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Research and Development

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# ORD Annual Report



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# **ORD Annual Report 1986**

Office of Research and Development  
U.S. Environmental Protection Agency  
Washington, DC 20460

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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.

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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 each committee has been asked to prepare an annual report. The FY-1986 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-1986; and (3) the identification of related research to be performed during FY-1987. 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.

Vaun A. Newill  
Assistant Administrator for  
Research and Development

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

### **Introduction**

Research in pesticides and toxic substances provides support to meet the current and future needs of the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and, to a limited extent, the Federal Food, Drug and Cosmetic Act (FFDCA). Research efforts are geared to provide scientifically valid yet cost-effective evaluations of the risks associated with pesticides uses and the manufacture and use of new and existing chemicals.

The research program in support of TSCA and FIFRA develops, evaluates, and validates health and environmental test methodologies and procedures to improve the predictability of human risk estimates, develop exposure monitoring systems, environmental fate and effects methods, and guidelines for performing environmental risk assessments. Additional research develops and evaluates release and control methods for new and existing chemicals, structure activity relationships as predictors of chemical fate and biological effects, and procedures for ensuring the human and environmental safety of the products of biotechnology. The contamination of ground water from pesticides is another area of emphasis in the ongoing research program.

### **Major Research Issues**

#### **ISSUE: Test Method Development**

Under TSCA and FIFRA, manufacturers must test chemicals and pesticides for potential hazards to the public health and to the environment. Consequently, research is needed 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. Because sensitive, reliable, cost and time effective tests are needed, carefully screened methods under development include methods for identification of organic chemicals in products and trace-level wastes. Such methods will be incorporated into testing guidelines for use by industry and by those who must evaluate the safety of chemicals.

## **1986 Program Accomplishments**

### **Scientific Assessment**

Methods were developed for: (1) deriving factors for extrapolating male reproductive effects from laboratory animals to humans; (2) detecting the spread of antibiotic-resistant bacteria in the environment; and (3) detecting DNA adducts at ultratrace levels. A computer information system and data collection system for effects of chemicals on human reproduction was established.

### **Monitoring**

Analytical methods were developed to identify and quantitate azo dye chemical compounds in environmental samples and to support engineering research on azo dye waste treatment. These studies employed both tandem mass spectrometry and Raman laser spectroscopy. Cell biology and monoclonal antibody techniques were developed to identify and discriminate chlorinated dibenzo-*p*-dioxin isomers.

### **Health Effects**

In the pesticides health effects area, journal articles were prepared in the areas of reproduction/teratology and neurotoxicology. Also, reports were issued on the role of maternal stress in the etiology of birth defects, on inhibition of the expression of oncogenic transformation by certain pesticide chemicals, on growth enhancement of human bronchial epithelial cells by nickel sulfate, and on the use of a renal concentration test in the neonate as a predictor of long-term alterations in urogenital morphology. Other reports discussed test methods to determine the neurotoxic potential of pesticides. The reports will be used by the Office of Pesticide Programs for inclusion in testing guidelines for industry to follow.

In the toxics area, test methods were developed to detect the effects of toxic chemicals on the nervous system, male reproductive system, developing organisms, and the immune system. Bioassays to predict carcinogenicity using cell cultures were also delivered.

### **Environmental Processes**

In pesticides environmental research, test methods were developed for early life-stage toxicity

for Atlantic silversides, Tidewater silversides, Inland silversides, California grunion, and Gulf toadfish. Effects were determined for 21 organotin compounds on survival and growth of marine unicellular algae. In addition, a handbook of acute toxicity of chemicals to estuarine organisms was prepared.

In the toxics area, several reports addressing techniques for effects and uptake of sediment-associated chemicals by benthic marine species were issued. To answer testing issues related to species sensitivity and surrogate species testing, other reports covered the relative susceptibility of fish and aquatic invertebrates to reactive chemicals and the use of the fathead minnows as a surrogate for other aquatic species. Research established the estuarine species, *Cyprinodon variegatus*, as a carcinogen assay organism, identified three hepatic neoplasia types and developed similar systems for three fresh-water species.

## **FY 1987 Program Outlook**

### **Scientific Assessment**

In FY 1987, research will focus on the development of quantitative dose-response models for developmental and reproductive toxicology, on methods for detecting dose-rate effects of chemicals in mutagenesis, and the validation of human mutagenicity assays in clinical epidemiology.

### **Monitoring**

Research will be conducted on methods development for use in exposure monitoring research. Immunological techniques will be applied to exposure monitoring and dose measurements. Chemometrics will be studied for complex samples analysis. Efforts will be made to produce standard procedures for these techniques.

### **Health Effects**

In FY 1987, test methods development in support of FIFRA will continue in the areas of reproduction/teratology, neurotoxicology, genetic toxicology and immunotoxicology. Research emphasis in the area of immunotoxicology is a priority area for the Office of Pesticide Programs.

In toxics research, neurochemical, behavioral, and physiological methods for detecting neurotoxicity will be provided. Methods for predicting developmental and reproductive toxicity and germ cell mutation will continue under development. Methods will also be delivered evaluating the impact of chemicals on immune function, predicting the skin absorption of chemicals, and evaluating the effect of chemicals on microflora of the gastrointestinal tract. Methods

for evaluating tumor initiators and promoters will also continue to be developed.

## **Environmental Processes**

Research in the pesticides area will develop and validate bioassay methodologies for determining the effects of chemical pesticides on estuarine and freshwater animals. Methods will be made available to test fishes and crustaceans and other pesticide sensitive organisms. Environmental factors which may modify organism response will be determined so that proper interpretations can be rendered. Impacts on acute or chronic tests such as toxicity-time exposure relationships, sediment-water interactions and salinity will be examined. The new methods and test organisms may become monitoring tools providing the opportunity to make more reliable decisions when regulating.

Toxicity test methods will be developed for evaluating hazards associated with toxic chemicals to aquatic and terrestrial species. These methods will be used for evaluating new and existing chemicals under Sections 5 and 4 of TSCA, respectively. Some of the major methods which will be studied include tests for bioavailability for evaluating sediment bound toxicants for freshwater and estuarine organisms; tests to determine toxicant effects on avian egg viability and methods to use fish as surrogate assays for determining carcinogen and teratogen potentials in other life-forms.

## **ISSUE: Structure Activity Relationships (SAR)**

To enhance the efficiency of the regulatory process for toxic substances, it is convenient to group various chemicals which share common or similar chemical characteristics rather than to deal with each individual chemical. If it can be demonstrated that chemical relationships, such as similar molecular structures and similar modes of toxic activity, form a firm scientific basis for estimating probable environmental risks, then better guidelines and techniques can be applied and regulatory actions can be completed more quickly using less resources. SAR is vital for reviewing and screening PMN chemicals under Section 5 of TSCA. The findings and techniques established in this research are 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.

## **FY 1986 Program Accomplishments**

### **Health Effects**

A rapid, inexpensive method for calculating molecular electrostatic potentials was developed to

aid in predicting the toxicity of chemicals. Additional data were provided on the enzyme azoreductase to aid in predicting the toxicity of azo dyes.

### **Environmental Processes**

Three advances on SAR application have been made available. Methods have been devised for use which predict the mode of toxic action for PMN chemicals, which provide a comprehensive structure-toxicity method to estimate chemical toxicity to aquatic organisms, and which function to predict major metabolites of industrial chemicals. SAR applications were reported on identification of potential tumorigenic industrial chemicals and a knowledge base expert system for managing false negatives in chemical evaluations was delivered to OTS. Relationships between microbial rate constants and chemical properties have been published.

### **FY 1987 Program Outlook**

#### **Health Effects**

Studies will continue to explore which azo dyes will be converted by azoreductase to more toxic compounds. Toxicological data will be gathered on specific chemical classes such as acrylates and pyridines. Computer-assisted methods for relating mutagenicity to chemical structure and a data management system for genotoxic chemicals are being developed.

#### **Environmental Processes**

Structure activity relationships, used for evaluating PMN chemicals under TSCA, Section 5, will be developed for determining the fate and toxicity of toxic substances in the environment. While prediction of metabolites using the SAR concept will be included, emphasis will be on developing fate relationships for predicting photolysis and biodegradation. Estimation parameters which incorporate property/molecular reactivity will consider metabolic factors, bioaccumulation, and persistence. Compound structure influences on microbial rate constants and microbial transformation mechanisms will be described.

#### **ISSUE: Special Human Data Needs**

To improve the Agency's ability to estimate risks to human health, research activities in FY 1987 will examine population groups exposed to suspect toxicants in the environment to determine if biological indicators of dose and/or effects are related to environmental levels of exposure. Data are also being developed on adverse effects as measured by traditional epidemiological studies.

### **FY 1986 Program Accomplishments**

#### **Health**

Support was provided for examining the potential for using biological monitoring to estimate exposure to toxic chemicals.

### **FY 1987 Program Outlook**

#### **Health**

Research will focus on biochemicals and environmental epidemiology with emphasis on better methods of assessing exposure and effects.

#### **ISSUE: Ecology—Transport/Fate/Field Validation**

To adequately evaluate the likely perturbations a pesticide or toxic chemical may cause in the environment, it is necessary to understand probable exposure concentration/durations, movements through ecosystems, degradation rates, reservoirs, effects and residues. The Agency must have applicable techniques to attain this information; must be able to interpret findings and have a capacity to predict problems. Research in this area is designed to improve the criteria and standards against which users of the toxic materials and the Agency must comply. The intent is to provide new or improved state-of-the-art techniques to fill data gaps in order to have scientifically credible and legally defensible regulatory actions.

#### **Environmental Processes**

In the pesticides research area, findings of three important areas relating to field studies were transferred to program offices. Field effects of methyl parathion to terrestrial species were determined. Proposals were issued on how to test the limits of applicability, i.e., methods results laboratory vs. field comparisons and how to relate field to laboratory data to improve hazard evaluations in coastal/marine systems. Methods were field validated for predicting the effects of Abate on freshwater non-target organisms. Exposure determinations from the annual Dougherty Plain site study results were compiled and distributed and simplified exposure procedures (nomographs; tables) based on HSP-F model production runs were transferred in usable form to OPP in the form of a manual.

In the toxics program, marine studies determined the influence of scale on measured results from laboratory microcosms subjected to toxic chemicals. Field studies were used to verify the fate and effects resulting from microcosm experiments. Fate screening tests were applied to collect

biodegradation information which was used to predict the fate of toxic organic compounds.

Freshwater system investigations were completed and an evaluation of a pharmacokinetic model of fish, used as a surrogate species, for mammals for initial screening of PMN chemicals. The application of Leffler and Taub microcosms was evaluated for screening chemicals and information was released on SAR applications on microcosms at various ecosystem levels from single species to community level toxicant reactions.

Also, research results were released on environmental factors which govern the kinetics of abiotic redox transformations and on light-induced oxidation of inorganic substances, as were the study results of the model TOXIWASP applied in an exposure study of organic substances in the Delaware River.

Terrestrial system studies have determined the effects of cold stress on avian acute toxicity tests in an effort to reduce test result variability.

## **FY 1987 Program Outlook**

### **Environmental Processes**

Pesticides research will concentrate on the development, refinement and validation of techniques and models to predict transport, degradation and fate, as well as exposure estimates of pesticides through surface and subsurface matrices. Field and laboratory studies will be conducted to determine the validity of laboratory methodologies and if the results reflect environmental responses under natural conditions. Laboratory and field data will be used to assess pesticide hazards to surrogate species and populations and to provide information on pesticide sorption, leaching and residues. The environmental impact to ground-water caused by pesticides and other agricultural practices will be investigated. Pesticide processes in soils and ground-water will be characterized, information will be developed on spatial variability in subsurface cores, and evaluations will produce best management practices which could mitigate ground-water contamination by pesticides.

Toxic substances research is designed to provide methods, approaches and information for three evaluative areas concerned with field validation, exposure to toxicants and risk determinations. Field and lab related activities will include: (1) development of comparative toxicological correlations for identifying surrogate species used in toxicity testing; (2) development of assessment techniques and their evaluation in field sites for assessing hazards to ecosystems and biota; and (3) development of fate (such as biodegradation) and exposure mathematical models to evaluate or predict exposure and hazards associated with toxic

substances in the environment. Research will attempt to put limits on or define uncertainty of predictive methods and provide user guides for those models verified and/or ready for regulatory application. System-level effects studies will define adverse effects of toxic chemicals on system processes and functions. Investigations will focus on multispecies and community level methods and data generation. Application of multistage microcosms will be enlisted to enhance verification procedures of methods, models and hazards.

