site itself was in precisely the right location to detect changes due to alterations in traffic patterns.

This example illustrates one problem in trying to use data collected for one purpose for yet another purpose. The assumption that the windspeed at the airport reflects the windspeed at the downtown Richmond site may not be correct. Ideally, the windspeed should be measured at the CO monitor so the analyst could be more confident in interpreting the results.

7.2.3 Trends in CO in New Jersey

An analysis of CO data in New Jersey illustrates an attempt to relate statewide CO trends to gasoline consumption. Figure 5 was prepared by the N.J. Department of Environmental Protection to illustrate the progress made in reducing State CO levels from 1972 through 1976.[6] The dates for the initiation of the two phases of their inspection/maintenance (I/M) program are shown. New Jersey indicated that CO levels continued to improve despite an overall increase in gasoline consumption.

While progress in CO levels is clearly evident, the effectiveness of the New Jersey I/M program is confounded with the overall effectiveness of the CO emission reductions attributed to the Federal Motor Vehicle Control Program (FMVCP). Ideally, it would be desireable to separate the effects of the two control programs; this could be accomplished with a designed experiment. Concomitant meteorological data would be desirable to determine if changes in meteorology would aid in explaining the statewide CO trend.

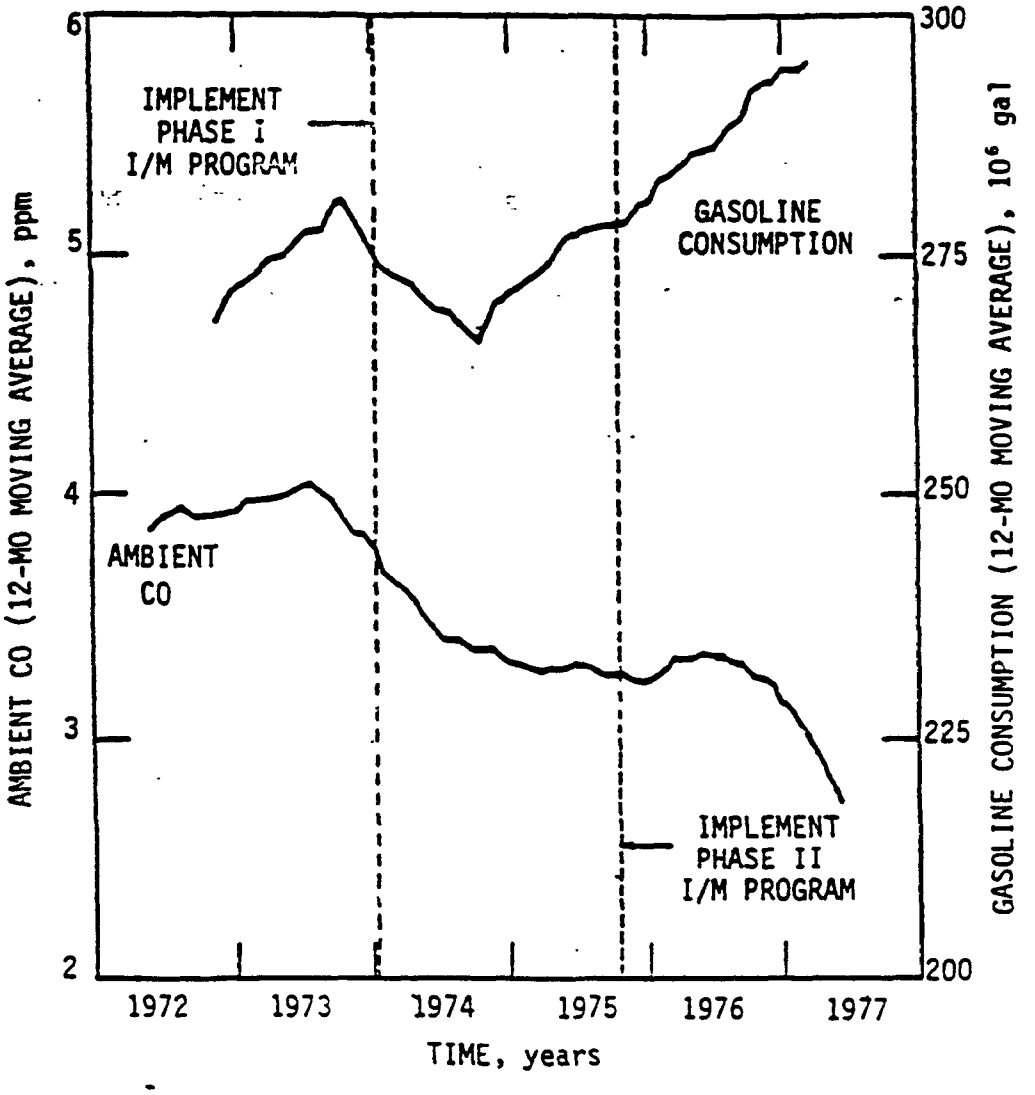

Figure 5. CO air quality from 18 monitoring sites and motor-vehicle gasoline consumption for N.J. from 1972 through 1976.

7.2.4 The Central Plains Drought

On February 24, 1977, the extremely dry soil conditions in the Central Plains and a strong frontal system resulted in dust being stirred up and transported east. Figure 6, a modified box-plot, shows peak TSP levels in Region VI (Central Plains) by quarter from 1972 through 1977; the dramatic increase in the first quarter of 1977 is obvious on this graph. Monitoring sites throughout Texas, Oklahoma, and Arkansas reported high TSP levels during this February duststorm. Several sites recorded daily values of more than 1000 $\mu g/m^3$; a single value of this magnitude would increase the annual geometric mean at a site by 10 percent.

In this example, the high TSP levels reported throughout Texas, Oklahoma, and Arkansas are substantiated by satellite pictures taken February 23-25, 1977 (Figure 7).

7.2.5 Conclusions and Recommendations

With the existing NAMS network, the best an analyst can do to facilitate the interpretation of air quality monitoring data is to seek other sources of information to help explain why an air quality trend has or has not taken place or why there is a significant difference between sets of data. The four case studies illustrate the importance of meteorology, emission changes resulting from control programs, and the impact of extraordinary events (e.g., the dustbowl of February 1977). A long-term solution is application of the principles of experimental design to the collection of air quality and appropriate concomitant meteorological data.[7] Such a solution is discussed in the following section.

7.3 LONG-TERM SOLUTIONS

One solution to the problem of trying to assess the effectiveness of EPA's control programs would be to select two or more urban areas and to collect concomitant information on a continuing basis to aid in answering both anticipated and unanticipated questions about effectiveness. The objective would be to determine cause-and-effect relationships between air quality and emissions after isolating the effects of meteorology; these relationships could be determined if data could be collected to estimate the impact of gasoline shortages, fuel switching, automobile control device tampering, contributions of various sources,

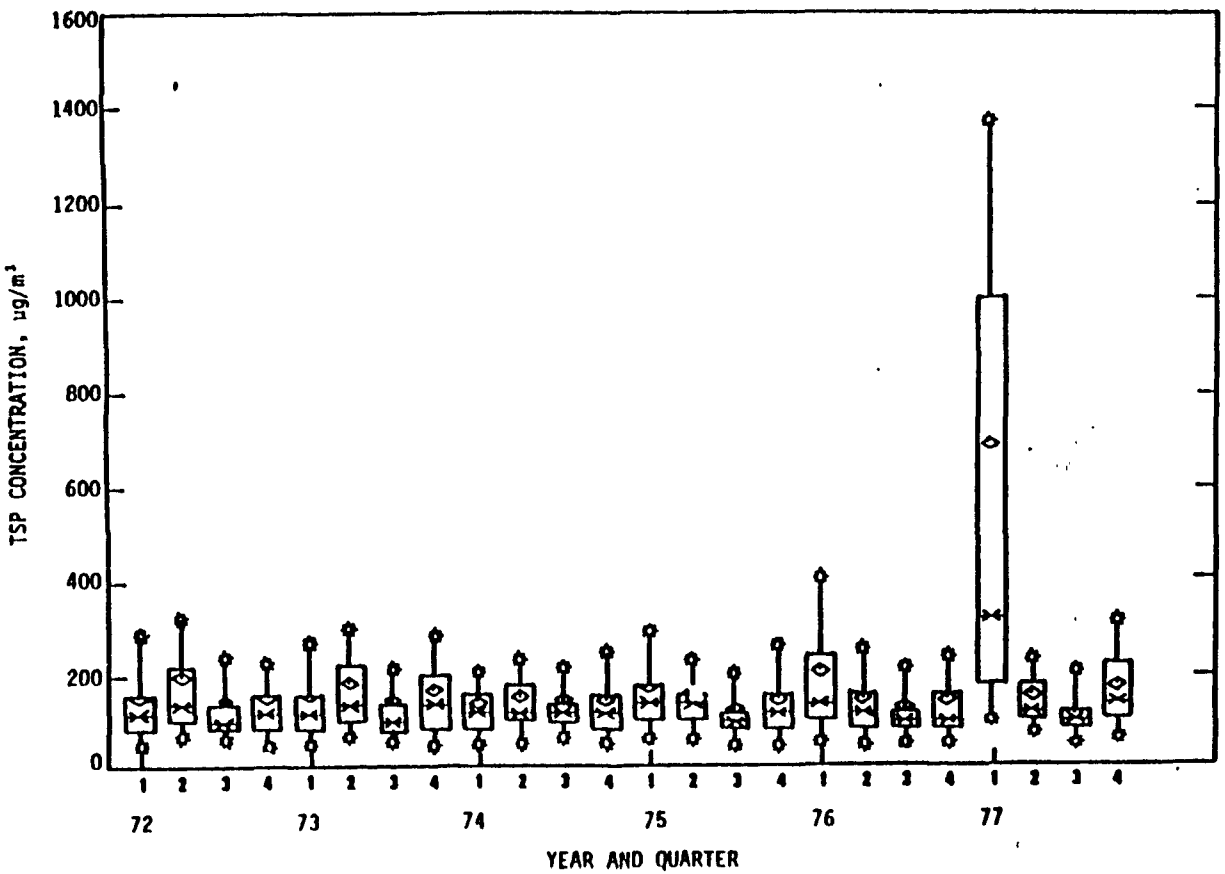

Figure 6. Quarterly TSP maximum values in Region VI from 1972 to 1977 illustrating the effect of the 1977 duststorm.

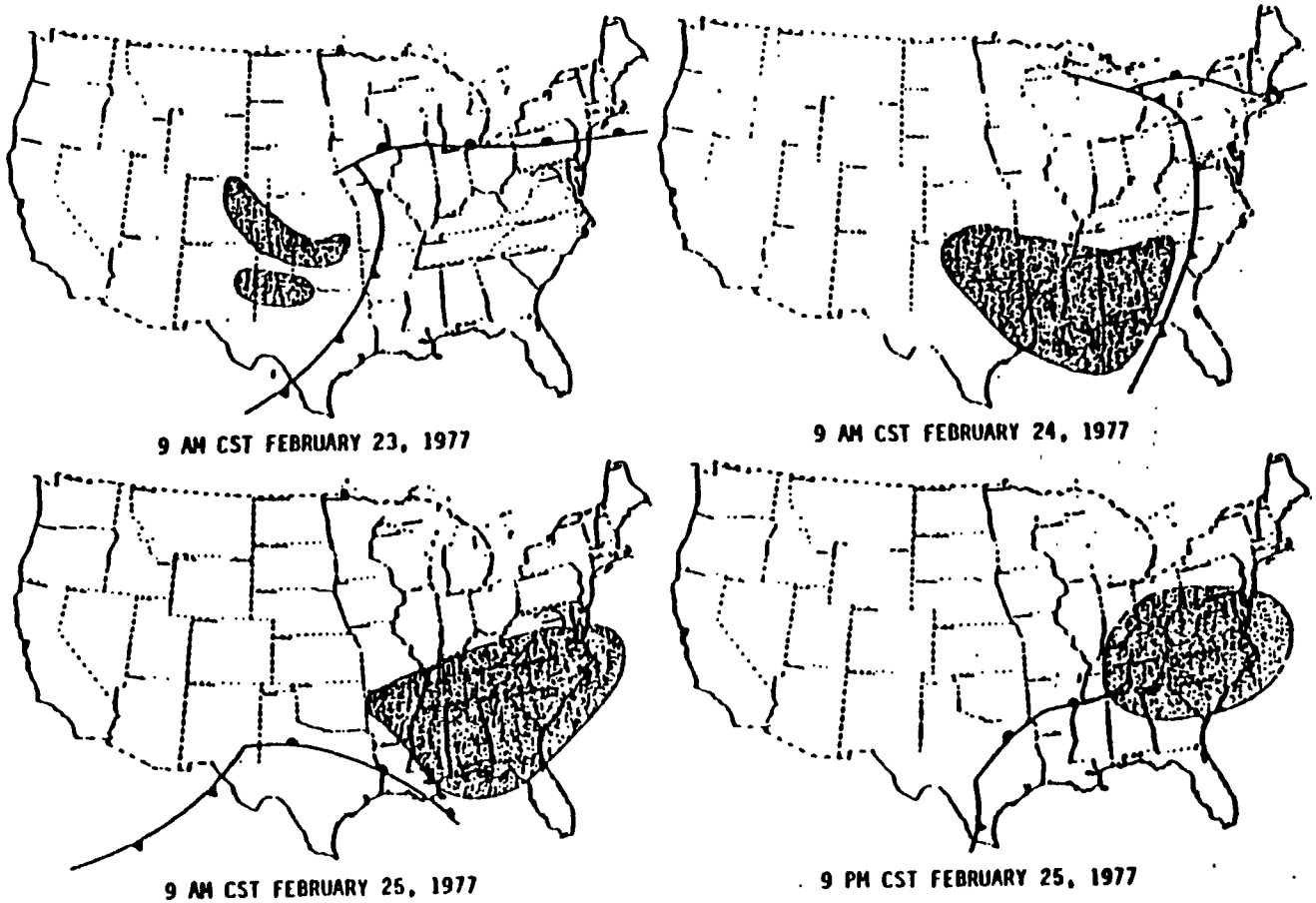

Figure 7. Satellite views of February 23-25, 1977, duststorm at succeeding time periods.

changes in instrument calibration, degree of human exposure, extent of fugitive dust, and so forth.

Air quality, monitoring, and emissions data would be collected according to an experimental design to test stated hypotheses. Each of the criteria pollutants--TSP, SO_2, CO, O_3, and NO_2--would be measured in the two or more urban areas along with IP and sulfates. Sources of emission changes to be considered in developing the experimental design include but are not limited to: (1) changing economic conditions; (2) increased or decreased refinery capacity; (3) fuel switching; and (4) growth patterns (e.g., the number of dry cleaning establishments).

At a minimum, experimental designs would use analysis of variance (ANOVA) and the analysis of covariance (COVA) to test hypotheses, and would use confidence intervals about means in question to display significant findings. Other appropriate statistical techniques would also be used to test hypotheses.

A contract has been let to explore this long-term solution in greater detail. The objective is to pose policy questions and then to determine what supplemental information would be needed to answer the questions in two or more urban areas. The associated costs are also to be determined. When the report on this contract is completed, its principal findings will be summarized and appended to this report.

7.4 REFERENCES

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6. New Jersey Department of Environmental Protection Annual Report: July 1, 1976-June 30, 1977. New Jersey Department of Environmental Protection, Trenton, N. J. (in preparation).

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8. DATA PRESENTATION

The purpose of this section is to review well-established data presentation techniques applicable to aerometric measurements and to provide guidance on selection of the forms most suitable to the scope of the problems to be analyzed. Selection is based on criteria such as audience applicability, spatial and temporal classification, and availability of computerized statistical and graphical resources. Therefore the discussion is focused on (1) the fundamental concepts to be displayed, (2) chart types, (3) input data forms, (4) statistical classifications, (5) audiences, (6) caveats/enhancements, and (7) available plotting resources. Finally, displays that meet these requirements are included.

