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AIR QUALITY MONITORING INTERIM

GUIDANCE

U.S. ENVIRONMENTAL PROTECTION AGENCY

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AIR QUALITY MONITORING

INTERIM GUIDANCE

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PREFACE

The Monitoring and Data Analysis Division of the Office of Air Quality Planning and Standards has prepared this report entitled "Air Quality Monitoring Interim Guidance" for use by the Regional Offices of the Environmental Protection Agency. The purpose of the report is to provide general guidance information on current air quality monitoring requirements and principles. This will allow the Regional Offices to prioritize their FY1974 monitoring related resources and program activities. Adherence to the guidance presented in the report will, hopefully, ensure mutually compatible ambient air quality data acquisition by all States and Regions and will also better allow the Regional Offices to evaluate State monitoring programs and related activities. Moreover, risks involved in policy decisions concerning National Ambient Air Quality Standards should be minimized. This report is intended to update previously issued official and informal air quality monitoring documents and will serve on an interim basis until more specific and detailed guidance documents are developed.

1. INTRODUCTION

The purpose of this report, a first in a series to be issued by the Monitoring and Data Analysis Division of the Office of Air Quality Planning and Standards, is to provide the Regional Offices of EPA with a general overview of both the issues and principles involved with the establishment and operation of the air quality monitoring program which is required under the State Implementation Planning process. It is expected that through a thorough understanding of these considerations that the Regional Offices will be better able to prioritize their FY1974 monitoring related program activities and resource allocations.

Information presented in this report* is intended to fulfill the following immediate objectives:

- Ensure that mutually compatible ambient air quality data are obtained by all States and Regions.
- Minimize risks associated with policy decisions involving National Ambient Air Quality Standards.

*Guidance presented in this report is geared toward the six criteria pollutants (sulfur dioxide, particulates, carbon monoxide, photochemical oxidants, hydrocarbons, nitrogen dioxide) and present State Implementation Plan requirements. Future issuances will be concerned with proposed SIP requirements dealing with such issues as complex sources and non-degradation.

- Better allow the Regional Offices to evaluate State and local air monitoring programs and related activities.
- Summarize and update existing monitoring information in one document based on the present state of knowledge.

Previous issuances by EPA related to air quality monitoring have been based more on operational experience with monitoring networks than on developmental research studies. This report is no exception. Information and guidance gleaned from such experience are an indirect outgrowth of monitoring activities which were intended to provide a basic characterization of the ambient air quality in the general atmosphere of an urban or rural area or around a specific source. Therefore, present guidance is of necessity limited by the constraints within which these previous efforts were conducted. Future guidance will also be based to some degree on retrospective analyses of existing networks and on data available from various on-going research projects. This should be the case until the monitoring information which is being obtained from evolving State and local networks can be evaluated in terms of how well it fulfills the decision-making needs of the Regional Offices. These needs relate to:

> EPA's desire to minimize risks in making yes/no decisions relative to the progress States are making toward attainment or non-attainment of ambient air quality standards; surveillance and subsequent action with respect to episodes; attainment and maintenance of standards.

- EPA's ability to ensure the representativeness of State derived data.
- EPA's ability to make risk decisions with respect to prioritization, strategy development and resource allocation.

Interim guidance presented in this report should allow the Regional Offices to develop the bases for the various decisions related to the above with some degree of confidence. It should also allow them to better discharge their monitoring responsibilities which specifically include the ability to:

- Ensure that the States
    - Utilize standard sampling methodologies and proper quality control procedures
    - Operate and maintain adequate analytical laboratories
    - Enter air quality data into the National Aerometric Data Bank.
- Check the validity of incoming data
- Obtain episode data
- Evaluate State and local air monitoring networks
- Establish quality assurance programs
- Assist in identifying "hot spots"
- Analyze data to assess compliance with National Ambient Air Quality Standards
- Predict trends in air quality
- Develop and operate regional monitoring programs which meet national and regional monitoring objectives.

Information presented in this report will serve on an interim basis until more explicit and detailed guidance is developed by the Monitoring and Data Analysis Division.

The following sections include a brief review of EPA mandated monitoring activities, factors involved in the physical collection of air quality data, general air quality data handling procedures and an example of an air quality monitoring evaluation process.

2. MANDATES FOR AIR QUALITY MONITORING

Air quality surveillance is the systematic collection and evaluation of aerometric and related data which include pollutant concentrations, source operating characteristics and emissions, and certain meteorological parameters. This report is concerned with monitoring operations* which are designed to measure pollutants emitted to or present in the atmosphere. Information provided from these monitoring operations should be responsive to the following objectives:

1. Judging compliance with and/or progress made toward meeting ambient air quality standards.

2. Activating emergency control procedures intended to prevent air pollution episodes.

3. Determining pollution trends throughout a region including the nonurban areas.

4. Developing a data base for the assessment of pollutant effects; land use and transportation planning; study of pollutant interactions, patterns and trends; evaluation of abatement strategies and direct enforcement of control regulations; and to improve the reliability of diffusion models through validation procedures.

The requirements and need for monitoring are closely related to the pollution control requirements specified by the

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* These operations include three distinct but interrelated elements: sampling networks, laboratory support, and data acquisition and analysis.

