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Standard Practice for Planning the Sampling of the Ambient Atmosphere[1]

This standard is issued under the fixed designation D1357; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this practice is to present the broad concepts of sampling the ambient air for the concentrations of contaminants. Detailed procedures are not discussed. General principles in planning a sampling program are given including guidelines for the selection of sites and the location of the air sampling inlet.

1.2 Investigations of atmospheric contaminants involve the study of a heterogeneous mass under uncontrolled conditions. Interpretation of the data derived from the air sampling program must often be based on the statistical theory of probability. Extreme care must be observed to obtain measurements over a sufficient length of time to obtain results that may be considered representative.

1.3 The variables that may affect the contaminant concentrations are the atmospheric stability (temperature-height profile), turbulence, wind speed and direction, solar radiation, precipitation, topography, emission rates, chemical reaction rates for their formation and decomposition, and the physical and chemical properties of the contaminant. To obtain concentrations of gaseous contaminants in terms of weight per unit volume, the ambient temperature and atmospheric pressure at the location sampled must be known.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D3249 Practice for General Ambient Air Analyzer Procedures

D3614 Guide for Laboratories Engaged in Sampling and Analysis of Atmospheres and Emissions

NOTE 1—A list of references are appended to this practice which provide greater details including background information, air quality modeling techniques, and special purposes air sampling programs (**1**).[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D1356.

4. Summary of Practice

4.1 This practice describes the general guidelines in planning for sampling the ambient air for the concentrations of contaminants.

5. Significance and Use

5.1 Since the analysis of the atmosphere is influenced by phenomena in which all factors except the method of sampling and analytical procedure are beyond the control of the investigator, statistical consideration must be given to determine the adequacy of the number of samples obtained, the length of time that the sampling program is carried out, and the number of sites sampled. The purpose of the sampling and the characteristics of the contaminant to be measured will have an influence in determining this adequacy. Regular, or if possible, continuous measurements of the contaminant with simultaneous pertinent meteorological observations should be obtained during all seasons of the year. Statistical techniques may then be applied to determine the influence of the meteorological variables on the concentrations measured (**2**).

5.2 Statistical methods may be used for the interpretation of all of the data available (**2**). Trends of patterns and relationships between variables of statistical significance may be detected. Much of the validity of the results will depend, however, on the comprehensiveness of the analysis and the location and contaminant measured. For example, if 24-h samples of suspended particulate matter are obtained only periodically (for example, every 6 or 8 days throughout the

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The boldface numbers in parentheses refer to the list of references at the end of this practice.

year), the geometric mean of the measured concentrations is representative of the median value assuming the data are log normally distributed. The geometric mean level may be used to compare the air quality at different locations at which such regular but intermittent observations of suspended particulate matter are made.

6. Basic Principles

6.1 The choice of sampling techniques and measurement methodology, the characteristics of the sites, the number of sampling stations, and the amount of data collected all depend on the objectives of the monitoring program. These objectives may be one or more of the following:

6.1.1 Air quality assessment including determining maximum concentration,

6.1.2 Health and vegetation effects studies,

6.1.3 Trend analysis,

6.1.4 Evaluation of pollution abatement programs,

6.1.5 Establishment of air quality criteria and standards by relating to effects,

6.1.6 Enforcement of control regulations,

6.1.7 Development of air pollution control strategies,

6.1.8 Activation of alert or emergency procedures,

6.1.9 Land use, transportation, and energy systems planning,

6.1.10 Background evaluations, and

6.1.11 Atmospheric chemistry studies.

6.2 In order to cover all the variable meteorological conditions that may greatly affect the air quality in an area, air monitoring for lengthy periods of time may be necessary to meet most of the above objectives.

6.3 The topography, demography, and micrometeorology of the area as well as the contaminant measured, must be considered in determining the number of monitoring stations required in the area. Photographs and a map of the locations of the sampling stations is desirable in describing the sampling station.

6.4 Unless the purpose of the sampling programs is site specific, the sites monitored should, in general, be selected so as to avoid undue influence by any local source that may cause local elevated concentrations that are not representative of the region to be characterized by the data.

6.5 Monitoring sites for determining the impact on air quality by individual sources should be selected, if possible, so as to isolate the effect of the source being considered. When there are many sources of the contaminant in the area, the sites sampled should be strategically located so that with wind direction data obtained simultaneously near the sites, the monitoring results will provide evidence of the contributions of the individual sources. Multiple samplers or monitors operating simultaneously upwind and downwind from the source are often very valuable and efficient.

7. Meteorological Factors

7.1 The meteorological parameters that are most important in an atmospheric sampling program are:

7.1.1 Wind direction and speed, the degree of persistence in direction, and gustiness;

7.1.2 Temperature and its changes with height above ground; the mixing height, that is, the height above ground that the pollutants will diffuse to during the afternoon; and

7.1.3 Solar radiation and hours of sunshine, humidity, precipitation, and barometric pressure. These parameters are important in assessing the pollution potential of an area and should be considered in the planning of a monitoring program and in the interpretation of the data. Pertinent meteorological and climatological information may be obtained from the local weather department. In many localities, however, the micrometeorology may be unique and meteorological investigations to provide data specific to the area may be needed.

7.2 The influences of each of the meteorological parameters important to air quality are discussed in detail. The methods of carrying out the related meteorological investigations are also discussed (**3**, **4**, **5**).