### **ISSUE: Health—Markers, Dosimetry, and Extrapolation**

For both the pesticides and toxic substances programs, health effects research in FY 1986 focused on development of methodologies for extrapolation of data from high to low doses and between mammalian species to enhance human health risk assessment predictability. In the toxic substances research program, particular emphasis is being placed on studies which involve defining the relationship between biological markers of exposure to neurotoxicants 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) between 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 are used to extrapolate toxicant risks to humans.

### **Health Risks**

Journal articles on extrapolation methodology were prepared on percutaneous absorption of Folpet in young and adult rats *in vivo* and *in vitro* and on age-related skin penetration of three insecticides in rats *in vivo* and *in vitro*.

A gene-tox carcinogenic data base was also developed to help determine those bioassay systems which best predict carcinogenicity. The dose-effect relationship of asbestos and other durable mineral fibers was provided to the Office of Toxic Substances in support of the ban and phase down of asbestos.

## **FY 1987 Program Outlook**

### **Health Effects**

In FY 1987, a number of methods for extrapolating neurotoxic risks from animals to humans will be investigated. Other research projects will study *in vitro* systems to predict the tumorigenicity of chemicals. Methods will be developed for detecting functional effects of prenatal exposure to toxicants.



Research will also continue in the areas of genetic toxicology, neurotoxicology and reproduction/teratology. Research will focus on the application of the parallelogram extrapolation approach for pesticides, on the effects of formamidenes on visual evoked potentials, and on comparison of *in vitro* and *in vivo* skin absorption of dinoseb in rats.

### **ISSUE: Exposure Monitoring**

The major TSCA related monitoring research efforts are directed toward improvements in monitoring systems to estimate total human exposure. Research is conducted to develop approaches for multimedia/multipathways of pollutants to estimate total human exposure. This entails development of questionnaires and human activity pattern analyses to identify key population segments which may be exposed to chemicals, investigation of environmental dose and personal monitoring devices, providing more accurate measures of the different exposure routes of pollutant intake, and incorporation of network monitoring systems with total human exposure monitoring through studies conducted in the human Exposure Assessment Location Project and research at the Environmental Methods Test Site. Additionally, research is conducted on chemicals and biological techniques to identify and quantify pollutants in biological tissues and fluids.

## **FY 1986 Program Accomplishments**

### **Monitoring**

Research for exposure monitoring in FY 1986 focused on implementation of the Environmental Methods Test Site (EMTS) and the Human Exposure Assessment Location (HEAL) Project. At EMTS, construction of the base map for the geographic information system (GIS) was defined and initiated and the quality assurance plan for the project was produced. The draft protocol and the quality assurance for the HEAL HCB/DDT pilot was approved by the participating countries. Additionally, reports on the use of kriging were produced and a preliminary computer program for analysis of human activity patterns was produced.

## **FY 1987 Program Outlook**

### **Monitoring**

The HCB/DDT pilot will be conducted at the EMTS. Work on development of a users guide for the GIS will continue. Statistical research on human activity pattern analysis using TEAM study results will be conducted.

## **ISSUE: Biotechnology/Microbial and Biochemical Pest Control Agents**

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 an intentional dispersion to control undesirable flora or fauna. Such microbial pest control agents (MPCA's) 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 insure that testing criteria and guidelines are appropriate and functional. Engineering research is also underway to develop and/or improve methods to contain or destroy genetically engineered organisms.

Under FIFRA, research is geared towards developing or improving bioassay methodologies for determining the effects of biological control agents (BCA's) on non-target receptors or hosts. This research includes testing protocols and effects information for unaltered and genetically altered microbial BCA's. Investigations focus on routes of exposure, methods to detect and identify agents, toxicity, infectivity, persistence and effects. The resultant information will be used to revise subpart M guidelines and to guide regulatory decisions in pre- and post-registration actions.

Pesticides health research in biotechnology involves development of data on the immunologic effects of microbial pesticides on mammalian cells. Also, methods are being developed for using monoclonal antibodies and biotinated DNA probes to identify genetic material from biological pesticides in non-target sites such as mammalian cells. Such methods will provide the basis for validation subpart M guidelines for testing microbial pesticides.

Under TSCA, research focuses on development of scientific rationales and procedures for evaluating the environmental survivability, reproduction, distribution, effects and risk associated with the escape of genetically manipulated organisms. The research results will be used to prepare protocols for use in evaluating TSCA products involving environmental application of microbes. This research will also support regulatory rule-making

specifying which products are to be considered under TSCA.

In the toxic substances health research area, studies are being conducted to determine the genetic stability and function of a baculovirus expression vector in vertebrate cells and to evaluate the health effects of species and strains of genetically altered organisms.

## **FY 1986 Program Accomplishments**

### **Health Effects**

A report on characterization of *Bacillus thuringiensis* Cytolytic Factor was prepared. This report will be included in the Office of Pesticide Programs' testing guidelines. Work also continued on developing assay methods for studying the genetic stability and gene expression of a baculovirus constructed to express foreign gene products. Efforts were also directed toward better characterizing microorganisms that degrade hazardous compounds in order to use these organisms in future studies to evaluate the health effects of mutant and recombinant organisms.

### **Environmental Processes**

A report was published on a FY 1986 workshop on "Enclosed Systems for Testing Microbial Pest Control Agents." In order to assess the fate and effects of non-target marine species of viruses, bacteria, fungi, and protozoa that are potential biorational agents, a study was completed where shrimp were exposed to an insect virus and histological and serological examinations were carried out. Also, a report was published on field validation of tests techniques for biological control agents of freshwater organisms and a progress report on the hazard assessment of biochemical agents on metamorphosis and growth of marine crustaceans.

Two other published reports increase the Agency's ability to obtain and interpret data on new biotechnology products. The reports describe a data base to assess the genetic stability of novel organisms and a data base for detecting, identifying and enumerating novel organisms in terrestrial environments. Several journal articles describe techniques for evaluating regrowth and persistence of genetically engineered bacteria released to terrestrial ecosystems, evaluation of techniques for the detection and enumeration of transconjugants in laboratory media, and the fate and survival of recombinant bacteria and recombinant DNA in insects.

## **FY 1987 Program Outlook**

### **Health Effects**

Research will continue in methods for the identification and characterization of microbial

agents. This work will include recombinant of DNA in plasmids and genome of bacilli, and on the competition of endogenous and non-endogenous intestinal microorganisms. Research will also continue on the ability of non-endogenous microorganisms to compete with endogenous organisms of the gastrointestinal tract and the implications of this to human health. The potential for genetic exchange between organisms will also be investigated.

### **Environmental Processes**

Research will be conducted to develop or improve bioassay methodologies for determining the effects of biological control agents (BCA's) on non-target receptors or hosts. This includes providing testing protocols and effects information for unaltered and genetically altered microbial BCA's and the study of biochemical and genetically altered agents. Investigations will focus on routes of exposure, methods to detect and identify the agents and the toxicity-infectivity, persistence and effects. Major research will commence on biotechnological applications, e.g., on genetically altered microbial control agents. Studies will discern how to handle, recover and monitor these organisms and how to determine probable impacts on non-target organisms in the aquatic and terrestrial environment. This research defines areas of concern and will result in more rapid and greater public acceptance of safe reliable bioengineered organisms and substances. BCA testing requirements, movement and survival in freshwater systems and biochemical and insect fungi BCA hazards to marine crustaceans will be determined. The information will be used for improving subpart M guidelines and for regulatory decisions in pre- and post-registration actions.

FY 1987 research will also address the need for a credible system for analyzing the potential environmental hazards of genetically modified microbes. This includes laboratory and field or microcosm studies to modify procedures for identifying, enumerating and tracking engineered organisms or genes in environmental situations. Factors which will be studied in the aquatic and terrestrial media are persistence, detection, potential for gene transfer and fate and effects. Research should provide testing protocols and provide information and guidance on hazards and on approaches to assessing those hazards. This will support regulatory rule-making for TSCA products which involve environmental application of microbes.

### **ISSUE: Engineering Release and Controls**

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 of and 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.

Models are being developed which can predict release of and exposure to classes of new chemicals for assessment of chemical-unit operations and processes, and the physical and chemical properties of chemical substances. Additionally, models to predict potential exposure and release levels, and the best control measures to control release of an exposure to new chemicals are being developed. Treatability testing of potentially toxic chemicals are also conducted.

Alternatives to mitigate the release of and exposure to specific existing and new toxic substances are being defined through the evaluation and adaptation of control measures related to the release of chemicals in the workplace and into the environment. Technologies, management practices, and personal protective equipment to limit the release into the environment, and exposure to those toxic substances, are being evaluated.

Under the Federal Insecticide, Fungicide, and Rodenticide Act, EPA is responsible for pesticide exposure studies, for reviewing and approving pesticide labels, for administration of the pesticide Farm Safety Program, and for supporting training and education programs for pesticide users through state extension services. The Agency is concerned that protective clothing currently recommended for use by pesticide users is not providing acceptable protection. This situation is aggravated by a lack of appropriate data. In order to improve the situation, EPA requires greatly improved documentation regarding the effectiveness of protective clothing. This program focuses on generating breakthrough-time and steady-state permeation rate data for concentrated formulations of high toxicity pesticides through a range of commonly available polymer gloves that may be suitable for use by mixers and loaders of pesticides. Evaluations of the job compatibility and degree of protection provided by clothing items other than gloves are also being conducted in laboratory and field testing.

## **FY 1986 Program Accomplishments**

### **Engineering**

A report entitled, "Interim Guidance Manual for Selecting Protective Clothing for Agricultural Pesticide Operations" was completed in FY 1986. This report provides information needed by the

Office of Pesticide Programs to make acceptable the protection provided by protective clothing for workers exposed to pesticides. Also, preliminary assessment was conducted on predictive techniques for extraction, flaking, and agglomeration unit operations. Interim reports were completed on the development of validation of predictive models and test methods for estimating the effectiveness of protective clothing for chemicals, and laboratory testing on half-mask respirators. Evaluations of procedures and methodology of asbestos abatement were also conducted.

## **FY 1987 Program Outlook**

### **Engineering**

Evaluations of polymer gloves for agricultural pesticide use are currently being conducted, and will be continued. Methodologies for estimating protective clothing performance will be evaluated for PMN review process. Full-scale piece respirators are being tested in the laboratory. Research on asbestos abatement will cover evaluations of plastic barrier effectiveness, glove bag removal, and localized vacuum removal, and an assessment of effectiveness of O&M guidance provided for asbestos abatement.

### **ISSUE: Ecology—Ecotoxicity and Risk Assessment**

In the past, emphasis in ORD's scientific assessment program has been placed on the assessment of risk to human populations. However, there is also a need to assess the risk to non-human populations and the environment. The development of ecological risk assessment protocols and guidance for terrestrial and aquatic ecosystems (primarily endangered species and commercial fisheries) is necessary to quantify the probability that adverse effects may occur as a result of exposure to a toxic substance and to estimate the significance of such effects in the environment. Since environmental data developed by industry may vary greatly from chemical to chemical, procedures need to be developed which provide guidance and consistency for the various environmental exposure activities. This work will develop risk assessment protocols and guidelines for the assessment of adverse effects on terrestrial and aquatic ecosystems.

## **FY 1986 Program Accomplishments**

### **Scientific Assessment**

Studies were initiated to develop procedures for performing environmental risk assessment.

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## Environmental Processes

The initial design of a computerized terrestrial model was completed, as was a survey of existing biological databases covering susceptible species. As part of an effort to integrate information from toxicity, biochemistry, and physiology with ecosystem models, a report was prepared describing a comparative physiology database for use in identifying susceptible populations. In addition a report describing suitable methods for estimating the probability of ecological damage was prepared. Also developed was a component of the Decision Support System, a gill exchange model which predicts the exchange and bioaccumulation of hydrophobic chemicals. The model has been computerized and a user's manual has been completed.

## FY 1987 Program Outlook

### Scientific Assessment

Guidelines for risk assessment for terrestrial and aquatic ecosystems focusing on endangered species and commercial fisheries will be completed.