8.1 CONCEPTS TO BE DISPLAYED

A simple but accurate presentation of statistical measures of large data bases or parametric relationships contributes greatly to the reader's understanding of the data. The most common displays of data on air quality and source emissions include (1) current status of the pollution problem, (2) statistical or descriptive trend, (3) impact of one or more parameters on another, (4) comparison of two or more groups or classes for a specific parameter, (5) relation of component parts to the whole, and (6) spatial and temporal patterns.

Statistical measures may be chosen not only from individual monitoring-site or emission point-source populations of averages, medians, percentiles, maximums or standards exceedances but also from aggregates (weighted or unweighted) of these sites on a city, county, region, state, national, or global scale.

Data presentation should be carefully planned. The charts or graphs, as well as the statistical displays, may be easily distorted (intentionally or unintentionally) by compression or expansion of scales, by nonuniform or broken gridding, by line and shading optical illusions, and by cluttered or complex information. The following subsection introduces the most frequently used displays.

8.2 CHART TYPES AND USES

8.2.1 Tabular Summaries

Summarizing data in tabular format is an important first step in data analysis. The validity and accuracy of the data should be certified before applying summary techniques. The tabular summary provides a permanent record of the individual data items which can be further analyzed in future research projects.

Aerometric examples of this form are NADB's monthly listings of hourly air quality values and yearly listings of intermittent (daily or composite) values. These data are also summarized by NADB in the yearly and quarterly frequency distribution listings. Similarly, point-source emissions data are submitted to NADB by the National Emissions Data System (NEDS).

Tabular summaries provide comparisons of several parameters categorized at one or more levels. Examples are listings of TSP, SO_2, and NO_2 by day of the year (Table 11), weekly TSP/maximum values at several monitoring sites (Table 12), and TSP monthly averages by site type (Table 13).

Finally, either certain qualitative measures may not be readily applicable to graphing or more information is provided in a smaller document. One example is a display of current attainment status and trends using a variety of symbols and colors, as shown in Figure 8.

Tabular listings or summaries should be limited in most cases to technical support documents. For regional or national publications, these summaries should be limited to comparisons of one or two parameters and about five classes or categories. Tedious or complex tables often contribute to the reader's confusion and misunderstanding; moreover, descriptions of statistical techniques used in producing these tables are often either left out or limited in the text discussion.

8.2.2 Point Charts

Point charts are used primarily to describe situations where scatter or clustering are important. Since these displays for large data bases would be almost impossible to draw manually, computerized techniques have been applied. Rapid display of data to detect outliers, parametric relationships, or data distribution is clearly a benefit to the statistician. Common uses are correlation or cluster analysis (Figures 9 and 10), plotting air quality concentrations by year (Figure 11), and comparison of air quality for several

TABLE 11. MULTIPLE PARAMETER LISTING, 1979, µg/m³

Yr/mo/day	TSP	SO_2	NO_2
79/01/01	125	35	45
79/01/02		43	52
79/01/04	86	50	
.	.		.
.	.		.
.	.		.
79/12/31	145	83	96

TABLE 12. WEEKLY TSP MAXIMUMS AT CITY SITES, 1979, µg/m³

Week beginning	Sites			City max	City avg
	4th & Market	6th & Vine	18th Jackson		
Jan 7	120	50	70	120	80
Jan 14	163	No sampling	99	163	131
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
Dec 29	103	52	63	103	73
1979 Max	236	99	136	236	187
1979 Avg	125	55	86	125	77

TABLE 13. REGION 5 MONTHLY AVERAGES BY SITE TYPE, 1979, µg/m³

Month	Commercial			Industrial			Residential			Remote		
	Sites	Obs	Avg	Sites	Obs	Avg	Sites	Obs	Avg	Sites	Obs	Avg
Jan												
Feb												
.												
.												
.												
Dec												
Total												

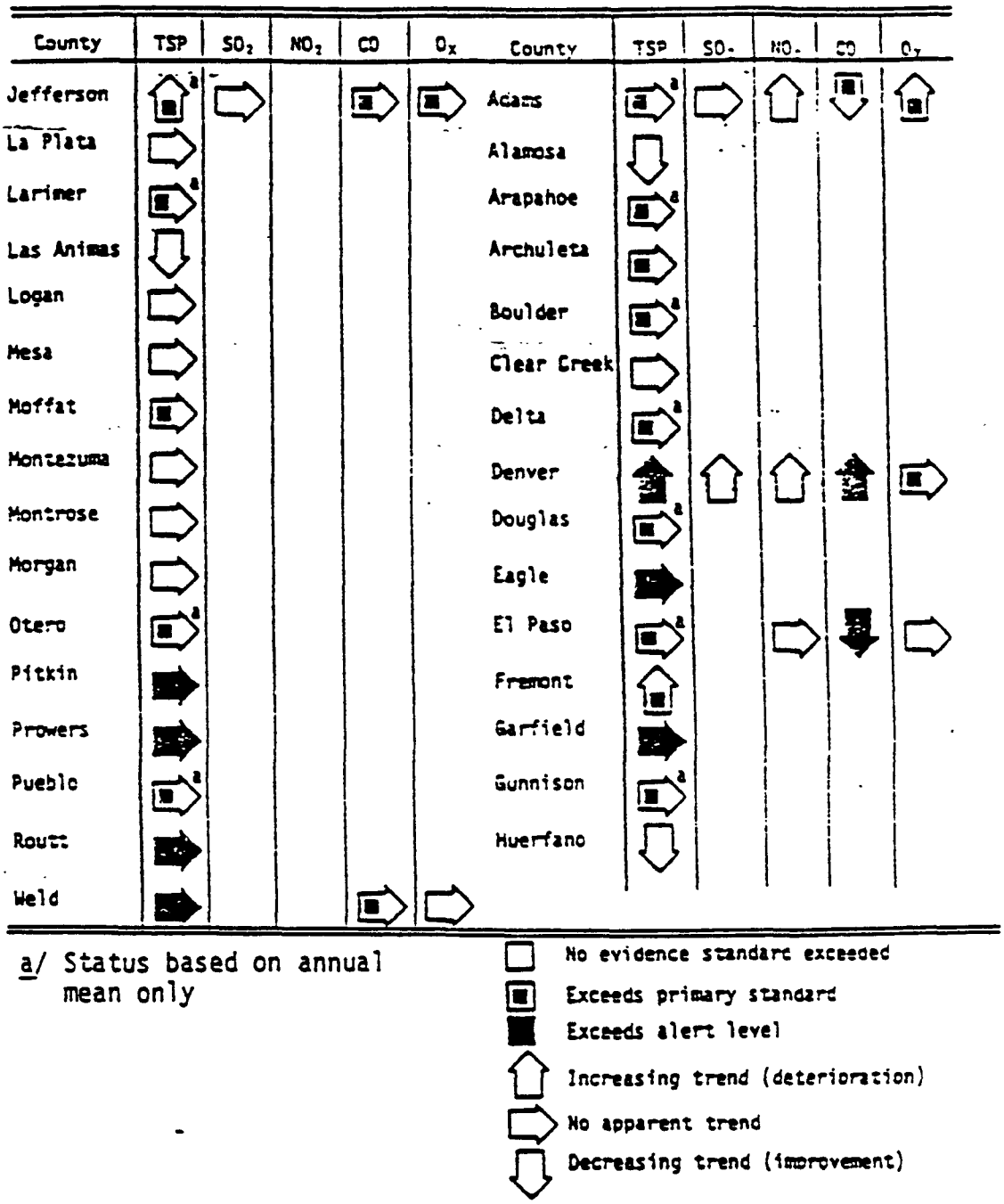


Figure 8. Status and trends in air quality in Colorado.

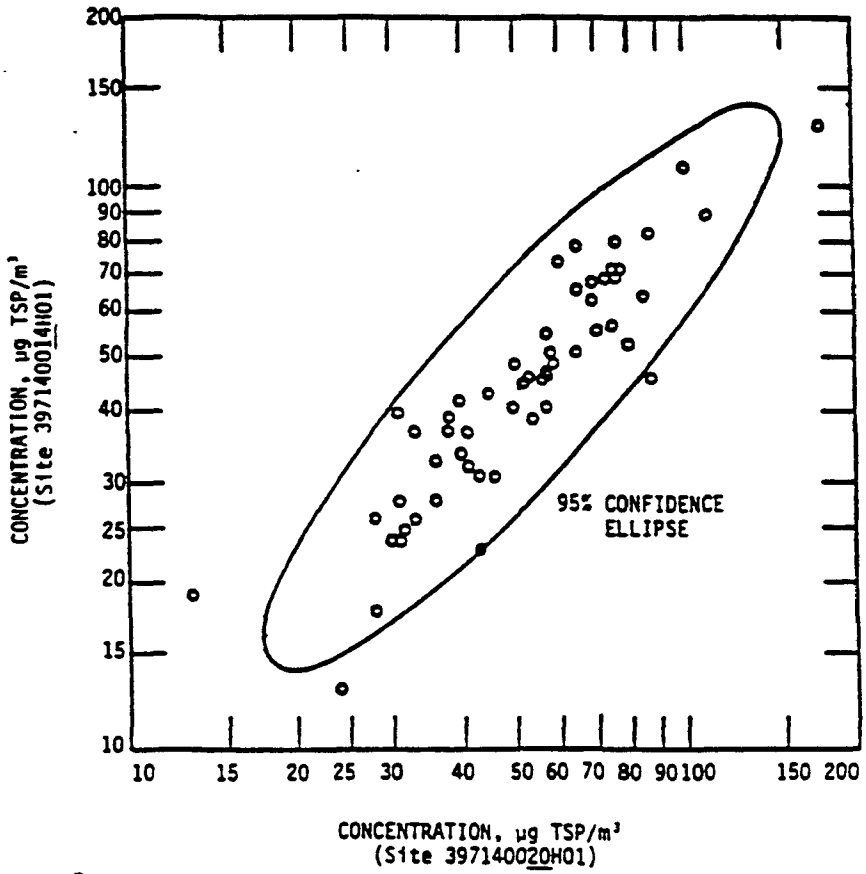


Figure 9. Intersite correlation test data.

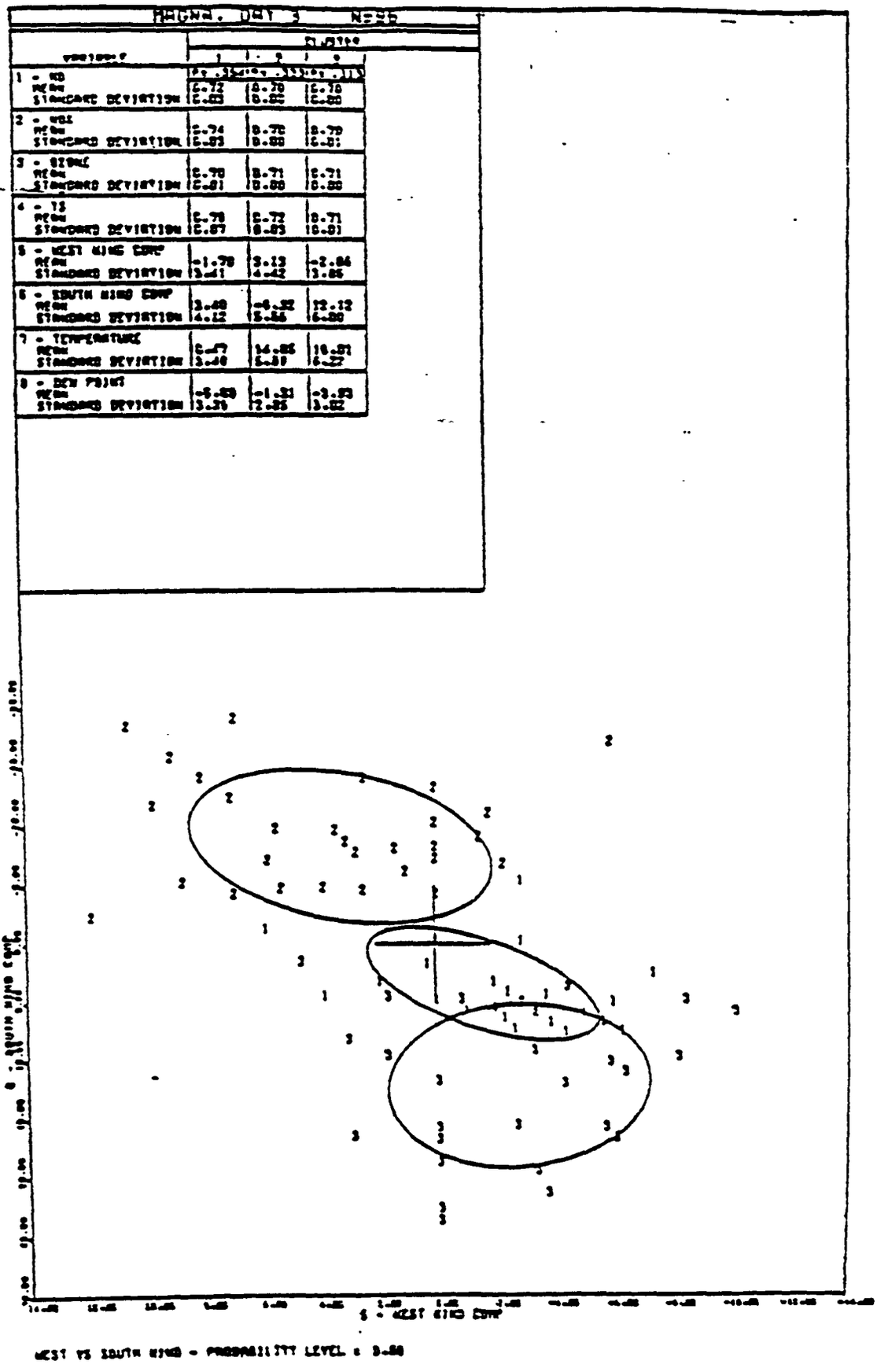


Figure 10. Magna, Utah, day 3, 0.50 probability ellipses of the west-east and south-north wind components for three cluster types. Winds from the west and south are positive.

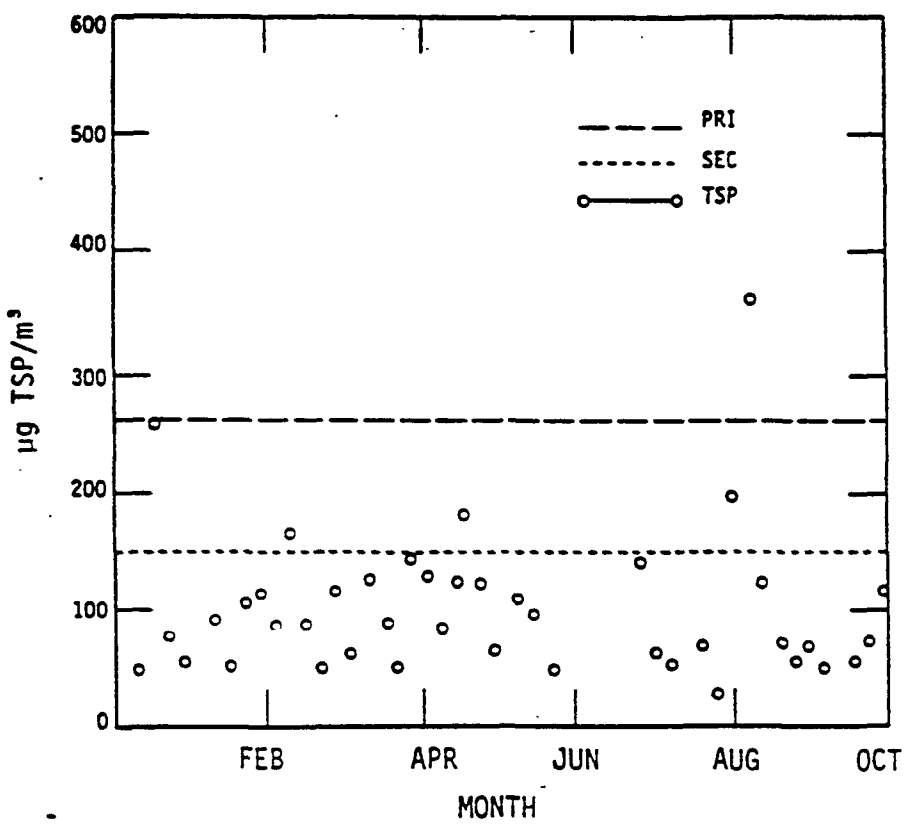


Figure 11. Twenty-four hour TSP values, 1972.

categories (Figure 12).

