on-the-spot, elemental analysis of air particulates collected on filters (including respirable and inhalable particulates) and vapors collected on membranes by chemical adsorption. It was designed to meet the accuracy requirements for sampling in the workplace. The sampling method is nondestructive and can detect 23 elements. The survey meter provides immediate elemental analysis of air particulates and vapors present in the work environment; the alternative is to send the samples to an analytical laboratory. The meter can be used for rapid on-site checking of air contaminants in the case of accidental releases, as well as for routine monitoring purposes. For example, it can be used in the metallurgical and energy production industry to monitor welding fumes (which contain toxic metallic elements) or to measure air contaminants found in other workplace environments. The device is portable and is enclosed in a small compact carrying case. It uses a microprocessor-based, energy-dispersive, X-ray fluorescence technique to measure sequentially the concentrations of selected sample elements whose calibration parameters are stored in memory. Analysis time is on the order of 100 seconds/element.

Predicting Pollution Pathways in the Atmosphere Although great improvements have been made in our understanding of the processes that move pollutants through the atmosphere and deposit them in aquatic or terrestrial ecosystems, an even greater understanding is necessary to solve the problems presented by acid rain and the change in the heat budget of the earth caused by carbon dioxide increases. A step in this direction has been made by the production of stable, nontoxic tracer gas that can be released from source areas and detected at great distances.

Understanding and predicting pollutant transport are important because it is a principal means by which health effects might be produced in the public by an emerging technology. The OHER research program pioneered the mathematical modeling, or prediction, of pollutant behavior in the atmosphere because of the early responsibility for understanding the possible effects of radioactive contamination. Models of the movement of materials through and chemicals reaction in the air and soil are crucial to rational decisions related to citings of toxic waste dumps and to optimal decisions on mitigation to correct past mistakes. However, the validity of models and predictions must be tested, and OHER has also supported the development of the necessary tools for verification.

Although gas tracers have provided valuable information of this kind, it is also known that pollutant gases often interact with minute particle clouds (aerosols) from which the particles may be deposited on the ground or become resuspended in air. Pollutants themselves may even originate as aerosols. New instruments were needed to understand the transport and cycling of particles in streams, lakes, oceans, and the atmosphere. This need was met by developing aerosol and particle analyzers for both atmospheric and aquatic studies. Today these analyzers form a vital part of the Nation's ongoing research into the effects of airborne chemical pollutants, notably acid rain.

The major benefit of this research has been a sounder understanding of the relationships between pollutant releases and their concentrations in the human environment. Information of this nature is essential to regulation of pollutants in the general interest and for sound industrial planning.

Atmospheric Tracers Several nonradioactive, chemically inert systems have been developed to trace the dispersion of materials released into the atmosphere. These include tracers, samplers, and extremely sensitive analyzers that can detect materials at concentrations as low as 2 parts per quadrillion (10^{-15}). Such systems can be used to trace dispersions at ranges of over 100 kilometers.

Increased concern over the regional and international aspects of air pollution has created a need for reliable model calculations of concentrations as far as 1000 kilometers from pollutant sources. Experimental verification of these calculations, as well as environmental assessments based on model simulations, is essential to establish the credibility of models of dispersion processes. One way to verify the models is to trace the movement of actual materials in the atmosphere. This requires cost-effective, nonreactive and nondepositing tracers for local (less than 100 kilometers), intermediate (100 to 1000 kilometers), and long-range (greater than 1000 kilometers) dispersion of pollutants. The tracers must also be nonradioactive, nontoxic, and inexpensive and have low natural background to perform adequately.

Three sampling systems for perfluorocarbons have been developed. The BNL automatic tracer sampler was designed to be easily portable (15 pounds), automatic, and reliable. Each sampler can take a sequence of 23 samples of air. The start/stop time, flow rate, and total volume through the sampling tubes can be controlled. Each sampling tube contains 150 milligrams of Ambersorb, which traps all of the perfluorocarbon. The tracer is then recovered by thermal desorption from the sample tubes and separated by gas chromatography. An electron-capture detector provides measurement accuracy of 10 to 20 percent at concentrations as low as 2 parts per quadrillion (background concentration) with an 8-liter capacity air sample.

A second sampler, the prototype called the "dual-trap sampler," combines both sampling and analysis. Using two sampling tubes, it simultaneously traps a new sample as it analyzes the previous sample. This device can provide analysis of one air sample