Summary

The papers contained in this publication were presented at and comprised the major portion of the technical program of the Conference on Recent Developments in Monitoring Methods for Toxics in the Atmosphere. The conference was sponsored by ASTM Committee D-22 on Sampling and Analysis of Atmospheres and was held in the summer of 1987 at the University of Colorado, in Boulder, Colorado.

The papers in this volume are divided into five sections, dealing with the following topics: institutional monitoring programs, volatile organic compounds, acid gases, HCl and heavy metals from municipal solid waste incineration, and personal hazards of airborne toxics. The papers, prepared by experts in the above areas, focus on developments and challenges concerning instrumentation, monitoring data, sampling, and calibration standards needed for meaningful measurements of toxics in the atmosphere. These authors attempt to describe existing capabilities and deficits, and requirements for further needed research to aid the monitoring efforts of industry and federal and state programs in the United States and other countries. The following commentary provides brief summaries of the papers included in the five sections of this volume.

Institutional Monitoring Programs

This section of the book comprises two papers that were designed to illustrate the scope and character of federal and state monitoring programs in the United States dedicated to the development of data on airborne levels of toxic substances to which people are exposed. *Komp et al.* provide a perspective of monitoring programs for U.S. Environmental Protection Agency (EPA) Region 8 in support of the EPA's national air toxics strategy. *Crowe* describes the objectives and criteria of a monitoring network for toxic air contaminants which has been implemented by the state of California. These two papers exemplify the ongoing types, status, and needs of federal and state air toxic monitoring programs.

Volatile Organic Compounds

Extensive analyses of air samples have identified and quantified literally hundreds of volatile organic compounds. A number of these have been shown to possess carcinogenic or other chronic or acute toxicity properties. These compounds represent one of the most serious human health hazards from environmental pollution being faced today. The six papers in this section provide an overview of standards and methods being employed for quantitative assessments of volatile organic compound (VOC) levels in the ambient air environment and current capabilities for their identification and measurement. The papers by *von Lehmden* and *Jayanti et al.* address the critical topic of assessing capabilities for

measuring volatile organic compound levels generated during hazardous waste incineration, viewed as one potential way of disposing of hazardous material wastes via thermal decomposition. While incineration appears to offer a viable means for such disposal, improper design or control of the incinerator and its operation conditions can result in the generation and emission of a variety of volatile organic compounds. The paper by *von Lehmden* discusses criteria for program strategies in designating standards of volatile organic compounds needed for the EPA's hazardous waste incineration audit program to meet EPA goals, while the paper by *Jayanti et al.* details some of the results of this program, obtained in audits of hazardous waste trial burns, using such standards.

Crist describes the results of EPA comparisons between Tenax cartridges and evacuated stainless steel canisters for the sampling of ambient air in field studies, and the subsequent analysis of the sampled air for volatile organic compounds. He discusses the resultant data in terms of quantitation and bias in ambient air measurements. The paper by *Rhoderick and Zielinski,* of the National Institute of Standards and Technology (NIST, formerly NBS), outlines the methodology and analytical evaluation used for the preparation of multicomponent mixtures of volatile organic compounds, demonstrating the accuracy and multiple-year stability of mixtures containing as many as 17 organic compounds in the low parts-per-billion range. These mixtures have been used in the EPA's ambient air and hazardous waste incineration audit programs as NIST-traceable national standards.

A critical evaluation of various gas sampling techniques and methods for increasing the sensitivity of these techniques is presented in a paper by *Risch,* in which practical guidelines are discussed for optimizing the methodology for accurate trace analysis of volatile organic compounds in contained atmospheres. This paper covers the advantages and disadvantages of direct, headspace, dynamic, and automated gas sampling techniques, including gas chromatography results obtained using a special cryotrapping system. In the remaining paper in this section, *Shushan et al.* report on the design and application of coupling a tandem mass spectrometer system to mobile trace atmospheric gas analyzer technology for real-time measurements in the characterization and quantification of urban plumes of volatile organic compounds generated by a polluting source. This equipment has the ability to monitor up to 128 different compounds simultaneously, with real-time output in concentration.

Acid Gases

The three papers in this section discuss standards, analytical methods, and instrumentation used for characterizing trace levels of sulfur and nitrogen species in the atmosphere. Species such as SO_2 and NO_x have been implicated in acid deposition that can have serious detrimental effects on the ecological health of vegetation and of marine life in lakes and estuaries, an environmental problem that has long-range effects because of the transport of such pollutants across state and national boundaries. The paper by *Dorko and Cai* describes the design and characterization of a permeation tube calibration system that was used to assess the long-term stability of standard mixtures containing SO_2 in air at 100 parts-per-billion. Attention was given to the accuracy of measurements using both sulfur flame photometry and pulsec fluorescence. This work was carried out to provide well-characterized standards of such mixtures for use in EPA dry acid deposition studies and in dynamic dilution systems to generate calibration mixtures in the low parts-per-billion level. The paper by *Goldan* describes techniques for cryogenically enriching and quantifying levels of gaseous sulfur compounds in the atmosphere below 300 parts per trillion, by volume, for real-time monitoring of reactive sulfur-bearing acid precursors from natural sources. This paper discusses methods for enhancing the detectability of such species and the design of a multistage dynamic dilution system using calibrated permeation tube sources for direct instrument