Point charts usually are accompanied by some "best-fitting" solid line to describe annual trend or diurnal or seasonal pattern. The integrity of the individual points is the foremost reason for displaying data in this way.

8.2.3 Line or Curve Charts

The line or curve chart is perhaps the most widely used method of presenting summarized data graphically. The chart is also the most easily constructed manually. The most common uses in displaying air quality or emissions data are:

1. Data coverage over a long time period (Figure 13).
2. Emphasis on movement rather than on actual amount (Figure 14).
3. Comparison of several series (same measurement unit) on same chart (Figure 15).
4. Trends in frequency distribution; e.g., population exposure (Figure 16).
5. Use of the multiple amount scale (Figure 17).
6. Estimates, forecasts, interpolation, or extrapolation (Figure 18).

8.2.4 Surface Charts

The simple surface or band chart depicts a single trendline with shading or crosshatching filling in the area between trend and base lines to enhance the picture of the trend. Thus, in this chart type:

1. The magnitude of the trend is emphasized,
2. A cumulative series of components of a total trend is depicted, and
3. Certain portions of the chart are accented for a specific purpose.

Figure 19 exemplifies classification of CO data by concentration level and by number of monitored days.

8.2.5 Column/Bar Charts

Column/bar charts are intuitively simple for most readers to follow since they accent discrete dates or categories with comparative heights of the columns/bars for one main statistic. The primary purpose is to depict numerical values of the same type over a given time period (i.e., multiple years), as shown in Figure 20. Other uses are:

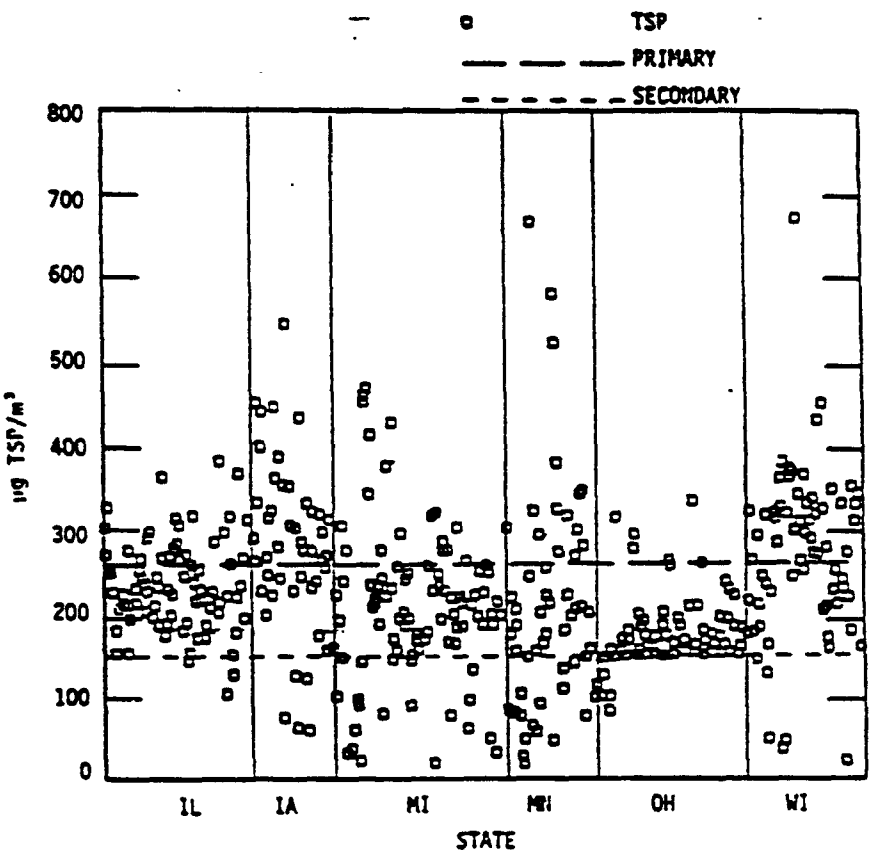


Figure 12. Air quality data, 24-h TSP concentration values, October 15, 1976.

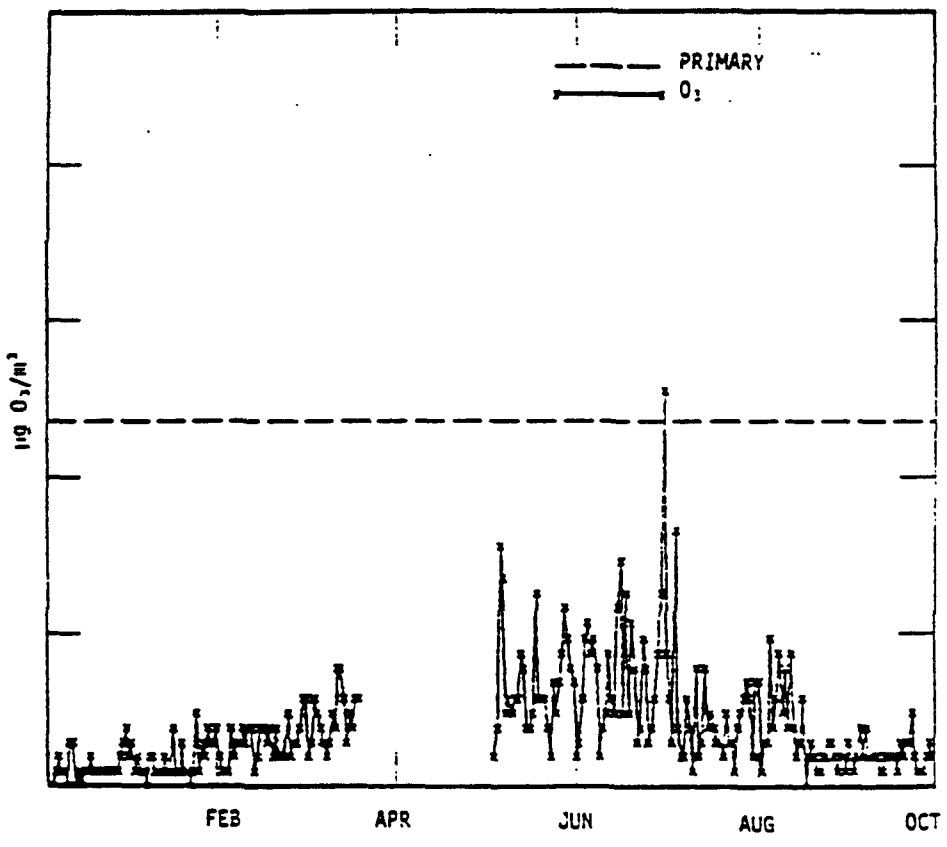


Figure 13. Maximum 1-h O_3 values/day, 1977 (SAROAD site 141220002P10).

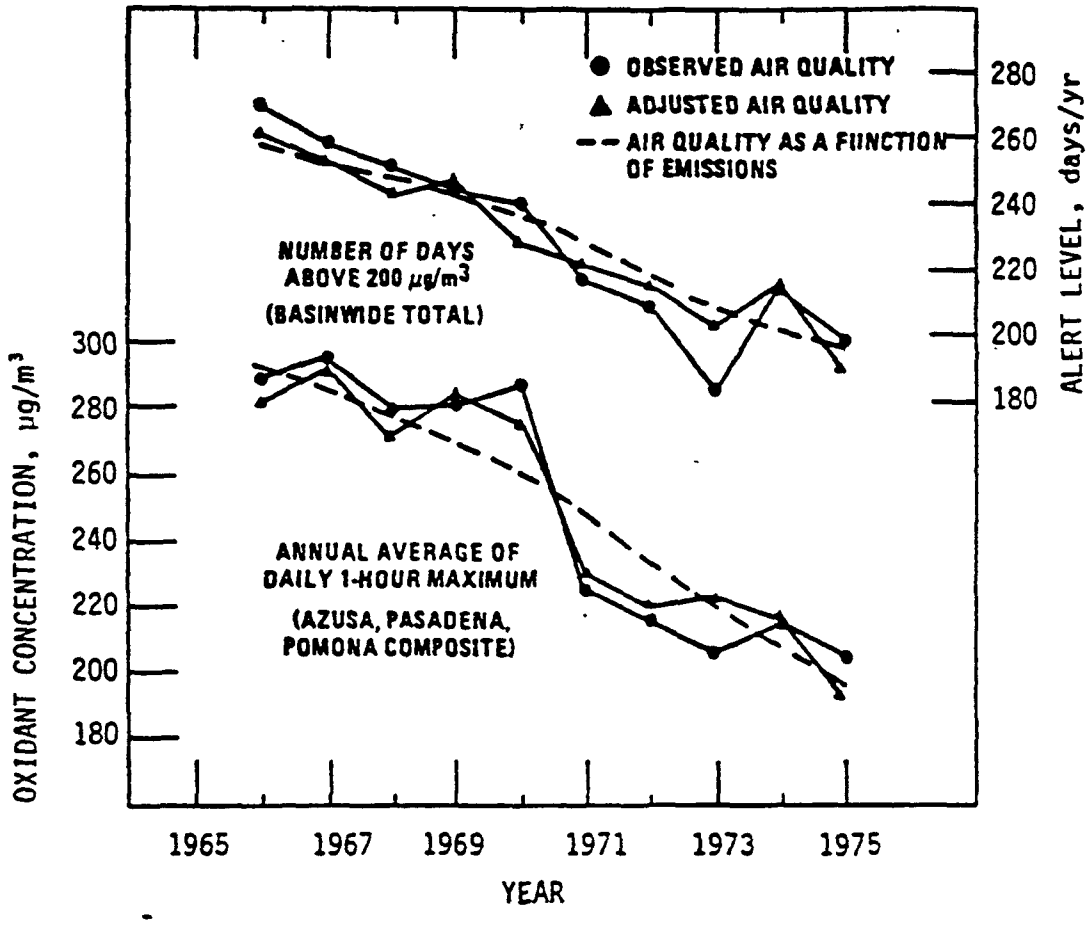


Figure 14. Oxidant trends adjusted for meteorology.

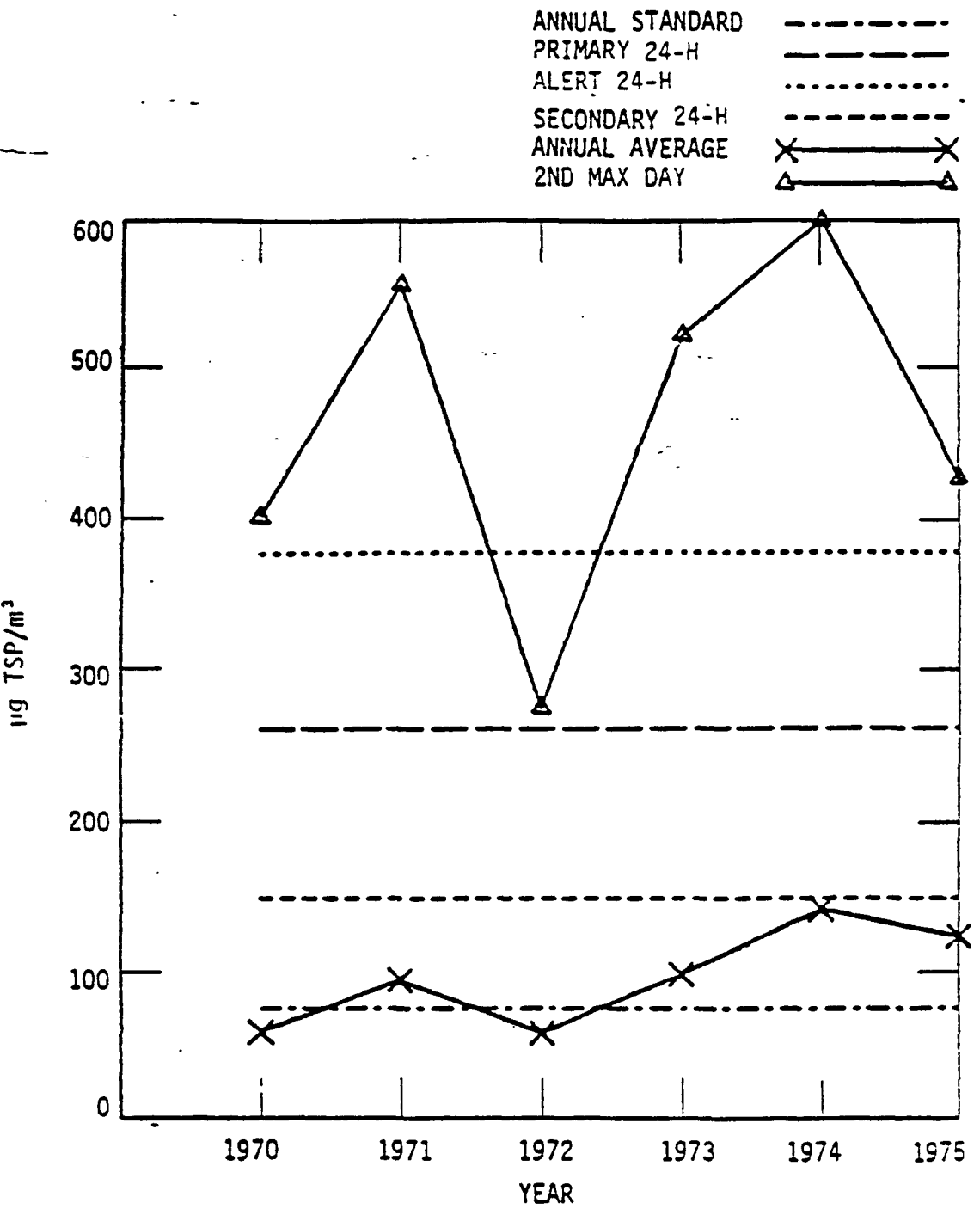


Figure 15. Annual average and second-high day TSP values, 1970-75.