### Environmental Processes

FY 1987 studies will develop ecological risk models and integrated risk assessment processes which express probability of risk to important ecological populations. These studies include combining exposure and hazard methods and data and utilizing modified existing or new fate, transport and effects models to depict risk. Levels of uncertainty coupled with these approaches will be described. Extrapolation of data across populations and multiple usage of information will be initiated to identify reliable endpoints. Integration of models, output and other information will allow ecosystem degradation criteria to be developed. Some key factors to be addressed are ecosystem stability, resiliency, stratification, kinetic changes or exchanges and transport and fate. Substantial modeling will address multimedia risks and the models will be subtended with appropriate software packages.

### ISSUE: Support

For certain assessments, because data are lacking, the ORD staff is required to conduct literature searches, interpret data or render technical and scientific judgments. In cases where program office evaluations are complicated and/or controversial, independent peer review of assessments are required to ensure consistency. There is a continuing need for ORD participation in and review of major exposure and hazard assessments conducted by OPTS which provide

Agency policy makers with technical expertise from qualified scientists, and for improving Agency regulatory decisions. Finally, in both the pesticides and toxics areas, support will continue for quality assurance and maintenance and dissemination of standard reference materials. This entails the production of pure chemicals in solvent solutions or in environmental media to ensure the precision and accuracy of routine analyses as well as the production of reference spectra to identify unknown chemical compounds in routine environmental monitoring.

## FY 1986 Program Accomplishments

### Scientific Assessment

Detailed assessments in the areas of carcinogenicity, mutagenicity, reproductive toxicity and exposure on a variety of chemicals were delivered to the program offices. Additional support was provided by ORD personnel serving as expert witnesses in litigations and in review of program office proposed test rules and pesticides review.

### Monitoring

A 1985 annual report (EPA Pesticides and Industrial Chemicals Repository) summarized the activities of the repository and its continuing mission to provide a source of analytical reference materials. This program helps to insure a single common source of certified standard samples necessary for good quality control. Samples are supplied to and used by federal, state, local and academic laboratories. The report indicates the distribution of 30,000 samples to over 1,400 laboratories each year and includes information by type of laboratory, types of standards (samples) and by country.

A 1985 annual report (Intercomparison Program for Pesticides) described a study program which tests the ability of various laboratories to perform pesticide analysis for environmental monitoring purposes. This study evaluated the OPP contract laboratories and identified a need for continued monitoring of all laboratories engaged in measurement and analysis. Average analytical results need to be improved. Also conducted was the annual bulk audit program for analysis of asbestos from building materials and insulation; a report of the results was produced. The need for quantitative analysis of these materials was investigated. An audit program for airborne asbestos identification was started by development of a standard transmission electron microscope method for asbestos analysis.

### Environmental Processes

Technical assistance was provided to OTS by ORD in areas requiring special research aid or

scientific expertise necessary for TSCA implementation. This assistance enhances both regulatory action(s) and program management to insure that deliverables are appropriate to needs and priorities. Another completed TA project determined the chronic toxicity of phthalate esters to two test organisms, *Daphnia* and fathead minnows.

## FY 1987 Program Outlook

### Scientific Assessment

Detailed assessments in the areas of carcinogenicity, mutagenicity, reproductive toxicity and exposure on a variety of chemicals were delivered to the program office. Additional support involved serving as expert witnesses in litigations and review of program office activities including proposed test rules, and special review of pesticides.

### Monitoring

A program will be maintained to provide quality assurance/quality control to laboratories engaged in pesticides monitoring activities. This will provide the prevision and accuracy for analytical and other data to support Agency requirements. Secondly, the repository for standard chemicals and its distributional function will continue to supply high purity certified samples to users.

A study will also be conducted in an effort to produce quality assurance chemicals which match program office needs more readily than current procedures. The airborne asbestos audit program development will be increased to develop a standard analytical method this year.

### Environmental Processes

Technical assistance will be provided to OTS on complex problems relating to environmental fates, exposure, effects and risks of toxic chemicals or bioengineered organisms necessary for implementation of TSCA. The forms of technical assistance to be accomplished include workshops and peer and other reviews and provision of special data or information which is not otherwise available. This includes toxicity tests and support for exposure and risk modeling and assessments.

## Test Method Development

### 1986 Program Accomplishments

#### Monitoring

- Report on application of analytical methods for detecting organic compounds in biological tissues—FY 1986. 12/86

- Journal article on azo dye identification and quantitation procedures. 11/86
- Report on application of analytical methods for detecting organic compounds in air—FY 1986. 12/86

#### Health Effects

- Journal articles on percutaneous absorption of folpet in young and adult rats *in vivo* and *in vitro*. 9/86
- Journal articles on age-related skin penetration of three insecticides in rats *in vivo* and *in vitro* studies. 9/86
- Neurophysiological effects of perinatal lead exposure in monkeys. 9/86
- The evaluation of neuron-specific proteins as biochemical indicators of toxicity. 9/86
- Comparison of *in vitro* and *in vivo* testicular function. 9/86
- Journal article on role of maternal stress in the etiology of birth defects. 6/86
- Cytogenic methods for detecting chromosome damage. 9/86
- Journal article on inhibition of the expression of oncogenic transformation by chemicals. 9/86
- Quantification of neurotypic and gliotypic proteins for assessing neurotoxicity following toxicant exposure. 9/86
- Complete development of two immunotoxicity assays in animals. 9/86
- Journal article on growth enhancement of human bronchial epithelial cells by nickel sulfate. 9/86
- Journal article on the use of renal concentration test in the neonate as a predictor of long-term alterations in urogenital morphology. 9/86
- Report on the dose-response curve for 1,2 dibromoethane. 8/86
- Testing protocol for rapid and cost-effective assessment of reproductive damage. 9/86

#### Environmental Processes

- Report on critical responses of populations of crustacea to toxicants. 12/85
- Report on reproductive biology of *Menidia peninsulae*. 12/85

- Report: Handbook of Acute Toxicity of Chemicals to Estuarine Organisms. 9/86
- Report on techniques for effects and update of sediment-asso. tox. chemicals by Benthic Marine Species. 6/86
- Report on the fathead minnow as a surrogate for other aquatic species. 7/86
- Report on use of relative, position-specific eff. measure. of benzo(a)pyrene metabolism as field indicators of carcin. stress aquatic environ. 9/86
- Report on analysis of several tumor types exper. induced Sheepshead minnow and their signific. to mammalar lesions. 9/86

### ***Structure Activity Relationships (SAR)***

#### **1986 Accomplishments**

##### **Health Effects**

- Report on how to use molecular electrostatic potential to make risk assessments on chemically induced toxicity for one class of chemicals. 9/86
- Report on SAR studies on azoreductase II. 9/86

##### **Environmental Processes**

- Report on SAR methods to predict mode of toxic action for PMN chemicals. 10/85
- Report on a comprehensive structure-toxicity method to estimate toxicity of chemicals to aquatic organisms. 3/86
- Delivery of a knowledge-base expert system for managing false negatives in chemical evaluation. 6/86
- Report on SAR methods to predict major metabolites of industrial chemicals. 8/86
- Report on SAR identification of potential tumorigenic industrial chemicals. 9/86

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

#### **1986 Program Accomplishments**

- Proceedings of conference on medical screening and monitoring for effects of chemical exposure in the workplace. 9/86

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

#### **1986 Program Accomplishments**

##### **Environmental Processes**

- Final Report on Field Effects of Methyl Parathion to Terrestrial Species. 12/85
- Draft Users Manual—Simplified Exposure Procedures (nomographtables) to OPP Based on HSP-F Production Runs. 1/86
- Report on hazard evaluations and relate field to lab data with proposal on how to test limits of applicability. 2/86
- Report on field validation for predicting effects of Abate (Temephos) on non-target organisms. 6/86
- Dougherty plain project report. 9/86
- Report on pharmacokinetic model of fish as a surrogate species for mammals in initial screening of PMN chemicals. 10/86
- Report on field validation of fate and effects of selected toxic chemicals derived from laboratory microcosms. 12/85
- Journal article on environmental factors governing the kinetics of abiotic redox. tranformation. 12/85
- Journal article on light-induced oxidation of pollutants involving natural inorganic species. 12/85
- Progress report on evaluation of Leffler & Taub microcosms for screening chemicals. 1/86
- Report on effects of cold stress on avian LD-50 and LC-50 tests. 2/86
- Report on the influence of scale in marine microcosms perturbed by toxic chemicals derived from laboratory microcosms. 3/86
- Journal article on exposure studies of organics in Delaware River using TOXIWASP. 4/86
- Journal article on SAR at the ecosystem levels single: species relative tox. vs. ecosystem level tox. using microcosms. 8/86
- Report on suitability of biodegradation information from fate screen tests for pred. fate of tox. organ. compounds in microcosms and field studies. 9/86

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

### **1986 Program Accomplishments**

#### **Health Effects**

- Report on test methods to determine the neurotoxic potential of pesticides. 12/85
- Journal articles on development of new techniques to evaluate heritable gene mutations. 9/86
- Predictive models for dose effects of asbestiform minerals. 9/86
- Journal article on the review and analysis of the literature of select chemicals and the establishment of the gene-tox data base. 7/86
- Journal article on metabolism of benzo(a)pyrene in monolayer cultures of human bronchial epithelial cells from a series of donors. 3/86
- Journal article on interspecies comparison of adult to developmental toxicity ratios. 8/86
- Effects and interaction of metals and metal chelators on aversion learning. 3/86

#### ***Exposure Monitoring***

### **1986 Program Accomplishments**

#### **Monitoring**

- Annual report on research activities and methods development at the EMTS. 12/86
- Interim report on pollutant sources and human exposure to toxic pollutants using TEAM data—FY 1986. 12/86

## ***Biotechnology/Microbial and Biochemical Pest Control Agents***

### **1986 Program Accomplishments**

#### **Health Effects**

- Characterization of *Bacillus thuringiensis* cytolytic factor. 9/86

#### **Environmental Processes**

- Summary Report: Exposure Studies of Insect Virus, Bacterium, and Protozoa and Fungus on Non-Target Estuarine Crustacea. 11/85
- Report on field validation of test techniques for biological control agents on freshwater organisms. 12/85

- Report on workshop for ORD/OPP entitled: Enclosed Systems for Testing Microbial Pest Control Agents. 6/86
- Progress report on hazard assessment of biochemical agents on metamorphosis and growth of marine crustaceans. 9/86
- Progress report on the effects of insect fungi in crustacea. 9/86
- Report on data base for detecting, identifying, and enumerating novel organisms in terrestrial environments. 1/86
- Report on development of data base assessing genetic stability of novel organisms. 2/86
- Internal report on regulatory res. for biotech: identification and enumeration techniques, survivability and genetic exchange in genet. altered microorg. 9/86

## ***Engineering Release and Controls***

### **1986 Program Accomplishments**

- Interim guidance manual for selecting protective clothing for agricultural pesticide operations. 9/86
- Preliminary assessment of predictive techniques for extraction, flaking, and agglomeration unit operations. 1/86
- Interim report on the development of validation of predictive models and test methods for estimating the effectiveness of protective clothing. 5/86
- Interim report on laboratory testing on half-mask respirators. 9/86
- Report on the fate of azo dyes in activated sludge process. 10/86
- Evaluations of procedures and methodology of asbestos abatement. 3/86

## ***Ecology: Ecotoxicity and Risk Assessment***

### **1986 Program Accomplishments**

#### **Environmental Processes**

- Report describing design specifications for models including quantitative uncertainty estimates. 7/86
- Report on comparative physiology data base for the identification of susceptible species. 9/86

- Report on components and characteristics of prototype terrestrial exposure model. 9/86
- Report on functional objectives and recommendations of prototype computer system. 7/86
- Journal article on model developed to describe exchange of non-polar hydrophobic toxicants across fish gills. 8/86
- Computer program of gill exchange model for predicting bioaccumulation of hydrophobic xenobiotic chemicals. 9/86

## **Support**

### **1986 Program Accomplishments**

#### **Monitoring**

- Annual report on intercomparison program for pesticides. 7/86
- Annual Report: EPA Pesticides and Industrial Chemicals Repository. 5/86
- Guidelines for field testing soil, data, and transport models—final report. 4/86
- Report on asbestos audit program. 9/86

#### **Environmental Processes**

- Final report on chronic toxicity of phthalate esters to *Daphnia* and fathead minnows. 3/86