Clean Air Act of 1967 and the Clean Air Amendments of 1970. This legislation authorizes EPA to:

- Promulgate national ambient air quality standards
- Promulgate national emission standards of performance for new stationary standards
- Promulgate national emission standards for hazardous pollutants
- Promulgate national emission standards for motor vehicles and aircraft.

The development of these standards and subsequent enforcement require that information on ambient concentrations of pollutants concerned by this legislation be available.

Specifically, the following monitoring related activities are mandated*:

1. Clean Air Act, December 1970, Section 110(a) (2) (C)

   Each State shall adopt a plan which provides for the implementation, maintenance and enforcement of primary and secondary standards and which includes..."provision for establishment and operation of appropriate devices, methods, systems, and procedures necessary to (i) monitor, compile, and analyze data on ambient air quality and (ii) upon request, make such data available to the Administrator."

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*As of the date of this report, some of the Federal Register Notices are for proposed regulations. Therefore, the monitoring activities alluded to in these proposed regulations are not now required (e.g., for complex sources and no significant deterioration).

2. Federal Register, April 30, 1971, Volume 36 Number 84

    a. Details national primary and secondary ambient air quality standards for sulfur dioxide, particulates, carbon monoxide, photochemical oxidants, hydrocarbons, and nitrogen dioxide.

    b. Specifies standard reference methods for above pollutants.*

3. Federal Register, August 14, 1971, Volume 36 Number 158

    a. Classification of Regions according to pollutant concentrations.

    b. Quarterly air quality reports are required.

    c. Minimum air quality network requirements are delineated.

    d. At least one sampling site must be located in the area of estimated maximum pollutant concentration.

    e. Description of the air quality surveillance system should include:

        - Basis for the design of the system
        - Location of samplers by UTM grid coordinates
        - Sampling schedules
        - Methods of sampling and analyses
        - Method of data handling and analysis procedures
        - Timetable for installation of additional equipment
        - Stations selected for monitoring during episodes

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*See 7b

4. Federal Register, February 1, 1973, Volume 38 Number 21

   Quarterly reports submitted by the States to the Administrator through appropriate Regional Office shall include all air quality data from the surveillance network:

   . according to the SAROAD format

   . within 15 days after the end of each reporting period.

5. Federal Register, April 18, 1973, Volume 38 Number 74 (proposed rules)

   Determinations of impact of mobile source emissions as a result of a "complex" source require data on:

   . present air quality, topography, meteorology

   . size of facility, nature, design

   . expected mode of operation.

6. Federal Register, May 7, 1973, Volume 38 Number 87 (proposed rules)

   Revises secondary standards for sulfur dioxide by revoking the annual standard.

7. Federal Register, June 8, 1973, Volume 38 Number 110 (proposed rules)

   a. In transportation control measures development, (hydrocarbon, nitrogen dioxide) carbon monoxide and photochemical oxidant data must be compatible with the emissions inventory for the subregion involved.

   b. Specifies three tentative candidate reference methods for the determination of nitrogen dioxide. (Replaces method promulgated on April 30, 1971)

8. Federal Register, June 18, 1973, Volume 38 Number 116 (proposed rules)

   Areas which due to growth rate will exceed National Ambient Air Quality Standards in the next 10 years should be identified and data on air quality and human activity should be provided.

9. Federal Register, July 16, 1973, Volume 38 Number 135 (proposed rules)

   For purposes of evaluating the prevention of significant air quality deterioration, the following are required:

   - 1972 baseline particulate and sulfur dioxide data including the maximum concentrations in an area.
   - Where a source (as described in the Federal Register) is to be constructed a minimum of 2 continuous instruments for sulfur dioxide and/or 2 intermittent instruments for particulate matter.
   - The source monitor instruments should be located in the zone of expected maximum concentration as determined by diffusion modeling.
   - The source should summarize the data monthly and report to the State semiannually.

3. AIR QUALITY DATA ACQUISITION

The levels and distributions of air quality are often quite variable in both time and space. Knowledge of these variations, their significance and their causes, is essential for the proper interpretation of air quality data. The degree to which these variations are detected and quantified depends, in large part, on the adequacy of coverage and "representativeness"* of monitoring sites within an Air Quality Control Region (AQCR). Available pollutant measurements for many AQCR's are inadequate for comprehensive air quality and trend analyses. However, it is expected that through adherence to, and consideration of, the general factors and principles discussed below that the quantity, quality and uniformity of data being collected will be enhanced and that the data requirements of EPA's monitoring objectives will be fulfilled.

3.1 General Network Design Considerations

The development of network designs should be based on knowledge of the existing pollution levels and patterns within the AQCR. The areas of highest pollution levels must be

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*Representativeness connotes the effect of sampler placement on the usability of the measurements.

defined, together with geographical and temporal variations in the ambient levels. Isopleth maps of ambient concentrations derived from past sampling efforts and/or from diffusion modeling are the best tools for determining the number of stations needed and for suggesting station locations. Also, information on meteorological parameters, topography, population distribution, present and projected land uses including areas where growth is anticipated, pollution sources and areas of potential sources is extremely useful in network design. Where isopleth maps are not available, information from various organizations such as the Bureau of Census and local planning agencies can provide the basis for initial designs. Additionally, information on emission densities and/or land use can be used together with wind-rose data to pinpoint areas of expected higher concentrations. Maps of population density are essential in locating stations for monitoring during episodes and provide a general indication of human exposure in relation to various source distribution patterns.