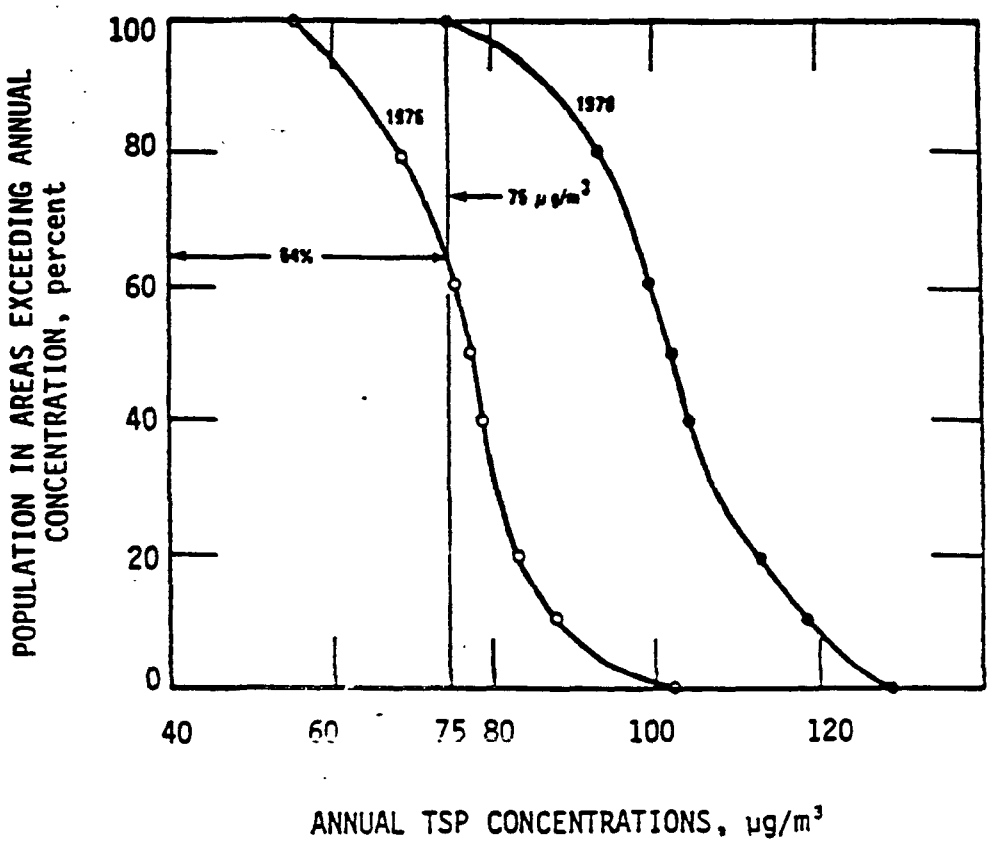


Figure 16. Population exposure distributions of annual mean TSP for 1970 and 1976 in city of Chicago.

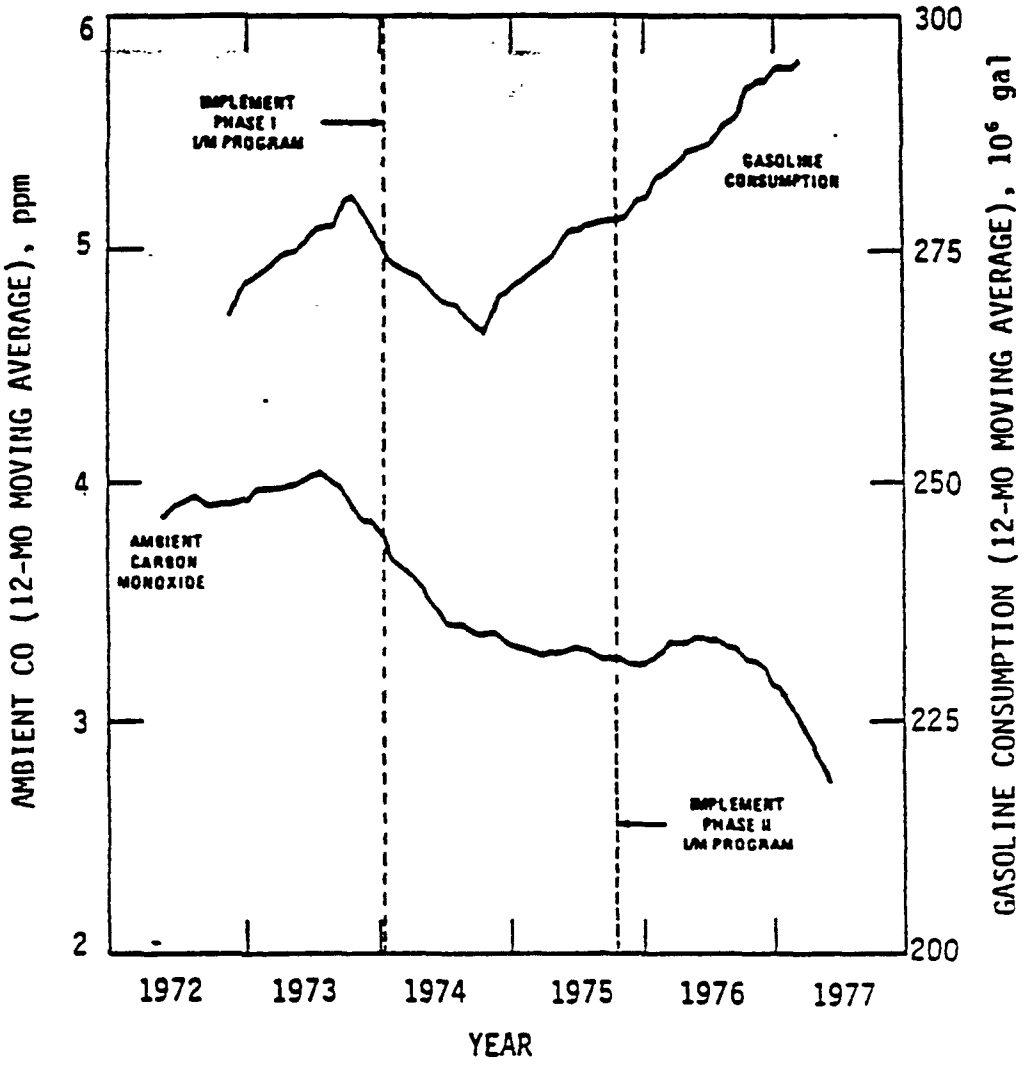
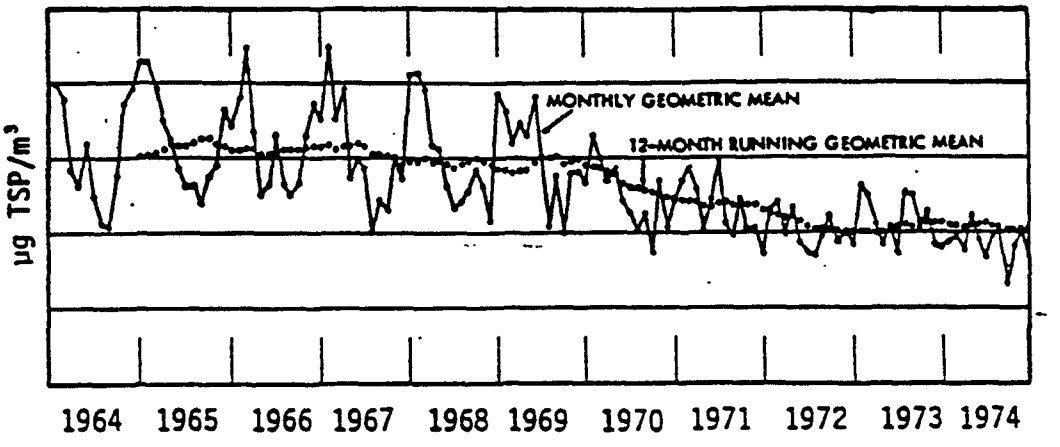


Figure 17. Ambient CO concentration and gasoline consumption, 1972-77.



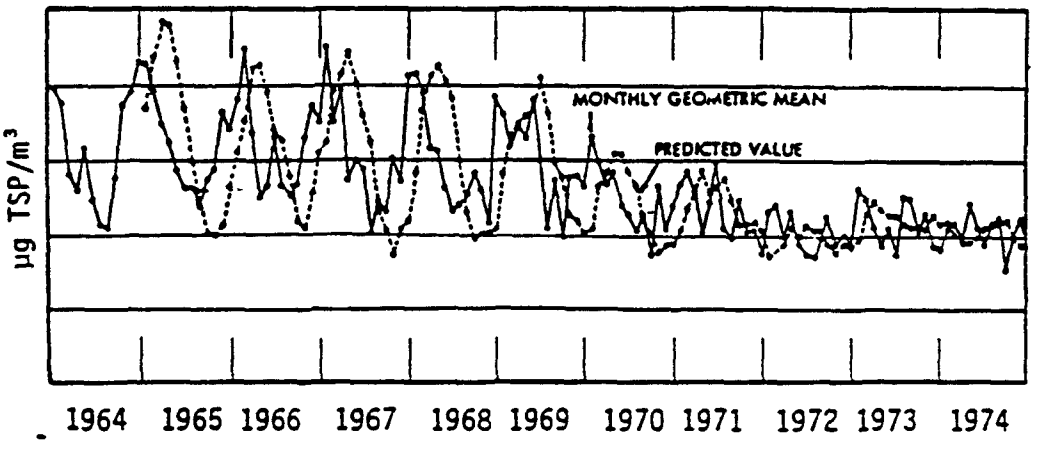


Figure 18. Comparison of monthly GM, 12-mo running GM, and predicted monthly means (by double moving average method), 1964-74.

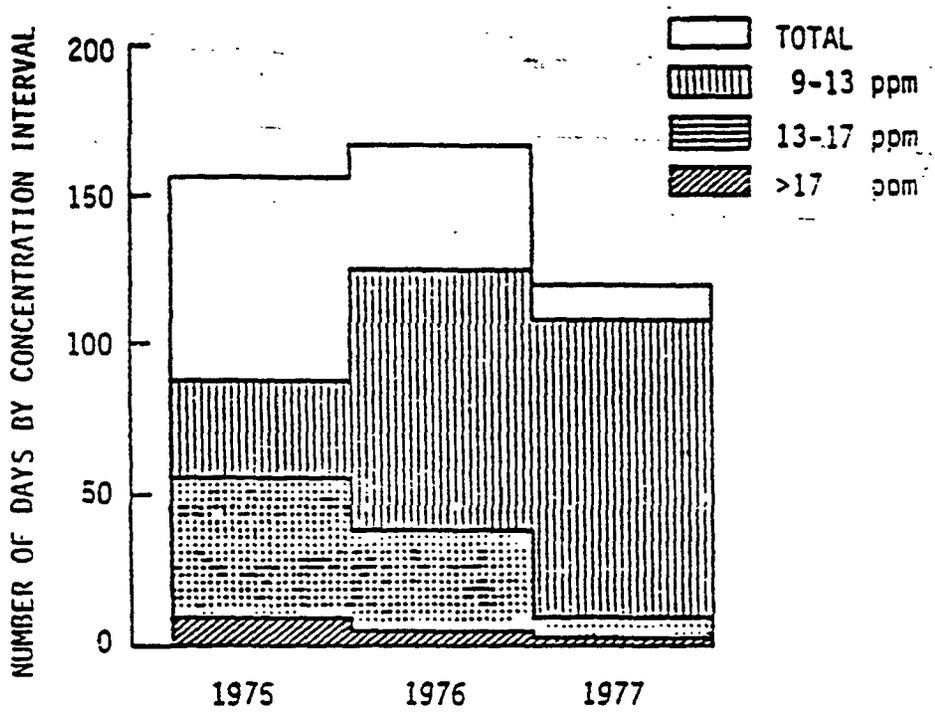


Figure 19. Trends in CO levels in New York's 45th Street Station, April-January, 1975-77.

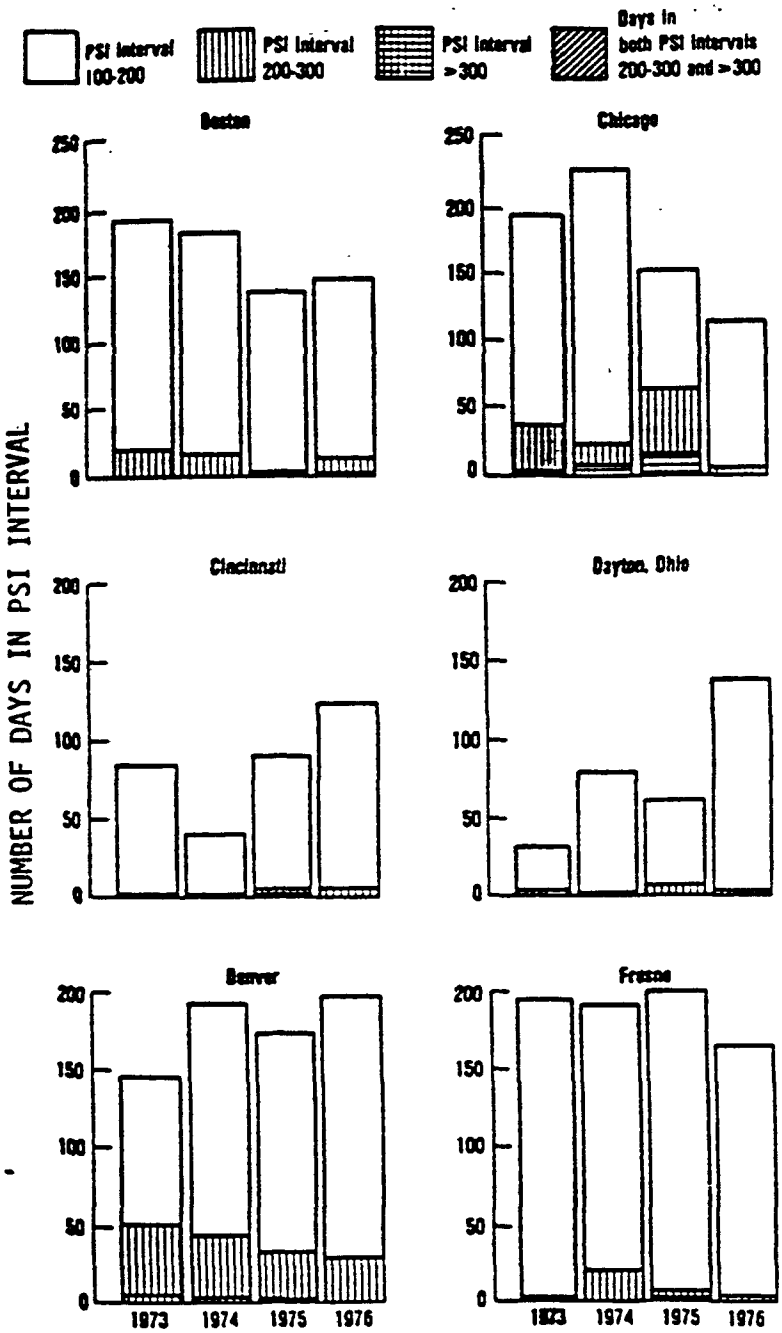


Figure 20. Trends in PSI levels, 16 cities, 1973-76.

1. Comparison of numerical values of the same type for several categories (Figure 21),

2. Comparison of two or three independent series over time such as grouped columns, subdivided columns, and three dimensions (Figure 22),

3. Display of increases or decreases, losses or gains, or deviation from requirement or norm (Figure 23),

4. Display of ranges of maximal and minimal values for a series (Figure 24).

The wind rose is a familiar application of the bar graph in circular form (Figure 25).

Caveats to be considered in preparation of these charts are irregular time sequences, spacing between columns/bars, scale breaks, shading, and the ordering or sequencing of items represented by the columns/bars.

8.2.6 Pie/Sector Charts

The familar pie/sector chart in the form of a circle compares component parts, and shows their relation to the whole. Source emission categorization lends itself well to this chart type (Figure 26), as does population exposure (Figure 27). The pie chart is often used with line, column, bar, or map displays to exhibit geographic or categorical components of trends.

8.2.7 Map Charts

Map charts are attention-getters, and they are most applicable to environmental statistics, especially air quality. National, regional, State, county, and city maps may depict formation and transport of air pollutants in a real-time, dynamic sense. Moreover, within boundaries, current year-of-record and trends may be shown through isopleths, symbols, or shading. Figures 28 and 29 demonstrate two applications of the treatment of data in the dynamic (isopleth) and static modes.

8.2.8 Three-Dimensional Charts

Advanced computerized graphic techniques have made the three-dimensional chart type a viable alternative to three-way tables and to restrictive two-dimensional plane representations. The most significant applications have been to dispersion modeling and contour mapping (Figure 30).