## **Test Method Development**

### **FY 1987 Program Outlook**

#### **Monitoring**

- Report on application of analytical methods for detecting organic compounds in biological tissues—FY 1987. 12/87
- Report on application of analytical methods for detecting organic compounds in air—FY 1987. 12/87

#### **Health Effects**

- Journal article describing validated test protocol to detect and characterize neurotoxicity. 10/86
- Report on age-related neurotoxic sensitivity to organophosphate induced delayed neurotoxicity. 10/86
- Report on germ cell cytogenetic test systems. 12/86

- Glutathione Synthesis: A Requirement for Sperm Nuclear Decondensation During Oocyte Maturation. 3/87
  - Maternal Toxicity of Methoxychlor and Dibutyl Phthalate. 2/87
  - Neurobehavioral Assessment of Egyptian Pesticide and Textile Workers. 12/86
  - Pyrethroid Effects on Schedule-Controlled Behavior: Time and Dosage Relationships 12/86
  - Behavioral and Neurochemical Effects of Amitraz Exposures in Rats. 6/87
  - Some Behavioral Effects of Triphenyltin. 3/87
  - Embryonic Dosimetry of Putative Teratogens. 8/87
  - Comparison of the Behavioral Effects of Endosulphan in Juvenile and Adult Rats. 9/87
  - Carcinogenic Initiators and Promoters: Report on 4 Agents. 2/87
  - Test System for Evaluating the Effect of Environmental Chemicals on Metabolism by Microflora of the Gastrointestinal Tract. 9/87
  - Report on prediction of skin absorption with the rotating diffusion cell (RDC) model. 9/87
  - Modification of Aversion Learning: A Behavioral Assay for Studying Metal-Chelator Interaction. 6/87
  - Report on developmental toxicity of phenolic congeners. 9/87
  - Report on immune function in young adult mice exposed to 2-deoxycoformycin in utero. 12/86
  - Evaluation of the immunotoxic effects of di-n-octyltin-dichloride in the rat. 2/87
  - Evaluation of seizure models as indicators of neurotoxicity. 8/87
  - A sound stimulation system for auditory research with small research animals. 9/87
  - Report on detection and quantification of nervous-system protein in cerebrospinal fluid in toxicant exposed rats. 9/87
- #### **Environmental Processes**
- Report on optimization of environmental factors during the life-cycle of *Mysidopsis bahia*. 12/86



- Final Report: Methods Manual for Spawning, Culture and Testing of Atherinid Fishes. 12/86
- Report on toxicity-time relationships for fish exposed to pesticides. 9/87
- Journal article on detection and discrimination of chemicals in feed. 6/87
- Report on the uses of oysters and fishes as carcinogen assay subjects in laboratory screening systems. 9/87
- Report on effects of photosynthesis on uptake of selected chemicals. 1/87
- Report on low cost amphibian test for specific cytotoxicity effect. 6/87
- Report describing a mathematical model for uptake of chemicals by plants. 6/87
- Report on integrated multiple endpoint test to screen for dermal toxicity, neurotoxicity and acute toxicity. 8/87
- Report on biochemical and pathological effects of contaminated sediment on marine fishes. 9/87
- Journal article describing relationships between microbial degradation rate constants and chemical properties. 9/86
- Report on efficacy of fish embryo infection assays to screen environmental carcinogens. 9/87
- Report on comparison of rapid estuarine/marine chronic tests results with those from long-term chronic tests with synthetic chemicals. 9/87
- Methods manual for marine algae toxicity tests. 9/87

## ***Structure Activity Relationships (SAR)***

### **1987 Program Outlook**

#### **Health Effects**

- Structure-activity relationships based on causally derived parameters for one class of chemicals of interest to OTS. 9/87
- Pattern recognition analysis of azo dyes using mammalian azoreductase. 9/87
- Report on SAR studies on chlorinated pyridines. 3/87
- Review of approximate methods for calculation of molecular electrostatic potentials and their use

in the comparison of chemicals for toxicological assessment. 6/87

- Identification of substructures associated with Salmonella mutagenicity by CASE-SAR analysis for PMN use. 9/87
- Computer assisted structure-mutagenicity relationships for some nitrogen containing chemicals of interest to OTS. 3/87
- Provide a combined data management system for genotoxic chemical. 12/86
- Journal article on the genotoxicity of acrylates in cultured mammalian cells. 8/87

#### **Environmental Processes**

- Report describing SAR models for predicting the toxicity and uptake to terrestrial plants and animals. 6/87
- Report on evaluation of SAR methods for estimating physical/chemical properties of industrial chemicals. 10/86
- Delivery of Version 1 of a computer system for QSAR estimation of physical/chemical properties and ecotox. effects. 6/87
- Report on database for QSAR models of ecotoxicity. 8/87
- Feasibility report on the development of SAR models for chronic toxicity to fish, invertebrate, and algae. 9/87

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

### **1987 Program Outlook**

- Determine feasibility of using monitoring or screening methods to assess exposure-effect relative to two organ systems. 12/86

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

### **1987 Program Outlook**

#### **Environmental Processes**

- Final data report on the field validation of freshwater hazard assessment methodology. 12/86
- Users Guide/Manual for Unsaturated-Saturated Zone Pesticide Exposure Model. 1/87

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- Report on spatial variability of soil release characteristics (Dougherty Plain Site) for use in PRZM (testing). 3/87
  - Journal article on results of field testing of PRZM and PESTANS leaching models for coastal plain soils. 3/87
  - Report on chemical characteristics of a pesticide in aquatic field site after use application. 4/87
  - Journal article: Correlation Between Tissue Cholinesterase Levels and Chemical Exposure in Avians. 6/87
  - Journal article of spatial variability of pesticide application. 11/86
  - Dougherty Plain Annual Report. 9/87
  - First Annual Report—North Carolina Pesticide Runoff-Estuarine Exposure/Risk Assessment Field Study. 9/87
  - Report on mathematical models for transport and transformation of toxic chemicals in subsurface environments. 10/86
  - Report on comparative sensitivity of larval stages of pelagic spawning estuarine fishes to toxic substances 12/86
  - Project report on rates, constraints, and kinetic formulation for organic chemicals and metals. 12/86
  - Report on environmental assessment on an azo dye. 5/87
  - Report on microbial transformation rate constants for chemicals of high priority to OTS. 3/87
  - Journal article on amphipod crustacean *Hyalella azteca* acute freshwater sediment toxicity tests. 3/87
  - Report on response of laboratory and field communities to stress: impact of pentachlorophenol. 3/87
  - Journal article in bioaccumulation of hexachlorobenzene from contaminated sediments by amphipods and Oligochaetes. 8/87
  - Journal article on freshwater sediment acute toxicity test with the amphipod crustacean *Hyalella azteca*. 8/87
  - Report relating response of single species and benthic communities to toxic chemicals. 8/87
  - Report on SARs of chemical toxicant groups as measured by microecosystem functional responses. 11/86
  - Journal article on aerobic biodegradation of complex organic mixtures. 12/86
  - Book chapter—Abiotic Organic Chemical Transformations at the Sediment Particle-Water Interface. 5/87
  - Journal article on oxidation processes in aquatic environments. 6/87
  - Journal article on environmental factors affecting microbial transformation rates of pollutants. 8/87
  - Progress report on acute/chronic toxicity extrapolation method for freshwater organisms. 9/87
  - Report on a draft protocol for a naturally derived mixed cult microcosm for hazard evaluation of toxic chemicals. 9/87

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

#### **1987 Program Outlook**

- Report on the application of the parallelogram extrapolation approach for pesticides. 9/87
- Report on the effects of formamidines on visual evoked potentials. 10/86
- Comparison of *In Vitro* and *In Vivo* Skin Absorption of DINOSEB in Rats. 9/87
- Report on comparison of tumorigenicity for 5 mineral fibers by means of intrapleural inoculation. 6/87
- Report on the use of *in vitro* systems to assess the carcinogenicity of asbestiform minerals. 9/87
- Validation of a Human Behavioral Test Battery: Effects of CO Exposure on Human Performance. 9/87
- Report on effects of prenatal exposure to selected organic compounds on development of sensory systems. 6/87
- Report on teratogenic effects of diphenyl ethers on the pulmonary system of neonatal rats. 9/87
- Report on percutaneous absorption of organic compounds in young and adult rats. 9/87

- Onset Visual Evoked Potential and Motion Adaptation in Humans: A Study to Provide Data for Rat to Man Extrapolation. 6/87
- Validation of a Learning Paradigm: Effects of Selection Delay and Scopolamine and Acquisition and Steady-State Performance on an Automated Radial-Arm-Maze. 3/87
- A Novel Method for Detection and Characterization of Neuronal Phosphoproteins Bound to Nitrocellulose. 9/87
- Evidence That Genes for Tumor Markers are Clustered with Cellular Oncogenes on Human Chromosomes. 7/87
- Report on expression of cellular oncogenes in normal and transformed respiratory tract cells and implications for risk assessment. 8/87
- Evaluation of Industrial Chemicals in the Rat Tracheal Cell Transformation Assay on Potential Human Respiratory Carcinogens. 5/87
- Report on the use of evoked brain potentials in the evaluation of toxic exposures. 10/86

### ***Exposure Monitoring***

#### **1987 Program Plans**

- Interim report on pollutant sources and human exposure to toxic pollutants using TEAM data—FY 1987. 12/87
- Users Guide—Data Base Management System (GIS) for EMTS. 12/87
- Annual Report of Pesticide Total Exposure. 9/87

### ***Biotechnology/Microbial and Biochemical Pest Control Agents***

#### **1987 Program Plans**

##### **Health Effects**

- Report on the competition of endogenous and non-endogenous intestinal microorganisms: utility in health research. 8/87
- Journal article on recombination of DNA in plasmids and genomes of bacilli. 9/87

##### **Environmental Processes**

- Report on biological control agent testing requirements for representative freshwater species. 12/86

- Report on lab testing and evaluation of selected MPCA's on non-target arthropods. (Terrestrial) 6/87
- Report on susceptibility of stressed non-target species to microbial pest control agents. 9/87
- Journal article: Evaluation of Techniques for Detection and Enumeration of Trans-Conjugates in Lab Media. 11/86
- Journal article: On Methods to Evaluate Conjugal DNA Transfer in a Terrestrial Microcosm. 12/86

### ***Engineering Release and Controls***

#### **1987 Program Outlook**

- Evaluations for Polymer Gloves for Agricultural Use. 9/87
- Assessment of Toxic Exposures and Releases from Filtration Unit Operations: Feasibility Study. 11/86
- Report on methodologies for estimating clothing performance for PMN review process. 9/87
- Interim report on laboratory testing of full-facepiece respirators. 9/87
- Evaluation of plastic barrier effectiveness, glove bag removal, and localized vacuum removal. 9/87
- Evaluation of the effectiveness of O&M guidance provided for asbestos abatement. 7/87

### ***Ecology: Ecotoxicity and Risk Assessment***

#### **1987 Program Outlook**

- Initial Design and Specifications of Computerized Terrestrial Exposure Model. 9/87
- Soils and Meteorological Databases for Terrestrial Exposure Models. 9/87
- Report on intertaxa correlations for toxicity to aquatic organisms. 9/87
- Report on baseline data and database definition for seagrass ecosystems. 9/87
- Report on efficacy and accuracy of empirical models of toxic impacts and species interactions in small mammals. 9/87

- Report on prelim. ident. of existing models to predict physiologic and life history consequences of animal body burdens of xenobiotic chemicals. 9/87
- Report on wildlife population model dynamics: emphasis on identification of critical components. 12/86
- Report on development of ecosystems resiliency data base. 7/87
- Documentation report on databases to support aquatic ecosystem models. 8/87
- Journal article: Describing Algorithms for Using Standard Laboratory Results to Predict Effects on Natural Populations. 8/87
- Prototype Population Model and Software Incorporating Lethal Effects of Narcotic Chemicals on Natural Populations. 2/87
- Update WASP 4.1 aquatic exposure model for risk assessment. 9/87
- Computer program of model predicting kinetic exchange of hydrophobic xenobiotics. 9/87
- Report on comparison of models for representing bioconcentration and biomagnification in fishes. 9/87
- Report on selection of critical terrestrial ecosystems. 9/87
- Report documenting the coupled plant-soil model and software for predicting the fate of xenobiotic chemicals in terrestrial plants. 9/87
- Documentation report on preliminary models and software that predict wildlife body burden of xenobiotics as a func. of exp. rte. and avoidance mechanism. 9/87
- Report on efficacy and accuracy of empirical models of plant species interactions; development of existing models to incorporate chemical insult. 9/87
- Report on survey and analysis of mathematical models suitable for assessing risk to terrestrial ecosystems from releases of xenobiotics. 9/87
- Review article on effects of chemicals on soil microorganisms responsible for ecosystem processes—carbon, nitrogen, phosphorus, sulfur cycles. 9/87

