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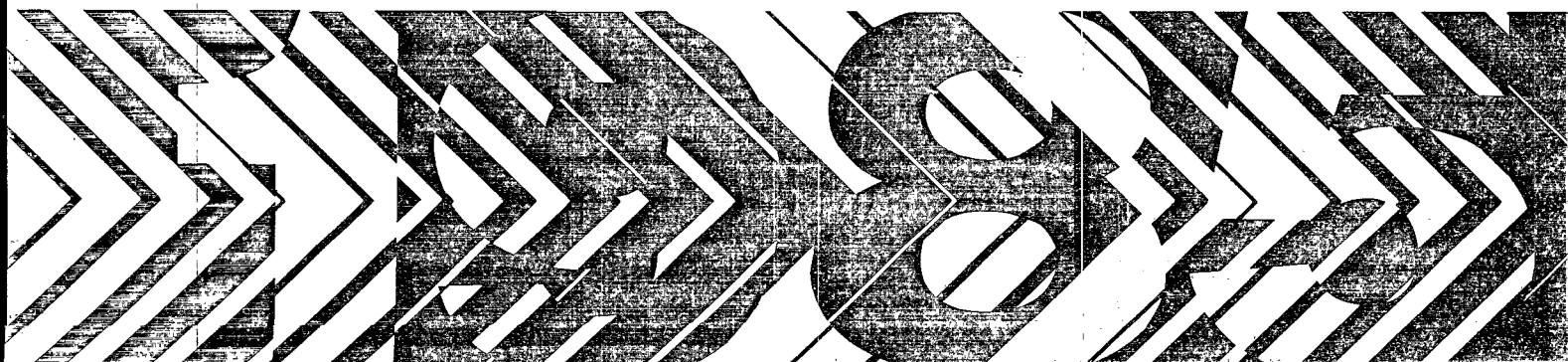
Washington DC 20460

Research and Development

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# ORD Annual Report





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## ***Foreword***

EPA's Office of Research and Development (ORD) continues to strive for excellence in the Agency's research program. Because the overall goal of our program is to provide the scientific and technical information necessary to support the Agency's regulatory and enforcement responsibility, representatives from ORD's client program and regional offices actively participate on each of our five research committees (Air and Radiation; Water; Toxics and Pesticides; Hazardous Waste and Superfund; and Multimedia Energy). We believe that the EPA research committee system has strengthened our ability to plan and manage the essential scientific and technical work of the Agency.

For the second consecutive year, I have asked each committee to prepare an annual report. The FY-1985 report is designed to provide the reader with three things: (1) a summary of major research issues as defined by each committee; (2) highlights of major accomplishments that were responsible to those issues in FY-1985; and (3) the identification of related research to be performed during FY-1986. The major purpose of this document is to acquaint the reader with the interests of each committee, and to highlight specific research outputs. We hope that you find the reports enlightening and useful.

Donald J. Ehreth  
Acting Assistant Administrator  
for Research and Development

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## **The Organization**

The EPA's Office of Research and Development headquarters in Washington does the strategic planning and budgeting for a program of more than \$250 million in research per year.

Our research is conducted out of 14 laboratories located from as far east as Narragansett, RI, to as far west as Corvallis, OR. We have major research centers in Cincinnati, OH and Research Triangle Park, NC. These laboratories report to five major headquarters offices which are organized along discipline lines: health; environmental processes and effects; environmental engineering and technology; monitoring systems and quality assurance; and health and environmental assessment.

## ***Air and Radiation Research Committee***

### **Introduction**

The Air research program provides the Office of Air and Radiation (OAR) with the scientific data bases, methodologies, assessments, models, emission reduction technologies and corresponding quality assurance support to develop and implement air quality standards and ensure compliance with them. The research program has two focuses. The first is research on the six air pollutants for which National Ambient Air Quality Standards (NAAQS) have been set. These pollutants are carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), particulate matter (PM), ozone (O<sub>3</sub>), nitrogen oxide (NO<sub>x</sub>), and lead (Pb). The other aim of the program is to study potentially hazardous air pollutants (HAPs) which are defined as pollutants that cause irreversible or reversible incapacitating illness and have not already been regulated as NAAQS pollutants.

In an effort to develop a more cohesive, responsive, long-range research program, the Assistant Administrators for Research and Development (ORD) and OAR identify the priority research issues for the Air and Radiation research programs. These issues cut across scientific disciplines (e.g., monitoring, health, engineering, risk assessment, environmental processes), and the pollutant-specific structure of the research programs. The following discussion of ORD's major accomplishments in FY 1985 is organized by these issues.

### **Criteria Air Pollutants**

#### ***Scientific Assessments***

During FY 1985 technical analyses were provided to the Office of Air Quality Planning and Standards (OAQPS) in support of their proposal and promulgation of the NAAQS for NO<sub>x</sub>, CO, SO<sub>2</sub>, and PM. In addition, work was continued on Air Quality Criteria Documents (AQCD) for O<sub>3</sub> and Pb.

For O<sub>3</sub>, a Clean Air Scientific Advisory Committee (CASAC) meeting was held on the first external review draft (ERD) of the AQCD. Comments from the CASAC are currently being addressed in a second ERD, which is scheduled for completion on November 15, 1985. A follow-up CASAC meeting will be scheduled to review the second ERD in March of 1986. A final AQCD is scheduled for completion in October of 1986.

The second ERD for Pb was published on October 15, 1984 and the second CASAC meeting, which granted closure on all issues covered to that time, occurred in May of 1985. An addendum to the Pb AQCD is now being prepared to consider blood-lead/blood pressure relations. A CASAC meeting is scheduled for January of 1986.

An international symposium on aerosols was held on May 19, 1985, sponsored and organized by ORD. The proceedings from the symposium will be published during FY 1986.

#### ***Health Data***

Two clinical studies of the pulmonary and immunological effects of oxidants, such as O<sub>3</sub> and nitrogen dioxide (NO<sub>2</sub>), did much to increase understanding of ozone's effect on the pulmonary immune system. One of these studies investigated the response of otherwise healthy adults with allergic rhinitis exposed to various concentrations of O<sub>3</sub>. Another study compared the respiratory responses to O<sub>3</sub> of healthy adults with and without naturally acquired respiratory infection. The negative findings suggest that the host defense mechanism in these individuals are not compromised by exposures to O<sub>3</sub> at the ambient concentration tested. These results corroborate the findings of two animal studies, also completed in FY 1985, of the immunological effects of O<sub>3</sub> and NO<sub>2</sub>. In addition, an animal study was completed on the effects of chronic exposure to SO<sub>4</sub> and ammonium sulfate, a commonly occurring aerosol particle. Results of this study are being analyzed.

A five-year follow-up study of the neurobehavioral effects of Pb in children was completed. In addition, animal studies attempting to replicate earlier findings on the neurological consequences of Pb exposure were performed. These studies indicate that neurobehavioral effects can be seen in children at much lower levels of Pb than previously suspected.

Data from animal toxicology studies and epidemiological investigations can be better used for standard setting if methods are developed to relate these data quantitatively to actual human exposures and effects. This is the purpose of extrapolation research. Of particular importance is the need to determine where pollutants are deposited in the respiratory systems of many species and how each species differs in processing, neutralizing, and eliminating the pollut-

ant. In FY 1985, two important projects were completed on O<sub>3</sub> dosimetry in several animal species. The first of these made significant advances in the mathematical accuracy of existing O<sub>3</sub> dosimetry models, particularly those predicting physicochemical properties and secretory parameters. The other project, an experiment study in animals, related exercise and O<sub>3</sub> dose and correlated these with existing human studies cited in the Criteria Document for O<sub>3</sub>.

Three extrapolation projects were completed on respiratory tract deposition of particles in animals. One showed the complexity of deposition patterns for hygroscopic particles. Six to eight-fold differences in these patterns are seen in varying conditions of lung temperature and humidity. Regional deposition curves were established for aerosol particles in five common laboratory animals. These curves can be related to available human data. Deposition of insoluble particles was found to be related to route of breathing and activity level. A major finding was that current samplers underestimate the mass of larger particles (10-15 $\mu$ m) deposited under conditions of oronasal breathing.

#### **Welfare Data**

Based upon analysis of the O<sub>3</sub> field data taken by the National Crop Loss Assessment Network (NCLAN) and processed through agricultural economic models, substantial dollar losses were attributed to O<sub>3</sub> damage under the exposure scenarios studied. However, several problems became apparent from some of the field data. The most prominent one was the role of soil moisture deficits on crop response to ozone. These responses had not been studied earlier but evidence indicated a reduced ozone response during dry weather. To interpret the yield data properly and to establish secondary standards based upon real world events, research was designed this year to establish the level of importance of soil moisture. The field exposure equipment for the entire national network was redesigned, built or purchased, and installed in FY 1985 to conduct moisture research. This new research endeavor will accommodate revised exposure regimes to approximate more closely the daily durations normally found in the field.

A comprehensive multi-year research program was initiated to assess the problem of visibility degradation. A number of studies have been conducted to characterize the visibility degradation in the U.S. and to identify the source of haze producing aerosols. Also a study was completed on the temporal and spatial variability of the visual effects of stack plumes.

To improve the Agency's ability to assess the impact of pollutants or materials damage, an instantaneous atmospheric corrosion monitor has been developed and evaluated. This monitor is now being used in field

experiments where air pollution levels will be related to materials damage.

#### **Monitoring**

A promising new method of measuring non-methane organic compounds (NMOC) was studied and the commercially available components were evaluated.

The spectrophotometer network is now operational. This network provides sites which State and local agencies can use to check the certification of their ozone monitoring devices against a primary standard. A final report for the National Air Pollution Background Network was prepared and will be published as an ORD project report. The subject of the report was the background ozone concentrations in remote National Forests over an extended time period.

A final report was submitted on the validation of a Manual Test Method for Determination of CO Emissions. A final validation of the Alkaline Permanganate Method for NO<sub>x</sub>, SO<sub>2</sub> and CO<sub>2</sub> is continuing. Collection efficiencies for NO<sub>x</sub> and CO<sub>2</sub> are 100% but the SO<sub>2</sub> collection efficiency is 90%.

The Stanford Institute of Mathematics and Statistics (SIMS) published a final report detailing the results of a Five Year Study on Air Quality. This study statistically evaluated risk analysis for environmental toxicants. Over 100 technical papers resulted from this work.

A report was submitted on research to assess the causes of visibility reduction in the West and this work was augmented by the use of a multistation monitoring network. Airborne LIDAR (laser induced direction and ranging) was used in the support of the study of plume/air mass transport in several Western areas.

#### **New Source Performance Standards (NSPS) and State Implementation Plans (SIPs)**

##### **Air Quality Models**

To increase the accuracy of current urban scale air quality models, a number of studies have examined the role of volatile organic compounds (VOCs) in producing ozone. The data obtained from these studies have been used to improve the chemical mechanisms currently used in air models to describe and characterize the formation of ambient ozone from precursor components. Also, to develop a scientific method to assess the role of individual VOCs to produce ozone, an experimental procedure for estimating atmospheric reactivity was developed which used the hydroxyl radical (OH) as a single indicator of atmospheric reactivity. (OH is a major atmospheric

oxidizing agent.) In this procedure, the reaction of VOC under OH attack is assumed to represent the more complex processes of atmospheric oxidation.

Special fluid model facility experiments were completed on the demonstration of Good Engineering Practice for developing stack height estimates needed for air quality modeling of emission sources located in complex terrain. Also, a report has been completed on the development of air quality models for complex terrain application.

Urban and regional scale air quality models for particulate matter were completed in support of the Agency's efforts to regulate inhalable particles. To develop better analytical tools to assess the relative contribution of pollution sources to specific receptors, source apportionment techniques have been evaluated. Specifically, a number of studies have been completed including target transformation analysis of aerosol mass and receptor model for airborne organic species.

A major report has been completed on assessing the state of the science on atmospheric diffusion for use in air quality modeling. The report evaluates existing techniques and provides a critical examination of the research required. This work will have wide application to a number of models used in assessing air quality impacts from stationary sources.

### **Monitoring Systems**

Over 65,000 filters were received, analyzed, and the data entered into the system for development of the Inhalable Particulate Network Data Base. The filters were analyzed for mass, inorganic chemicals and metals. In support of amendments to the NAAQS regarding particle size, sampler inlets for particles  $\leq 10 \mu\text{m}$  were evaluated for suitability.

Quality assurance was provided for all of the air programs to ensure that technical data are of known accuracy and precision. Support was provided to the Office of Air and Radiation, the Regions, other ORD laboratories, the World Meteorological Organization and the World Health Organization.

A report was published providing an assessment of the Precision and Accuracy for State and Local Air Monitoring Sites (SLAMS) for 1982.

### **Control Technology**

In 1985, pilot scale testing with fuel oil showed that up to a 75% reduction in  $\text{NO}_x$  levels can be achieved using reburning techniques with initial  $\text{NO}_x$  levels of 200 ppm or above. It was also shown that using coal as the reburning fuel is dependent on the coal properties and is not as effective as natural gas due to the fuel-nitrogen effects. In conjunction with the Electric Power Research Institute, a joint symposium

on  $\text{NO}_x$  Control Technology was conducted to transfer the latest technological developments to designers, users and educators.

A preliminary study showed that simulated high nitrogen hazardous wastes can be combusted with  $\text{NO}_x$  levels of less than 100 ppm. This study will be expanded in 1986 to determine the potential for using high nitrogen hazardous wastes as fuel supplements.