For many areas, information as described above may be wholly inadequate and/or unavailable. In these cases, the resulting networks will need to be modified as more information and experience are obtained. But this should be true even in those areas where adequate information is available. Network design should be continually assessed and evaluated in terms of how well the resulting data fulfills the previously discussed monitoring objectives keeping in mind the need for monitoring the data base required for long term trend analysis. As more resources become available (and based on the objectives-evaluation process), network designs should be upgraded accordingly.

3.2 Size of Monitoring Network

The number of sampling stations required depends primarily on the existing pollution levels, their variability, and the size of the region.* The size of the network must be adequate to allow for definition of the area(s) where ambient concentrations may be expected to exceed air quality standards. Information on air quality in other areas, including the non-urban portions of the region, should also be collected. Also, issues such as complex sources, transportation control measures, hot spots, supplementary control systems, and fugitive dust problems may influence the monitoring network size.

A first approximation of the number of stations required in a region may be obtained from general curves based on a qualitative evaluation of cities of different population classes in terms of their existing networks, pollution patterns, geographic distribution of sources, and the like.** The relationship

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* Most obviously availability of resources is also an important consideration.

** Guidelines: Air Quality Surveillance Networks, Office of Air Programs Publication No. AP-98, U.S. EPA, May 1971.

between population and network size (see below) was derived from such investigations, combined with experience. In general, population is a good index to network size. In certain situations, however, such as the relative absence of sulfur dioxide in western portions of the United States, such relationships are not applicable. In these situations, additional information, such as source strengths and their locations, is essential before network size can be determined.

Based on the above population relationship and according to a priority classification assigned to each AQCR for carbon monoxide, nitrogen dioxide, particulate matter, photochemical oxidants, and sulfur dioxide, the minimum size of an air quality monitoring network can be determined. An AQCR is assigned a priority classification according to a comparison of its air quality levels to the air quality standards. Generally in priority I AQCR's the air quality is poorer than primary standards. In priority II regions it is between secondary and primary levels and in priority III regions it is better than secondary standards. For particulate matter and sulfur dioxide, the classification criteria provide for priorities of I,II,or III while for carbon monoxide, nitrogen dioxide, and photochemical oxidants priorities of I or III are applicable.

Table I presents the recommended minimum number* of air quality monitoring sites by AQCR classification and population class. (Note

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* This number omits sites for monitoring complex sources, nondegradation, transportation control measures, supplementary control systems, fugitive dust. Guidance on these issues is forthcoming.

Table 1. RECOMMENDED MINIMUM NUMBER OF AIR QUALITY MONITORING SITES

Classification of region	Pollutant	Measurement method[i]	Minimum frequency of sampling	Region population[c]	Minimum number of air quality monitoring sites[h]
I	Suspended particulates	High volume sampler	One 24-hour sample every 6 days[a]	Less than 100,000	1
				100,000–1,000,000	4+0.6 per 100,000 population.
				1,000,001–5,000,000	7.5+0.25 per 100,000 population.
				Above 5,000,000	12+0.16 per 100,000 population.
		Tape sampler	One sample every 2 hours		One per 250,000 population up to eight sites.
	Sulfur dioxide	Pararosaniline or equivalent[d]	One 24-hour sample every 6 days (gas bubbler).[a]	Less than 100,000	3.
				100,000–1,000,000	2.5+0.5 per 100,000 population.
				1,000,001–5,000,000	6+0.15 per 100,000 population.
				Above 5,000,000	11+0.05 per 100,000 population.
			Continuous	Less than 100,000	1.
				100,000–5,000,000	1+0.15 per 100,000 population.
				Above 5,000,000	6+0.05 per 100,000 population.
	Carbon monoxide	Nondispersive infrared or equivalent.[e]	Continuous	Less than 100,000	1.
				100,000–5,000,000	1+1.15 per 100,000 population.
				Above 5,000,000	6+0.05 per 100,000 population.
	Photochemical oxidants	Gas phase chemiluminesence or equivalent.[f]	Continuous	Less than 100,000	1.
				100,000–5,000,000	1+0.15 per 100,000 population.
				Above 5,000,000	6+0.05 per 100,000 population.
	Nitrogen dioxide *				
II	Suspended particulates	High volume sampler	One 24-hour sample every 6 days[a]		3.
		Tape sampler	One sample every 2 hours		1.
	Sulfur dioxide	Pararosaniline or equivalent[d]	One 24-hour sample every 6 days (gas bubbler).[a]		3.
			Continuous		1.
III[g]	Suspended particulates	High volume sampler	One 24-hour sample every 6 days[a]		1.
	Sulfur dioxide	Pararosaniline or equivalent[d]	One 24-hour sample every 6 days (gas bubbler).[a]		1.

[a] Equivalent to 61 random samples per year.

[b] Equivalent to 26 random samples per year.

[c] Total population of a region. When required number of samplers includes a fraction, round-off to nearest whole number.