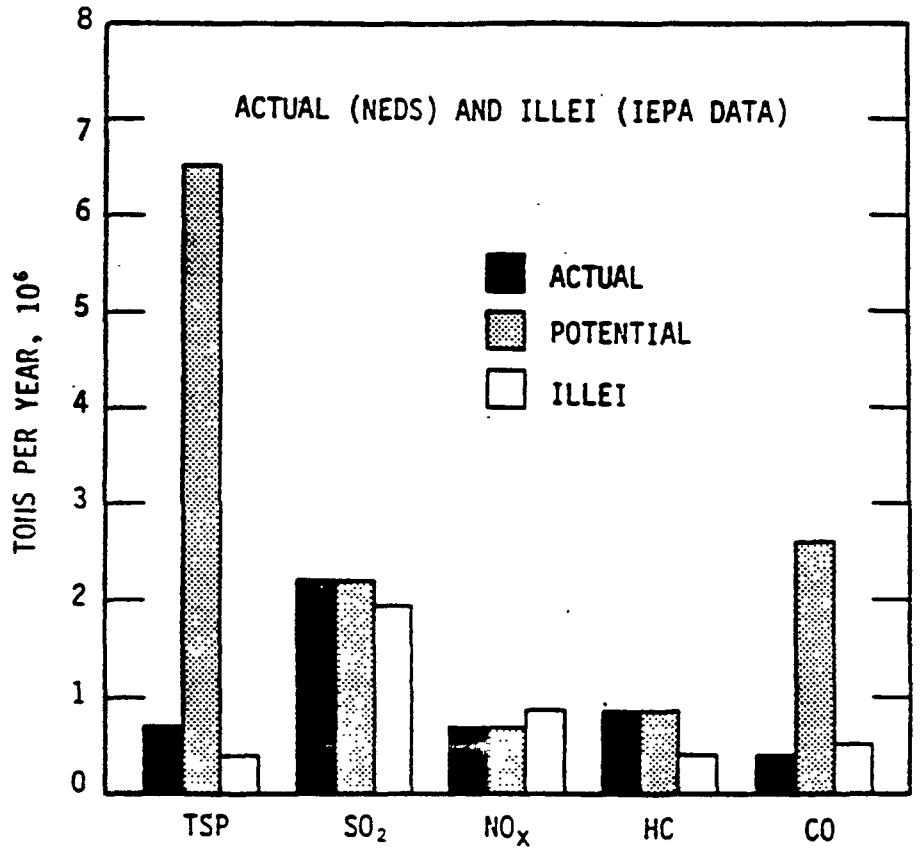


Figure 21. Actual vs. potential emissions for Illinois, tons/year.

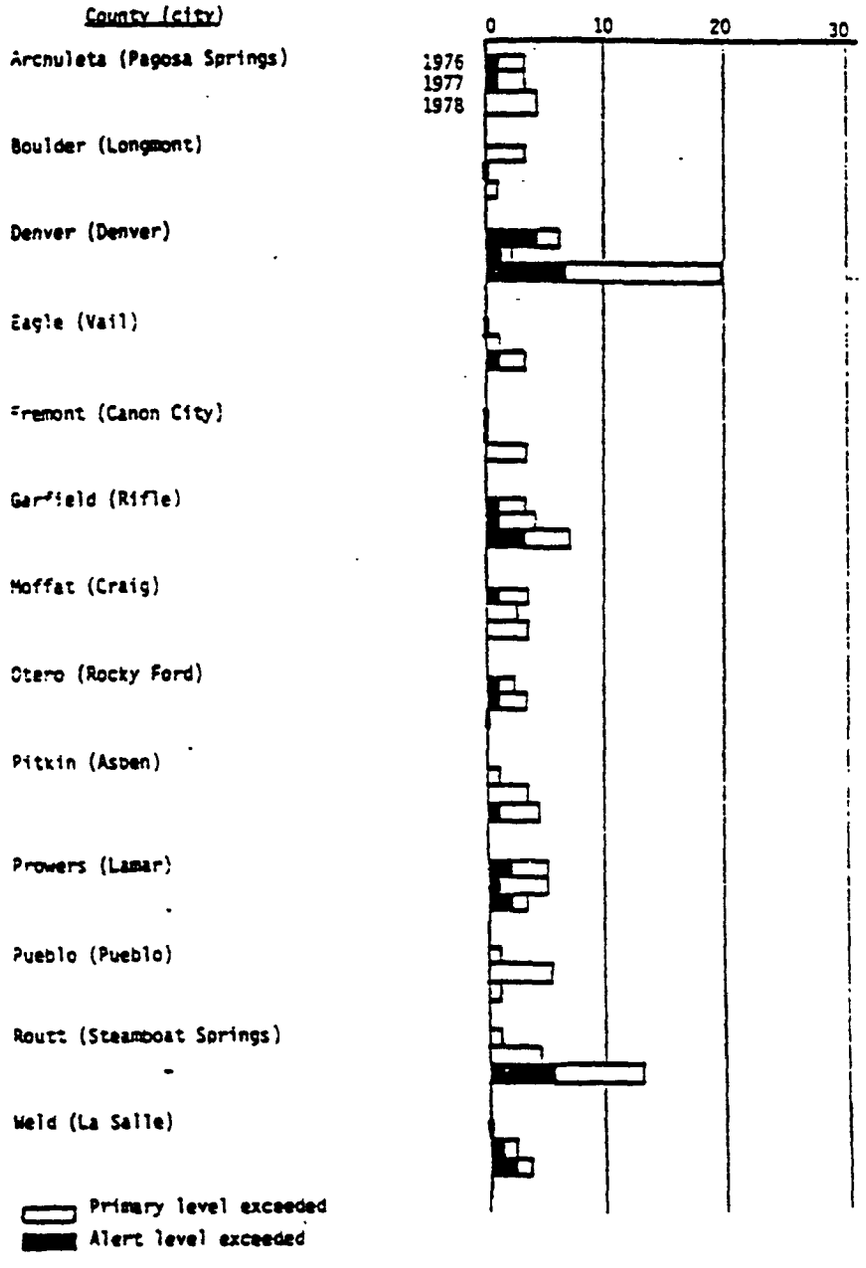


Figure 22. Number of days per year that the TSP primary standard or alert level was exceeded, Colorado.

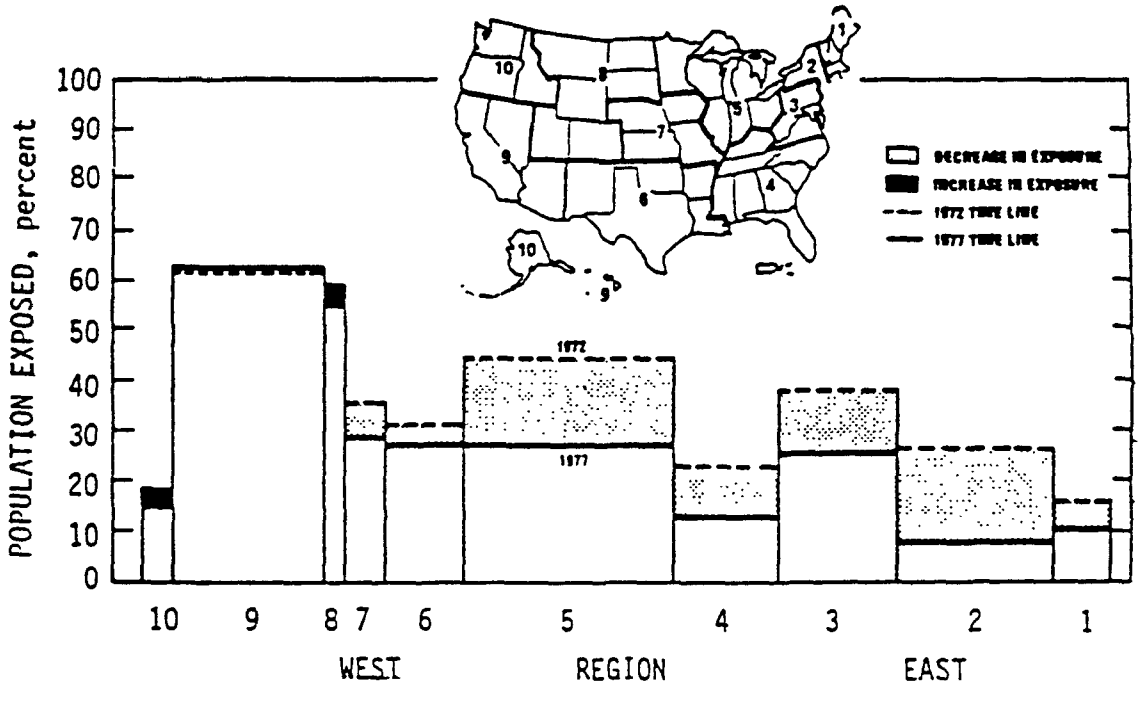


Figure 23. Regional changes in metropolitan population exposures to excess TSP levels, 1972-1977 (width of each regional column is proportional to its metropolitan population).

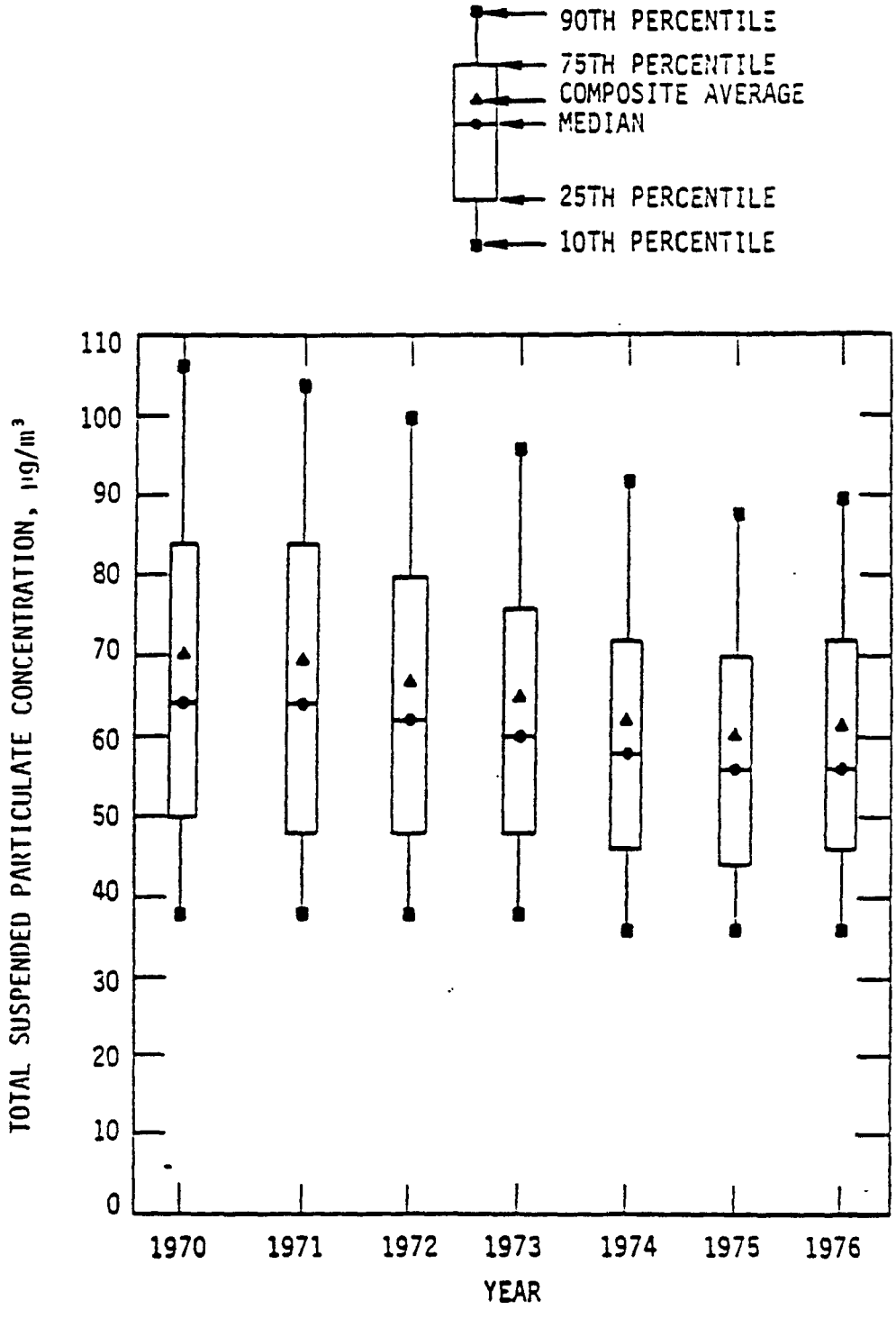
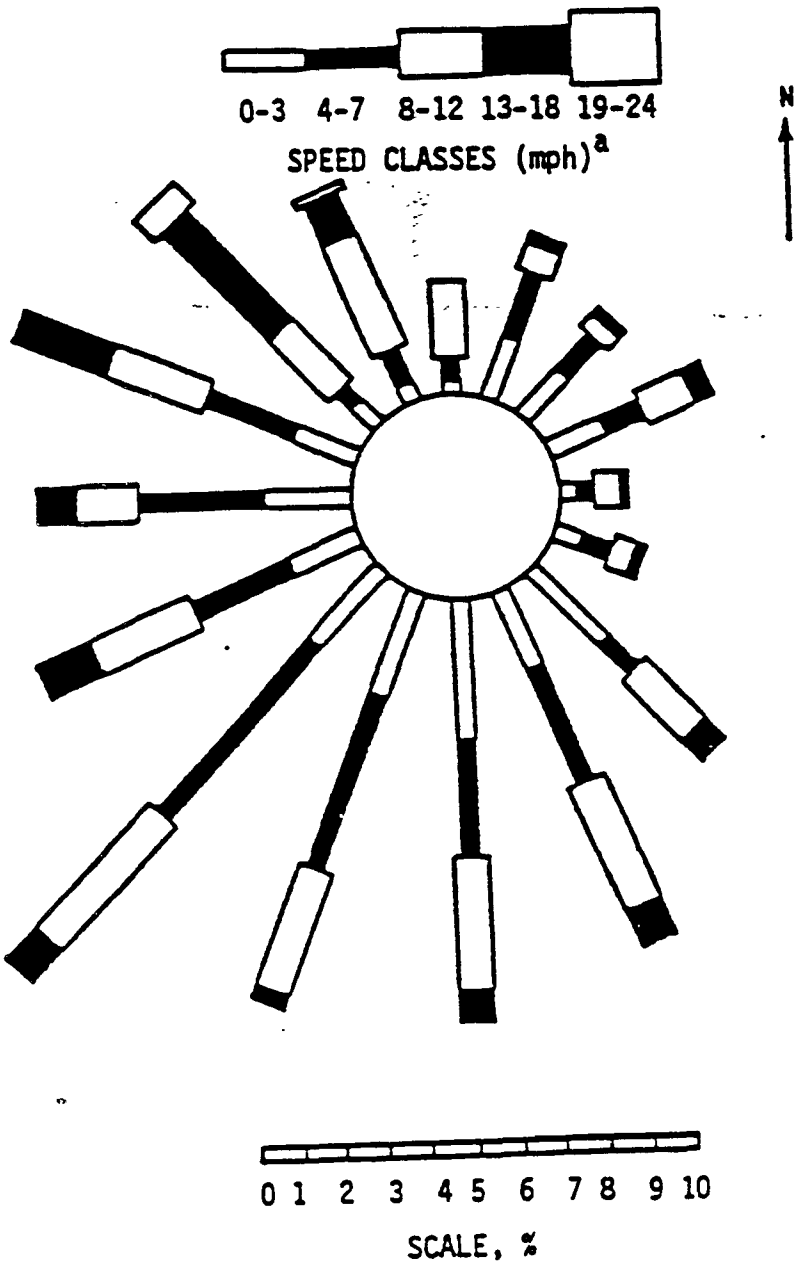


Figure 24. Trends of annual mean TSP concentrations from 1970 to 1976 at 2350 sampling sites.