On August 2, 1985, EPA announced its intention to set Standards of Performance for Residential Wood Combustion. Critical technical questions exist concerning the appropriate emission measurement method and the long-term viability of catalytic control technology now on the market. An emission measurement project was initiated and completed comparing three candidate methods. Results are being analyzed and will be used to determine if one or more of these methods is acceptable.

Significant achievements were attained in the area of flue gas desulfurization (FGD) control technology. In dry FGD, a pilot-scale spray-dryer/baghouse system was constructed and operation has begun. In wet FGD, sodium formate was found to be a less costly alternative than other organic acid additives.

*A Lime/Limestone Flue Gas Desulfurization Inspection and Performance Evaluation Manual*, an SPMS milestone, was completed and distributed to regional and State personnel involved in inspection and permitting of FGD systems for electric utility coal-fired boilers.

*The Ninth Symposium on Flue Gas Desulfurization* was held jointly with the Electric Power Research Institute to transfer information and program results to users and other interested parties.

Data were developed on the influence of flare head design and relief gas composition on flare performance. A technical paper on the findings was presented at the annual meeting of Air Pollution Control Association in Detroit. The results were also presented in a technical report (EPA/600/2-85/106), "Evaluation of the Efficiency of Industrial Flares—Flare Head Design and Gas Composition."

Research on the technology of organic acid enhancement of limestone FGD processes, initiated in 1977, was concluded in FY 1985. This technology was introduced commercially in 1981 and has been so successful that further research by EPA is unnecessary.

The Agency is now considering an NSPS for industrial boilers. ORD provided input in FY 1985 which allows consideration of the performance capabilities of current and future emission control technologies. As a result, future technologies can be specifically designed to accommodate a particular technology,

and the environmental benefits of the NSPS are not compromised by high emissions.

EPA research on electrostatics resulted in two technological breakthroughs for particulate control. The "E-SOX" concept combines advanced electrostatic precipitator and spray dryer technology so that both jobs are handled by the same equipment. By separating and maximizing the particle charging and collection functions, significantly enhanced collection efficiency can be achieved, with reduced space requirements. The improved ESP performance is itself very useful for retrofit upgrading and, possibly, for meeting NSPS. The super electrostatic augmented fabric filtration—"(Super) ESFF"—concept promises to reduce by two thirds or more the number of bags required in a baghouse for a conventional power plant. This is achieved through the application of electrostatics to the filtration process to significantly reduce pressure drop across the filter.

## Hazardous Air Pollutants

### *Scientific Assessments*

Fourteen final Comprehensive Health Assessment Documents were delivered to OAQPS in FY 1985. Among these were documents on cadmium, ethylene oxide, dioxin, vinylidene chloride, chloroform, and nickel.

In addition, Tier I Health Effects Summary documents were prepared for six compounds; the compounds were chloroprene, acrolein, acetaldehyde, phosgene, phenol, and hydrogen sulfide.

### *Monitoring Systems*

Research to develop, evaluate, and standardize monitoring systems for measuring potentially hazardous air pollutants in the ambient air and from sources was accelerated to support the Agency's efforts to better characterize air toxics. For chemicals presently difficult or impossible to measure in the ambient air, advanced techniques were investigated. Techniques specifically studied in FY 1985 were combined mass spectrometry, gas chromatography/Fourier transform infrared spectrometry, supercritical fluid chromatography, tunable atomic line mass spectrometry and cryogenic concentration. To improve the surveillance and control of industrial sources, techniques such as capillary column chromatography, selective detector, and portable monitors were investigated. The Toxic Air Monitoring System (TAMS) was operated to provide needed data on the presence, concentration, and sources of potentially hazardous air pollutants, in particular, VOCs. The system also was used to augment ongoing activities of long-term pollutant trends.

### *Control Technology*

Three wood stove control technology projects were initiated. Two of these are investigating catalyst long-term emission control performance. The first one involves operating four catalytic stoves in the lab, under simulated residential use, on a continuous basis with periodic emission measurements. The second project tests aged catalysts obtained from homeowners in various regions of the country. The third project is investigating alternative noncatalytic control technologies. Initial tests on a combustion chamber modification, consisting of a small gas-fired secondary pilot burner coupled with enhanced secondary air injection achieved over 95% CO and total HC reductions relative to the normal emission levels of this commercially available stove.

A report on "Hazardous/Toxic Air Pollutant Control Technology: A Literature Review" was distributed to each State air pollution control agency through the EPA Regional Offices. A manual for "Evaluation of Control Technologies for Hazardous Air Pollutants" was developed to assist State and local air pollution control agencies in preparing and reviewing permits for HAP emissions. The manual is being reviewed by State and local agencies and will be published in FY 1986.

Planning for accidental release research was begun. A literature search was performed and contracts were made with several groups inside and outside EPA. The following areas were identified for further work: (1) development of an information system (2) production of a Prevention Reference Manual for use in reviewing industry accidental release prevention plans including pre- and post-release plans, (3) evaluation of control technology with emphasis on post-release control options, and (4) validation of models being used for industrial in-plant application to estimate the exposure resulting from accidental release.

### *Health Data*

Dose response information to support the hazardous air pollutant program is developed in the areas of mutagenicity and cancer, neurotoxicology, inhalation toxicology, and developmental biology. The chemicals are either selected by OAR as high priorities or by the researchers to develop, test, or calibrate their testing systems. In FY 1985, two studies of toluene were completed. Specifically, the first phase of a neuro-behavioral evaluation in humans was completed, and results of the photo-oxidation products of a toluene/NO<sub>x</sub> atmospheric transformation study were published in *Environmental Science and Technology*. In addition, animal studies of subchronic exposure to toluene were begun.

Numerous other chemicals were investigated; the following are examples of the studies performed. A



journal article has been prepared on nitropyrene mutagenicity, metabolism, and DNA binding in tracheal cells. Results show that methoxychlor changes in the pituitary function may indicate toxic effects from nitropyrene. A journal article was written to describe the findings of a micro mutagenesis assay on extracted indoor air particulate matter from a pilot field study conducted in Columbus, Ohio.

The Integrated Air Cancer Project (IACP) is an interdisciplinary research program to develop the scientific methods and data bases for identifying the major sources of carcinogenic chemicals emitted into the air or arising from atmospheric transformation. During FY 1985, IACP field sites became fully operational. These integrated field studies involve sampling, analysis, and bioassay of source samples, as well as near and far ambient samples from both indoors and outdoors. Sampling of residential wood combustion was completed in FY 1985 and subsequent bioassays were begun.

#### ***Atmospheric Processes***

In order to determine the transport, transformation, and fate of hazardous air pollutants, a number of laboratory and field experiments have been completed. Smog chamber studies which can simulate a variety of atmospheric conditions were conducted on potential hazardous air pollutants. This research provides necessary information on the lifetimes and daughter products of important hazardous compounds. Also, selected chemicals which are emitted to the atmosphere in large quantities were tested for producing potentially mutagenic compounds as a result of atmospheric oxidation reactions.

#### **Mobile Sources**

##### ***Monitoring Systems and Control Technology***

Although there has been a reduction in the development of large synfuel plants, interest in smaller industrial units and combined cycle plants for power generation has increased. Environmental Monitoring Plans were reviewed for the Great Plains Coal Gasification Associates and Dow Syngas coal gasification projects, the Forest Hill heavy oil project, and Unocal's Parachute Creek and Seep Ridge oil shale programs. Results of year-long monitoring at the Cool Water Coal Gasification project were analyzed and discussed at the first semi-annual Monitoring Review Committee meeting. Improved data are needed to develop better designs for facilities.

An analysis of non-synfuels energy areas was performed to determine which emerging energy industries may pose environmental problems in the future. Special permits were reviewed for oil shale projects

by Getty and City Service, and environmental impact statements for an Alaskan coal mine and Pacific Shale Oil projects were analyzed.

A number of studies have been completed on the characterization of the emissions from a variety of motor vehicles including light and heavy duty engine categories. One major study was completed on the characterization of emissions from vehicles using methanol and methanol/gasoline blended fuels. This information will be used by the Agency in developing regulations involving the use of methanol as a motor vehicle fuel. Also, work was completed on assessing the ambient temperature and fuel effects on emissions from light duty diesel vehicles. Another study was completed on the development of real-time measurements for carbon monoxide emissions from in-use vehicles equipped with three-way catalysts.

Additional data analyses were undertaken of the Denver, Colorado-Washington, D.C. human exposure data base, focusing on the relationship of CO exposure profiles to breath CO levels as measures of blood carboxyhemoglobin (COHb). Efforts were continued to validate existing computer simulation models using the 1,600 profiles of CO collected in Denver and Washington, D.C. Models were also developed of CO exposures in highway microenvironments, and a workshop was held at Harvard to review the results of exposure modeling and monitoring efforts.

#### ***Health Data***

The Coburn-Foster-Kane (CFK) equation purports to make it possible to determine inhaled doses of CO based on the level of COHb in the venous blood of humans. In FY 1985, EPA completed clinical studies to determine the validity of the CFK equation. Analyzed results show that the CFK equation is valid. Also, data collection was completed in a study to determine pre-anginal changes in left ventricular function in individuals with ischemic heart disease exposed to CO at levels sufficient to cause COHb levels of 4%. A manuscript was prepared and was submitted to a peer reviewed journal. A follow-up study was initiated, in which individuals with ischemic heart disease were exposed to CO to determine if measurable responses could be detected in these individuals at COHb concentrations of approximately 6%. Studies of CO effects on hand-eye coordination were begun and a final report on the first experiment has been prepared and approved.

#### **Global and Macroenvironments**

Inhouse laboratory studies were conducted to determine the composition and rates of emissions from household building materials, such as particle board and adhesives. Research was also conducted to

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determine the organic emissions from unvented space heaters. Work was initiated on the development of a computerized data base for sources of indoor air pollutants.

In May 1985, an "Indoor Air Source Characterization Workshop" was held in Chapel Hill, North Carolina. This EPA sponsored meeting attracted 60 researchers representing U.S. and foreign research institutes, universities, and private companies. Twenty-five papers, including three by EPA researchers, were presented on combustion sources, indoor materials, and biological sources.

The first phase of scheduled field testing to develop and demonstrate low-cost residential radon mitigation techniques was completed in 18 homes in the Reading Prong in eastern Pennsylvania. The short-term results are encouraging. In four homes with initial radon levels of up to 7.4 working levels (wl), radon was reduced to 0.03 wl or less by the application of refined versions of these mitigation measures, representing indoor radon reductions of 97 to 99%.

Research has continued to assess the health and environmental effects of increased uvB radiation due to the decrease of stratospheric ozone. In FY 1985, research focused on the effects of uvB radiation on such crops as soybeans, maize, wheat, rice, and citrus fruit, as well as biologically important systems such as phytoplankton and zooplankton. Research was also conducted on stratospheric ozone model development, and epidemiology of melanoma, and the effects of increased uvB radiation on photochemical smog formation.

## ***Interdisciplinary Research Committee***

### **Introduction**

The interdisciplinary research program develops risk assessment guidelines and ensures consistent application of these guidelines throughout the Agency. Activities in this area also support the dissemination of scientific and technical data from the Office of Research and Development (ORD). Finally, the interdisciplinary research program provides resources to conduct long-range exploratory research through the grants, centers and visiting scientists programs and provide central management, audits and compliance monitoring for the Agency-wide Quality Assurance Program.

### **Scientific Assessments**

In late 1983, the Toxics Integration Task Force recommended that EPA underscore its commitment to consistency and technical quality in risk assessments by intensifying its work on risk assessment guidelines and establishing the Risk Assessment Forum. Since these activities cut across all media, and affect all parts of EPA, they have been considered part of the Interdisciplinary Research Committee. These activities have continued into FY'85, and we expect them to continue in the years beyond as well.

Five risk assessment guidelines were proposed in FY '85 for public comment. They are:

- Proposed Guidelines for Carcinogen Risk Assessment
- Proposed Guidelines for Exposure Assessment
- Proposed Guidelines for Mutagenicity Risk Assessment
- Proposed Guidelines for the Health Assessment of Suspect Developmental Toxicants
- Proposed Guidelines for the Health Risk Assessment of Chemical Mixtures

The proposed guidelines and the public comment were reviewed favorably by the Science Advisory Board, and the revisions requested by the Science Advisory Board were made. The five guidelines will be published early in FY '86. In FY '86, the Agency expects to propose guidelines for male infertility, female infertility, systemic toxicants, and use of measurement information in exposure assessments.

The Risk Assessment Forum is a body of senior scientists representing each Assistant and Associate Administrator who meet regularly to resolve intra-agency disputes relating to the analysis of scientific information or the use of science policy. The Forum assists EPA's risk assessment process in several ways:

- It analyzes scientific information and science policy issues for use in Agency risk assessment,
- It develops risk assessment procedures not covered by the guidelines.
- It recommends revisions to the guidelines whenever such revisions appear to be necessary.
- It reviews selected risk assessments upon referral from the program offices or senior Agency management.
- It recommends appropriate research to reduce uncertainties in risk assessment.