[d] Equivalent methods are (1) Gas Chromatographic Separation—Flame Photometric Detection (provided Teflon is used throughout the instrument system in parts exposed to the airstream), (2) Flame Photometric Detection (provided interfering sulfur compounds present in significant quantities are removed), (3) Coulometric Detection (provided oxidizing and reducing interferences such as O_3, NO_2, and H_2S are removed), and (4) the automated Pararosaniline Procedure.

[e] Equivalent method is Gas Chromatographic Separation—Catalytic Conversion—Flame Ionization Detection.

[f] Equivalent methods are (1) Potassium Iodide Colorimetric Detection (provided a correction is made for SO_2 and NO_2), (2) UV Photometric Detection of Ozone (provided compensation is made for interfering substances), and (3) Chemiluminescence Methods differing from that of the reference method.

[g] It is assumed that the Federal motor vehicle emission standards will achieve and maintain the national standards for carbon monoxide, nitrogen dioxide, and photochemical oxidants; therefore, no monitoring sites are required for these pollutants.

[h] In interstate regions, the number of sites required should be prorated to each State on a population basis.

[i] All measurement methods, except the Tape Sampler method, are described in the national primary and secondary ambient air quality standards published in the FEDERAL REGISTER on Apr. 30, 1971 (36 F.R. 8186). Other methods together with those specified under footnotes (d), (e), and (f) will be considered equivalent if they meet the following performance specifications.

Specification	Pollutants: Sulfur dioxide	Pollutants: Carbon monoxide	Pollutants: Photochemical oxidant (corrected for NO_2 and SO_2)
Range	0–2,620 µg./m.³ (0–1 p.p.m.)	0–58 mg./m.³ (0–50 p.p.m.)	0–980 µg./m.³ (0–0.5 p.p.m.).
Minimum detectable sensitivity	26 µg./m.³ (0.01 p.p.m.)	0.6 mg./m.³ (0.5 p.p.m.)	20 µg./m.³ (0.01 p.p.m.).
Rise time, 90 percent	5 minutes	5 minutes	5 minutes.
Fall time, 90 percent	5 minutes	5 minutes	5 minutes.
Zero drift	±1 percent per day and ±2 percent per 3 days.	±1 percent per day and ±2 percent per 3 days.	±1 percent per day and ±2 percent per 3 days.
Span drift	±1 percent per day and ±2 percent per 3 days.	±1 percent per day and ±2 percent per 3 days.	±1 percent per day and ±2 percent per 3 days.
Precision	±2 percent	±4 percent	±4 percent.
Operation period	3 days	3 days	3 days.
Noise	±0.5 percent (full scale)	±0.5 percent (full scale)	±0.5 percent (full scale).
Interference equivalent	26 µg./m.³ (0.01 p.p.m.)	1.1 mg./m.³ (1 p.p.m.)	20 µg./m.³ (0.01 p.p.m.).
Operating temperature fluctuation	±5° C.	±5° C.	±5° C.
Linearity	2 percent (full scale)	2 percent (full scale)	2 percent (full scale).

The various specifications are defined as follows:

Range: The minimum and maximum measurement limits.

Minimum detectable sensitivity: The smallest amount of input concentration which can be detected as concentration approaches zero.

Rise time 90 percent: The interval between initial response time and time to 90 percent response after a step increase in inlet concentration.

Fall time 90 percent: The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.

Zero drift: The change in instrument output over a stated time period of unadjusted continuous operation, when the input concentration is zero.

Span drift: The change in instrument output over a stated period of unadjusted continuous operation, when the input concentration is a stated upscale value.

Precision: The degree of agreement between repeated measurements of the same concentration (which shall be the midpoint of the stated range) expressed as the average deviation of the single results from the mean.

Operation period: The period of time over which the instrument can be expected to operate unattended within specifications.

Noise: Spontaneous deviations from a mean output not caused by input concentration changes.

Interference equivalent: The portion of indicated concentration due to the total of the interferences commonly found in ambient air.

Operating temperature fluctuation: The ambient temperature fluctuation over which stated specifications will be met.

Linearity: The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

* EPA is currently evaluating three measurement techniques for NO_2 and will publish a new reference method by March 1974. The method chosen will prescribe the sampling frequency and minimum number of air monitoring sites.

that the standard reference method for nitrogen dioxide is currently being reevaluated in terms of three proposed tentative candidate methods. Meanwhile, in cases in which it appears desirable that State NO_2 monitoring activities be continued, such continuation is to be encouraged provided that either chemiluminescence or Saltzman methods are used.)

3.3 Location of Monitoring Stations

The location of sampling stations must be such that the resulting information can be used to fulfill the data requirements of the previously presented monitoring objectives. The monitoring network should consist of stations that are:

a. Pollution oriented

Areas most heavily polluted must be identified and monitored. It is in these areas that progress toward meeting air quality standards is most critical.

b. Population oriented

A portion of the network must be located according to population distribution. This is especially important during episodes.

c. Representative of the Region

Area-wide data are needed to show conformity or lack of to the air quality standards. This includes both urban and rural portions of the AQCR. In rural areas, consideration must be given to places where growth is anticipated or new sources are expected to locate.

d. Source category and/or source oriented

These stations provide a measure of the effectiveness of control strategies.

e. Background oriented

For assessing the quality of air entering the Region, stations must be situated on the periphery of the Region.