## ***Support***

### **1987 Program Plans**

#### **Monitoring**

- FY 1986 Annual Report on intercomparison program for pesticides. 6/87
- Annual Report: EPA Pesticides and Industrial Chemicals Repository. 6/87
- Manual of Quality Assurance in Pesticide Laboratories. 1/87
- Revised and updated manual for analytical methods for tissue and environmental samples. 1/87
- Evaluation report on air models to assess human exposure to toxic organic compounds. 12/87
- Report on asbestos audit program. 12/87
- Annual report—QC sample program EPA repository for toxic and hazardous materials—FY 1987. 12/87
- Development and Validation Procedures for Total Exposure Multi-Media Models (Air Model Evaluation). 12/86
- Annual report—QC sample program EPA repository for toxic and hazardous materials—FY 1986. 12/86

#### ***Environmental Processes***

- Internal report on status of exposure and risk modeling support provided by CWQM team. 9/87
- Development of Potential Risk Identification System for Existing Industrial Chemicals by ITC. 6/87
- Internal report on status of chemical reviews, assessments and modeling support/training provided. 9/87
- Report on the toxicity-persistence of Cationic Poly-Electrolytes. 9/87

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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 to develop management standards for wastes which protect human health and the environment. Research support for this program provides the scientific and engineering bases 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) and the Office of Waste Programs Enforcement (OWPE) require scientific and technical support from the Office of Research and Development to mitigate health and environmental problems at priority sites listed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). ORD's program provides a core of scientific and technical expertise 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. Many of the Superfund-sponsored activities consist of field testing and evaluating technologies developed in other research programs, such as hazardous waste; however, as a result of the Superfund Amendments and Reauthorization Act of 1986, ORD will, for the first time, begin research that is focused on problems that are unique to Superfund sites.

The major research issues identified by the Assistant Administrators for the Office of Solid Waste and Emergency Response (OSWER) and the Office of Research and Development (ORD) provide the framework for this discussion of the ORD research accomplishments for FY 1986 and the proposed program outlook for FY 1987.

### **ISSUE: Alternative Technologies**

Information and data developed in this issue support the Office of Solid Waste (OSW) implementation of those portions of the RCRA amendments which require banning high-hazard wastes from land disposal. For safe disposal of such wastes, the effective alternative or waste-altering treatment processes must be evaluated and performance parameters established.

#### ***1986 Program Accomplishments***

For evaluation of existing full-scale treatment technologies which support OSW's "Best Demonstrated Available Technologies" (BDAT) land disposal restriction program, performance of several alternative treatment process units were evaluated for distillation, thin film evaporation, steam stripping and biological treatment for hazardous waste solvents; neutralization, cyanide destruction, chromium reduction, and chemical precipitation for metals, cyanides, and corrosive wastes. Test data show that these alternative treatment technologies are preferable to direct land disposal, and that good design and operation are critical for reduction of waste hazard potential to acceptable levels.

Other data characterize residuals at 10 incinerators. Generally, these data show that incinerator ashes would pass the existing toxicity test (EP); however, in some cases, they also show that the incinerators would not pass the proposed Toxicity Characteristics Leaching Procedure (TCLP) for metals and organics.

Technical Resource documents on treatment alternatives for dioxin and solvent wastes were produced. These TRDs provide information on design and performance of alternative treatment technologies for treating wastes banned from direct-land disposal.

Six pilot-scale units for in-house cyanides and metals research were fabricated and installed. Inorganic waste treatment data were generated for neutralization, lime precipitation, sulfide precipitation, chromium reduction, cyanide oxidation, and mixed-media filtration. Two other pilot-scale units for in-house biological treatment research were installed.

Waste-minimization case studies were conducted on seven processes in support of the Waste

Minimization Report to Congress. Waste-minimization audit procedures developed were applied to three waste-generating facilities. Audit results were encouraging. Several significant opportunities for reducing cyanide and solvent waste generation having paybacks of less than one year were identified. In FY 1987, this latter program will include four of the "first third" waste streams prohibited from land disposal.

The Hazardous Waste Engineering Research Laboratory sponsored the annual hazardous waste research symposium. Approximately 1,000 people attended and some 60 papers were presented.

Significant technical and laboratory testing support was provided to Environment Canada in a cooperative project. Protocols for testing solidified hazardous waste were evaluated. In the area of emerging technologies, field application of APEG (alkaline polyethylene glycol) reagents was successfully demonstrated at Montana Pole, an inactive wood-preserving site in Butte, Montana. At this site, 9000 gallons of pentachlorophenol-contaminated light oil containing chlorinated dibenzodioxin and chlorinated dibenzofuran (CDDs/CDFs) homologs, ranging from 422 ppb of tetra isomers to 84,000 ppb of octa isomer, had been separated from ground water. From Butte, the test equipment was sent to Kent, Washington, where it was used to treat 8,000 gallons of solvent-oil wastes containing CDDs and CDFs.

In laboratory tests, oil from the Montana site was effectively decontaminated by the APEG reagent at conditions as mild as 70°C after 15 minutes. Total TCDDs and total TCDFs were reduced from 422 ppb and 147 ppb to below detection limits for TCDDs, and to 33.3 ppb for TCDFs. At 100°C and 30 minutes of reaction time, all of the CDD/CDF homologs were reduced to quantities below detection limits. The field equipment used to implement the chemical process consisted of a 2700-gallon reactor mounted on a 45-foot trailer and equipped with a boiler/cooling system and a laboratory/control room.

The APEG process, which successfully destroys CDDs and CDFs in liquid haloorganic wastes, may revolutionize the treatment of such wastes. The process cost in the Butte, Montana decontamination field demonstration was less than 10 percent of the projected cost of on-site incineration.

Related work with KTEG (potassium tetraethylene glycol) reagent has shown that complex to be capable of destroying ethylene dibromide (EDB) and a host of other halogenated organics. The most recent work with KTEG was oriented toward reactor design for full-scale destruction of EDB formulation stocks and investigation of the reaction kinetics of KTEG with a

series of compounds. The reagent successfully dehalogenated carbon tetrachloride, chloroform, methylene chloride, ethylene dichloride, ethylene dibromide, and chloropicrin.

The white-rot fungus (*Phanerochaete chrysosporium*) has been found to mineralize a broad spectrum of persistent organopollutants including: pentachlorophenol, hexachlorobenzene, lindane, chlordane, Mirex, atrazine, DDT, DDE, benzo(a)pyrene, methoxychlor, 2,3,7,8-TCDD, and PCB congeners. After 90 days of incubation and two additions of glucose, more than 99 percent of the DDT was degraded. This naturally occurring organism shows promise for the treatment of toxic pollutants, even in low concentrations.

### 1987 Program Outlook

During 1987, in cooperation with the state of California, the alternative technologies program will concentrate on evaluation and demonstration of six alternative treatment processes. Six to eight existing treatment systems for controlling hazardous wastes banned from land disposal will be evaluated. Process evaluation will include composting of toxic wastes, UV-hydrogen peroxide treatment of pesticide rinse wastes, treatment of auto-shop wastes, low temperature thermal treatment, chlorinated solvent adsorption, and an HF acid treatment process. Three more pilot-scale technologies for in-house organic treatability research will be investigated. In-house organic and inorganic BDAT treatability studies will support OSW development of regulations and respond to ban-waiver petitions. Testing in FY 1987 will focus on the "first-third" listed wastes to be restricted from land disposal under HSWA. Four additional hazardous waste minimization facility audits will be performed. Technical resource documents on alternative treatment technologies for corrosives, halogenated organics, metals and selected special waste streams will be produced. The 13th annual hazardous waste research symposium will be sponsored. The cooperative study with Environment Canada on waste solidification will be completed. Tests to determine if solidification is an appropriate means to treat residuals from alternative treatment processes prior to land disposal will be initiated.

Work will continue on reactor design and full, field-scale demonstration of CDD and CDF destruction in waste oils and on reaction studies for KTEG detoxification of a series of chlorinated organic solvents such as chloroform, carbon tetrachloride, and methylene chloride. Laboratory testing of techniques for removing PCBs from harbor, sewer and lagoon sediments will also continue. Currently, in response to needs in Region II, investigators are removing and separating the sediments from water, then using solvent

extraction followed by chemical dehalogenation to destroy PCBs being entrained/adsorbed by the solids.

Research will continue to identify degradation products of selected organopollutants formed by the white-rot fungus in simulated waste treatment systems. This will include a search for the conditions necessary to promote mineralization of the organopollutants and any conditions leading to inhibition of mineralization. A determination of lethal concentrations of pollutant will also be undertaken.

Full-scale testing of the white-rot fungus requires knowledge of cultivational practices specific to the fungus and of requirements for protection against indigenous microflora. The effect of selected abiotic soil factors (moisture, temperature, pH) on the survival in the absence of competing microorganisms of the fungus will be investigated. To support maximal growth of the fungus, the ranges of environmental factors will be optimized. The effect of soil biota on the survival and growth of *P. chrysosporium* will be assessed to determine the influence of indigenous microbial populations.

Investigation of the complex system of 10-15 extracellular enzymes expressed by *P. chrysosporium* will include development of criteria that can be used to predict the activity of certain lignin-degrading enzymes towards persistent toxic aromatic pollutants. This information is critical to any effort to optimize the degrading ability of *P. chrysosporium* towards these persistent pollutants.

## ISSUE: Waste Characterization

Human health, environmental effects and risk assessment information and procedures are developed to assist in the characterization of waste and assessment of their hazards. This information will assist in the development and revision of regulations, and will be used in permitting and enforcement decision-making. Research products will provide simpler, less costly, and more accurate information and risk assessment methodologies.

### 1986 Program Accomplishments

During FY 1986, 62 Health and Environmental Effects Profiles (HEEPs) were prepared for use by the Office of Solid Waste in making listing decisions under Section 3001 of RCRA. To support the Hazardous and Solid Waste Amendments—1984 requirements which restrict land-disposal of certain hazardous wastes, 100 Reference Doses (RfDs) and 40 carcinogenicity evaluations were prepared. As RfDs are prepared and verified, they are entered into the Integrated Risk Information System (IRIS). Currently, 90 such profiles are in IRIS. Four petitions or Exposure Information

Reports were reviewed and assistance on health/exposure assessment provided to work groups and the permit assistance team. Forty-five subchronic testing protocols were developed for specific chemicals, and work continued on various aspects of health and exposure assessment methodology.

Under development are short-term *in vivo* and *in vitro* bioassays for use in screening protocols to determine whether wastes, as single chemicals or complex mixtures, are hazardous. The screening protocol for determining potential adverse effects on human health included cancer and non-cancer endpoints. Toxic endpoints evaluated included carcinogenicity/mutagenicity, neurotoxicity, reproductive effects, teratogenicity, general toxicity and immunotoxicity. The findings with four known toxic chemicals, each with specific toxic endpoints, gave very good predictability for each specific endpoint. Validation studies indicated that screening is capable of detecting specific biological activity of pure compounds as single components. Since most hazardous waste and hazardous waste sites contain complex mixtures, future screening will focus on more single-chemical constituents of complex mixtures, including comparative organ-specific toxicity, interactions, synergism, and antagonism.

Activities in environmental processes research supported risk assessment, listing, and waste-banning decisions. The behavior of two groups of important ground-water contaminants, alkylbenzenes and halogenated aliphatic hydrocarbons, was studied in microcosms containing actively methanogenic aquifer material. Although chloroalkenes degrade anaerobically to produce products that are more hazardous and more mobile, this study showed that sequential reductive dechlorination need not result in the appreciable accumulation of products and that the reduction can be rapid and extensive once activity begins. The significant anaerobic degradation of the alkylbenzenes has important implications for remediating polluted ground waters.

An *in vivo* fish model was adapted to monitor respiratory-cardiovascular responses of rainbow trout exposed to acutely toxic aqueous concentrations of chemicals. Observed responses for acute toxicity syndromes in the fish have allowed the grouping of similar response sets caused by other chemicals into four types: AChE inhibitors, respiratory irritants, respiratory uncouplers, and narcotics.