The Forum has completed two actions to date—classification of carcinogenicity for trichloroethylene and perchloroethylene according to EPA's proposed carcinogen risk assessment guidelines, and interim acceptance of the carcinogen risk assessment for vinyl chloride by ingestion prepared by the Carcinogen Assessment Group and used in a pending regulatory package by the Office of Drinking Water. Seven other Technical panels have also been formed. Their work includes:

- Finding a better way to convey risk estimates and their uncertainty to decision makers; their first effort is development of alternative methods of estimating parameters of the multi-stage model in carcinogen risk assessment
- Proliferative hepatocellular lesions of the rat: review and future use in risk assessment (neoplastic nodules)
- Interim risk assessment procedures for mixtures of chlorinated dibenzodioxins and dibenzofurans
- Acceptable daily intakes
- Resolution of several issues in risk assessment of arsenic by oral exposure
- Establishment of appropriate safety or uncertainty factors for cholinesterase inhibitors

- Convening of an expert workshop on carcinogen risk assessment needs

The Forum staff is completing a Charter for future Forum operations, and several other issues are expected to be taken up in FY'86.

### Technical Information and Liaison

As the primary research arm of the Environmental Protection Agency, ORD provides scientific information needed by EPA to develop and enforce regulations. Appropriate and timely dissemination of research results supports the scientific basis for EPA regulations and increases confidence in the decision making process.

The Center for Environmental Research Information (CERI) provides centralized support for the production of information products in a cost-effective manner, ensures consistent uniform dissemination of research results, and provides a technology transfer program to synthesize information and develop presentations to support specific, high-priority program objectives at the lowest cost to the government.

In FY'85, CERI continued to support ORD laboratories by writing summaries of research projects conducted by or for ORD, editing documents and summaries, assuring the quality of material submitted for printing, typesetting and producing documents, assuring the quality of and preparing documents for submission to the National Technical Information Service, controlling the distribution of documents, and responding to requests for publications and documents.

The technology transfer program continued to assess the status of research and regulations, discuss with the Research committees their priorities for the dissemination of material, develop innovative information transfer mechanisms, and ensure that information on improved technology and management practices is distributed to appropriate audiences to comply with EPA regulations.

### Exploratory Research

The Office of Exploratory Research (OER), which administers the Research Grants Program and the Environmental Research Centers Program, supports interdisciplinary research efforts related to a broad range of long-term environmental issues. The goal of both programs is to provide basic scientific information on which the Agency can make regulatory decisions.

The Research Grants Program is divided into five program areas including environmental health, biology, engineering, air and water. Research is sponsored on a number of broad topics such as the identification and characterization of hazardous

contaminants in various media (air, water and soils); understanding the intermedia transport, conversion and fate of pollutants in the environment; human and ecological risk assessment; incineration and combustion studies; emissions reduction and control processes associated with hazardous sites; and development of new technologies in industrial wastewater treatment.

Investigator-initiated research applications are received in response to an annual solicitation document and grants are selected on the basis of technical merit, the potential relevance toward meeting the Agency's long-range research goals and the contribution toward a balanced research program.

During FY'85, 414 grant applications were reviewed by ad hoc peer review panels, 122 were approved for scientific merit and evaluated by in-house scientists for Agency relevancy. Fifty-seven new proposals were awarded and fifty-seven continuing grants were processed for funding. Abstracts of the 114 grants awarded in FY'85 were published and widely distributed within and outside EPA.

The Environmental Research Centers Program supports long-term environmental research in science and engineering. The program consists of eight university-based centers, each specializing in an area of interest to EPA, including ground water, hazardous waste, environmental epidemiology and marine science research. Support to each center is provided through a cooperative agreement with EPA and the center's research program is managed by a center director, along with an EPA project officer. The center director is assisted by a Science Advisory Committee (SAC) which advises the director on the technical progress of ongoing research and reviews proposals for further research. The SACs are composed of scientists and engineers from industry, government and academic institutions. At least two staff scientists from EPA laboratories are members on each SAC.

During FY'85, substantial changes were made in the management of the centers to address prior problems identified by the Science Advisory Board. Seven of the eight centers were extensively reviewed by ad hoc panels of expert consultants. All passed review and final reports of the seven site visits were received. The eighth center, the Hazardous Waste Elimination Research Center at Louisiana State University is scheduled for review in June 1986.

### Quality Assurance

Quality assurance (QA) activities play an integral role in the planning and implementation of environmental data collection efforts and in establishing the quality of the resulting data. Quality assurance is the process

of assessing whether the data provided by the data collectors to the data users is of the quality needed and claimed. The Quality Assurance Management Staff (QAMS) is charged with developing appropriate policy and management guidance and with overseeing the quality assurance activities of EPA offices and laboratories responsible for collecting environmental data.

During FY'85 QAMS has had significant impact on the planning, implementation and oversight of Agency QA activities. The following describes a few of QAMS' most important accomplishments:

The primary thrust by QAMS during the past year has been on reviewing, and where necessary, revising planning guidance [QA program plans (QAPP) and data quality objectives (DQO)]. QAPPs are detailed descriptions of the design of an Office or laboratory's QA program and of the way in which that program is implemented. QAMS updated the 1980 QA program plan guidance. The new guidance will be tested for one year, evaluated, changed, where necessary, and finalized. All 42 Offices and laboratories are submitting revised plans in early FY'86 for QAMS approval.

Data quality objectives are now mandated for all significant Agency environmental data collection activities. Data quality objectives are statements of the data quality required by data users to assure that the resulting data are of the quality needed. QAMS issued guidance that describes the process that should be used in developing DQOs. QAMS is now reviewing the "first round" of DQOs submitted by 15 Program Offices and ORD laboratories for their highest priority environmental data collection activities.

QAMS is not only responsible for providing planning guidance for QA activities but is also charged with preparing guidance for line management to use in evaluating the implementation of their QA programs. During FY'85 QAMS completed management systems audits (MSAs) for the Office of Drinking Water and for Region IV. MSAs evaluate the way an office carries out its QA program, using the approved QAPP as the basis for the audit. In addition to the detailed audit reports, the experience gained from these audits led to the development of a protocol for conducting management systems audits for National Program Offices and Regional Offices.

In FY'85, QAMS undertook a major effort to provide information on reliability and availability of sample collection and analysis methodology for data collection activities. This effort is known as RUMM (Routinely Used Measurement Methods). QAMS performed a careful review of the 304(h) analytical methods.

QAMS supported the expansion of a computerized system to assist line management in determining the status of QA activities. The system is now operational in Region 2 and is being set up in Regions 5 and 6.

QAMS has also made major inroads into defining the responsibilities and authorities of personnel responsible for QA. QA performance standards are now in place for each Assistant Administrator and for each Regional Administrator for FY'86. QAMS is assuring that adequate resources are provided to implement the QA activities by adding line items in tier one and tier two Agency workload models.

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## ***Hazardous Waste/Superfund Research Committee***

### **Introduction**

The Resource Conservation and Recovery Act (RCRA) authorizes a regulatory program to identify wastes which pose a substantial hazard to human health or the environment and develop waste management standards which protect human health and the environment. Research support for this program provides the scientific and engineering basis for characterizing wastes, determining the hazards they pose, and formulating controls. In addition, Section 311 of the Clean Water Act authorizes research to support prevention and control of hazardous materials releases.

The Office of Emergency and Remedial Response (OERR) requires scientific and technical support from the Office of Research and Development to mitigate health and environmental problems at the priority sites listed under authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). ORD's program produces a core of scientific and technical information to support the implementation requirements of CERCLA and the enforcement actions undertaken to obtain cleanup and recovery of costs. It concentrates on evaluating equipment and techniques for discovering, assessing, preventing, controlling, removing and ultimately disposing of hazardous substances released into the environment. Because of the nature of the Superfund-sponsored effort, activities consist of field testing and evaluating technologies developed in other research programs, such as hazardous waste.

### **Hazardous Waste**

#### ***Alternative Technologies***

Research supporting this objective is intended for use by the Office of Solid Waste (OSW) in implementing the portions of the RCRA amendments which require banning high hazard wastes from land disposal. In order for these wastes to be safely disposed, the effectiveness of alternatives and waste altering treatment processes must be evaluated and performance parameters established.

Under the program to evaluate existing full-scale treatment technologies to support OSW's Best Demonstrated Available Technologies (BDAT) landfill restriction regulations, 83 plants were screened for evaluation in 1985. Site Visits were made to 20

facilities and field tests were conducted at six plants. Sampling and analysis activities were conducted on residuals from 10 incineration facilities. The Toxicity Characteristics Leaching Procedure (TCLP) was conducted on the incinerator residue and compared with the existing Extraction Procedure (EP). An assessment of incineration capacity was conducted and a report was prepared on the practical limits of waste parameters that impact the feasibility of incineration. An overview assessment of waste stabilization and fixation processes was conducted. Two investigations were initiated to provide technical assistance to EPA Regions I, II and V in the identification of cost-effective technology to remove PCBs from sediments in Bedford Harbor, the Hudson River and Waukegan Harbor.

Waste minimization case studies were conducted at eight facilities that reuse or recycle solvents and metal wastes. The case study results will be utilized by OSW in preparation of the waste minimization report to Congress mandated by the HSWA amendments. Technical Resource Documents (TRDs) were initiated for wastes containing solvents and dioxins. Efforts underway in 1985 will be continued through 1986. Field evaluations of full-scale waste treatment facilities will be continued as will pilot scale investigations of BDAT technologies for treating wastes. Mobile pilot scale units will be assembled for conducting on-site treatment evaluations of BDAT systems for treating waste. Wastes minimization audits will be conducted at full-scale facilities. TRDs will be prepared for wastes containing metals, cyanides, and corrosives. Cooperative agreements for conducting demonstrations of advanced technologies will be initiated with states and universities. Support to the Regions and OSW will be provided for the evaluation of Research, Development and Demonstration (RD&D) permits. Efforts to elucidate the biochemical and genetic mechanisms used by bacteria for degrading polychlorinated biphenyls and field tests of the survivability of white rot fungus under a variety of conditions will also be continued.

#### ***Waste Characterization***

Health and risk assessment information is needed for developing and revising regulations, permitting and enforcement decision-making and regulatory policy making. Products of this research will provide more

applicable, simpler and more accurate information and risk assessment methodologies.

Activities in 1985 included preparation of Health and Environmental Effects Profiles (HEEPs) to support RCRA 3001 listing decisions, as well as revision of Acceptable Daily Intake (ADI) and Unit Cancer Risk (UCR) calculations to support the land banning program. Because of the urgency of initiating the land banning effort, fewer HEEP's were produced in 1985 so that the ADI and UCR effort could be initiated. Methodologies for conducting risk assessments are also being updated to incorporate recent developments in toxicology, including the use of structure-activity relationships and exposure evaluations.

Health research has developed an *in vivo/in vitro* toxicological screen for evaluating potentially hazardous waste samples and process stream residuals. The biological methods employed in the screen are designed to be rapid, inexpensive, and capable of screening large numbers of wastes. Emphasis is on identifying a wide range of potential toxic responses associated with each waste by employing methods from several disciplines of toxicology, including mutagenesis/carcinogenesis, general toxicology, neurotoxicology, reproductive teratology, and immunotoxicology. The protocol involves oral administration of waste material samples to rodents for ten consecutive days. At the end of the ten-day period the whole animal, body tissues, and fluids are evaluated for toxicity in each endpoint. The goal of the screen is to maximize the amount and type of information obtained by exposing metabolically competent, intact animals to hazardous waste mixtures. The protocol is being validated using a series of control compounds of known and defined toxicity. The validation study ensures that the protocol will be capable of detecting biologically active wastes and will allow assessment of its use as a predictive tool for known chronic effects.

The validation study has been initiated with four chemicals; cyclophosphamide, acrylamide, diethylstilbesterol, and chlordecone. The data from the initial study have been statistically evaluated, and a series of scientific papers have been submitted for peer review and for publication in the scientific literature. The greatest progress has been accomplished in the mutagenesis, carcinogenesis, and cytotoxicity assay areas, where a battery of these tests has been validated and used to evaluate a series of RCRA waste samples.

Environmental Processes research has progressed in several areas. Subsurface transport and fate efforts involved investigating biotransformation of several chlorinated hydrocarbons using actual aquifer materials from anaerobic regions, construction of soil profile microcosms for evaluation of their usefulness

in predicting waste mobility in vadose zones, and continued development of the two-phase flow model. Structure-activity (QSAR) research produced predictions of the bioaccumulation potential of all the chemicals identified in waste mixtures, structure-toxicity models for estimating the LC 50 and no-effect concentration levels for seventy percent of the known industrial chemicals and a user oriented program which estimates the joint toxicity of the chemicals selected for evaluation.

Scientific Assessment activities for 1986 will include generation of HEEP's for waste listing decisions and initiation of a new effort to respond to the permitting requirements of landfills and surface impoundments. Efforts to review the information available on chemicals for evaluating their associated acceptable daily intake and unit cancer risk values will be expanded to support the land disposal restriction program.

Health research development of the toxicological screening protocol will continue. Emphasis will be on evaluating the results of research and validation efforts to date, and identification of options and associated advantages for future efforts.

Environmental Processes research supporting subsurface transport and fate will develop existing soil and aquifer microcosms into standard protocols for predicting waste mobility and field test available models that describe solute transport in the subsurface. Also, a protocol for determining a site's vulnerability to contamination will be developed and field evaluated to determine its applicability to various hydrogeologic regimes. Multi-media modeling efforts will couple compatible transport and fate models from several media to produce a screening level and site-specific multi-media exposure assessment package. Probabilistic techniques will be developed and used to address uncertainty.

### **Dioxins**

This research is intended to help the Agency assess dioxin contamination and develop procedures for addressing it. Health research and risk assessment activities are being conducted, as are transport and fate research and a quality assurance support program. Technologies which have the potential to detoxify or decontaminate dioxins and dioxin-like compounds are also being evaluated.