Many stations are capable of meeting more than one of the above general criteria. On a priority basis, the stations should be capable of at least providing information on:

- Areas of estimated maximum concentration in all major urban complexes of the Region (particulates and sulfur dioxide in priority I and IA Regions).
- Transportation related pollutants in those cities and regions requiring transportation control measures.
- Trends and prorgress toward achievement of National Ambient Air Quality Standards
- Pollutant levels during episodes

3.4 Sampling Site Characteristics

In the selection of a particular site for a single sampler or a complex station, it is essential that the sampler(s) be situated to yield data representative of the location and not be unduly influenced by the immediate surroundings. Although no definitive information is available concerning how air quality measurements are affected by the nearness of buildings, height from ground, and the like, both general and specific guidance can be provided based on operational experience.

3.4.1 General Siting Considerations

a. Avoid sites where there are restrictions to air flow in the vicinity of the air inlet -- such as adjacent to buildings, parapets, trees.

b. Avoid sampling sites that are unduly influenced by downwash from a minor local source or by reentrainment of ground dust, such as a stack located on the roof of a building where the air inlet is located or close to ground level near an unpaved road. In the latter case, either elevate the sampler intake above the level of maximum ground turbulence effect or place the sampler intake away from the source of ground dust.

c. The monitoring site should be generally inaccessible to the public; have adequate security, electricity and plumbing.

d. Uniformity in height above ground level is desirable. Roof top* samplers should be utilized in moderate to high density areas (in terms of structures). Ground level samplers should be utilized in low or sparse density areas (in terms of structures).

*Roof top is defined as the average building height above ground for a particular section of the Region.

3.4.2 Specific Siting Considerations

Specific guidelines for siting air monitoring stations in areas of maximum pollutant concentrations are presented in Table 2. In addition, Table 3 presents specific stationary pollutant sources for which monitoring (e.g., for hot spots) should be undertaken, where applicable.

3.5 Sampling Frequency

Sampling averaging times depend upon the primary use of the data. To show compliance with, or progress towards meeting ambient air quality standards, the sampling equipment must be capable of producing data consistent with the averaging times specified by the standards. For example, if the standards are set in terms of daily and hourly averages, then the sampling frequencies must be in the same averaging time.

Although standards for particulates and sulfur dioxide, for example, are in terms of annual averages and maximum daily concentrations,it is not economically feasible to operate the entire network on a daily basis. Adequate coverage may be maintained with intermittent sampling at frequencies calculated statistically for desired levels of precision. In order to increase the statistical precision of the estimate for the annual average, a systematic sampling schedule should be utilized.* Also, the frequency of air monitoring necessary to characterize an air pollutant for a given time period and area can be determined from equations that

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* G. Akland, Design of Sampling Schedules, JAPCA22(4), April 1972.

Table 2. SITING GUIDELINES FOR AREAS OF ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS

POLLUTANT CATEGORY	POLLUTANT	STATION LOCATION	POSITION OF AIR INLET: SUPPORTING STRUCTURE	POSITION OF AIR INLET: VERTICAL CLEARANCE ABOVE SUPPORTING STRUCTURE, FEET	POSITION OF AIR INLET: HORIZONTAL CLEARANC BEYOND SUPPORTING STRUCTURE, FEET[a]
Primary Stationary Source Pollutant	SO_2	Determined from atmosphere diffusion model, historical data, emission density, and representative of population exposure.	Ground or Roof Top	10-15 10-15	> 5 > 5
	NO_2[c]	Same as above	Ground or Roof Top	10-15 10-15	> 5 > 5
	Particulates	Same as above	Roof Top	10-15	> 3
Primary Mobile Source Pollutant	CO (1-hour averaging time)	Representing area of high traffic density, slow moving traffic & obstructions to air flow (tall buildings) & pedestrian population such as major downtown traffic intersections. 10-15 feet from street curb.	Ground	5-6	> 3
	CO (8-hour averaging time)	Representing area of high traffic density in residential area such as major thoroughfare in center city or suburban area. 10-15 feet from street curb.	Ground	5-6	> 3

Table 2. SITING GUIDELINES FOR AREAS OF ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS (CONTINUED)

			POSITION OF AIR INLET		
POLLUTANT CATEGORY	POLLUTANT	STATION LOCATION	SUPPORTING STRUCTURE	VERTICAL CLEARANCE ABOVE SUPPORTING STRUCTURE, FEET	HORIZONTAL CLEARANCE BEYOND SUPPORTING STRUCTURE, FEET[a]
Secondary Pollutant	Oxidants	Representing residential area downwind of downtown area (5-15 miles from downtown and > 300 feet from major traffic arteries or parking areas).[b]	Ground or	10-15	> 5
			Roof Top	10-15	> 5
	NO_2[c]	Same as above	Ground or	10-15	>5
			Roof Top	10-15	>5

a Not applicable where air inlet is located above supporting structure.

b Downwind of prevailing daytime wind direction during oxidant season.

c When standard reference method (or equivalent) is suggested.