A metal speciation modeling approach was developed for evaluating potential mobilities of arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and thallium in ground waters under conditions reflecting leachate contamination from a failed land disposal facility.

Although these studies divide the metals into "mobile" and "relatively immobile" groups, a high degree of uncertainty still exists about such predictions because of the wide variability in ground-water characteristics, and the lack of redox equilibria in many ground-water systems. Information was gathered on the role of microorganisms in the anaerobic transformation of xenobiotic compounds for assessment of kinetic concepts of degradation in natural environments. Finally, to provide input to the mathematical model developed to estimate potential ground-water contamination from chemicals in land disposal sites, extensive laboratory measurement of hydrolysis rate constants for 26 compounds regulated under RCRA were performed.

### 1987 Program Outlook

Approximately 90 HEEPs and 180 pre-HEEPs will be prepared for OSW use in FY 1987. In addition, 100 Reference Doses and 40 carcinogenicity profiles will be prepared. Additional health and exposure evaluations will be provided in support of ban-waiver petitions, ACL and permit applications. Major new emphasis will be on development of risk assessment methodology, including the initiation of a project to develop guidance on risk assessments for the incineration process.

The health research program will continue development of a screening protocol for determining waste toxicity using short-term *in vivo* and *in vitro* bioassays. This protocol is used for predicting potential human health hazards and as an indicator of future research needs. Bioassays for the most significant, potentially debilitating, health endpoints are under development to reduce the uncertainties in assessing hazards and risks from complex mixtures of unidentified and uncharacterized wastes.

Environmental processes research will be conducted in three major areas: risk assessment, listing, and land disposal restriction programs. Multimedia assessment models for predicting potential migration of wastes from land disposal sites into the air, soil and ground water will be developed as will quantitative structure-activity predictions of waste toxicity and models for predicting waste concentration in ground water. Studies have been initiated to determine the ability of wetlands to retain or transform hazardous wastes.

### ISSUE: Dioxin

This research supports Agency assessments of the extent and severity of dioxin contamination and development of control procedures. Research continues in health and risk assessment activities and in transport and fate and quality assurance

assistance. Technologies with the potential to detoxify or decontaminate dioxins and dioxin-like compounds are also being evaluated.

### 1986 Program Accomplishments

Engineering evaluated chemical reagents, alkaline polyethylene glycol (APEG) reagents, and use of the mobile incinerator for treatment of dioxin contaminated soils. Methods for decontaminating PCB transformer and capacitor fire sites were also evaluated.

In laboratory soil column and batch leaching experiments using contaminated soils from Missouri and New Jersey, TCDD was shown to be strongly bound to the waste-soil matrix. Disposal of these soils by themselves would be safe as regards leaching and mobility of TCDD in water. A report "Solubility of 2,3,7,8-TCDD in Contaminated Soils" indicated that solubility of TCDD in these soils was regulated not by clay and native organic matter, but by the levels of other organic contaminants present in the wastes with the TCDD. This finding suggests that soils containing higher concentrations of other organic contaminants would allow leaching of greater amounts of dioxins.

During FY 1986, an analysis of soil ingestion rates was performed to assist in the determination of dioxin exposure to humans from ingestion of contaminated soil. From a literature review, the vapor-phase photolysis of 2,3,7,8-TCDD and the kinetic and tissue distributions of 2,3,7,8-TCDD were evaluated.

Monitoring research produced an evaluation report on current methods for analyzing 2,3,7,8-TCDD. Reference standards were prepared for tetra isomers and for the important isomers in the penta, hexa and hepta homolog series. Experiments were conducted to evaluate co-elution and to optimize analytical procedures for identification and quantitation in environmental samples. A monoclonal antibody to 2,3,7,8-TCDD was produced and will be evaluated for its ability to detect 2,3,7,8-TCDD in samples.

Of particular note is the major progress achieved in the development of a monoclonal assay for TCDD in the health program. A thyroglobulin was conjugated with dioxin and this conjugate was used to immunize mice and produce hybridomas. To assay the cultures, a solid-phase radioimmunoassay was developed. Fourteen hybridomas were identified that produce monoclonal antibodies reacting with bovine serum albumin-TCDD (BSA-TCDD) but not with BSA alone. Two hybridomas showed preferential binding of BSA-TCDD of more than 200-fold. One of the two was purified and showed high binding to BSA-TCDD; this should allow detection of less than 1 ng of dioxin per ml or about 50 pg in a 50  $\mu$ l sample. In



general, the procedure looks promising and further attempts will be made to demonstrate specificity and binding characteristics.

Also determined was the linear relationship between *in vivo* toxicity of dioxin (weight loss, thymic atrophy) and induction of hepatic microsomal cytochrome P-488-dependent monooxygenases AHH (aryl hydrocarbon hydroxylase) and EROD (ethoxyresorufin O-diethylase). More importantly, there was excellent quantitative correlation between the *in vivo* structure activity relationships for 15 PCDFs and their *in vitro* activities such as AHH induction in rat hepatoma H-r-II E cells and as ligands for the 2,3,7,8-TCDD receptor protein. This makes the use of the *in vitro* AHH induction assays suitable as a short-term quantitative test system for this class of compounds.

Work continues to define the cytosolic receptor binding as an assay applicable as a short-term test system for PCDDs and PCDFs using cell cultures. Results to date are promising and the study has progressed to the use of radiolabeled ligands of TCDD and TCDF for determination of the binding power and further characterization of the receptor. Work is also progressing to develop and test computational structure-activity relationship methods based on molecular properties related to the mechanisms of interaction with biological systems. The work is also addressing ways to assess the toxicity of dioxin-like chemicals.

Laboratory experiments were conducted to determine the bioavailability of polychlorinated dibenzo-p-dioxins in the aquatic environment to two species of fish—carp and fathead minnows. Although the nominal water concentration of 2,3,7,8-TCDD was 0.2 ppt, based on input of stock solution, a large portion of the material was associated with suspended solids or was attached to the aquaria walls. The “dissolved” 2,3,7,8-TCDD concentrations were only about 0.005 ppt or 2.5% of the nominal water concentration due to TCDD’s extreme hydrophobicity. Although the rate of uptake of 2,3,7,8-TCDD appears to be slow, the rate of depuration is even slower, and the steady-state bioconcentration factor (BCF) for fathead minnows is estimated to exceed 80,000 and for carp 33,000. BCFs calculated on the basis of the dioxin concentration in water free of suspended particulate matter are approximately six times greater or in excess of 200,000 for carp. Although no-effect water concentration cannot be predicted; for carp, it would probably be less than 1 ppq.

### 1987 Program Outlook

The health research program will develop test methods to detect health effects and will collect data relevant to the assessment of human health

effects from dioxin and related compounds. Endpoints to be studied include neurological effects and immunotoxicological effects. This research will further the development of a method for using molecular designators to assess and predict toxicological activity of dioxin-like compounds.

Engineering research will address mobility of dioxins from soils containing high levels of other organic contaminants. High priority is being given to soils from wood preservative sites that are contaminated with oil/pentachlorophenol and higher chlorinated dioxins and furans. Data from this work will be used by OSW in listing decisions under RCRA and in guidance for making site specific decisions on “how clean is clean.”

Environmental processes research will continue work to determine rates of uptake, body burden and tissue distribution of 2,3,7,8-TCDD through exposure to fish, plants, and large mammals. In addition, the mobility of dioxins in soils and the degradation of 2,3,7,8-TCDD and other dioxin isomers will be evaluated, as will the rates of photolysis of 2,3,7,8-TCDD and other dioxin isomers.

### ISSUE: Waste Identification

Analytical methods development for identifying hazardous wastes and their chemical constituents will continue. Analytical methods 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 RCRA facility monitoring requirements.

### 1986 Program Accomplishments

1986 accomplishments included work on the development, evaluation and validation of monitoring methods. Generic methods for analysis of Appendix VIII compounds were developed. The generic approach being developed is intended to reduce the cost and time needed for the analysis of wastes. One example is the evaluation of a general extraction procedure, EP III, for hazardous waste. Another is a thermal-spray coupling device to make solid and nonvolatile analysis possible by MS/MS instrumentation.

To assist with problems associated with measuring an ever-increasing number of organic and inorganic contaminants in complex environmental matrices, at ever-decreasing levels of sensitivity, monitoring research has worked on the development of advanced analytical methods for detection, including such techniques as Liquid/Gas Chromatography, and Mass, Fourier Transform Infra-Red, and Inductively Coupled Plasma Spectroscopy. Also, biological procedures have

been evaluated as possible analytical screening techniques.

Several monitoring methods designed to map subsurface conditions were evaluated. These methods included electromagnetic conductivity, ground penetrating radar, and resistivity. The standardization of subsurface monitoring methods was initiated in order to improve the quality of data collected.

### *1987 Program Outlook*

Several projects will be pursued at the Ada and Las Vegas laboratories to improve ability to monitor pollutants in surface soils, the subsurface unsaturated zone, and ground water. These include geophysical techniques to characterize site geohydrology and locate surface contamination; among the FY 1987 projects are investigations of the capabilities of electromagnetic induction, resistivity, and magnetometry techniques and their subsequent use in EPA field operations; coupling of lasers and downhole fiber optics for direct measurement of groundwater quality; and evaluation of other traditional ground-water monitoring methods. Research on subtitle D facilities will include development of expert systems for location standards and monitoring in wet environments and fractured zones.

A computerized Geographical Information System (GIS) for integrating terrain, remote sensing and sampling data will be evaluated and made available for pilot use in the Regions. The Las Vegas laboratory will continue to provide overhead remote sensing to locate waste disposal sites, detect waste discharges, identify erosion and other types of deterioration, and to define environmental impacts of land use.

### **ISSUE: Land Disposal**

Research in land disposal provides guidance on design, permitting, operation, maintenance, closure and regulation of land treatment, storage and disposal. Other research subjects include large-volume waste disposal, mining wastes, solid waste (non-hazardous) characterization and technology transfer. In addition, source characterization and control techniques for air emissions from hazardous waste treatment, storage and disposal facilities are the focus of research activity.

### *1986 Program Accomplishments*

During FY 1986, several major accomplishments were achieved in support of the Office of Solid Waste (OSW). A report on prediction and mitigation of subsidence damage to covers of hazardous waste landfills was completed. The final report presents methods to estimate the amount of cover subsidence that may be expected when the

physical characteristics of wastes are known. Settlement time may also be estimated. Methods are described to prevent or mitigate subsidence. Included are methods to hasten pre-closure settlement and methods to strengthen waste materials to minimize the amount of post-closure settlement. Containerized (e.g., drummed) wastes were found to contribute most to post-closure settlement, and thus to subsidence in a RCRA-permitted landfill. This contribution may be prevented by not landfilling with contained waste and by filling all voids with high strength materials. The final report was prepared in response to a critical OSW need for information on the potential for subsidence damage to hazardous waste landfill covers.

A project was undertaken to characterize municipal waste combustor residue and its leachate. The information gained will contribute directly to a critical need of the Office of Solid Waste for meeting a Congressional mandate in the Hazardous and Solid Waste Amendments (HSWA) of 1984. That mandate requires a report to Congress as the basis for further needed action regarding the possible regulation of the residues as hazardous waste. The project will sample bottom ash, fly ash, quench water, and ash landfill leachate for comprehensive analysis of hazardous components. Based upon earlier results from other investigations, unacceptable concentrations of heavy metals and several complex organics may be present. This project will continue in FY 1987.

A technical guidance document was issued. Entitled, "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities," this report discusses the five elements of a construction quality assurance (CQA) plan (responsibility and authority, CQA personnel qualifications, inspection activities, sampling strategies, and documentation). The document also addresses inspection activities for six facility components. These components are foundations, dikes, low-permeability soil liners, flexible membrane liners, leachate collection systems, and final cover systems. This guidance document will help CQA personnel to ensure that a constructed hazardous waste land disposal facility will meet or exceed all design criteria, plans and specifications.

Two reports on leachate collection systems for hazardous waste facilities were completed. The first, "Leachate Collection and Gas Migration and Emission Problems at Landfills and Surface Impoundments," identifies and describes potential problems and is based on interviews with regulatory officials, design engineers, and commercial firms involved in hazardous waste land disposal facility management. The second, "Avoiding Failure of Leachate Collection and Cap

Drainage Systems," describes state-of-the-art design, construction, inspection, maintenance, and repair activities to avoid system failures.