Accomplishments in 1985 included a risk analysis of TCDD contaminated soil and initial analysis of other non-2,3,7,8 dioxin congeners. Preliminary pharmacokinetic studies with rhesus monkeys have been completed and are producing findings which must be subjected to confirmation studies.

Engineering research on dioxin treatment alternatives has progressed in several areas. First, develop-

ment of in-situ stabilization techniques for mitigating dioxin transport in soils is nearly finished. Results of these studies indicate that portland cement and lime-treated asphalt are viable stabilization techniques. Other findings indicate that leachate concentrations of 2,3,7,8 dioxin may be limited by its aqueous solubility to the range of two to three parts per trillion. The utility of inactive mines to serve as repositories for dioxin contaminated soils has also been investigated, and on the basis of evaluation of 29 sites, the concept appears viable. Finally, field testing of the mobile incinerator continued. Installed at the Denny farm site near McDowell, MO, tests using dioxin contaminated liquid wastes and soils have verified the effectiveness of its control devices and its destruction removal efficiency.

Monitoring research has produced an evaluation report on current methods for analyzing 2,3,7,8 TCDD. Improvements to current methodology are suggested.

Environmental Processes research identified anomalies in sorption/desorption of dioxin from soils and initiated studies to identify their causes. Differences were also found in isomer bioconcentration levels in carp and fathead minnows exposed to trace concentrations in water and sediment. These differences appear to be related to different rates of metabolism in the fish rather than rates of uptake from water.

For most offices, 1986 research will build on research already conducted. Risk assessment activities will expand methodologies developed in 1984 and 1985 to include scientific advances and new information in the areas of bioavailability, body burden and epidemiology. Engineering research will evaluate the ability of white rot fungus to metabolize dioxin found in soils. This fungus has recently been shown effective in metabolizing recalcitrant, halogenated compounds such as PCBs, DDT, and lindane. Field experiments evaluating the ability of UV photolysis in combination with APEG reagents to detoxify contaminated soils will also continue.

Environmental Processes research will continue to explore the transport and fate of dioxin. Saturated and unsaturated zone microcosms using soils from contaminated sites will be employed to determine rates of movement and transformation of 2,3,7,8 dioxin. This will be accomplished by both dosing the microcosms with radio-labelled compound and measuring the release of "aged" dioxin. Rates of photodegradation in soils will also be measured. Rates of dioxin uptake by fish, plants and large animals will be determined by tissue and organ analysis after controlled exposure. Biomagnification factors will also be calculated.

### ***Waste Identification***

Analytical methods needed for enforcing Section 3001 of RCRA must be standardized and tested to determine their validity and reliability. New methods and procedures for detecting the presence of hazardous wastes under field conditions are also required to satisfy Section 3013 of RCRA, which establishes facility monitoring requirements.

Accomplishments for this objective in 1985 fall into the categories of development evaluation and validation of monitoring methods. Analytical validations include four extraction methods, a method for most target herbicides, and the inductively coupled plasma chromatography method. Methods evaluated a single laboratory validation for the flash point of wastes, a method for monitoring mercury, and methods for determining corrosivity, metals dissolution, and ignitability. All of these validations were performed by single laboratories and were sufficient in some but not in all instances to consider the method completely validated. Methods that are not class specific and intended for a large group of analytes require multi-lab validation.

Several monitoring methods designed to depict subsurface conditions were evaluated. These included electromagnetic conductivity methods, ground penetrating radar, resistivity methods, and borehole techniques.

A computerized Geographical Information System (GIS) for integrating terrain, remote sensing, and sampling data was also evaluated.

### ***Land Disposal***

Research into land disposal provides guidance on design, permitting, operation, maintenance, closure and regulation of land treatment, storage and disposal facilities.

Land disposal research produced several significant handbooks and technical resource documents during 1985. These included publications for use in estimating the attenuation by soils of hazardous chemical solutions and procedures for assuring the quality of construction used in land disposal facilities. A document on the design, construction and evaluation of clay liners for landfills, surface impoundments and stockpiles was also produced. A compilation of all the available information on the design, construction and evaluation of clay liners was prepared and some information was presented for the first time. The information it contains was obtained from existing literature, private and public engineers, and evaluations of the performance of 17 existing liners.

Other accomplishments included field testing of an electrical leak detection technique on a retention pond, a report on the efficiency and costs of controlling volatile organic emissions from surface



impoundments, and initiation of a research program designed to make artificial intelligence techniques available for permit writers.

Land treatment research has also progressed and a final report on closing petroleum refinery land treatment facilities is being prepared. In order to finish this study, several major efforts were completed, including development of a screening protocol for predicting the treatability of wastes, degradation, transformation, toxicity, and transport studies. Other 1985 accomplishments include selection of study sites for evaluating the treatability of wood preservatives and initiating laboratory treatability studies on creosote and pentachlorophenol.

During 1986, research will continue in areas previously initiated. Additional guidance will be provided on the design and performance of containment systems for waste management facilities, and guidance on design and control technologies developed for Subtitle C facilities will be adopted for Subtitle D facilities. A large volume waste program will be initiated to assess the environmental problems these systems cause. Also, the artificial intelligence program will be continued in order to provide the Regional offices with timely support for land disposal and incineration permits.

Land treatment research will continue with emphasis on producing a training manual for applicants and permit writers and determining the effects on organics degradation of varying the frequency of waste loading.

### ***Incineration***

Research to support the permitting of incinerators and improvements in design is used by EPA and other permitting officials to evaluate the acceptability of incinerating particular wastes and to monitor operating units for compliance with performance requirements. Laboratory, pilot and full-scale units are investigated to determine the performance of a range of incinerators and other thermal treatment devices.

During 1985, emissions performance testing continued on industrial processes. These tests are designed to provide data in support of proposed RCRA standards for practices that involve disposing of wastes as part of the operation of another industrial process. Tests were conducted on two asphalt plants, a steel furnace, and two industrial boilers. Interim reports were published on incinerator operating parameters which correlate with hazardous material destruction. The Combustion Research Facility (CRF) received all of its final RCRA and TSCA permits and has finished a series of incinerator failure mode experiments. Experiments at CRF for transient feed impacts on incinerator performance have been

delayed to allow for trial burns on dioxin-bearing wastes from several Superfund sites. Eleven combustion facilities were base tested for dioxin emissions to provide data for Tier 4 of the National Dioxin Program.

In 1986, all prior research on waste disposal in industrial processes will be assembled into three guidance documents on best practices for industry to employ in safely disposing of hazardous waste in its respective processes. A stoker-fired boiler will be tested under nonsteady state operating conditions to determine the impact on waste destruction efficiency. A report will be published on incineration conditions required for destruction of three dioxin bearing wastes from Superfund sites. Research will be continued to assess the impact of thermal destruction process failure modes on facility performance. Special emphasis will also be placed upon assessing the fate of metals in thermal destruction processes.

### ***Quality Assurance***

The purpose of the quality assurance program is to ensure that data of known quality are used throughout hazardous waste research. Analytical standards and reference materials are being developed for and distributed to all participating laboratories. Quality control and performance evaluation samples are also being developed and distributed to appropriate laboratories. Additional support is being provided to state laboratories to facilitate their performance of the required measurement and monitoring functions. This is taking the form of assistance in instrument calibration and provision of reference materials.

Overall, 30,000 quality control check samples were distributed to Agency contractors, state, local and EPA laboratories. More than 20,000 organic calibration standards were distributed to this same set of labs. Activities supporting this objective should remain largely unchanged in 1986.

### ***Control of Hazardous Releases***

Accidental releases of oil and hazardous materials occur frequently and constitute a significant environmental hazard. The research conducted in this program supports both the Clean Water Act's releases section and RCRA's underground storage tank (UST) provisions. The object of this research program is to develop technical information and guidance needed for headquarters staff and on-scene coordinators in developing and implementing regulations, as well as cleaning up actual releases.

In 1985, a major research effort was initiated to support development of the underground storage tank regulations mandated by the 1984 amendments to the RCRA. The primary goals were to identify methods for detecting leaks from USTs and to design a methodology for evaluating these methods. An

initial state-of-the-art report was completed. A start was made in engineering an apparatus for conducting evaluations at full-scale uncontrolled conditions. Also, sensors were evaluated for detecting leaks once they leave a tank. These sensors are intended to assess the magnitude of leaks and the nature of the environment being threatened. First priority is being given to development and standardization of techniques for determining the extent of dispersion and movement of materials from leaking tanks.

In response to the requirements of the Clean Water Act, a series of research programs have been in progress to prevent and contain hazardous materials releases. Accomplishments in 1985 include completion of guidance manuals on selection and use of sorbents to contain and clean up liquid hazardous releases and on overtopping control techniques for hazardous waste impoundments. A report was completed on the feasibility of canine olfaction technology for detection of hazardous substances. In addition, aerial photography was used in support of twelve releases in order to provide a rapid assessment of potential harm to health and the environment.

Efforts in 1986 are expected to produce technical handbooks on hazardous substance releases prevention and removal, a report on non-destructive techniques for locating subsurface releases and chemical containers, and a report on the use of chemicals to control floating hazardous materials. Also, chemical and site specific risk assessments for USTs will be initiated.

Environmental processes research will test and field validate a multimedia bioassessment protocol for determining the bioavailability and toxicity of hazardous releases on various environmental settings. This will be conducted at waste or spill sites and be used to determine the significance of the risks posed to exposed organisms. The monitoring program will continue to use remote sensing in support of releases.

In 1986, engineering research supporting the UST program will fabricate and install the test apparatus required for evaluating volumetric leak detection methods for tanks containing petroleum fuels. The accelerated regulatory development schedule also requires an evaluation of methods for tanks containing chemicals and hazardous wastes. Major programs also will be initiated in the areas of leak prevention (in response to incidents such as the release at Bhopal, India) and corrective actions for leaking tanks.

Environmental processes research will also address corrective actions by carrying out a series of laboratory and field tests of promising biological and physical/chemical techniques for in situ corrective action. A survey will be conducted to identify other

techniques which may have been successful in correcting problems at other types of hazardous waste sites.

## **Superfund**

### ***Site Assessment***

The success of removal and remedial actions frequently depends on an accurate appraisal of the nature and severity of the problem. Research activities supporting this objective provide the techniques and procedures that on-scene coordinators at uncontrolled waste sites need to assess the degree of hazard and the specific cleanup requirements quickly and effectively.

Site, situation, and chemical specific exposure and risk assessments covering single chemicals and complex mixtures were prepared for OERR, the Regions, OSC's and ERT personnel. During 1985, on-scene coordinators were given a new tool for assessing the hazards posed to humans at uncontrolled sites in the form of a procedure for estimating vapor emissions from landfills. Rapid response health assessments were provided for determining responses to emergency situations, and health effects assessments were prepared for use in setting cleanup goals.

Engineering support consisted of direct technical support to OERR for developing guidance for conducting remedial investigations and feasibility studies, and cost estimation procedures for remedial action alternatives. Feasibility studies, reports and plans were reviewed for more than six sites. Engineering assessments were provided for various processes used in stabilizing uncontrolled wastes, and an interim report was prepared on the issue of placing stabilized dioxin contaminated soils in used mines.

Assuming the availability of resources and reauthorization, site and situation assessment activities will continue and remain largely unchanged in 1986. A chemical-specific catalogue of sensitive population subgroups will be developed, as will a report on the data requirements for remedial action engineering evaluations. Short-term, quick-turnaround technical advice and reviews will continue to be provided to the Regions and Enforcement.

### ***Technology Evaluation***

Reports, manuals, and handbooks are being prepared to provide design and operational data and cost effectiveness information for decisions regarding removal and remedial actions.

In 1985, EPA's mobile incinerator was successfully demonstrated in Region VII through a field evaluation

of its ability to destroy dioxin-contaminated liquids and soils. In addition, the mobile carbon regenerator's ability to reactivate filtration carbon was also successfully tested. Field applications handbooks were completed for the following remedial action technology areas: leachate plume management, cover systems, stabilization and solidification techniques, fugitive dust control, accelerated methods of in-situ stabilization, and dioxin handling practices. Full-scale evaluations of slurry trench cut-off walls are being conducted at two sites, and public requests for new and innovative site control technologies have been issued.

Assuming the availability of resources, an ambitious program is envisioned for 1986. The mobile carbon regenerator will be demonstrated at the Stringfellow Hazardous Waste Site in California. It will reactivate spent carbon from a physical/chemical treatment system being used to treat leachate at this location. The mobile in-situ containment/treatment system will be tested, in conjunction with the U.S. Air Force at Volk Air National Guard Field in Wisconsin. An abandoned training site contaminated with solvents, fuels, and possibly PCBs will be used. Another major activity will be to evaluate, under controlled-condition testing, commercially available, innovative technologies which can be applied to the Agency's emergency response and remedial activities. Also, a study will be conducted to evaluate the use of a modular transportable incineration system (i.e., with a capacity five to ten times that of the mobile incinerator currently in use) for cleanup of Superfund sites in New Jersey.

Technical evaluation of innovative remedial and removal technologies will be pursued and include in-situ chemical and microbial waste degradation and air stripping of volatile organics from soils. Ongoing evaluations of the integrity of several full-scale slurry walls will be completed. Evaluations of multiple component walls, such as bentonite used with flexible membrane liners and cements, will be initiated, as will the efficacy of electrokinetic techniques for remedial action for contaminated soils and leachates. Vegetative techniques will also be studied for the extraction of small concentrations of organics from soils. An expert system for remedial action performance and reliability assessment will also be initiated.