Table 3. MAJOR STATIONARY POLLUTANT SOURCES

SOURCE*	POLLUTANT				
	Particulates	CO	SO_2	HC	NO_2
Asphalt concrete plants	X				
Petroleum refineries	X	X	X	X	
Storage vessels for petroleum liquids				X	
Secondary lead smelter	X				
Secondary brass & bronze production plants	X				
Iron and steel plants	X	X			
Sewage treatment plants	X				
Fossil fuel steam electric ($>$ 1000 million BTU per household input)	X		X		X
Cool cleaning plants	X				
Primary aluminum ore reduction	X				
Lime plants	X				
Phosphate rock crushing	X				
By product coke oven batteries	X				
Municipal incinerators ($>$ 250 tons per day of refuse)	X				
Portland cement plants	X				
Nitric acid plants					X
Sulfuric acid plants			X		

*Also, any source emitting greater than 4000 tons per year of these pollutants.

Table 3. MAJOR STATIONARY POLLUTANT SOURCES (CONTINUED)

SOURCE*	POLLUTANT Particulates	CO	SO_2	HC	NO_2
Carbon black plants	X	X	X		
Feed & grain mills	X				
Sulfur recovery plants			X		
Copper, zinc, lead smelters	X		X		
Pulp and papermills	X	X	X		
Grey iron cupolas	X	X			

*Also, any source emitting greater than 4000 tons per year of these pollutants.

predict the precision of the sample mean of the air pollutant as a function of: the frequency of sampling, the standard deviation of the logs of the air pollutant measurements, and the level of confidence*. Table 1 presents the recommended sampling frequencies based on the above considerations. It should be noted that for detection of maximum pollutant concentrations the sampling frequencies may require modification in certain portions of the AQCR.

3.6 Instrumentation

A variety of sampling devices and instruments are being used to collect samples and measure ambient air quality. Mechanical samplers are most generally used to collect integrated samples in the field. (Integrated sampling is conducted over a given time period to yield a single sample to represent the entire time period.) In automatic sampler-analyzers, the collection and analytical processes are combined in a single device. This type of instrument produces a continuous analysis, with the output in a machine-readable format or in a form suitable for telemetry to a central data-acquisition facility. Table 4 summarizes general information on types of instrumentation, use, specificity and associated costs.

Standard reference methods for the operation of particulate, sulfur dioxide, carbon monoxide, photochemical oxidant and hydrocarbon instrumentation are specified in the Federal Register

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*W.F. Hunt, The Precision Associated with the Sampling Frequency of Log-Normally Distributed Air Pollutant Measurements, JAPCA 22(9), September 1972.

Table 4. CLASSIFICATION OF AIR POLLUTION SAMPLING TECHNIQUES

Type	Use	Specificity	Common averaging time	Relative cost[a]	Required training of personnel[b]	Remarks
Mechanical						
Hi-Vol	Integrated quantification	Total suspended particulate and multiple specific pollutants	24 hours	Moderate	Moderate	Detailed chemical analysis of Hi-Vol and gas samples require sophisticated laboratory trained chemists, and is costly.
Gas sampler	Integrated quantification of gas	SO_2, NO_2	24 hours	Moderate	High	
Spot tape sampler	Relative soiling index	Unknown	2 hours	Low	Low	Provides only a rough, relative index of particulate soiling.
Automatic						
Gas	Continuous analysis of gaseous pollutants	Single gas or group of related gases	Continuous sample integration usually 1-15 months	Moderate to high	Moderate to high	Continuous measurements allow use of any desired averaging time by computation. Accuracy is generally much better than other methods. Calibration is simplified. Data is available instantaneously.
Particulate sorting (automatic tape)	Continuous analysis of soiling rate	Unknown	(Same as above)	Moderate	Moderate	

[a] Low refers to \$0-\$500; Moderate refers to \$500-\$2000; and High refers to above \$2000.

[b] Low requires common maintenance; Moderate requires a technician; and High requires an experienced technician or professional with professional support staff.

of April 30, 1971. In addition, three tentative candidate reference methods for nitrogen dioxide have been proposed in the June 8, 1973, Federal Register.

Other sampling and analysis methods are acceptable and will be considered equivalent to the reference methods if it can be demonstrated to the EPA Administrator's satisfaction that they have a consistent relationship to the reference method and/or at the Administrator's discretion meet various performance specifications. Such specifications include the following factors:

- Sensitivity
- Stability and reliability
- Zero drift
- Reproducibility
- Precision
- Response time
- Calibration
- Accuracy

The actual selection of particular monitoring equipment should follow a careful evaluation of information pertaining to the instrumental specifications and a knowledge of the user's specific application. This selection process should be objective and include considerations of (e.g., for automatic air monitoring equipment*):

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*Field Operations Guide for Automatic Air Monitoring Equipment, U.S. EPA, October 1972.

a. Instrument description factors

- Application
- Measurement principle
- Schematic diagram
- Auxiliary equipment

b. Installation and operation factors

- Space requirements
- Weight
- Power requirements
- Temperature operating range
- Humidity operating range
- Vibration operating range
- Portability
- Signal output
- Air sampling rate
- Sample line pressure
- Calibration
- Sample line construction
- Reagent flow rate
- Reagent consumption

c. Performance factors

- Range
- Sensitivity
- Rise time

- Fall time
- Zero drift
- Span drift
- Precision
- Operation period
- Noise
- Interference
- Operating temperature fluctuation
- Linearity
- Specificity

The objective evaluation process for equipment selection should also be based on a general understanding of the measurement technique employed by various monitors. Operational principles commonly incorporated in continuous air monitoring instrumentation include:

- Conductivity
- Colorimetry
- Coulometry
- Flame photometry
- Flame ionization
- Nondispersive infrared photometry
- Reflectance and transmittance
- Nephelometry
- Chemiluminescence

Information on these principles including their specificities and interferences is presented in the previously referred Field Operations Guide.