[a]Bias removed and calms distributed.

Figure 25. Wind rose pattern.

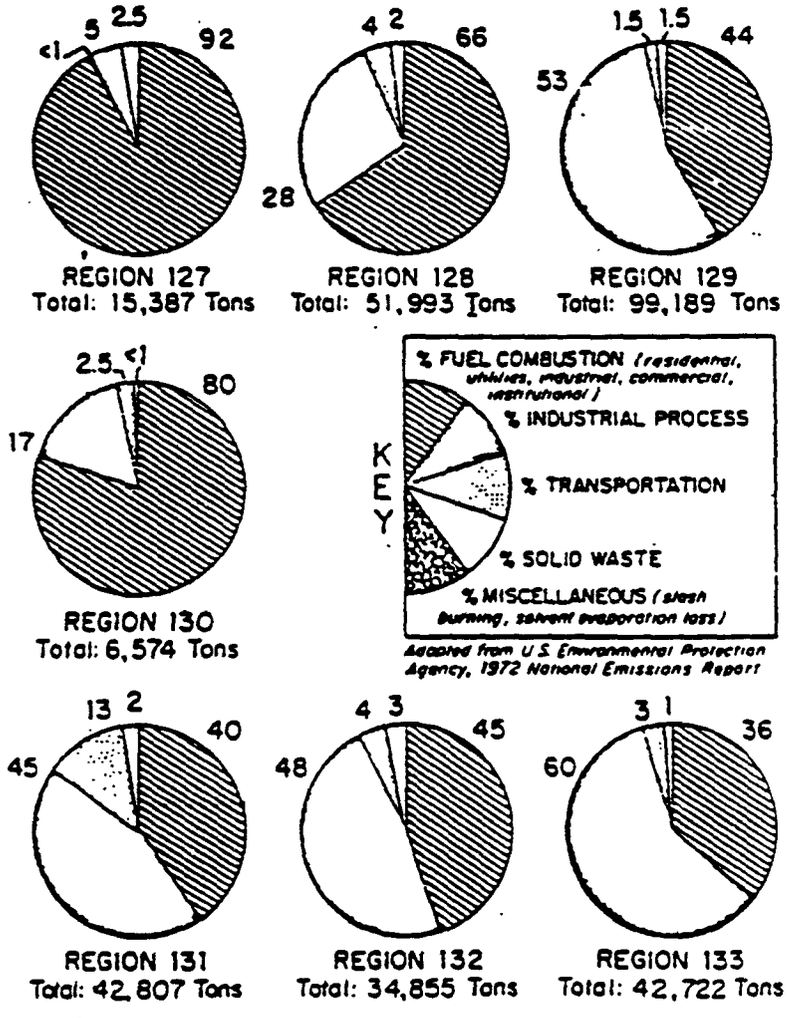


Figure 26. Source category contributions to particulate air pollutants.

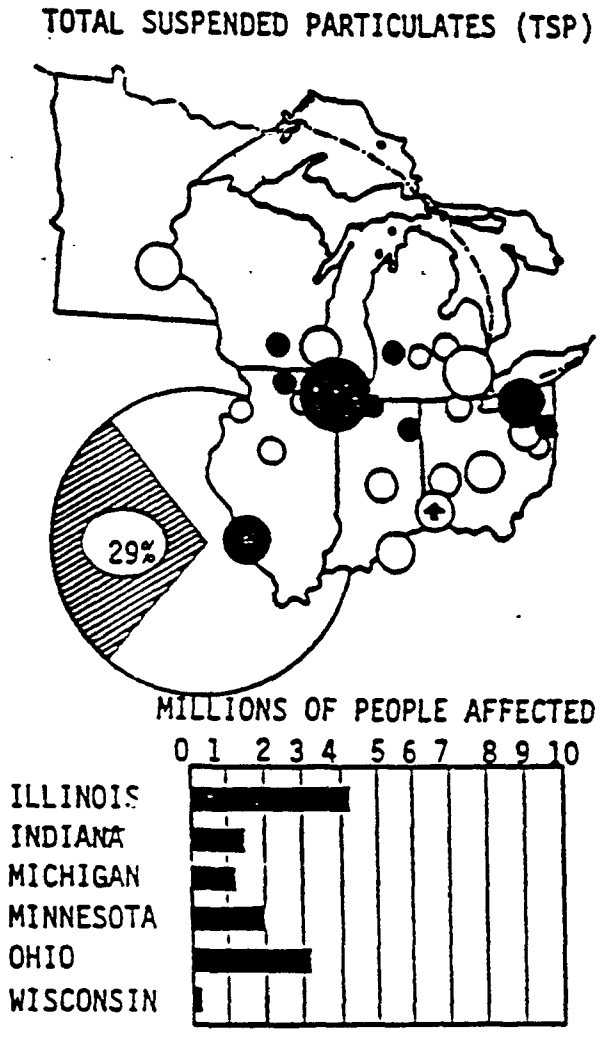


Figure 27. Air quality status (TSP) and trends in 25 largest urban areas in EPA Region 5. Pie chart depicts the percent of population exposed to levels greater than NAAQS for TSP in Region 5. Bar chart is estimated number of people exposed to these exceedances on a state-by-state basis.

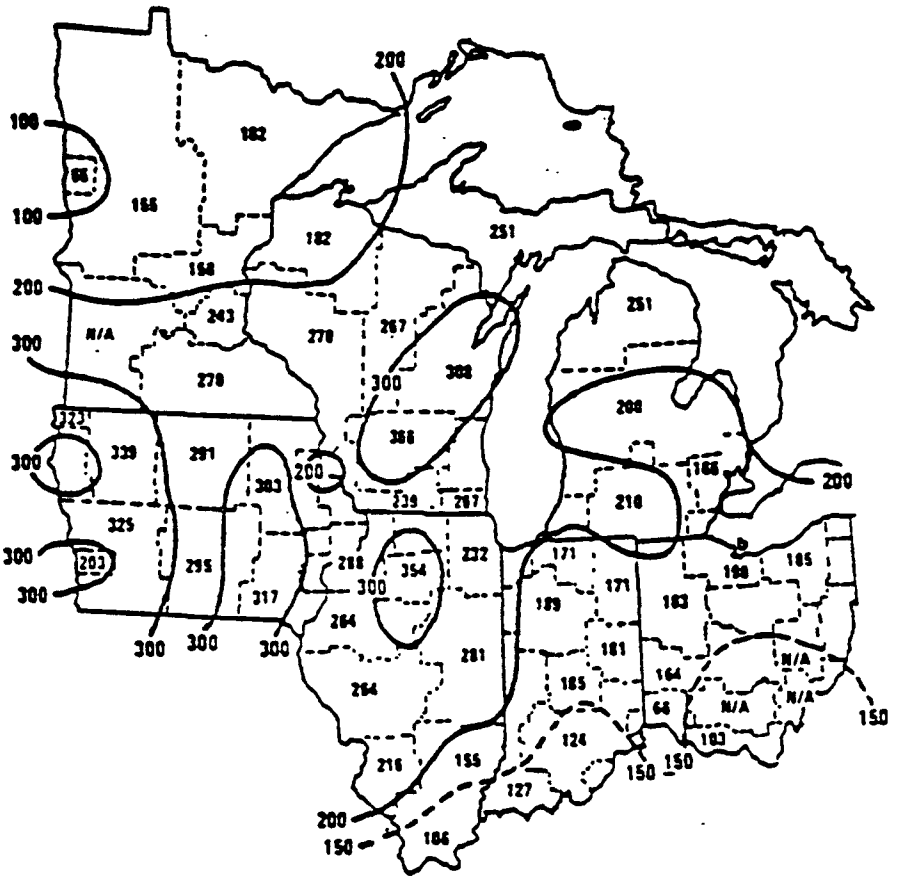
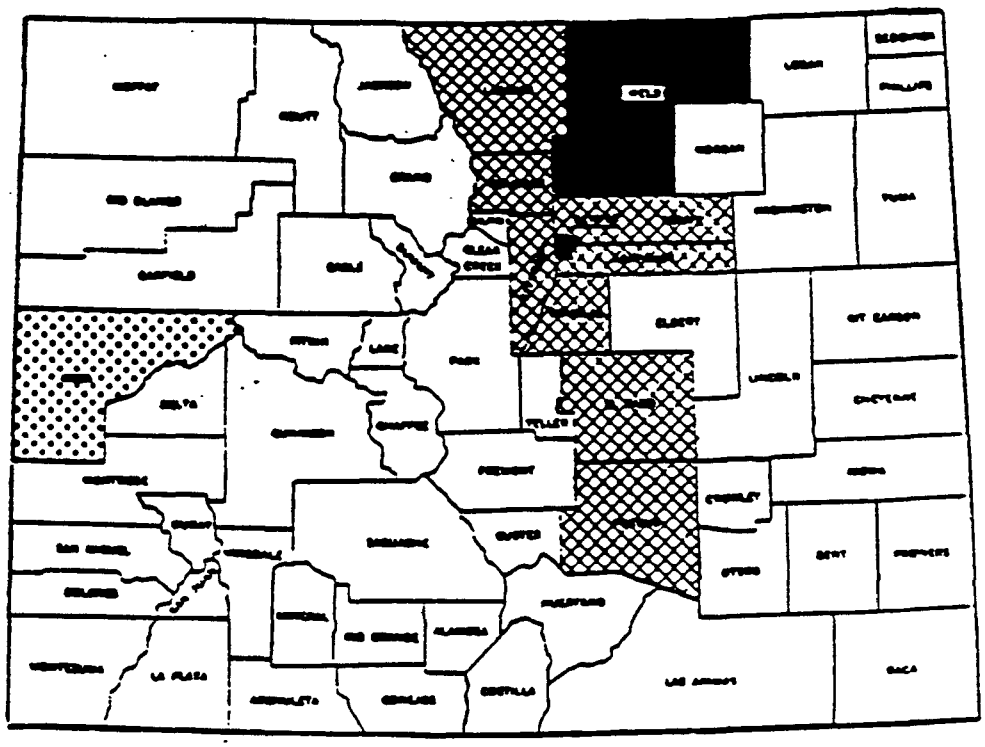


Figure 28. Isopleths of TSP concentrations ($\mu g/m^3$) in EPA Region V and Iowa for October 15, 1976.



Insufficient data (<75% of maximum possible observations)

No evidence primary standard exceeded

Primary standard exceeded

Alert standard exceeded

Figure 29. Air quality status, Colorado, 1972.

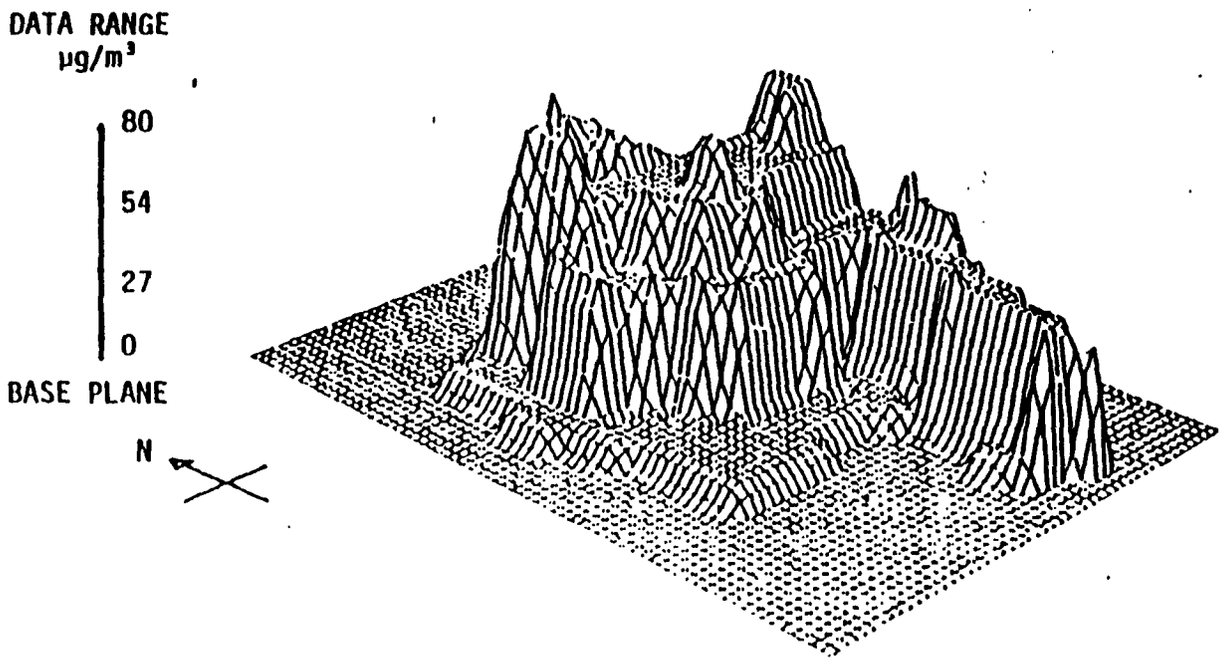


Figure 30. Three dimensional plot of NO_2 concentrations, µg/m³, November 1973.

8.3 CLASSIFICATION OF DATA

One of the early goals for standardizing the codes to be applied nationally to air quality monitoring sites was selectivity for analysis. The SAROAD codes provide time classification, general geographic classification, and site/neighborhood classification. However, only the first two are currently available at NADB for user applications. A profile of environmental quality on any geographic basis will require more unique ways of data classification and analysis in the future.

8.3.1 Time Categories

Overall, the NAAQS's dictate the following categories as most important: year (TSP, SO_2, NO_2), quarter (Pb), day (TSP, SO_2), 8 hours (CO), 3 hours (SO_2), and 1 hour (O_3, CO). However, trends analysis techniques could require classification by hour of the day; day of the week; week; and month for multiple year comparisons. Autocorrelation techniques may require other nonstandard time intervals and hence a more flexible data base retrieval system. Research needs will require further analysis of long- and short-range transport, and time selection will be critical for trajectory analysis.

8.3.2 Geographic Categories

Summary statistics are usually retrieved from NADB on a monitoring or site point-source basis. All individual sites may be retrieved for a city, county, Air Quality Control Region (AQCR), and State for a given time span. Aggregation statistics are not yet standard selection options, except in special computer routines not available to all users. Nationwide reports either summarize individual site statistics for all States or select certain geographic regions, urban areas, or special interstate areas. Likewise, regional and state reports aggregate individual site statistics from all sites or from selected counties or cities. Multicounty, county, and city agencies have more opportunity to deal with specific subcounty areas in annual quality reports.

8.3.3 Site/Neighborhood Categories

This largely unexplored categorization has the potential to be a most interesting summary in future regional and national reports. It is now a part of the National and Regional Environmental Profile (NREP) effort. The new

monitoring regulations require that sites be classified according to neighborhood and monitoring objective. Site types published previously were industrial, commercial, residential, and agricultural within center city, suburban, near urban, rural, and remote areas. The new classifications are microscale, middle scale, neighborhood scale, and urban scale. Once established, NAMS will be categorized and summarized in any of the classification schemes.

8.4 INPUT PARAMETERS, DATA TRANSFORMATIONS, AND STATISTICAL COMPARISONS

Table 14 outlines the details of data types which could be summarized. Note that effort was made to delineate individual air quality and emissions statistics from aggregate statistics and counting summaries. Counting summaries are generally used internally as management tools. Only a few such summaries should be related in RNEP's or in reports to the Administrator. Much work remains on standardizing data transformation techniques. In addition, the techniques of maximum-likelihood estimation, application of the general linear model (GLM) regression and analyses of variance, and spectral (time-series) analysis could be applied in more cases than they are presently.