#### ***Personnel Protection***

Information on personnel health and safety equipment and procedures is being developed through evaluations and assessments of technical components so as to ensure protection during removal and cleanup operations.

During 1985, the following efforts were undertaken: the permeation resistance to ten liquid hazardous

substances of a chlorinated polyethylene outer garment material was evaluated and a report delivered; the construction of a two and one-half hour chemical protective ensemble was completed and the ensemble breathing apparatus was submitted to NIOSH for certification testing; modification of the breathing apparatus to correct deficiencies noted by NIOSH is underway. A five-year personnel protection research plan was prepared to address research needs of the Superfund, Toxic Substances, and Pesticides programs and a major RFP was prepared as a key implementation step. Discussions have been held among EPA, OSHA, NIOSH, and the Coast Guard (USCG) regarding development of formal cooperation on chemical protective clothing research.

In 1986, efforts will include additional testing of chemical protective ensembles, evaluation of decontamination agents and procedures, evaluation of personal cooling devices and evaluation of personal hazard detectors. An intra-EPA workshop is planned to discuss EPA's requirements for personnel protection technology research and to inform key personnel of pertinent research activities of EPA and other organizations. Coordination efforts will continue through participation in an ASTM committee on protective clothing and other technical organizations and meetings. It is expected that a formal coordination agreement among EPA, NIOSH, OSHA, and USCG will be implemented in 1986.

#### ***Reportable Quantities***

Risk information needs to be prepared on specific chemicals for use by OERR in setting and adjusting the amount that must be released in order for Federal notification to be required.

In 1985, OHEA completed sixty reportable quantities (RQs) chapters of Health and Environmental Effects Profiles (HEEPs) and completed an additional ninety RQs carried over from the previous year. An equal number is expected to be completed in 1986. Significant support will also be provided for identifying potential carcinogens on the CERCLA list of chemicals using a new carcinogenicity evidence scheme.

#### ***Technical Support***

Site and chemical specific assessments of exposure and health risks at uncontrolled sites were provided to the program office. The Regions and the states. Engineering technical support was provided to Region X for the Western Processing and Chrome Waste sites, to Region IX for the Stringfellow, Iron Mountain and Celter Chemical sites, to Region VII for the Denney Farm and La Bountie sites, to Region VI for the Compass Industries landfill fire, to Region V for the Calumet Harbor PCB disposal, to Region IV for the Whitehouse sites, to Region II for the Prices' landfill,

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Li Poir, Hyde Park, and the Love Canal sites, and to Region I for the Gilson Road, the Beacon Heights and the McKin sites. Fourteen technology transfer briefings were presented to EPA Regional offices and several states on cover technology, stabilization and solidification processes, in-situ treatment techniques, and a general overview of eleven handbooks covering remedial technology.

Environmental Processes technical assistance was provided upon request. Efforts were directed to workshops aimed at Headquarters, Regional, and state staffs, particularly with regard to groundwater hydrology and movement of contaminants in the subsurface. Preparation of a second volume of a handbook explaining the use of three levels of mathematical models was initiated. The new volume will incorporate several field applications of the models from the original volume and will feature extensions and modifications of the codes for greater user convenience. A user's guide for minimizing the adverse environmental effects of cleanup of uncontrolled hazardous waste sites was also completed.

Assuming the availability of resources, 1986 activities will remain largely unchanged. In addition to site and chemical specific risk assessments, OHEA support will also include a field study to determine the volume of soil that accumulates on the hands of on-site workers. Engineering support is expected to remain unchanged, the level of support being directed proportionate to the level of program office activity. Environmental Processes support will also continue and focus on groundwater related assistance, including training and advice on the use of models, and assistance for bioassessing sites and cleanup effectiveness.

## ***Multimedia-Energy Research Committee***

### **Introduction**

The multimedia energy research and development program provides the scientific and technical information necessary to support the Agency's permitting and standard-setting processes and to allow for the development and utilization of energy sources in an environmentally acceptable manner. Research is conducted: (1) to better understand the phenomenon of acid deposition and provide information upon which mitigation decisions may be made; (2) to expand EPA's knowledge of the performance, reliability, and cost of the limestone injection multistage burner (LIMB) control technology; (3) to characterize and evaluate synthetic fuels discharges; and (4) to evaluate the impacts of energy development in cold climates.

### **Acid Deposition**

Research on acid deposition is coordinated through the National Acid Precipitation Assessment Program (NAPAP), which is administered by the Interagency Task Force on Acid Precipitation (ITFAP). EPA is one of the joint-chairs of the Interagency Task Force and has the lead role in the aquatic effects and the control technology research areas. The term "acid rain" refers to the atmospheric deposition of acidic or acid-forming compounds in either dry or wet form. These compounds exist in the atmosphere as gases or aerosol particles containing sulfur oxides ( $\text{SO}_x$ ), nitrogen oxides ( $\text{NO}_x$ ), hydrogen chloride, sulfuric acid, nitric acid, and certain sulfate and nitrate compounds. While scientists generally agree that these compounds are responsible for deposition of varying degrees of acidity, many questions persist about the causes, effects, and methods of mitigating or controlling acid deposition. The objective of acid deposition research is to develop the necessary data to understand fully the sources and characteristics of acid deposition; the extent of damage or potential damage; and the corrective measures that may be used to diminish the problem.

### **Atmospheric Processes**

Improvements are needed in both the scientific understanding and the field data bases on atmospheric transport, transformation and deposition on acidic substances in order to develop more scientific

ically acceptable, yet simplified models to meet assessment and policy needs.

Quantification of source-receptor relationships is needed to evaluate the effectiveness of control strategies proposed to reduce acid deposition. The complex (nonlinear) processes of transport, chemical and physical transformation, and wet and dry deposition are not well understood. Analytical tools (mathematical models) need to be developed to simulate these processes. Such tools provide the means to quantify the contribution of specific sources (or areas) of emissions to acid deposition at specific receptor sites (or areas).

In FY'85, ORD completed development of the initial version of the Regional Acid Deposition Model (RADM). The RADM contains modules that simulate atmospheric transport, dispersion, chemical and physical transformation, precipitation, scavenging, and dry deposition. These modules are being revised as the uncertainties in the transport, chemistry, and deposition processes become better understood and are better able to be characterized. In FY'86, sensitivity studies needed to evaluate and refine the RADM components will be conducted. Such information is necessary to design field experiments to develop data necessary to evaluate and improve the RADM. When fully developed and evaluated, the RADM will provide the analytical tool needed to evaluate the effectiveness of control strategies proposed to reduce acid deposition.

### **Deposition Monitoring**

A long-term quality-assured monitoring record of total deposition (both wet and dry) is needed with sufficient spatial and temporal scale to: (1) provide data for long-term trend analyses; (2) evaluate atmospheric models; and (3) determine exposure in effects studies.

The deposition monitoring research program provides a wealth of deposition data on wet precipitation through the National Trends Network (NTN). This 150-station network operated at peak capacity in FY'85, providing important scientific information on wet acidic deposition from sites throughout the nation. The NTN will continue to be fully supported in FY'86.

A growing body of evidence suggests that dry deposition, in the form of gases and aerosols, contributes significantly to total acidic deposition. Dry deposition rates vary with surface cover and topography, and are affected by wind speed and humidity. Until our recent efforts to develop and deploy accurate monitoring instrumentation, we could only estimate rates of dry deposition. In FY'85, EPA conducted field testing of a prototype dry deposition monitor and established a pilot dry deposition network of six sets of monitoring equipment at five locations in the eastern U.S. Our site at West Point, NY, was equipped with dual monitors to enable us to evaluate the variability of the equipment. Other locations are: Oak Ridge, TN; Whiteface Mountain, NY; College Park, PA; and Research Triangle Park, NC. EPA completed the design for siting a full national network to measure regional dry deposition. We estimate that the system will contain 90 stations when it becomes fully operational, and that these will be installed over the next several fiscal years.

In FY'85, EPA began installation of a mountain cloud chemistry/forest exposure monitoring network. High elevation forests are frequently exposed directly to clouds. Cloud or fog droplets can collect directly on vegetation and affect it. The mountain cloud chemistry/forest exposure monitoring networks sites will measure air and cloud water chemistry, the frequency of cloud contact, and the amount of acidic material deposited on vegetation. Measurements using common observational techniques will be made at sites in the Appalachians, Adirondacks, and Laurentians. By the Spring of 1986, the EPA network will have sites located at Whiteface Mountain, NY; Hubbard Brook, NH; Shenandoah National Park, VA; and Mt. Mitchell, NC. The Tennessee Valley Authority (TVA) is installing a site at Whitetop Mountain near Mt. Rogers, VA; and the Canadians are installing sites at Montmorency, Quebec and at Mt. Tremblant, Quebec. These sites will be used to establish the rates of deposition to elevated forest regions in eastern North America by fog and low clouds and to test the various proposed hypotheses for observed forest die-back.

### ***Aquatic Effects***

Acidic deposition is believed to be a major contributor to episodic depressions of pH in aquatic systems, which may result in biological effects such as reduced fish populations. The risk to surface waters and aquatic biota in the United States is only partially known. Improvements are needed in both the scientific understanding and the field data bases which define the processes affecting: (1) the current state of surface waters and watersheds, (2) the chemical and biological changes to those resources, and (3) the rate of change resulting from altered loadings of acidic or neutralizing substances. These improvements will

allow the development of more scientifically acceptable yet simplified relationships and models for assessment and policy needs.

Two major research efforts have been mounted to improve our understanding of aquatic effects—the National Surface Water Survey and the Direct/Delayed Response Project.

Terrestrial effects of acidic deposition fall into two major categories: effects on watersheds and soils; and effects on forests. The major issues deal with whether effects can be shown or suspected, their extent, their magnitude and the rate at which they occur.

Acidification of surface water is a watershed-level phenomenon, and a full understanding of all the biogeochemical processes involved is not expected for some years. The DDRP will make predictions of surface water response using a subset of the appropriate processes. In FY'86, EPA will initiate a watershed research program designed to test the predictions made by the D/D models by using experimental manipulations in a small number of watersheds.

Preliminary data on foliar damage and growth reductions in several species of trees in different forest ecotypes suggest that environmental pollution including acid deposition may be a major or contributing cause. EPA and the U.S. Forest Service have been working closely to sponsor research in several forest types to address the questions of the causes of observed changes in forest health, and their extent and magnitude. In FY'86, EPA, in close cooperation with the Forest Service, will be implementing field research in spruce/fir forests in the Northeast and Southeast, in commercially important pine species in the Southeast, in mixed hardwood forests of the East, and in some western coniferous forests. The research program will address the major hypotheses of cause related to air pollutant impact in each of these forest types.

### ***Effects on Materials***

The population-at-risk of common building materials in the United States is only partially known. Improvements are needed in both the scientific understanding and in the field data bases that define the exposure and processes affecting: (1) the current state of materials; (2) the changes to those materials; and (3) the rate of change resulting from altered loadings of acidic or neutralizing substances. These improvements will allow the development of scientifically acceptable yet simplified relationships and models for assessment and policy needs.

The materials effects program produced, in FY'85, a comprehensive regional estimate of the damage to

materials from acid deposition and other airborne pollutants. While a significant amount of controversy has arisen concerning the assumptions, methodologies, and calculations of the analysis, the 17-state study provides a useful basis for the technical dialogue. The study covers several metals plus paint and masonry. The principal finding was that the annual estimate of damage over the region studied was \$2 billion (within uncertainty bounds between \$0.5 billion and \$6 billion) for the amount of damage that is occurring due to acid deposition.

In FY'86, the program continues to determine those materials and resources at risk and develop data bases and methods for differentiating the effects of acid deposition from those of natural and other man-made sources.

### **Assessments**

Improvements are needed in the methodologies for integrating acid deposition research, models and data bases and for assessing uncertainty in order to meet policy needs.

The assessment research program performs two vital functions: (1) integrates the various aspects of the acid deposition research program, and (2) provides information for formulating appropriate decisions that address acid deposition issues. A major part of this effort is to develop assessment tools and documents. In FY'85, EPA published "The Acidic Deposition Phenomenon and Its Effects—Critical Assessment Review Papers."

In FY'86, the program continues to develop strategic emissions/source-receptor dose-response models and data systems to meet the needs of policymakers; and provide the scientific basis for evaluation of alternative systems of control and mitigation strategies. EPA will update and maintain the NAPAP data bases; conduct detailed analyses of aquatic, meteorological, forestry, and materials data; and integrate and compare the various NAPAP sources of information to develop assessment methodology and documents.

### **Limestone Injection Multistage burner (LIMB)**

EPA continues to develop LIMB technology that is designed to reduce both SO<sub>x</sub> and NO<sub>x</sub>, the two major acid rain precursors. The LIMB technology is designed to be retrofitable to large and small existing coal-fired boilers.

### **LIMB Technology Development**

Additional information is necessary to document the reliability and cost-effectiveness of LIMB technology to reduce the emissions of sulfur and nitrogen oxides.

The LIMB performance goal is to reduce SO<sub>x</sub> emissions by 50-70% and NO<sub>x</sub> emissions by 50-80%. During FY'85, EPA continued the development of high surface area sorbents and sorbents treated with "promoters" such as sodium carbonate to improve the sulfur capture ability of the LIMB technology. Laboratory tests are continuing to define the optimum conditions for the injection of the sorbent. During FY'85, work continued on a cofunded contract for a full-scale demonstration of the LIMB technology on a wall-fired utility boiler. EPA is providing approximately 30% of the total funding for this demonstration. Most of the remainder will be funded by Babcock and Wilcox, the State of Ohio, and Ohio Edison, which is also providing the power plant.