The selection of a specific monitoring instrument should be made only after a comprehensive evaluation which considers the above factors and principles. It is strongly recommended that no instrument be purchased unless the manufacturer provides a guarantee that the instrument will perform in accordance with the specifications published in either the 30 April 1971 Federal Register or the draft equivalency guideline document entitled "Ambient Air Monitoring Equivalent and Reference Methods." Interim guidance on the selection of air quality monitoring instrumentation can be obtained from the Quality Assurance and Environmental Monitoring Laboratory at NERC, RTP/N.C. QAEML will provide this guidance until equivalency guidelines on methods and instrumentation are published in the Federal Register.

3.7 Laboratory Quality Assurance

Quality assurance is an integral part of any viable monitoring effort. It begins when the selected methodology obtains a valid measure of the analytical parameter, when the laboratory tools (reagents, instruments, standards) are of invariant quality, and when the operational techniques used ensure exacting replication for the entire analytical procedure. The objective of quality assurance is to produce reliable data for decision making.

The two primary aspects of a quality assurance program are standardization and quality control. While standardization development (production of reference methods, equivalency guidelines, monitoring procedures and guidelines) is the general responsibility of EPA, the National Bureau of Standards, and certain professional associations and committees, quality control is within the purview of State air pollution control laboratories.

The Regional Offices should assist the States in developing an effective quality control program through the implementation of the following:

- Training of managers and operators
- Data reporting schemes which include evidence of quality control considerations
- Operation of an intralaboratory quality control program
- Periodic, random checking of instrumentation and equipment calibration
- Cross-checking of samples
- Checking of reagents, reference samples, and quality of personnel
- Participation in an interlaboratory testing program
- Use of formalized schedules, procedures, logbooks and calibration curves for all monitors.

4. AIR QUALITY DATA ANALYSIS

Even the best air quality data are of little value unless they are properly analyzed and interpreted. While analysis calls for the use of various statistical procedures and methods, the interpretation requires a complete and detailed knowledge of where and under what conditions the data were collected, methods utilized, assumptions, time span, etc. Without this descriptive information, the data collected are meaningless.

Air quality data must first be validated before analysis and interpretation can proceed. This should involve:

a. Application of corrections for known instances of instrument malfunction, drift, or other deviations from normal instrument operation.

b. Using various criteria such as looking for atypical high values, low values and extreme changes in values for consecutive observations. These former data values (outliers) should be further analyzed to ascertain their basis. Steps in handling outliers include:

   - Checking for instrument or coding errors
   - Checking historical data
   - Examining meteorological data
   - Reviewing possible changes in the environment of the monitoring site

c. Reporting data values based on the accuracy and precision inherent in the instruments and analytical methodology.

d. Determining the completeness of the data base. (For the data to be representative, samples should be collected throughout the time interval under study rather than bunched all together.)

e. Developing surrogate procedures for handling data values below the limits of detection of the instruments employed.

Once the data has been completely validated and checked for supporting descriptive information, various statistical analyses can be performed. These can range from the calculation and comparison of means and variances, the development of frequency distributions, development of wind rose-air pollutant concentration correlations and isopleth contours to the use of time series analysis and other trend techniques. There are various computer based calculation routines and data reporting programs available from EPA which perform most of the above analyses. For example, there are various meteorological programs available in PL-1 that correlate wind speed, wind direction and pollutant values. Also EPA's SAROAD system can be utilized to access data for various analysis and reporting purposes.

Currently there is under development a Comprehensive Data Handling System which would give State agencies the ability to perform statistical analysis of their air quality data through a statewide aerometric data system. This system would utilize SAROAD formats and editing routines.

As discussed in Section 2, there are various air quality data reporting requirements imposed on the States by EPA. The normal flow of ambient air data (including meteorological data) is from State and local agencies to the EPA Regional Offices and then to the National Air Data Branch of the Monitoring and Data Analysis Division. Data submitted to the Regional Offices must be in SAROAD* format on either coding forms, punched cards or magnetic tape.

The Regional Office should transmit the State and local data to the National Air Data Branch either by wire or mail. The Branch will process the data through editing programs and will provide error messages to the Regional Offices. The Regional Offices are then responsible for correcting errors through contact with the States. Corrected data is then to be resubmitted to the Branch for file updating and the performance of various statistical analyses. Figure 1 details the data flow process from the State and local Agency source through the various validation and verification procedures which are performed by the Branch in conjunction with the Regional Offices.