8.5 AUDIENCE APPLICABILITY

The most important consideration in data presentation is applicability to a specific audience. For example, the report to the Administrator may cover not only air quality assessment but also the end results of EPA programs and regulatory policies. The data needs are national in scope for the environmental assessment, perhaps with highlighted urban areas on criteria and noncriteria pollutant issues. Both air quality and emissions data, current status and trends, would be given on a national and possibly a region basis; this level would require more graphic presentation than a technical/management report--for example, a graphical summarization of data resulting from singular national events (volcanic eruptions or widespread duststorms).

A report to the Regional Administrator may be merely a subset of the report to the national Administrator, but with emphasis on regional policies. The summary statistics are usually given state by state, by selected major urban areas and by regions.

Reports to other government agencies and in response to congressional and (to a large extent) public inquiries are usually limited to specific areas throughout a State. Environmental profiles provide an easily understandable

TABLE 14. OUTLINE OF INPUT PARAMETERS, DATA TRANSFORMATIONS, AND STATISTICAL COMPARISONS

- Individual ("raw") air quality data
  - All hourly concentration values
  - All daily concentration or "index" values
  - Maximum/minimum site values
  - Average/median site values
  - Quantiles by site
- Individual emissions data
  - Process
  - Stack
  - Plant
- Aggregate air quality data for given category
  - Maximum/minimum values
  - Average or median of maximum/minimum data values
  - Weighted average/median of averages/medians
  - Maximum/minimum quantiles (e.g., max all 90th percentiles)
  - Average/median quantile of like quantiles
- Aggregate emissions data for given category
  - Maximum/minimum process
  - Maximum/minimum stack
  - Maximum/minimum plant
  - Average/median process
  - Average/median stack
  - Average/median plant
- Counting summaries for given statistic
  - Number of sites, cities, counties, States, regions
  - Number of processes, stacks, plants, cities, etc.
- Data transformations
  - Distributional (e.g., Weibull, logarithmic)
  - Regression
  - Analysis of variance (ANOVA)
  - Spectral analysis and smoothing techniques
- Example statistical comparisons by site, geographic, and time categories
  - Total number of pollutant sites
  - Number of sites exceeding annual standard
  - Number of sites exceeding short-term standards
  - Counties with data
  - Counties exceeding standards
  - Days exceeding primary standard
  - PSI class distribution
  - Site averages by year
  - City averages by year
  - Counties (urban areas, etc.) with significant pollutant trends up, down, no change
  - Emission estimates by major source category
  - Emission density vs. population and land use

graphic summary of environmental status and trends, and solve the problem of repetitive requests.

Air quality standards "violations" and trends on a pollutant/county or urban area basis (using colored maps) are the main tools of the RNEP effort. The most common question--Where are the least polluted areas of the United States?--has not been addressed directly in EPA reports because of the complexity of issues regarding sufficiency, representativeness, and comparability of data. However, profiles with an added impetus to incorporate the PSI will at least indirectly address this issue.

Scientific and technical audiences may have stringent requirements for level of data summary and documentation of the statistical analysis techniques.

8.6 CAVEATS AND SUGGESTIONS

The following should be considered in planning graphics displays:

1. Descriptive or statistical parameters required?
2. Time to develop a summary from individual data?
3. Cost for preparation of graphics?
4. Data quality assured, valid, and carefully analyzed?
5. Proper emphasis on purpose of chart?
6. Chart not too light, heavy, confusing, complex?
7. Color/shading required?
8. Lettering styling and size appropriate?
9. Scale heights distorted?
10. Data gaps in chart treated correctly?
11. Too much gridding and/or lettering?
12. Grid units appropriate?
13. Grid points clearly identified?
14. Use of pictorial symbols and descriptive titles?
15. Chart self-explanatory?

8.7 AVAILABLE PLOTTING RESOURCES

Graphic display packages are available at both the USEPA National Computer Center (NCC),[2] Research Triangle Park, N.C., and the Washington Computer Center (WCC) Washington, D.C. "Stand-alone" systems include *Integrated Plotting Package (IPP), Harvard Graphic, Tektronix, Calcomp,* and *Statistical Analysis System (SAS).* Subroutines are available for user program interface under most of these systems. Currently, statistical analysis and graphics programs developed in some EPA Regional Offices are being documented for use by other regions; these include PSI, box-plot, and pollution/wind roses.

8.8 GUIDANCE FOR SELECTION OF CHARTS

No single standardized list of charts should be mandatory for displaying aerometric data; however, the following steps should be used to guide the selection of the most relevant charts.

1. Will the audience be interested in technical details and require follow-up documentation concerning both data base and data analysis methodology? If so, individual data or tabular summary may be sufficient. If graphics are needed, see steps 2-12 below.

2. Select the geographic scale of the summary: national, regional, AQCR, SMSA, county, urban area, city, township, or monitoring site/source.

3. Select concept to be charted: trend, current status, parameter(s) vs. parameter(s), one parameter vs. several categories, composition of components, or maps.

4. Select time class: hour of day; day of week; month; calendar quarter; season; year; or multiple year.

5. Select period of analysis: start year/month/day/hour and end year/month/day/hour.

6. Select statistical summaries: individual, summation, or aggregation.

7. Select statistical analysis technique: descriptive statistics; distributional; regression; ANOVA; spectral analysis; or trend analysis.

8. Select site type, if desired: industrial, commercial, residential, and so forth.

9. How can the analysis be accomplished? Manually (small data base), hand calculator/computer, or large computer.

10. If a computer is necessary, are there statistical analysis and/or graphics systems available? Check NCC, WCC, and Regional Office.

11. Retrieve data according to selection criteria above.

12. In preparation of the chart, follow Section 8.7 caveats.

8.9 SUMMARY AND RECOMMENDATIONS

This section discussed established data display techniques applicable to aerometric measurements, and provided guidance for determining the formats most suitable for the concepts to be displayed, the audience applicability, the input data classification and analysis, and the plotting resources. The discussion was limited to data resulting from the air monitoring and emissions inventory processes. The purpose of such data is to provide quantitative insights to help abate air pollution, manage natural resources, plan environmental programs, and inform the public.

The discussion did not consider topics such as sufficiency, representativeness, and data validity, and it assumed data to be efficiently accessible. Since new statistical analysis techniques are covered in preceding sections, this section discusses only analysis by currently available techniques.

Finally, the section did not attempt to standardize graphic formats; it merely provided guidance and criteria, and gave example displays of suitable data presentations. Graphics must accurately portray the data, help readers understand the data, and help captivate interest. The guidance and criteria in this section are not meant to stifle the innovation and creativity of those preparing these artforms.

8.10 FUTURE ISSUES

Section 8 will be modified as new statistical techniques are used to yield different parametric relationships and thus different graphics. Mandatory standardized analysis techniques may result in standardized computer graphics programs. Questions to be addressed in the future are:

1. How stringent will USEPA be on data completeness and "representativeness"? Should we display quality assurance data? If so, should we exclude source-impacted monitoring sites, or restrict analysis to NAMS?

2. How can special "success stories," nonattainment status, or other policy/regulatory issues be displayed in environmental assessment documents? Should they be included?

3. Will population exposure analysis be used in future reports to the Administrator? Will population exposure software be easily used by Regional Offices?

4. How frequently will the RNEP's be published? How do the profiles relate to the report to the Administrator, to Congress, and to the *National Air Quality and Emissions Trends Report*? Should the profile format change from year to year and perhaps cover selected urban areas or regions in "off" years?

8.11 REFERENCES

1. Spear, Mary E. Practical Charting Techniques. McGraw-Hill, Inc., New York, N.Y., 1969.

2. NCC User Reference Manual.

9.0 CONTINUITY OF YEAR-TO-YEAR REPORTS

This section focuses on two major topics which can seriously affect the continuity of data reported throughout time. First are changes in the operational definitions for measurements of pollutants and in the statistical indicators or techniques. Second are shifts in the data base.

The discussion assumes that detailed data, as opposed to summary values, will continue to be available from NAMS. It also assumes that as data needs change with time, published reports will reflect the new priorities rather than maintain format merely for historical continuity.

9.1 METHOD CHANGES

Data analysts preparing air quality reports should continually check for changes in measurement techniques. These changes may require the adjustment of the raw data for past years to maintain consistency in the data base.

The data base should not prevent the adoption of a new statistical indicator (for example, a change from the median to the mean as an indicator of the central tendency of a distribution). Availability of detailed data for past years should make it possible to compute values of the new indicator for data of the past. There should be no reason for presenting trend tables with old indicator values for past years and new indicator values for the present year. Similarly, introduction of a different statistical method should be accompanied by a presentation of its applicability to data of the past.

9.2 NAMS NETWORK CHANGES

The discussion above assumes that the number and location of monitors providing data is held constant over the years for which the trend is studied. However, the NAMS network will probably undergo many changes in years to come as more is learned about the nature and effects of the various pollutants, as funding levels change, and as source configurations are altered. If summarization of data is carried out on the urban level (as recommended in Section 4 instead of by monitoring site, effects of changes in the network will be

minimized. If an index of air quality is adopted, it is recommended that the subset of NAMS used for index determination remain unchanged over a relatively long period.

There are a number of ways in which changes in the NAMS network could occur; each would have a distinct effect on the continuity across years. In particular, there are three changes that could occur even if the subset of NAMS used for index determination remains fixed.

1. The stations could be resited within an urban area,
2. The network in an urban area could be expanded, or
3. The network in an urban area could be contracted.

Effects of these changes can be minimized by the procedures given below.

A station should be resited only if there is hard evidence to justify it. If resiting occurs, data from both the old and new sites should be gathered concurrently for one year to firmly establish the differences between the two sites and to assist in correcting any misleading conclusions formed using data from the old site.

A change in location for a station used to report the maximum concentration for an area should not affect the continuity of the data base; in fact, the maximum monitoring site should be reviewed periodically to assure a reasonable approximation of the maximum concentration associated with the urban area.

It is difficult to foresee plausible reasons for resiting those stations located according to the criteria of high population density and poor air quality, unless there is a considerable change in air quality patterns over the urban area. In this case, the resulting "discontinuity" of the data base would reflect a discontinuity in the measured phenomenon and should be noted.

If the NAMS network in an urban area is expanded, past values of indices and trend analyses can be adjusted by relating concurrent values from the old network stations to those from the new combined network.

If the NAMS network in an urban area is contracted, all indices and trend computations for past years should be redone using only the data from the smaller network.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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EPA-450-4/81-015		February 1981

4. TITLE AND SUBTITLE	5. REPORT DATE
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7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
W.F. Hunt, Jr., (Chairman), G. Akland, W. Cox, T. Curran, N. Frank, S. Goranson, P. Ross, H. Sauls and J. Suggs	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
U.S. Environmental Protection Agency Offices of: Air, Noise and Radiation, Research and Development and Planning and Management EPA Region 5	11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The Intra-Agency Task Force on Air Quality Indicators was established to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends in national publications. This report summarizes the recommendations of the Task Force grouped into four categories: data base, data analysis, data interpretation and data presentation. The report includes the position papers prepared by the Task Force members dealing with precision and accuracy data, detecting and removing outliers, area of coverage and representativeness, data completeness and historical continuity, statistical indicators and trend techniques, inference and conclusion, data presentation, and continuity of year-to-year reports.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Intra-Agency Task Force on Air Quality Indicators Air Quality Indicators Statistical Methodologies Data Base Data Analysis Data Interpretation Data Presentation Precision and Accuracy Data	Outliers Representativeness Data Completeness Statistical Indicators Trend Techniques Continuity of year-to-year reports	

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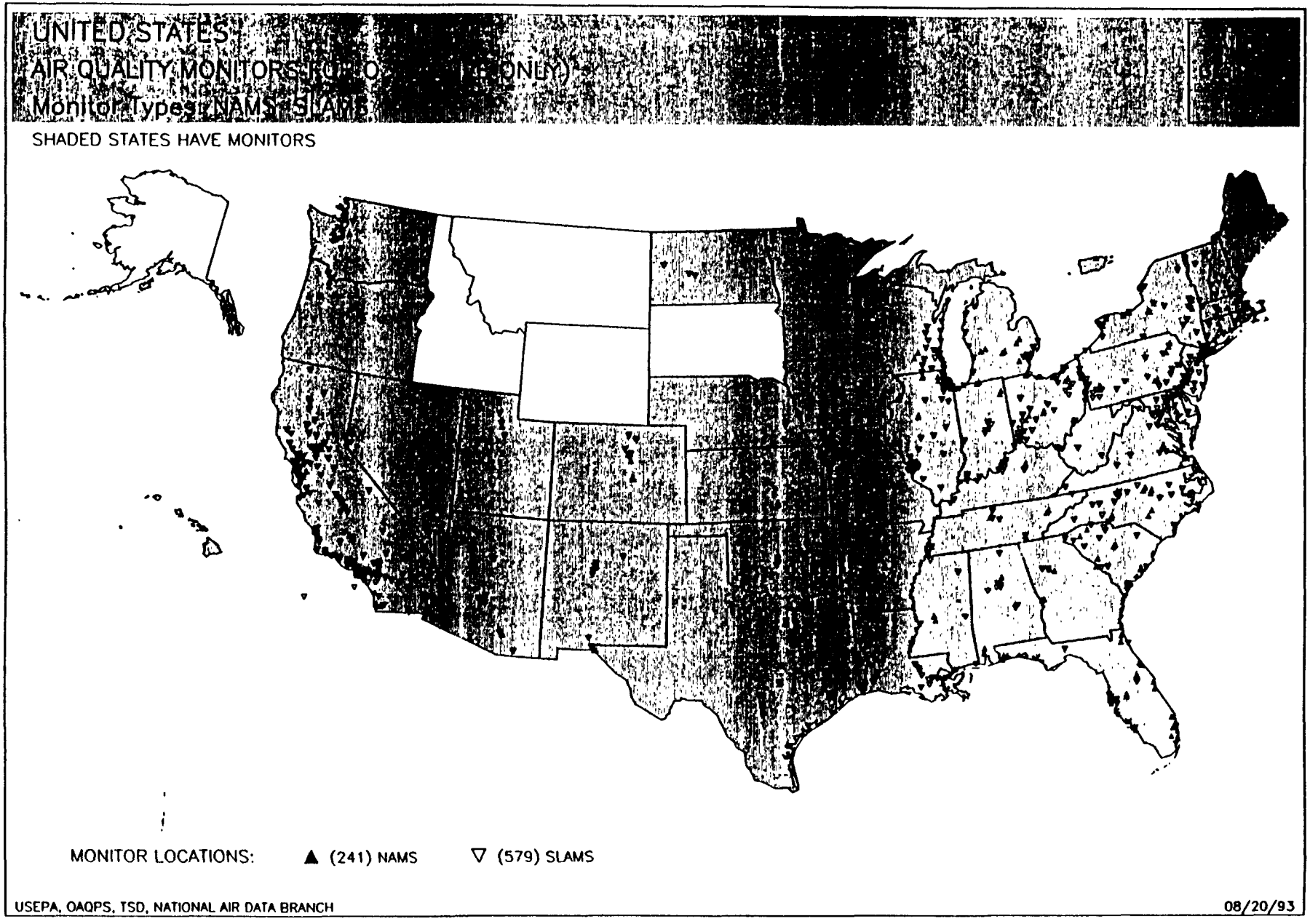
APPENDIX K