During FY'85, a basis for the preliminary process design of the full-scale wall-fired boiler demonstration of LIMB was developed and peer reviewed. The final process design is scheduled to be reviewed in FY'86.

The FY'86 program continues laboratory and pilot-scale research of the LIMB process to improve engineering knowledge of the effects of operating parameters and system variables on NO<sub>x</sub> control and SO<sub>2</sub> capture. EPA initiates prototype testing of a tangentially-fired boiler to provide the basis for transferring development information into design criteria for practical hardware. We continue to develop design criteria for commercial-scale demonstration of a wall-fired boiler. The wall-fired demonstration is scheduled for completion in mid 1988.

### **Synthetic Fuels—Environmental Engineering**

EPA has consulting responsibilities as specified in the Energy Security Act, and assists the Synthetic Fuels Corporation (SFC) and its project developers in evaluating monitoring data.

### **Synfuels Discharges and Control Technology**

The synfuels program activities during FY'85 provided support to the Regional Offices, States, and the Synthetic Fuels Corporation (SFC) in the development of viable Environmental Monitoring Plans (required by SFC sponsors) to determine problem discharges and effectiveness of in-place controls, review of environmental impact statements, and permit applications.

Although there has been a reduction in the development of large synfuel plants, the interest in smaller industrial units and combined-cycle plants for power generation has increased. Environmental Monitoring plans were reviewed for the Great Plains Coal

Gasification Associates and Dow Syngas coal-gasification projects, the Forest Hill heavy-oil project, and

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Unocal's Parachute Creek and Seep Ridge oil shale programs. Special permits were reviewed for the Getty and City Service oil-shale projects, and environmental impact statements for an Alaskan coal mine and the Mobile and Pacific Shale Oil Projects were reviewed.

The FY'86 program will continue to provide engineering and technical support to the Regions and States for permitting and Environmental Impact Statement review of monitoring plans for projects sponsored by the U.S. Synthetic Fuels Corporation. Studies will be initiated on multimedia problems, and on control needs of those energy technologies that are closest to commercial development. Technical manuals for key control areas of coal and oil shale processes will be prepared.

### **Cold Climate Research**

The Cold Climate Research Program addresses environmental and health issues applicable to most cold weather regions, but primarily to the State of Alaska, where natural resource development, expanding population and the extreme climate pose unique problems. The research program concentrates on those areas of highest concern to Region X and the State.

#### ***Cold Climate Data Needs***

In FY'85, the Cold Climate Program emphasized resource development and habitat modification issues, including the impacts of oil and gas development, the environmental impacts of placer mining, the evaluation of asbestos in drinking water, the toxicology and fate of petroleum hydrocarbons in oiled waters, and the impact of particulates, particularly woodsmoke, on human health in urban areas.

The FY'86 program will continue to address environmental problems unique to cold weather regions. It continues to evaluate the impacts of oil and gas development on coastal tundra wetlands; to evaluate the impacts of placer mining on aquatic ecosystems; to improve air models for application to North Slope problems; and to evaluate the urban woodsmoke problem.



## **Water Research Committee**

### **Water Quality Based Approach/Permitting**

A continuing issue in water quality regulation is the water quality based approach (WQBA-program) which focuses on the quality of ambient marine and freshwaters essential to protect human health and aquatic life. This contrasts with an earlier Agency emphasis on the technology-based approach effort which focused on effluent limits. Emphasis is now placed on characterizing the attainable uses of a water body based on natural features and surrounding land forms, single chemical criteria development, and toxicity reduction through biomonitoring. Determination of wasteload is based on these factors. Diffuse or nonpoint sources of contamination are addressed through best management practices. These activities are supported by permit and receiving water monitoring, methods standardization, and quality assurance.

**FY 1985 Accomplishments**—During FY 1985 ORD supported the Water Quality Based Approach (WQBA) in the areas of health effects, risk assessment, monitoring, and water quality. Research was initiated to develop a tiered battery of health effects bioassays for use in the NPDES program. *In vitro* and *in vivo* bioassays were applied to six different municipal wastewater effluents. The effluents included those consisting of only domestic waste streams and several which contained both industrial and domestic wastes. Although all the streams exhibited toxicity, those with industrial wastes were more toxic. Some of the less toxic effluents had a greater effect on streams because they made up a larger percentage of the stream flow.

Methods for measuring a spectrum of microbial indicators in turbid waters and shellfish meats were developed or adapted to determine if a quantitative relationship exists between microbial indicators and disease in shellfish consumers. The microbial indicators included fecal coliforms, *E. coli*, enterococci, *Clostridium perfringens*, and bacteriophage.

Information on health and environmental effects of specific chemicals was gathered, summarized and quantified into acceptable daily intakes (ADIs) for use by the Regions and states. The Ambient Water Quality (AWQ) criteria were revised.

In the area of methods evaluation and standardization, several manuals were produced. Manuals on toxicity testing were produced for acute toxicity for fish, chronic short term tests, and precision of the duckweed (*Lemna*) test. State-of-the-art reports on the rapid chronic mammalian cell toxicity test and the availability of open channel flow calibration were produced. Priority pollutant methods standardization in water was completed in FY 1985, as were GC/MS priority pollutant methods standardized for biological tissue.

Effects of holding time and temperature on coliform testing for waters was published as was an improved method to reconstitute waterborne viruses and revised urology methods on sample cytotoxicity removal. User friendly data reduction PC packages for use by Regions were provided.

Information on minimum data sets necessary for evaluating site-specific water quality assessments was published. Several reports of large-scale applications of assessment techniques for complex chemical effluents impact analyses, biological integrity impact analyses, and methods for distinguishing between discharge and run-off were produced.

In the area of quality assurance, three reference calibrants were added to the repository biological toxicity testing system; single laboratory precision/accuracy testing was performed for biological and chemical test procedures; and reference materials and performance audit materials were supplied to support fresh water analysis. Performance evaluation studies were conducted for trace metals, minerals, nutrients, PCBs, pesticides, volatile organics, cyanides, residues, and oil and grease. Traceability to the National Bureau of Standards was established for volatile organics and trace metals of the performance evaluation (PE) samples and PCB in sediment. Biological quality control samples, calibration standards, and other quality control samples were distributed.

In the area of environmental processes and effects, a report was produced on evaluation of the index of biotic integrity using fish for freshwater aquatic ecosystems. A handbook of transport and transformation of rates and estimation procedure for conven-

tional pollutants was produced, and a workshop on the storm water management model (SWMM III) was held. Reports on the following subjects were produced: case studies on the use of short-term chronic toxicity tests of complex effluents, evaluation of available marine toxicity tests for effluents, research strategy for application of water quality based approach to estuaries, a tiered approach to integration of single chemical and toxicity controls in the water quality based approach, field validation studies to evaluate site-specific criteria guidelines, and requirements of the minimum data set for calculation of final acute values based on tested species sensitivity. Ten water quality criteria documents and fifteen draft aquatic life advisories were also produced.

**FY 1986 Program**—In FY 1986 bioassays that were developed in previous years to determine toxicity of municipal and industrial waste discharges will be field tested at several different field locations. The results of these field evaluations will be combined and a methods manual will be produced in FY 1987.

During the year, several possible epidemiological sites for study of the relationships between microbial indicators of water quality and disease in clam and oyster consumers will be selected. Sites under consideration include Narragansett Bay, Pamlico Sound and the U.S. Coast of the Gulf of Mexico. Factors to be considered in site selection include: population of at least 50,000 discharging to the site, both clams and oysters being harvested in the same area and a harvesting season long enough to obtain a range of water quality. After the site has been selected, shellfish harvested from waters of known quality will be fed to human volunteers. Measurements of microbial indicators in the harvesting water and shellfish meats will be made using the spectrum of possible indicator organisms. The organisms that best correlate with disease in shellfish consumers will be proposed as the appropriate indicator organisms or criteria.

In the methods evaluation/standardization and quality assurance areas, research of the previous year will be continued with some changes in emphasis. In the biological methods area there will be increased emphasis on methods and culturing techniques for sheepshead minnow, mysid shrimp, and *Champia* algae.

In the area of chemical methods development, generic instrumental approaches to monitoring rather than a chemical-by-chemical approach will be evaluated. Development and evaluation of metal speciation and toxicity monitoring probes will be undertaken.

The development of comprehensive ecological criteria for meeting goals of the Clean Water Act will continue, as will the work on the national atlas and

maps of aquatic ecoregions. Environmental processes characterization research will be conducted and data bases and wasteload allocation models will be developed, improved, simplified, and tested as required for implementing the water quality based approach. The Center for Water Quality Modeling will maintain and provide model codes, user manuals, and training and user assistance.

Toxicity test methods for aquatic life will be developed, verified, and transferred to Regions and states for predicting instream water body and biological impacts in fresh, brackish and marine systems. The significance of toxicity persistence to biota will be determined and methods developed for factoring these into the permitting process. Research will continue to integrate pollutant-specific toxic control techniques with whole effluent toxicity testing procedures and best available technology (BAT) limits for use in water quality permitting. Field tests will be conducted to combine site-specific criteria modification for techniques with the whole effluent toxicity approach. Some freshwater and marine specific chemical aquatic life criteria and advisories will be developed as needed. Research will be conducted to develop, modify, and apply experimental knowledge based on expert systems for environmental assessment needs.

The cooperative ecological research with the People's Republic of China will continue in FY 1986 to address the impact of contaminants on freshwater organisms and will be at the stage in which field verification of methodologies will be emphasized.

#### **Wastewater Treatment Technology**

This issue is concerned with identifying new or additional information or technologies needed to improve the reliability and cost-effective upgrading and construction of municipal treatment facilities and the compliance of existing municipal and industrial facilities. The problems unique to the management and treatment of wastewater from small communities are of major concern and require special attention. The management of sludge produced by treatment plants is not only a major technical problem but also represents a major cost component of wastewater treatment and management.

**FY 1985 Accomplishments**—In the engineering area, major accomplishments included ten Regional seminars on "Improving POTW Performance Using the Composite Correction Program Approach." A major technical assistance effort was initiated in 1984 with Region III and Maryland, Pennsylvania, and Virginia. It focused on municipal and industrial toxicity reduction and innovative nutrient control of point source to support the implementation phase of the Chesapeake Bay Program and resulted in three major engineering projects that were implemented during 1985. The

design manual, "Odor and Corrosion in Sanitary Sewerage Systems and Treatment Plants," was published. Engineering evaluations were completed for innovative projects funded by the Construction Grants I/A Program. Estimates of toxics removals by POTWs were provided in support of the new RCRA amendments. The GC/MS tape work has continued to identify additional toxicants that were not included on the initial list of the 129 priority pollutants. This information will help identify industrial toxicants of national concern.

The engineering research program also continues to support the development of sludge regulations. A seminar publication entitled "Composting of Municipal Sludges" was widely distributed in 1985. The handbook, "Estimating Sludge Management Costs," was published, providing cost-estimating curves and covering both capital costs and annual operating and maintenance (O&M) costs for commonly used processes in municipal wastewater sludge treatment, storage, transport, use, or disposal.

In the health area, criteria Profile Documents are being finalized to support the new technical regulations for sludge. The purpose of the documents is to present information that can be used for the calculation of "hazard indices." Included are cancer data (potency estimates), oral chronic toxicity data used in the quantification of hazards in the food chain, and inhalation and aquatic toxicity data used in deriving hazard indices for the incineration and ocean disposal of sludges. The application of mutagenicity data has not yet been determined.

A major accomplishment for the Office of Health Research was the publication of the state-of-the-art summary document entitled "Health Effects of Land Application of Municipal Sludge." A project was also initiated to determine the occurrence and distribution of pathogens and chemicals in products marketed from sludge.

In the monitoring and quality assurance area, "Guidelines for the Analysis of Water Pollutants" was published in the Federal Register. Discharge monitoring quality assurance performance audits were performed for the 7,000 major dischargers in the NPDES system and the quality assurance repository was maintained. Alternative test procedure requests were analyzed for 44 cases submitted in accord with the Clean Water Act regulations.

**FY 1986 Program**—The 1985 engineering activities will continue during 1986. Major attention will be devoted to collecting critical information for a design manual on fine bubble aeration systems and conducting regional and state seminars on innovative and alternative (I/A) technology. Due to the tremendous number of requests from the municipal sector,

four additional seminars on the Composite Correction Program will be conducted in 1986. Work will also begin on protocol that will enable the Regions and the states to evaluate reasons for failure of I/A projects for the 100% modification/replacement program. Field validation of the industrial and municipal toxicity reduction protocols will be conducted during 1986.

Studies of crop uptake of organics in sludge, studies of die-off of pathogens on sludge-amended soils, and evaluations of sludge injection into a landfill will be conducted. Studies characterizing solids entering municipal wastewater, raw sludge and treated sludge for pathogens and other indicator organisms will be conducted. Also, metals balance studies will be conducted around normally operating multiple-hearth and fluidized bed sludge incinerators in order to collect meaningful toxic organic emissions data for the new sludge regulations.

A feasibility study will be conducted to identify a population with sufficient exposure to sludge products to support an epidemiological study associating infectious disease with exposure to wastewater aerosols from land application sites. Work will be initiated to develop a pathogen risk assessment methodology for sludge.