calibration in the 50 to 500 parts-per-trillion range. In the paper by *Drummond et al.*, advances in instrumentation modifications for the determination of the parts-per-trillion levels of several acid gases are discussed. Applications of such instrumentation to the measurement of atmospheric levels of peroxyacetyl nitrate, NO_2, NO_x, and ozone in clean and urban air in field studies are shown. Attention also is given to instrumental calibrations for measurements at trace atmospheric levels and to gas phase reactions involving NO_x species.

HCl and Heavy Metals from Municipal Solid Waste Incineration

This section treats two topics of growing environmental concern, namely, emissions of HCl and of toxic heavy metals on air particulates from municipal solid waste incinerators.

The paper by *Rollins et al.* discuss sampling and analysis methods for continuous monitoring of HCl emissions, focusing on a comparison of commercially available conditioning and measurement systems. The results of a detailed field evaluation of the performance of six HCl continuous monitors at a municipal solid waste facility are compared and show good agreement with wet chemistry results for most of the analyzers tested, demonstrating how minimum and acceptable sample line losses of HCl can be achieved. The paper by *Breton* details the characteristics of an infrared absorption-based continuous HCl emission monitoring system which has been used extensively on municipal waste incinerators in Germany in compliance with regulations developed by the Federal Republic of Germany. Over 100 of these systems have been installed in Europe and elsewhere. The system, which employs a long-path gas cell nondispersive infrared photometer, is designed for HCl measurement after gases have passed through cleaning systems. The paper discusses the measurement principles, the design and operational characteristics of the long-path gas cell and gas sampling system, measurement accuracy, maintenance requirements, and raw gas and clean gas measurements.

The paper by *Greenberg* presents the results of studies of the elemental composition of air particulates emitted from three municipal incinerators using instrumental neutron-activation analysis, a true multielement technique having a sensitivity adequate for determining 30 to 40 elements in air particulate matter. Analyses were conducted on fly ash and on in-stack samples of total and size-fractionated suspended particulate material collected isokinetically at the three incinerators. The analysis data, covering cadmium, nickel, chromium, lead, arsenic, and 34 other elements, showed large concentration differences between fly ash and suspended particulates. Crustal enrichment factors for a number of elements in suspended particles from municipal incinerators and urban aerosols also are illustrated and discussed.

Personal Hazards of Airborne Toxics

Two significant papers in this section describe the results of extensive studies aimed at the assessment of human hazards due to exposure to airborne toxics. The paper by *Stevens et al.* describes the results of field monitoring studies conducted in residential locations in two cities in the United States as part of the EPA's Integrated Air Cancer Project. These studies were designed to evaluate sampling, analysis, and receptor modeling procedures and to measure and compare the mass and mutagenic activity of the organic fraction of airborne fine particulate matter collected in these two residential locations. The results showed that, while a high proportion of the total organic aerosol mass in fine air particulates from both cities could be attributed to residential wood burning, the mutagenic potency of the organics extracted from the fine particles was found to be three to five times greater for motor vehicle emission sources than for the organic matter extracted from wood smoke. This paper illus-

trates how assessments of potential human health hazards due to air toxics can be made via the unique coupling of mutagenesis assay and advanced analytical measurements (carbon-14 analysis by accelerator mass spectrometry) of small carbonaceous samples with receptor modeling using multilinear regression techniques.

The paper by *Treitman et al.* describes the results of studies conducted in several cities in the United States of another area of personal exposure to air toxics that has attained a level of major national concern, namely that of indoor air pollution. This paper describes and compares the reliability of sampling and analytical methods for the quantification of nitrogen dioxide and respirable air particulate matter in indoor environments, covering population-based home characteristics, personal monitoring designed to assess such exposures, and associated health effects from an epidemiological point of view. The results show seasonal variations and variations in locations within homes of levels of nitrogen dioxide in both gas-heated and electric homes and in the level of air particulate matter in both smoking and nonsmoking homes. These results show higher levels of nitrogen dioxide in gas-heated homes than in electrically heated homes, and higher levels of air particulate exposures in homes in which people smoke than in homes in which they do not.

In summary, the papers presented in this publication illustrate the remarkable strides that have been made in sampling, instrumentation, standards, and analysis in monitoring programs for quantitatively assessing levels of toxic air pollutants and how significant the advances have been in the selective measurement of specific air toxic species. These papers have attempted to address some of the most important classes of air toxics that reflect current national and international concerns regarding human and ecological hazards.

Walter L. Zielinski, Jr.
National Institute of Standards and Technology, Gaithersburg, MD 20899; conference chairman and editor.