The report, "Estimating Leachate Production from a Closed Hazardous Waste Landfill," was issued. It presents a decision-free-based approach to estimating leachate production rates and times, and provides several practical examples of the approach in estimating production in both hypothetical and real-world situations.

Significant technical and laboratory testing support were provided to Environment Canada in a cooperative effort to evaluate protocols for testing solidified hazardous waste. Results of this study will be used by Canada to assist in development of regulations for solidification/stabilization technology. The results will provide that agency with critical data on the applicability of regulatory leaching procedures to predict performance of solidified/stabilized waste.

Two major laboratory studies demonstrated that, in contrast to the effects of pure solvents, diluted solvents or very low concentrations of chemical compounds in landfill leachates have no significant effect on clay soil permeability over the term of laboratory measurements. The data obtained from studying a variety of methods for testing permeant liquid, soil type, and permeability confirm that, where permeability is used as a measure of leachate/liner compatibility, site-specific tests must be conducted, and the procedure must be documented in detail if permit reviewers are to fully understand the meaning of the data.

Data from one and one-half years of hydrologic monitoring of three-layer cover plot studies have confirmed the utility of the HELP model in designing landfill cover systems. Calibration of the model using short-term observations, however, may lead to larger predictive errors, emphasizing the need to consider both short climatic events and long-term trends in applying the predictive results to multilayer cover design. This work also demonstrated the effectiveness of various soil moisture sensing systems in multilayered soils placed in accordance with engineering design.

A study evaluating 10 rapid testing methods for characterizing different commercially available bentonite clay types was completed. Using selected petroleum industry bentonite test methods, specific clay hydration techniques, and standardized laboratory techniques, made it possible to differentiate amounts of unaltered, polymer-treated, or chemically treated commercial bentonite products. Correlation between indicator test data and hydraulic conductivity performance could not be shown. The data obtained will be useful for identifying type-distinction of unknown bentonite products, and for confirming that bentonite products meet design engineering specifications.

Development was initiated on four expert systems to aid in review of RCRA permits for land disposal sites. They will provide data on the likelihood of subsidence, chemical resistance of flexible membrane liners, acceptability of waste analysis plans, and suitability of surface impoundment design. The first two of the four items are ready for testing and the other two will be ready during FY 1987.

In FY 1987, twenty-four staff professionals responded to over 200 requests for technical assistance from EPA program offices, Regional offices, industry, state officials, academia, Federal agencies, and Canada. State-of-the-art technology seminars were held in all 10 regions and at headquarters.

Research was directed toward determining the feasibility of land treatment of hazardous waste. Activities included laboratory, bench- and pilot-scale studies on soil and waste processes, organics degradation, and loading rates. Studies measured and interpreted the effect of surface soil changes on the underlying soil and the quality of runoff water from petroleum landfarms undergoing simulated closure. The field results over two years showed insignificant downward migration of the organics and heavy metals, and demonstrated that the closure period of two years in this study allowed significant reductions in waste/soil concentrations. In other work, laboratory column and field lysimeter studies were conducted to evaluate the efficiency of soil core and soil-pore water samples to detect the migration of the organic components of long-treated wastes through soil. Finally, four specific industrial wastes were used in studies to assess the potential for treatment using soil as the treatment medium. These wastes were API separator sludge, slop oil emulsion solids, pentachlorophenol wood preserving wastes, and creosote wood preserving wastes. The data, recommendations, and conclusions are useful for permitting and regulating land treatment facilities and for their design and operation.

### *1987 Program Outlook*

During FY 1987, technical assistance to program offices will be expanded to assist in the development of regulations and guidance to the Regional offices in the review of permits and special problems, to the Office of Enforcement in developing compliance actions, and to the public in their waste management activities to protect the public health and environment.

The four expert systems initiated during FY 1986 will be tested by selected permit reviewers, independent subject specific specialists, and program office staff. Development of additional systems will be initiated to assist in other high

priority RCRA permit-review decision areas. Specific topics will be selected after further consultation with the program office staff and permit reviewers. Anticipated decision areas to be addressed by the new systems are closure plans, cover systems, and leachate collection systems.

A methodology for estimating the reliability of flexible membrane liners (FML) in field service will be prepared. The product will be a personal-computer-based system with which a permit reviewer or disposal-site operator may determine the probability of FML failure versus time. The methodology will be based upon current knowledge regarding FML characteristics and responses to given conditions. The conditions will include those under the user's control (e.g., FML thickness) and those that are uncontrollable (e.g., weather).

A report will be produced describing the characteristics of municipal-waste combustor residues for several sites. The chemical characteristics of bottom ash, fly ash, quench water, and ash landfill leachate will be described. In addition, reports will be provided to OSW to assist them in their regulatory determination for large volume wastes. These include the topics of mitigation techniques for copper heap and dump leaching, gold/silver heap leaching and conceptual management practices to control cyanide releases, and utilization of soils to mitigate cyanide releases from mining operations.

A data base on leachate generation characteristics for municipal solid waste landfill leachates is being developed and should be available for use. The data base currently consists of mostly small-scale research lysimeters, that will have the capability of receiving and storing data from full-scale MSW facilities also. A report on municipal landfill gas condensate will be prepared which will evaluate the gas condensate for hazardous constituents and characteristics. Air emissions measurement data from the stabilizing and curing of hazardous wastes will be presented in another report.

Preparation of a guidance document for the design, construction, operation, and closure of an RCRA surface impoundment will be completed. Data will be provided on detailed characterization of leachate from actual hazardous waste facilities. This information will assist in liner compatibility determinations, correlation of liner performance versus waste, and determining the feasibility of formulating synthetic leachate for use in regulatory tasks.

ORD will continue to assist the program office in development, review, and implementation of regulatory systems for RCRA Subtitle D criteria. A study of the permeability of a soil liner test section constructed with normal field construction methods and evaluated using both infiltration and drainage

collection techniques will be completed. Data already obtained demonstrate the large variability obtained over an area of field construction.

The Geotechnical Analysis for Review of Dike Safety (GARDS) personal computer program will be completed and distributed to Regional permit writers and to the engineering community. The GARDS program provides comprehensive and rapid evaluation of dike safety for hazardous waste surface impoundments.

Research will attempt to determine the environmental conditions related to land treatment site closure. Such environmental protection parameters need to be identified to permit the orderly phase-out of land treatment operations.

## ISSUE: Incineration

Technical information and data are needed to support permitting of incinerators and improvement of design requirements. Results of this research are used by the Agency and permitting officials to evaluate the acceptability of incinerating particular wastes and in monitoring 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.

ORD has generated a large quantity of existing environmental performance data from more than 20 EPA-supported incinerator evaluations covering all of the commonly employed engineering designs operated by the user community, including liquid injection, rotary kiln plus afterburner, at-sea types, hearth or controlled air configurations, etc., and from several advanced or less popular schemes such as fluidized bed, molten salt and plasma arc concepts, etc. Several reports on this broad base of data have provided OSW, OTS, and OW program offices the scientific and technical bases for developing and promulgating their respective regulatory approaches and standards for controlling the thermal decomposition of hazardous wastes. Subsequent industry-supported trial-burn data from Regional permit actions continue to supplement and confirm the ORD data base.

Additionally, ORD's field- and pilot-scale evaluations of high-temperature industrial processes including boilers, cement, lime, aggregate, and asphalt kilns, and iron-making blast furnace concepts represent another 20 facilities of various designs where hazardous wastes are used for their fuel value in lieu of fossil energy sources. OSW uses this performance information in their continuing formulation of regulatory policy for these methods of treating hazardous waste. These non-incinerator systems now dispose of a volume of material by a factor of two or three times more than do conventional hazardous waste incinerators.

As the need for incineration and other forms of thermal destruction increases in response to land bans and Superfund actions, still more information and detailed performance data must be gathered in response to a wide spectrum of new questions posed by the Science Advisory Board as well as the concerned public. This additional data is necessary in order to effectively support facility permitting priorities by program and Regional offices, and involves such issues as improved design and operating conditions, reliability, monitoring techniques, residue and total effluent qualities, delisting, incinerating as-yet untested Superfund wastes, and more recently the issue of measuring the biological health impacts from incinerator stack emissions as compared to those from traditional fossil fuel combustion. ORD is addressing these new needs through a continuation of laboratory, pilot-scale, and field performance evaluations of a range of incinerators and other thermal treatment devices.

### *1986 Program Accomplishments*

In Fiscal Year 1986, the research emphasized generating additional incineration performance data for dioxin, Superfund and RCRA permit support actions. Support was provided to the Office of Water's long-term research needs for ocean incineration tests on PCBs and organochlorine wastes; delivering and interpreting ORD's performance results reports on high temperature industrial process tests to OSW through participation in their regulatory policy work group workshops; mobile monitoring van development with field testing; continued sampling and analysis methodology refinements for untested compounds and real-time monitoring concepts, and an extensive amount of field technology transfer and technical assistance which includes participation in a permitting program for disposing of Department of the Army chemical agent inventories.

Continuing progress was made on the primary concerns which repeatedly impair the Agency's ability to permit incinerators, namely products of incomplete combustion (PICs), toxic heavy metal fate and partitioning during thermal treatment, failure mode or off-design performance, and the new concern of biological health impacts of stack emissions. On the latter issue, two series of marine animal toxicity tests were completed at the Combustion Research Facility (CRF). The CRF accomplished a PCB trial-burn series in the rotary kiln, tests of a Superfund site waste involving solvent contaminated soils, and completion of a Superfund site dioxin waste test burn report. The overall FY 1986 program encompassed various incineration tests using rotary kilns, liquid injection units, plasma arc, industrial boilers, asphalt plants,

Center Hill's turbulent flame reactor, the kiln simulator burning plastics and chlorinated compounds, and additional progress in process control measurement and instrumentation.

### *1987 Program Outlook*

In 1987, studies will be conducted to address priority issues in incineration of hazardous waste including the potential for increased emissions to the environment during failure mode or off-design operation, products of incomplete combustion (PICs), toxic heavy metals partitioning and emissions, and in-depth studies of process monitoring parameters.

A field-scale evaluation of incinerator compliance assessment techniques and performance will determine the characteristics of all possible effluents (total mass emissions) in any form (e.g., solid, liquid, gas) at all exit points of a typical full-scale operating incinerator. Research in the boiler and industrial furnace areas will continue with pilot-scale boiler testing at two boilers to study further PIC and metals emissions under both steady and non-steady-state conditions in further support of OSW's boiler regulations.

A computerized data base will be further developed to manage both research and field data on hazardous waste incineration and treatment processes. The key information in the data base includes process design and operating conditions, waste characteristics, trial burn performance data and air pollution control device performance.

In addition, ORD has been working with OSW to develop necessary new and expanded incineration program initiatives and goals to be considered for FY 1987 through 1990 and beyond. These programs, if funded, will adequately address current unmet needs for additional research information related to OSW's urgent permitting and public information issues. The ORD incineration research facilities have been identified by OSW as being the most useful permitted facility for conducting pilot-scale evaluations relating to their initiatives.

Major classes of incinerators will be evaluated in both field and pilot/laboratory situations. The health effects of the initial waste will be compared directly to effects of air emissions and residues to evaluate whether the chemical alterations resulting from combustion of the waste represent an acceptable mitigation of health risk. Health endpoints to be evaluated include: genotoxicity, carcinogenicity, pulmonary toxicology, and other major target organ effects as appropriate. Currently available toxicological methods will be applied.

Existing methods will be evaluated for assessing risks from municipal and hazardous waste incinerators. From these evaluations, interim

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guidance on performing risk assessments from such incinerators will be developed.

### **ISSUE: Quality Assurance**

Improved method applications are needed to assure the reliability of monitoring data used in support of the RCRA program. The purpose of this program is to assure that EPA consistently produces scientifically and legally defensible environmental data in support of its critical regulatory and enforcement actions and research objectives. Analytical standards and reference materials are 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 provided to State laboratories to facilitate their performance of the required measurement and monitoring functions. This support includes instrument calibration and provision of reference materials.

#### ***1986 Program Accomplishments***

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 laboratories. All contractor laboratories were evaluated.

#### ***1987 Program Outlook***

Calibration standards and performance evaluation samples will continue to be developed and distributed to Agency laboratories, Agency contractors, state and local laboratories to assist in standardizing monitoring methods and for calibration of analytical techniques used in RCRA monitoring. Dynamic validation reports will be completed on all contractor laboratory program methods.