8. Topographical Factors

8.1 Topography can influence the contaminant concentrations in the atmosphere. For example, a valley will cause persistence in wind directions and intensify low-level nocturnal inversions that will limit the dispersion of pollutants emitted into it. Mountains or plateaus may act as barriers affecting the flow of air as well as the contaminant concentrations in their vicinity. Consideration should be given to the influence of these features as well as that of large lakes, the sea, and oceans (**2**, **3**).

9. Apparatus

9.1 Details of the apparatus or instruments employed in sampling the air or carrying out associated meteorological investigations are discussed in other ASTM methods and recommendations.

10. Sampling Procedure and Siting Concepts

10.1 The choice of procedure for the air sampling is dependent on the contaminant to be measured. See Practice D3249 for recommendations for general ambient air analyzer procedures. ASTM recommended methods have been published for most of the common contaminants that are sampled. Automatic instruments providing a continuous record of the concentrations of the contaminant should be utilized whenever possible to save manpower and increase efficiency. Very often factors such as temperature, humidity, and vibrations, as well as the power line voltage can influence the output of the air monitoring instrument and these should be controlled.

10.2 The monitors must be supplied with sample air that represents the ambient air under investigation. Careful consideration should be given to the sample conveying system. A duct system is often utilized for this purpose. There should be as few abrupt enlargements and elbows as possible, as these may affect the uniformity and hence the concentration of the contaminants measured. The material for the duct should be such that there will be little or no interaction between it and the contaminants in the air sampled. Employ temperature control to limit the condensation forming in the sampling lines. Take the samples from straight sections of the duct with the inlet lead to the monitoring instrument as short as possible.

10.3 The following guidelines are recommended for sampling locations unless site specific measurements are desired. The height of the inlet to the sampling duct should be normally from 2.5 to 5 m above ground whenever possible. The height of the inlet above the sampling station structure or vegetation adjacent to the station should be greater than 1 m. Sampling should preferably be through a vertical inlet with an inverted cone over the opening. For a horizontal inlet, there should be a minimum of 2 m from the face of the structure. For access to representative ambient air in the area sampled, the elevation angle from the inlet to the top of nearby buildings should be less than 30°. To be representative of the area in which a large segment of the population is exposed to contaminants emitted by automobiles, the inlet should be at a distance greater than 15 m from the nearest high-volume traffic artery. Photochemical oxidants or ozone samplers should be located at distances greater than 50 m from high traffic locations. Particulate matter samplers should be sited at locations that are greater than 200 m from unpaved streets or roads (**6**, **7**, **8**).

11. Plan of Sampling Procedure

11.1 The procedure for sampling should be undertaken in the following steps:

11.1.1 A general exploratory survey of the area including the topography, an inventory of sources for the contaminants, the height of their emissions, traffic, and land use data.

11.1.2 A preliminary meteorology analysis to identify wind direction frequencies, wind velocity, and temperature-height profiles.

11.1.3 Exploratory short-term temporary sampling requires a number of temporary sampling stations, to determine the need and the best sites for extensive long term monitoring. Using air quality models, and the input of emission inventory and meteorological information for the area obtained in 11.1.1 and 11.1.2, an estimate for the levels of air quality over the area may be calculated. The model results will provide guidance in determining the locations for monitors that will measure the maximum levels and the number of monitors required to characterize the air quality in the area of concern (**9**, **10**).

12. Quality Assurance

12.1 Quality assurance programs include all of the activities necessary to provide measurement data at a requisite precision and accuracy. An air quality assurance program should be developed and implemented for every air monitoring program to ensure compatibility of data both externally and between stations in the monitoring network.

12.2 Guidelines for quality assurance programs are given in Practice D3614. The quality assurance program should include all the following elements to the extent to which they are applicable:

12.2.1 Sampling and analytical procedures should be specified, using standard methods such as ASTM methods where applicable and appropriate to the objectives to be achieved.

12.2.2 Calibration procedures should be specified in the standard methods. For a continuing program, frequency of calibration re-checks should be specified.

12.2.3 Data collection and recording procedures should be specified, to identify responsibility for record keeping, analysis of recorder chart records, conversion to computer format, and method and frequency of reporting. Specifications should also be included for safeguarding equipment, samples, and records to maintain the chain of evidence if data are required for legal purposes.

12.2.4 Sample shipping and storage procedures should be documented, especially if the methods used impose any limits on time delay prior to analysis, refrigeration, or other storage conditions, or any other precautions in sample handling.

12.2.5 Methods of computation after analysis or automatic data recording should be specified, including data validation procedures used to minimize errors in computation or record keeping.

12.2.6 Independent audits of the entire measurement program by an outside agency are helpful, in which parallel sampling and analysis is conducted independently to verify the precision and accuracy of the final results. Simultaneous analysis of ambient atmospheres can be used, as well as independent measurements using cylinder gases or other calibration standards.

12.2.7 Interlaboratory tests (also called "round-robin" tests) are useful as a means of confirming the precision and accuracy of the methods used, and also make it possible for each organization to check its own performance against other laboratories or organizations engaged in the same type of activity.

12.3 For a continuing monitoring program, a manual is needed to formalize and document the quality assurance practices so that consistent operation of the entire monitoring program is assured over an extended period of time regardless of changes in personnel. This manual should document the methods used and the various sampling, calibration and other procedures mentioned above.

12.4 All monitoring equipment and apparatus should be carefully calibrated using highly reliable calibration standards. Such standards should be traceable to the National Institute of Standards and Technology, as far as possible, to provide a means for intercalibration for the various stations in a monitoring network. The calibration procedures should be described in the quality assurance manual.

13. Keywords

13.1 ambient atmospheres; sampling

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