In the quality assurance area, the costs associated with the repository, performance auditing, and other quality assurance services will be the subject of an effort of *externalization*. This activity will involve charging fees to public and private users for Quality Assurance services (e.g., quality control check samples). New legislative authority is being sought and a regulation is being drafted for promulgation.

### Oceans, Estuaries and Lakes

Marine research focuses on the development/validation of protocols for predicting the impacts from ocean disposal actions for use in the ocean dumping permit program and the 301(h) waiver program. Technology-related research in this area focuses on correlations between the type of treatment and the resulting environmental impacts following disposal and is used in assessing the appropriate level of treatment for wastes to be disposed to the ocean. Estuarine research develops procedures and information that supports decisions related to estuarine water quality. Great Lakes research is conducted on the transport, fate and effects of toxic materials in selected areas of that ecosystem for use by the Great Lakes National Program Office, the Regions and the International Joint Commission under the US/Canada Water Quality Agreement.

**FY 1985 Accomplishments**—In support of EPA's ocean disposal activities, effects assessment methods

were evaluated to determine the applicability of these procedures for use on dredged material. The effects of pollutant interactions on sediment toxicity were also determined. Researchers supported the 301(h) waiver program for ocean outfall discharges by providing technical assistance, as part of a national task force, for 21 applicants nationwide. Preliminary assessments of transport, fate and effects were completed for sewage sludge disposal at the 106-mile ocean dumping site and for incineration-at-sea activities. A pilot-scale study compared five alternative wastewater treatment systems for ocean discharge with a conventional activated sludge system for removal of toxic metals and organics. Partitioning of metals and organics on wastewater solids has been measured and fundamental correlations developed. A three-dimensional physical transport model and a three-dimensional hydrodynamic model were documented for use in the Great Lakes. Also, several studies of metal and organic contamination in the Raisin River/Monroe Harbor area were completed.

**FY 1986 Program**—The marine research program will continue to develop and test assessment procedures for evaluating the impacts of ocean dumping and ocean outfall discharge of wastes, to develop and test monitoring methods for coastal and deepwater application, to develop and revise screening procedures for characterizing the bioaccumulation potential of contaminants associated with wastes to be ocean disposed, and to evaluate the significance of bioaccumulation processes, resultant time residues and biological effects. The program will also continue to develop and evaluate methodologies to be used in predicting and assessing the exposure to and the effects of emission products from at-sea incineration of hazardous wastes.

Research to develop a procedure for evaluating alternative technology options and their impact on the viability of ocean dumping will continue. Research on major removal mechanisms in wastewater treatment processes will continue with emphasis on the development of a kinetic data base for sorption, stripping and biodegradation. The assessment of integrated wastewater treatment mechanisms will focus on partitioning toxic metals and organics on wastewater solids during treatment and the desorption or distribution encountered when sludges and wastewaters are discharged to the ocean.

Great Lakes research will study the transport, fate and effects of toxics, emphasizing studies of contaminated sediments. In addition, substantial technical assistance will continue to be given to the Office of Water, the Great Lakes National Program Office, and the Regions.

## Health Effects of Drinking Water Contaminants

This research defines the health risks from exposure to drinking water contaminants. Areas of major concern deal with developing toxicological testing and risk assessment methodologies for complex mixtures, determining the public health risk from exposure to waterborne infectious disease agents, conducting epidemiological studies to determine health risks in human populations exposed to various drinking water contaminants, and providing criteria documents summarizing the relevant scientific data to support the health risk assessment.

**FY 1985 Accomplishments**—In FY 1985 a symposium was held to summarize the state of knowledge on the health effects from exposure to disinfectants and disinfection byproducts. Also in FY 1985, a *Giardia* Methods Workshop was held in Region I. This workshop served to inform the Regions of the best methods to use for concentrating and identifying *Giardia* in drinking water supplies. Minimum infective dose studies were completed for rotaviruses in human volunteers. The dose-response data will be used to support revision of the microbiology drinking water standard. An Enzyme Linked Immunosorbent Assay (ELISA) method was developed to detect and identify pathogenic viruses (Norwalk, Hawaii, Snow Mountain Agent) in drinking water. This methodology can be used to identify several of the causative agents in waterborne disease outbreaks.

The Environmental Criteria and Assessment Office completed 28 health assessments on various organic, inorganic and microbiological drinking water contaminants.

**FY 1986 Program**—The proceedings of the state-of-knowledge symposium on health effects from exposure to disinfectants and disinfection byproducts held in FY 1985 will be published. This information will support revision of the trihalomethane and disinfection drinking water regulations as well as define future research needs. Research will continue to develop dose-response data in support of recommended maximum contaminant levels (RMCL) and health advisories (HA). Several chemicals to be completed are: xylenes, dichlorophenols, chlorine, and haloacetonitriles. Clinical, epidemiological and toxicological studies will be conducted to determine the association between the use of drinking water disinfectants (chlorine, chloramine and chlorine dioxide) and cardiovascular disease. Toxicological studies to determine the effects from exposure to multiple chemicals will be conducted for the volatile organic compounds. An epidemiological study to determine the association between radon in drinking water and lung cancer will be undertaken. In the area of microbiology, methods for identifying infectious

disease agents (e.g., *Campylobacter*, viruses, *Giardia* and *Cryptosporidium*) will be developed and improved. A study to determine the virulence and growth factors for *Legionella* and opportunistic heterotrophic organisms that occur in drinking water will be conducted.

Drinking water criteria documents will be finalized for seven inorganic, three organic, thirteen pesticide and two microbial agents. In addition, 30 HAs for new chemicals will be prepared. Three criteria documents will be prepared for the following disinfectants and their byproducts: chlorine, chloramine and chlorophenol.

## Drinking Water Technology

The Safe Drinking Water Act of 1974 directs the Environmental Protection Agency (EPA) to set national drinking water standards. This research program is focused on developing a defensible basis for standards that apply to public water supply systems and providing technical assistance to states, regions and utilities.

Major engineering research issues deal with the treatment of trace organics and disinfection byproducts. Also, control of microbiological contaminants and development of a fundamental understanding of disinfection kinetics remain a relatively high priority. For example, there is general concern over the occurrence of *Giardiasis* in the U.S., and a growing awareness of problems resulting from poorly operated treatment plants and deterioration of water quality in distribution systems. Finding cost-effective treatment processes to remove regulated contaminants from small water supplies that are not in compliance is also receiving major attention.

In the mandatory quality assurance area, ten regional laboratories are evaluated annually in support of the National Interim Primary Drinking Water Regulations monitoring certification program. This program is also responsible for methods development and analytical procedures to produce precise and accurate total measurement systems for chemical, microbiological and radiochemical analysis. Technically and economically feasible analytical procedures to be used by the Agency, States, municipalities and operators of public drinking water systems to monitor contaminants are also provided.

**FY 1985 Accomplishments**—Various filtration processes were evaluated to determine their effectiveness to remove *Giardia* cysts, bacteria, and turbidity. These include rapid rate filtration, diatomaceous earth, and slow sand filtration. Reports were produced on point-of-use (POU) technology for small systems and individual households to address activated alumina systems for fluoride reduction, activated

carbon for volatile organics reduction, and the management aspects of POU applications.

The proceedings of the seminar on plumbing materials and drinking water quality was published that addresses drinking water problems related to plumbing materials. Four papers on the effects of microbial growth conditions and their resistance to inactivation by disinfectants were prepared, as was a comprehensive paper that offers a reliable measurement of the organic solids content of finished drinking water.

Over 5,000 calibration standards and 55,000 quality control and performance evaluation samples were produced and distributed to EPA regional, state, local and EPA contract laboratories for analysis of public drinking water. Interlaboratory methods evaluation studies for maximum trihalomethane potential (MTP), purgeables, total organic halides, trace metals and total oxidants/chlorine dioxide were completed. Interlaboratory comparison studies involving the measurement of radionuclides in water were conducted that included gross alpha/beta, tritium and strontium-89/90. On-site laboratory evaluations in response to regional requests were also conducted. Technical support was provided for laboratory certification training courses.

**FY 1986 Program**—Research will continue to focus on developing information to assist utilities in complying with existing regulations and providing data to support proposed regulations. Large-scale experimental treatment technology projects will be conducted for organic and inorganic contaminant removal, especially related to ground water. Studies to evaluate the effectiveness of chlorine and alternative disinfectants for the control of water-borne pathogens will be continued. Evaluations of treatment technology for radionuclide removal and residues disposal management will also continue. Studies to determine the factors leading to deterioration of water quality in distribution systems will be conducted, and problems of small systems, including system design, performance and operational criteria, and institutional and pricing policies will also be studied.

The monitoring and quality assurance program will provide methods development and analytical procedures to produce precise and total measurement systems for chemical, radiochemical, and microbiological analysis and will develop less expensive methods for new parameters which have been established. This program will also conduct laboratory certification for the ten regions for organic and inorganic chemicals and microbiological analysis, will produce and distribute quality assurance and performance evaluation samples and standard reference materials and will also conduct requested on-site laboratory evaluations for radiochemical analysis of drinking water.

## Groundwater

Our science for assessing and predicting the impacts of ground-water pollution is meager but growing. In the past few years important gains have been made by the EPA ground-water research program in technology for accessing the subsurface and taking samples that are uncontaminated by the sampling process. Further, we know reasonably well how a few organic chemicals of concern behave in a few geological materials. However the state-of-the-art for ground-water monitoring is cumbersome, expensive, and insufficiently precise. Our capability for predicting the behavior of organic and microbiological contaminants is limited. Finally, there is little information available on the effectiveness or the costs of methods for in-situ cleanup of already polluted aquifers.

***FY 1985 Accomplishments***—Several significant publications were produced covering a wide range of topics. The following research reports were published: "State-of-the-Art of Aquifer Restoration Techniques," "DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeological Settings," "Methods for Determining the Location of Abandoned Wells," "Methods for Determining the Mechanical Integrity of Class II Injection Wells," and "Evaluation of Septic Tank System Effects on Ground-Water Quality." A handbook, "Ground Water Transport: Handbook of Mathematical Models" and "Guidance Manual for Vadose Zone Monitoring at Land Treatment Facilities" were also published.

Conferences on "Characterization and Monitoring of the Vadose Zone," "Surface and Borehole Geophysics in Ground-Water Investigation," and "Methods for Determining the Location of Abandoned Wells" were conducted. The program also participated/conducted the Fourth National Symposium and Exposition on Aquifer Restoration and Ground-Water Monitoring, a training course on Modeling Subsurface Flow and Contaminant Transport, and a technology transfer seminar on Protection of Public Water Supplies from Ground-Water Contamination.

Support of the International Ground-Water Modeling Center and the National Ground-Water Information Center was continued.

***FY 1986 Program***—In the processes area, research will continue on sorption biotransformation, facilitated transport, dispersion, immiscible flow, potential transport of metals due to complexation with organic chemicals, and other physical/chemical processes such as hydrolysis, substitution, and redox. Laboratory/field testing of potentially cost-effective aquifer restoration techniques will also continue. A major effort will be ongoing to aid regulation of underground injection, specifically on fluid front movement from Class I (Hazardous Waste) wells, to assess techno-

logical options for improving Class V (currently unregulated) injection well practices, to field verify mechanical integrity tests for injection wells and determine interaction of injected wastes with injection zone geological materials. Finally, emphasis will continue on technology transfer and technical assistance, including continued support of the National Ground-Water Information Center and the International Ground-Water Modeling Clearinghouse.

In the monitoring area, the program will continue to support the Regions in locating abandoned wells. Research will continue to determine the application of geophysics and other techniques for detecting and mapping fluid movement from injection wells. Evaluation and development of laser-induced fluorescence for monitoring ground water contamination using fiber optics will also continue. Hollow stem auger methods will be evaluated to determine if sampling wells completed by this method contribute to vertical movement of contamination outside well casings, potentially contaminating potable ground water.

## ***Pesticides and Toxics Research Committee***

EPA research on toxic substances and pesticides is directed toward fulfilling the Agency's need to meet the provisions of Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and, to a lesser extent, the Federal Food, Drug and Cosmetic Act (FFDCA). This research is directed toward development of health and ecological test methodologies, procedures to improve human risk estimates, exposure monitoring systems, and environmental fate and effects methods and risk assessments. It also focuses on structure activity relationships as predictors of chemical fate and biological effects. Other efforts are directed toward engineering and technological information needed to evaluate release and control methods for new and existing chemicals. Additional research is aimed at developing procedures for ensuring the human and environmental safety of biotechnology products as well as microbial and biochemical pest control agents.

Support is provided under the following issues:

### ***Test Method Development***

Under TSCA and FIFRA, manufacturers must test chemicals and pesticides for potential hazards to the public health and environment, and research is therefore conducted to provide guidance for performing such tests. Regulatory decisions on a chemical depend on qualitative and quantitative scientific data from industry regarding potential adverse environmental and human health effects of exposure to the chemical. Since the sensitivity, reliability, cost and time constraints of these tests vary widely, carefully screened methods are being developed and approved by the Agency. When completed, such methods will be incorporated into testing guidelines for use by industry and others who must evaluate the safety of chemicals.