*APTD Publications 0663, 0907, 0633

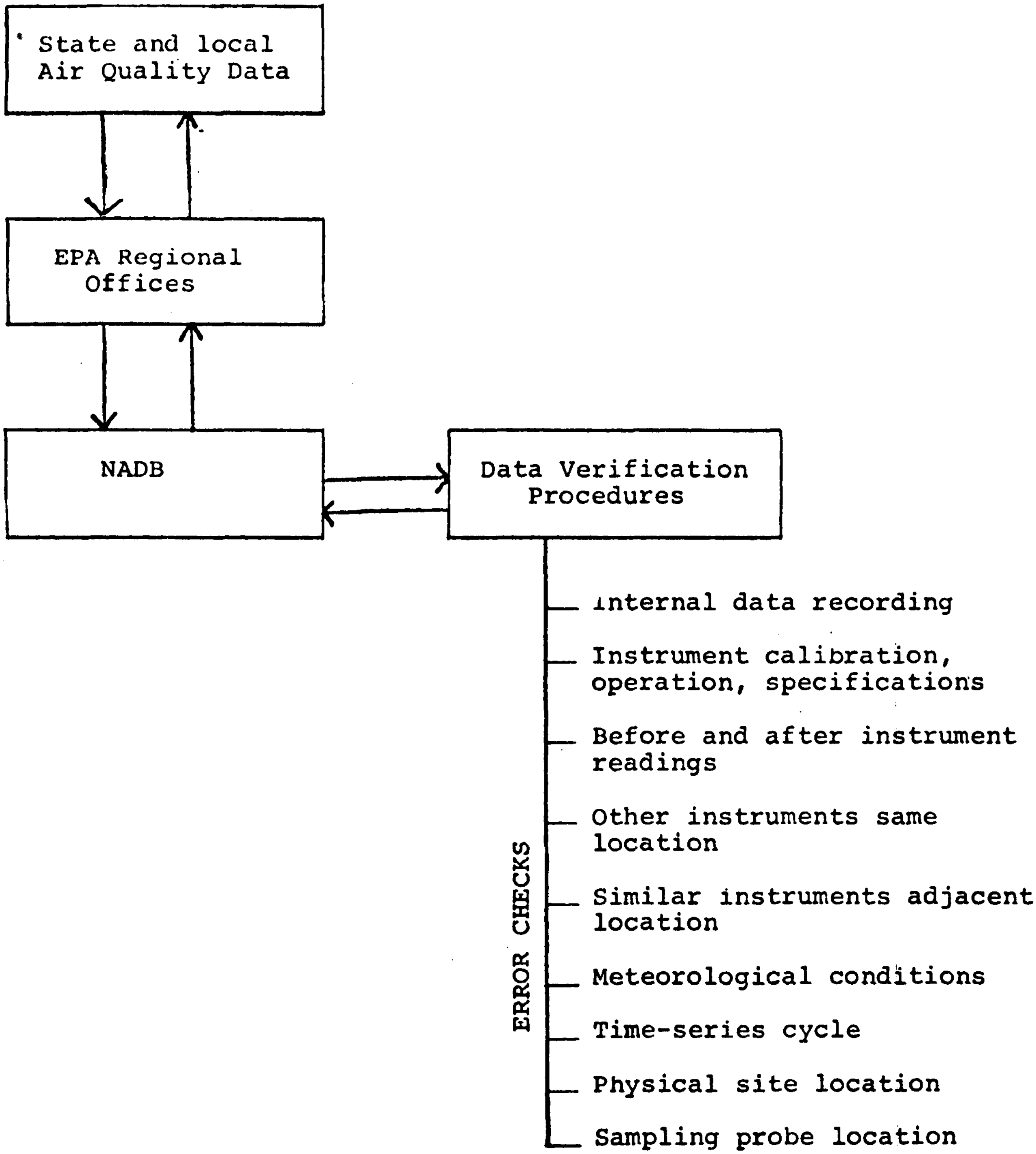

Figure 1. AIR QUALITY DATA FLOW

5. AIR QUALITY MONITORING EVALUATION

Regional Office evaluation of State and local air monitoring programs and data should be based on the factors and principles discussed in the previous sections. Such an evaluation process must include, as a minimum, consideration of the following elements:

a. Status and reliability of the air quality network

- Is the network large enough to ensure adequate coverage of the Region? Will hot spots be detected?
- Are sites properly located with respect to major sources and height above ground?
- Are episode monitoring sites identified?
- Is the sampling methodology equivalent to the EPA reference methods?
- Are proper quality control procedures being utilized?
    - Are instruments being properly calibrated on a routine basis?
    - Are standard reference materials being used?

b. Growth and activity of sources during monitoring periods

- How did the industrial and economic activities change?

- Were there significant deviations in emission patterns?
- In what areas did growth take place?

c. Atmospheric characteristics

- Was the weather unusually warm or cold?
- What was the average wind speeds and direction of predominant winds?
- What were the frequency and duration of inversions and stagnations?

d. Laboratory quality control

- What sample handling and verification methods were used?
- What are the details of the analytical method used?
- What is the type and source of the standard reference materials and samples?
- What is the frequency of use of check samples?
- When was the last time the laboratory participated in an interlaboratory testing program?
- What is the quality and calibration state of instrumentation?
- Does the laboratory have an intra-laboratory testing program?
- What is the level and training of the laboratory personnel?

e. Data analysis

- Have the data been properly validated?
- Has descriptive information been provided with the data?
- Are SAROAD reporting formats being used?