SAMPLE OUTPUTS FROM AIRS GRAPHICS

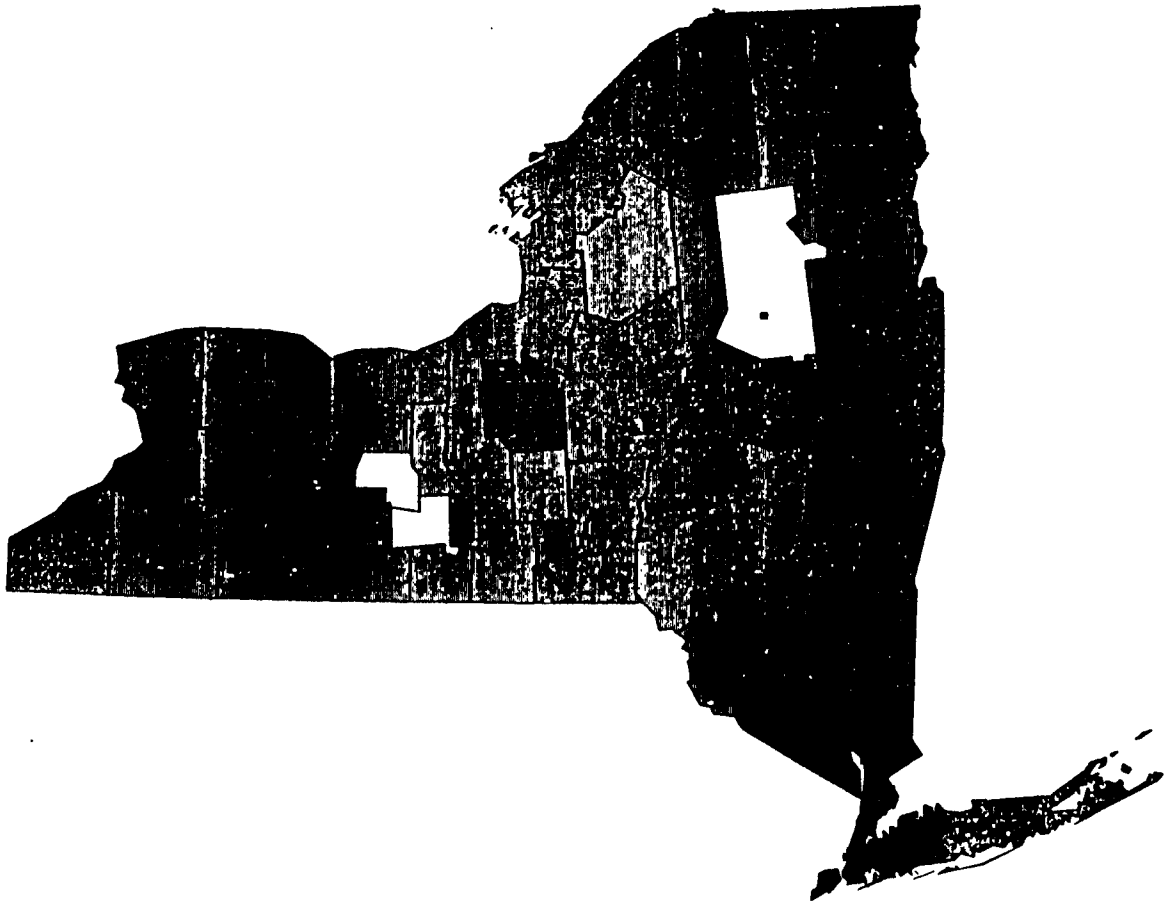

UNITED STATES
AIR QUALITY MONITORS FOR O
Monitor Types: NAMS, SLAMS
SHADED STATES HAVE MONITORS
MONITOR LOCATIONS:
▲ (241) NAMS
▽ (579) SLAMS
USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH
08/20/93

NEW YORK

AIR QUALITY MONITORS FOR O3 [illegible]NLY)

Monitor Types: (All)

SHADING INDICATES COUNTY POPULATION



COUNTY POPULATION:

< 25,000 | < 50,000 | < 100,000 | < 300,000 | >= 300,000

MONITOR LOCATIONS:

▲ (12) NAMS | ▽ (30) SLAMS | ■ (24) OTHER | | | (0) INDUSTRIAL

★ (9) UNKNOWN | ◆ (0) TRIBAL | + (0) INDEX SITE | + (0) NON-EPA

USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH

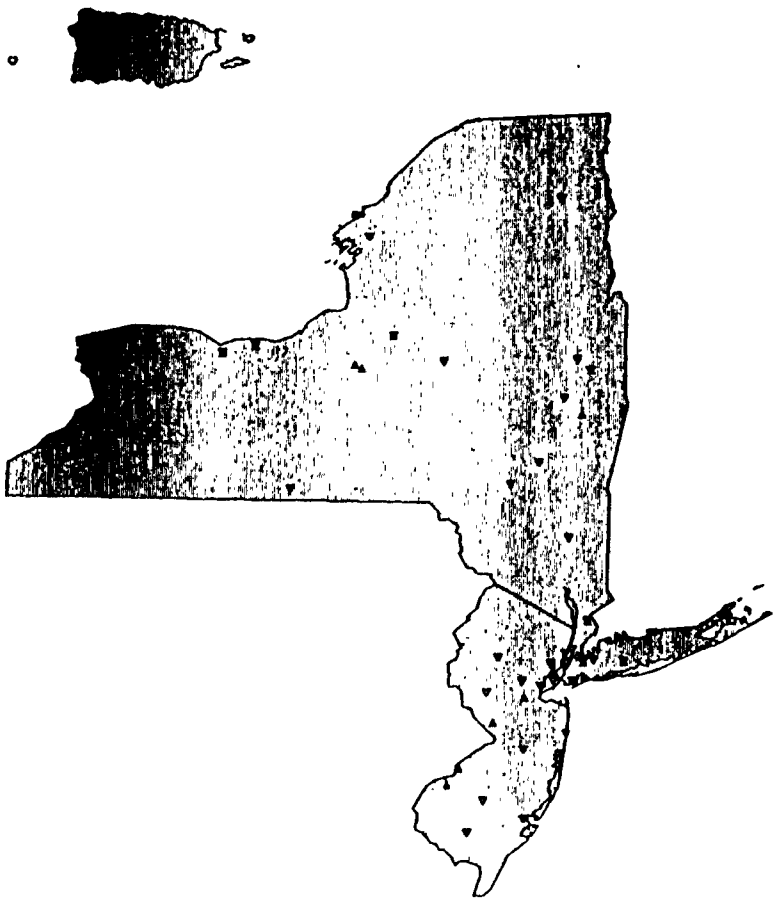
08/23/93

REGION II

AIR QUALITY MONITORS FOR [illegible] ONLY

Monitor types: NAMS

SHADED STATES HAVE MONITORS



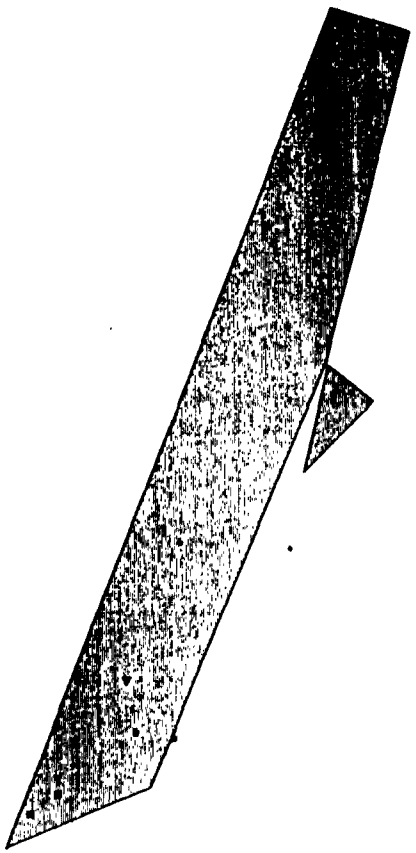
MONITOR LOCATIONS: ▲ (18) NAMS ▽ (42) SLAMS

USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH

08/20/93

SHADED COUNTIES HAVE MONITORS

171 TONS (< 1 % OF NATIONAL VOC EMISSIONS)



CIRCLES: 0 MILE RADIUS

MONITOR LOCATIONS:

▲ (0) NAMS ▽ (2) SLAMS ■ (2) OTHER □ (0) INDUSTRIAL

★ (3) UNKNOWN ◆ (0) TRIBAL + (0) INDEX SITE * (0) NON-EPA

■ PLANT LOCATION
(2 DISPLAYED)

USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH

08/23/93

SHADED STATES HAVE MONITORS

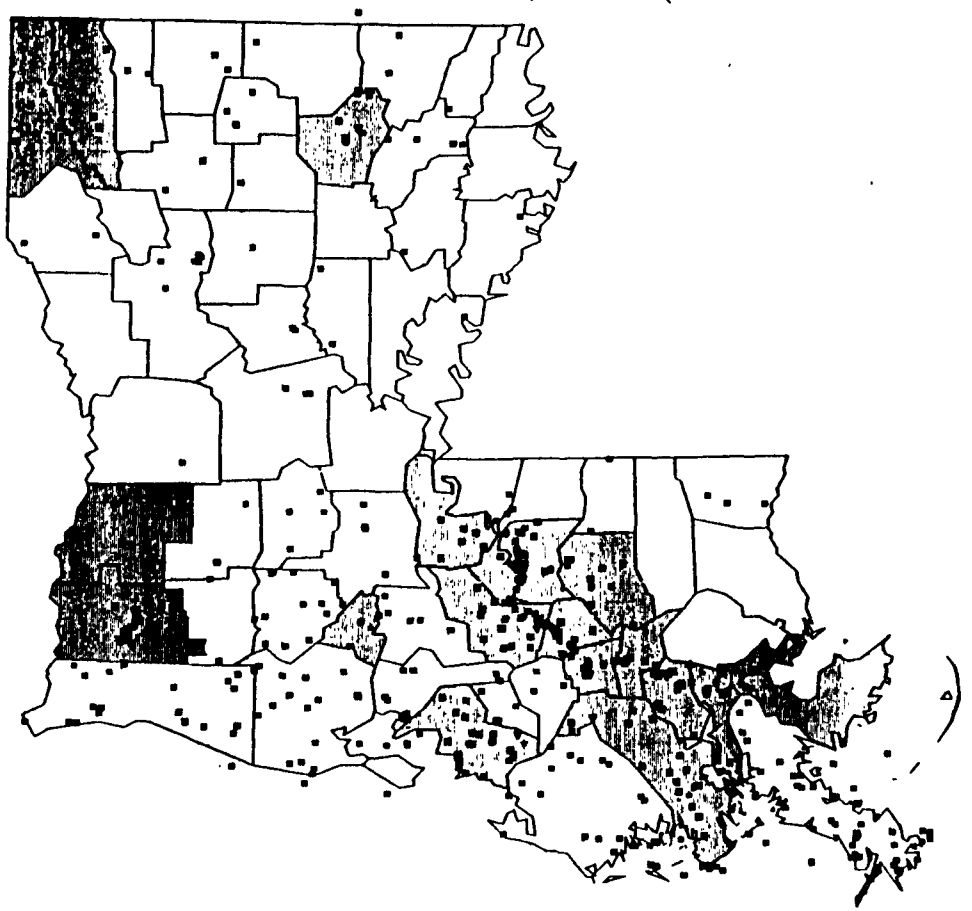
MONITOR LOCATIONS: ▲ (62) NAMS ▽ (79) SLAMS

LOUISIANA– AQ MONITORS F[illegible] (ACTIVE ONLY)
(All) – ALL SIC CODES
FACILITIES WITH VOC EMISSIONS [illegible] PY IN 1990 ((All))

AIR Grap[illegible] – EP[illegible]

SHADED COUNTIES HAVE MONITORS

118,369 TONS (5 % OF NATIONAL VOC EMISSIONS)



CIRCLES: 0 MILE RADIUS
MONITOR LOCATIONS:

▲ (6) NAMS
▽ (14) SLAMS
■ (8) OTHER
□ (0) INDUSTRIAL
★ (8) UNKNOWN
◆ (0) TRIBAL
✚ (0) INDEX SITE
* (0) NON–EPA

■ PLANT LOCATION
(516 DISPLAYED)
(6 NOT DISPLAYED,
LACK LAT.–LONG.)

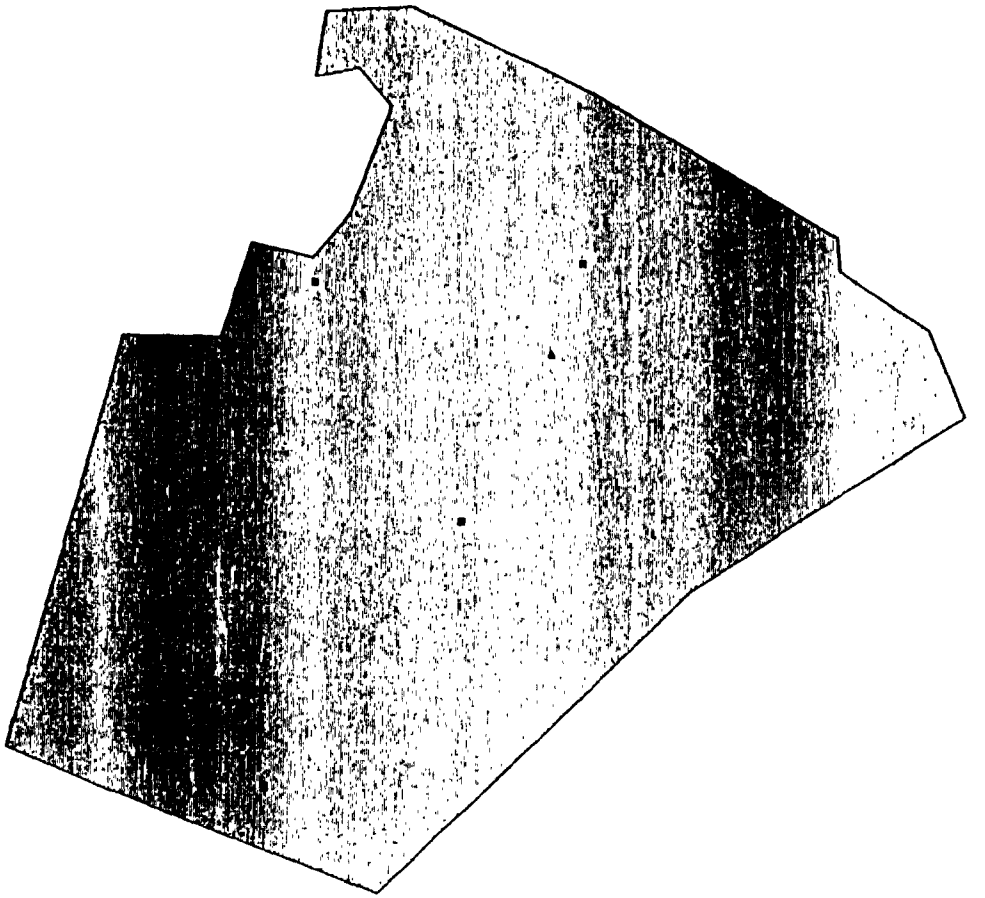
USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH

08/13/93

WAKE CO, NORTH CAROL[illegible] MONITORS FOR O3 (ACTIVE)
(All) – ALL SIC CODES
FACILITIES WITH VOC EMISSIONS [illegible]RY IN 1989 ((All))

SHADED COUNTIES HAVE MONITORS

670 TONS (< 1 % OF NATIONAL VOC EMISSIONS)



CIRCLES: 0 MILE RADIUS

MONITOR LOCATIONS:
▲ (2) NAMS ▽ (0) SLAMS ■ (1) OTHER □ (0) INDUSTRIAL ■ PLANT LOCATION
★ (0) UNKNOWN ◆ (0) TRIBAL + (0) INDEX SITE * (0) NON-EPA (5 DISPLAYED)

USEPA, OAQPS, TSD, NATIONAL AIR DATA BRANCH 08/13/93

APPENDIX L

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16. ABSTRACT

This document is designed to familiarize State and local air authorities with the Photochemical Assessment Monitoring Stations (PAMS) program and to provide guidance for designing PAMS monitoring networks. The document provides an explanation of the requirements of 40 CFR 58 pertaining to PAMS, specific guidance on network design and monitor siting, operational requirements, planning and approval processes, and data storage and communications systems.

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