### ***Health: Markers, Dosimetry, Extrapolation***

This research develops new techniques to estimate human exposure in order to improve the predictability of human risk from toxic substances through the development of biological markers to link chemical exposures and chronic effects, the development of the means to extrapolate from high to low doses and from animals to humans, and the performance of metabolism and related studies to improve both dose estimates and extrapolation to enhance human health risk assessment predictability. Additional

studies in the toxic substances research program involve defining the relationship between biochemical indicators of exposure to neurotoxins and behavioral dysfunction as well as studies in dosimetry and extrapolation related to genetically mediated health effects. Additional pesticides research includes evaluating the relationship(s) of age and dermal absorption using *in vivo* animal models as well as research on compound-induced reproductive alterations following exposure during developmental periods. Data generated in the toxics and pesticides areas will be used to extrapolate toxicant risks to humans.

### ***Special Human Data Needs***

This effort provides epidemiological data to assist in identifying and regulating existing chemicals which might pose health risks. Research focuses on identifying potentially hazardous substances, evaluating biological measures, and developing new epidemiological and biostatistical methods. Efforts in this area are also used for evaluation of animal test results on biological markers. Such activities will examine population groups exposed to environmental contaminants that are suspect toxicants for particular organ systems to determine if biological indicators of dose and/or effects are related to environmental levels of exposure and if they are correlated with adverse effects measured by traditional methods.

### ***Ecology: Transport, Fate and Field Validation***

This effort develops models to predict the transport, fate and transformation of pesticides and other chemicals in the environment. To adequately evaluate the likely perturbations a pesticide or toxicant chemical may cause in the environment, it is necessary to understand probable exposure concentrations/durations, movements through ecosystems, degradation rates, reservoirs, effects and residues. The Agency must have available techniques which may be applied to attain this information, must be capable of interpreting findings, and must have a predictive capacity to anticipate problems. Activities in this area are designed to meet these needs, to improve the criteria and standards against which industry, the users or the Agency must comply. The intent is to provide new or improved state-of-the-art techniques and fill data gaps so that scientifically credible and legally defensible regulatory actions can be taken. Additionally,



field testing and validation is conducted on such models as well as on test methods developed in support of testing guidelines.

#### **Engineering**

Under the premanufacture notification (PMN) process, manufacturers are required to submit information to EPA on the release and control of new chemicals and significant new uses of existing chemicals. EPA uses existing data to predict the risks from the release of new substances, and, under the existing chemicals control program, evaluates technological alternatives to reduce the release of and exposure to chemicals that are already in use.

This research focuses on the evaluation of chemical manufacturing processes to determine how and to what extent chemicals are released into the environment in manufacture. Efforts also examine chemical manufacturing processes to estimate byproduct and contaminant production. Additionally, alternatives to mitigate release of and exposure to new and existing chemicals are investigated and evaluated, including protective garments.

#### **Exposure Monitoring**

Research focuses on the development of methodologies for determining human exposure to environmental pollution. This includes personal monitoring instrumentation, population sampling schemes, questionnaires and diaries, exposure models, activity pattern data bases, and pilot field studies to determine the distribution of the population's exposures to environmental pollutants of concern to the Agency.

The major TSCA-related monitoring efforts include improvement in monitoring systems to estimate human exposure. Research will also be continued to develop approaches for multi-media/multi-pathway monitoring systems which generate data that will provide an estimate of total human exposure. Studies will also be conducted to incorporate environmental dose into personal exposure monitors and to provide a better understanding of the contribution of the different exposure routes on pollutant intake. The relationship of network monitoring to personal exposure monitoring will be evaluated in a Human Exposure Assessment Location Project.

#### **Structure Activity Relationships Data**

Since decisions regarding health and environmental risk of new TSCA chemicals rely on existing knowledge about similar chemicals and on estimations of physical and chemical properties, SAR is vital for reviewing and screening PMN chemicals under Section 5 of TSCA. The findings and techniques established in this research will be used to select appropriate toxicity tests, to document test results, to develop fate and effects data bases where necessary

and to provide the modeling means to predict toxicity. Health research emphasizes determination of qualitative effects and quantitative dose response data on specific, high-concern compounds and chemical classes. SAR research is also being conducted to develop correlations for predicting the environmental toxicity of new chemicals to freshwater, marine estuarine and terrestrial species, as well as for predicting the behavior and fate of toxic chemicals in the environment.

#### **Biotechnology**

Research in biotechnology constitutes a comprehensive effort to deal with potential problems posed by the release of bioengineered products into the environment as well as to determine the effects of microbial and biochemical pest control agents (MBPCAs). Environmental processes and effects research determines the survival and fate of genetically engineered organisms and other microbial pest control agents released into the environment and assesses their potential impacts. Health research develops predictive *in vivo* and *in vitro* tests for adverse health effects to human populations. Engineering and control technology efforts improve containment, control and destruction measures for genetically engineered organisms.

Many of the techniques required to adequately control or regulate microbial organisms or "biochemical" products (e.g., pheromones) apply to both TSCA and FIFRA mandates. Beyond these basic techniques, however, there is a divergence—microbial applications under TSCA are usually industrially oriented and relate to workplace exposure or accidental releases; the microbial applications under FIFRA are intended to control undesirable flora or fauna. Such microbial pest control agents (MPCAs) may be "natural" selected stock or may be genetically altered.

Users of biotechnological products must follow recommended Agency guidelines in a testing regime designed to help prevent adverse environmental impacts. ORD helps establish these techniques, determines if environmental effects are exhibited by previously untested non-target organisms, and conducts field-oriented validation studies as necessary to ensure that testing criteria and guidelines are appropriate and functional. Engineering research will also be conducted to develop and/or improve methods to contain or destroy genetically engineered organisms.

#### **Environmental Risk Assessment**

Ecosystem risk research will provide a scientifically based system to assess ecological risks from exposure to environmental toxicants. This system will provide the capability to assess risks associated with different uses of chemicals resulting from various options for

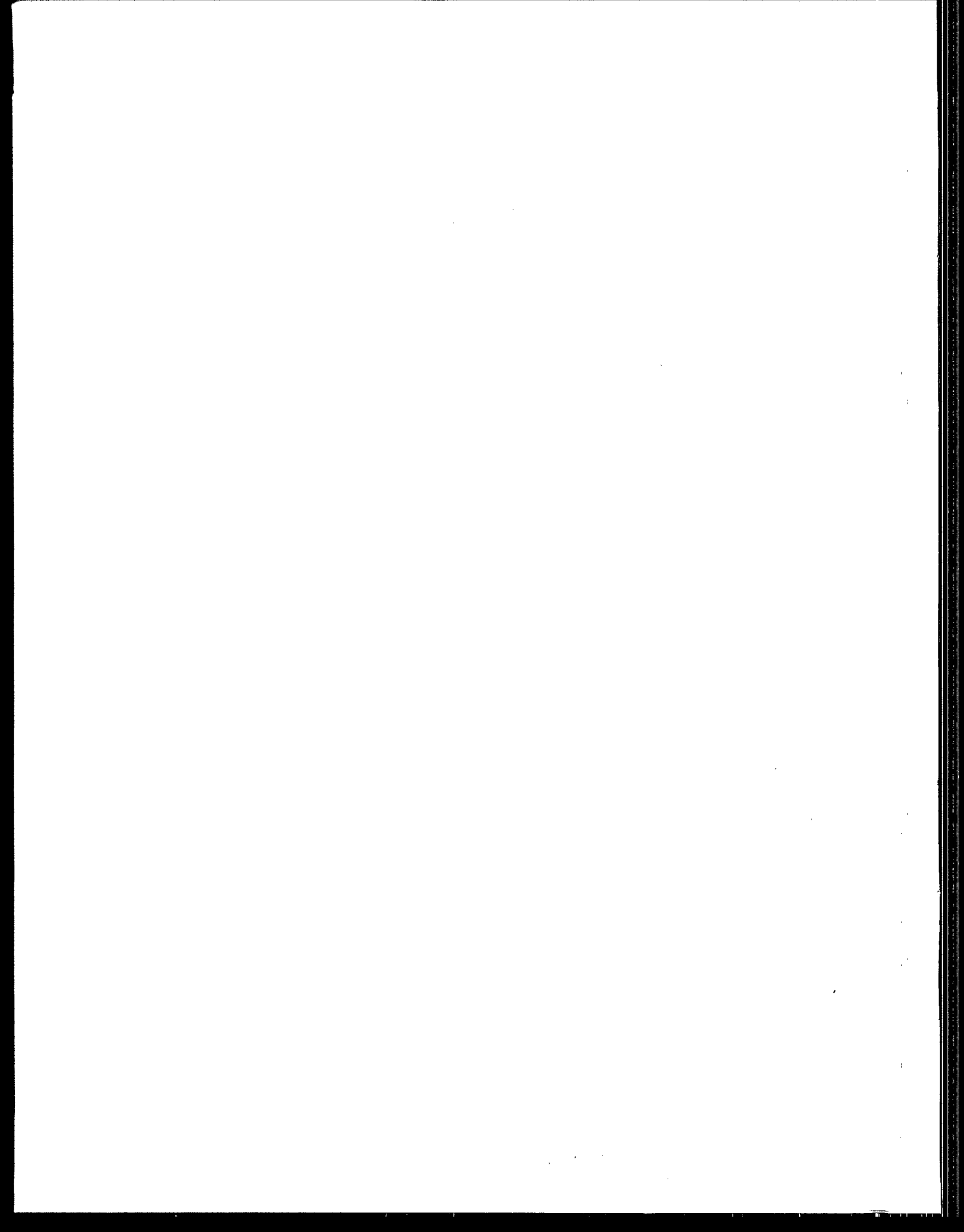


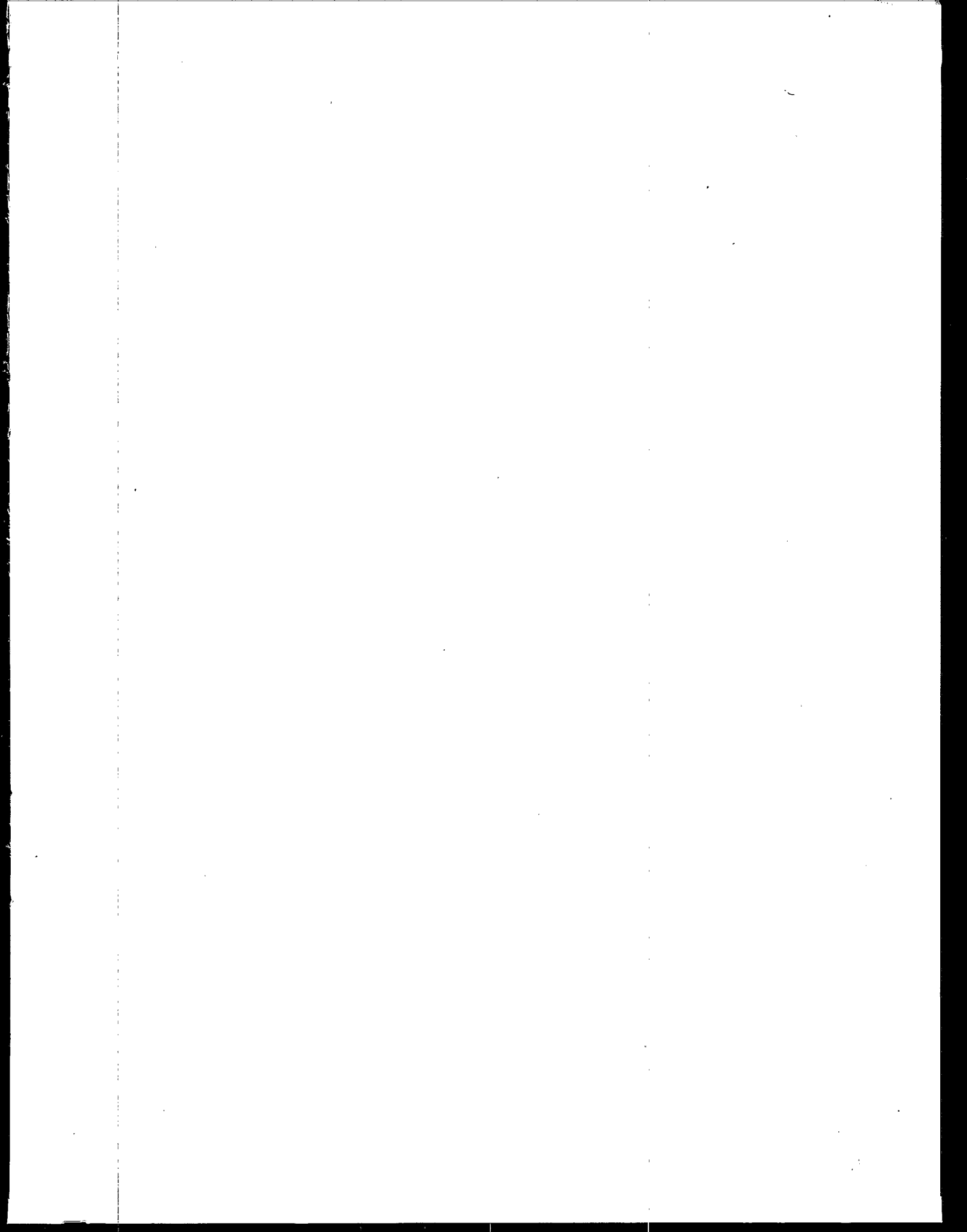
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regulating pesticides and toxicants to protect organisms in their natural environment. This research will provide for prognostic assessment, extrapolations to any patterns and levels of environmental release, inferences of types of responses to be expected in natural systems, and estimates of uncertainties in the assessments.

*Support*

This research provides support for risk and exposure assessment, quality assurance, dissemination of reference standards and quality assurance reagents.





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