### **ISSUE: Control of Hazardous Releases**

Procedures needed to prevent, contain and clean up accidental discharges of hazardous materials are the focus of research in this issue. Accidental releases of oil and hazardous materials occur frequently and constitute a significant environmental hazard. Such emergencies include releases from transportation accidents (rail cars, tank trucks, vessels, and pipelines); in-plant releases, where the hazardous material leaves the boundary of the plant; releases from uncontrolled hazardous waste disposal sites, and releases from underground storage tanks. The research conducted in this program supports the mandates of Section 311 of the Clean Water Act for release provisions and Title I of RCRA for underground storage tank provisions. The object of this research

program is to develop new and improved technology for the prevention and control of these releases and to provide technical information and guidance regulations, development and implementation.

#### ***1986 Program Accomplishments***

The engineering program completed two handbooks on hazardous substance release prevention and removal ("Manual for Preventing Spills of Hazardous Substances at Fixed Facilities" and "Reference Manual of Countermeasures for Hazardous Substance Releases"). The prevention manual provides guidance on preventing spills of hazardous substances in fixed facilities that produce, store, and transport substances from raw or starter materials. In this manual, emphasis is on smaller chemical manufacturing facilities and addresses almost 700 hazardous substances. The removal manual contains procedures for selecting treatment and disposal processes, or countermeasures. Again, some 700 hazardous substances are addressed. These documents are providing federal, state, local government, and industrial personnel with the most up to date information on preventing and cleaning up accidental releases of hazardous materials.

A state-of-the-art report on leak detection methods ("Underground Tank Leak Detection Methods: A State-of-the-Art Review") was published. This report contains a catalog of known leak detection methods, a description of in-tank detection methods (as contrasted with inventory or leak effects monitoring methods), a description of physical environmental and operational variables that each method must deal with to obtain a valid determination, and an evaluation of how well each method addresses each variable. The significance to EPA's Office of Underground Storage Tanks (and to the user community) is that none of the commercial methods identified appeared to address all variables adequately. This finding underscores the importance of the ongoing evaluation of volumetric leak detection methods, under which a full-scale, controlled condition, environmentally safe test apparatus was designed and installed. The results of this evaluation will provide direct input into the OUST development of regulations under the 1984 RCRA Subtitle I amendments, and will be of interest to state and local regulators as well as to the user community. Drafts of guidance documents on preventing leaks from underground storage tanks (USTs) and on corrective actions to clean up leaks from USTs were delivered.

Ten spill prevention control and countermeasure (SPCC) studies and 15 river contingency studies in support of Section 311(k) of the Clean Water Act were completed. Development of a subsurface

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system for monitoring leaks from underground storage tanks was initiated for detection of contaminants away from the leaking tank.

A state-of-the-art report was completed on subsurface biodegradation. Although prepared for underground storage tanks, this report may also serve as a general state-of-the-art on *in-situ* bioremediation of contaminated ground water. The report indicates that *in-situ* biodegradation, where applicable, is potentially a very cost-effective and environmentally acceptable remediation technology. Many contaminants in solution in ground water, and vapors in the unsaturated zone, can be completely degraded or transformed into new compounds by naturally occurring, indigenous microbial populations. In other studies, a bioassay protocol employing aquatic and terrestrial organisms was used to evaluate various solid waste and industrial leachates for their potential environmental impacts. A battery of bioassay tests was also verified in field trials to determine the impact of toxic waste sites in actual drainage systems.

### **1987 Program Outlook**

A guidance document on the use of nondestructive techniques for locating buried chemical containers will be published. Of the 17 techniques considered, four were selected as the most applicable: electromagnetic induction, metal detection, magnetometer, and ground penetrating radar. The report will present techniques for detecting steel and/or plastic containers under different subsurface conditions.

A new laboratory method for determining the effectiveness of chemical dispersants for controlling floating hazardous materials will be issued. This method is required by regulation and incorporates scientific advances made since the original EPA test was published in 1971. A recommended database covering the test results for numerous combinations of commonly transported crude oils and dispersants will be available to the Regional Response Teams. The field test and database should allow RRTs to reduce the time needed to approve the use of dispersants at a spill.

In a cooperative effort with the U.S. Coast Guard, the Minerals Management Service, and Environment Canada, a recommended method for testing offshore oil spill cleanup equipment will be completed. A major multi-agency international at-sea demonstration is scheduled off the Canadian, New Foundland coast.

The evaluation of existing volumetric methods for detecting leaks from petroleum tanks will be completed, and a similar effort initiated for tanks containing chemicals and hazardous wastes. A

major task will be initiated to develop new and improved design, construction, and operating practices for effective prevention of releases from underground storage tanks and to survey corrective action techniques for releases from underground storage tanks.

Monitoring will continue to provide aerial photography to assist in the assessment and mitigation of spills from facilities engaged in production, storage, processing, and distribution of hazardous materials. Performance criteria for evaluating leak monitoring methods will be established and methods for detecting leaks from underground storage tanks will continue to be evaluated. Field measurements will be conducted and private, local and state leak detection experiences will be investigated.

Development of a multi-media bioassessment screening protocol will continue, with modifications incorporated to reflect the results of field evaluations. *In-situ* cleanup procedures for controlling leaks from underground storage tanks will continue to be studied.

### **Superfund**

#### **ISSUE: Site Assessment**

Superfund develops technologies and information needed for assessing and managing uncontrolled sites. 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 for on-scene coordinators' need to quickly and effectively assess the degree of hazard and the cleanup requirements at specific uncontrolled waste sites.

#### **1986 Program Accomplishments**

In FY 1986, 58 Health Effects Assessment documents were completed on individual chemicals to support the program office in setting cleanup goals at National Priority List (NPL) sites. At the request of the program office, 16 rapid response health assessments were provided for use in emergency situations and for technical assistance/information on specific chemicals.

Remote sensing was provided for site assessment and prioritization of sites. For example, aerial photographic analysis of RCRA work disposal sites in Illinois (Chicago, Freeport, Sterling, and Sheffield). Similar projects were performed in each region to provide either single data analysis and assessments at a site or to provide documentation of change in site conditions. Also monitoring assisted in the assessment and demonstration of source and ambient air monitoring equipment and

analytical methods for abandoned sites. Protocols for analysis of aqueous samples were evaluated and protocols for sediment and ground-water sampling were prepared.

Engineering staff served on technical advisory committees, reviewed site assessment and feasibility plans and advised on engineering issues. Examples include the technical advisory work groups for the Iron Mountain and the Stringfellow sites and the EPA Ground-Water Modeling Policy Work Group. A prototype engineering cost model was developed to test its applicability to remedial action evaluations. A computer-assisted engineering design work station was established to demonstrate the application of this technique. If successful, the system will save time and cost in design engineering and the EPA remedial project management.

### *1987 Program Outlook*

Scientific Assessment assistance will continue to be provided to the Regions in FY 1987. Specific activities will include preparation of site/situation-specific risk assessments, rapid response health assessments and Health Effects Assessment documents for use in RI/FS and other response efforts. A central point for coordinating the review of Regional risk assessments and for providing a focal point for Regional Offices to request risk assessment assistance will be established.

Monitoring will produce protocols for soil sampling, guidelines for sampling design and guidelines for monitoring-well construction. Short-term, quick turn-around technical advice and reviews will continue to be provided to the Regions and the Enforcement program.

Engineering staff members will serve on technical advisory committees, review site assessment and feasibility plans, and advise on remedial action engineering issues. Based on data collected from surveys, technology evaluations, and other research activities, evaluations of technology applicability, feasibility, and costs will be provided for specific sites. A report on data requirements for remedial action technology screening, evaluation, design, and construction will be completed. Engineering cost models will be completed to assist in estimation of the costs of remedial action alternatives in a remedial investigation/feasibility study. The application of computer-assisted engineering design techniques will be demonstrated for remedial action assessments. ORD staff will serve on technical advisory committees, review site assessment and feasibility plans, and advise on engineering issues.

Technical advice and consultation on emergency and remedial response options will be provided to Regional CERCLA programs and Enforcement

offices. This activity will continue to be conducted primarily by ORD staff experts to the maximum extent possible. Technical comments on site and situation assessment plans and reports will continue to be a major part of this overall activity. In addition, a microcomputer-based system to provide a tool for consistent and reliable cost estimation will be developed for use in the Feasibility Study process. The system will be available to EPA headquarters and regional staff, state personnel, and contractors for quick, easy and accurate cost estimation. Engineering will also continue to develop and demonstrate computer-assisted engineering design techniques for evaluation of remedial action alternatives for uncontrolled hazardous waste sites.

### **ISSUE: Personnel Protection**

Personnel protection research in support of CERCLA activities is directed toward improving the safety, range, and efficiency of operations, and the reduction of personnel protection costs. EPA is obliged to provide those who perform the response activities at chemical spill and hazardous waste site incidents with chemical protective clothing, equipment, and procedures that will prevent personnel from receiving harmful exposures. Since all chemical protective clothing, equipment, and procedures have limitations, it is important that these limitations be defined through evaluation and testing to prevent misuse and personal injury. Defining the capabilities of personnel protection technology is also important to promotion of more efficient operations.

### *1986 Program Accomplishments*

An Intra-EPA Workshop on Personnel Protection Technology Research/Research Needs was conducted during 1986. The attendees represented six regions, the Occupational Health and Safety staff, the Environmental Response Team and ORD. Attendees identified a number of areas in need of research and these will be integrated into future research program plans. A multiyear contract for research on personnel protection technology to support EPA operational and regulatory programs was initiated. Development of a test kit for in-the-field assessment of the degradation and permeation resistance of protective clothing materials was initiated. Prototype kits should be ready during FY 1987.

An assessment of the technical and economic feasibility of decontaminating and reusing protective garment materials was initiated. An evaluation of the compatibility of high-pressure oxygen with the materials of construction of a previously developed self-contained breathing apparatus was conducted along with an



investigation of the state-of-knowledge concerning the health effects of routinely breathing high concentrations of oxygen. Also, an evaluation of heat stress management, including assessment of the performance of vital-signs monitors and personal cooling devices was initiated.

Interagency coordination of personnel health and safety issues has been enhanced by the implementation of a Memorandum of Understanding (MOU) amongst EPA, the Coast Guard, the National Institute of Occupational Safety and Health, the Occupational Safety and Health Administration, and the Federal Emergency Management Agency. This MOU covers research, development, testing, and evaluation of chemical protective clothing, equipment and procedures.

### *1987 Program Outlook*

FY 1987 efforts will include additional testing of chemical protective ensembles, evaluation of personal cooling devices and hazard detectors, and evaluation, development and verification of field methods for rapid on-site determination of appropriate chemical protective clothing. Another intra-EPA workshop is planned as is participation in the MOU Workshop Group. Other coordination efforts will continue via participation in ASTM Committee F-23 on protective clothing and other technical organizations and meetings.

### **ISSUE: Reportable Quantities**

Activities under this issue provide carcinogenicity and chronic effects risk information on specific chemicals for use by the program office in setting and adjusting the Reportable Quantity for a hazardous substance. The Reportable Quantity is the amount of a chemical that has to be released before the requirement to notify Federal officials of the release is triggered.

### *1986 Program Accomplishments*

During 1986, Reportable Quantity documentation, for carcinogenic and other chronic health effects, was prepared concurrent with health documentation efforts for the RCRA hazardous waste listing effort for 62 chemicals and wastes. In addition, draft Reportable Quantity documents were prepared for other chemicals on the original CERCLA hazardous substances list. OERR issues revised RQs for 102 chemicals based on chronic toxicity evaluations prepared by ORD.

### *1987 Program Outlook*

Scientific assessment will continue to provide carcinogenic and other chronic health effects documentation to support the adjustment of the Reportable Quantity for potential and actual CERCLA hazardous substances during 1987.

Approximately 90 chemicals/wastes will be evaluated and documentation prepared concurrently with RCRA listing activities.

Approximately 100 additional chemicals currently on the Acute Hazards List will undergo evaluation of carcinogenicity and other chronic effects for use in adjusting their Reportable Quantity. OERR will propose RQ adjustments for 191 suspect carcinogens based on evaluations prepared by ORD.

### **ISSUE: Technical Support**

Activity under this issue provides expert advice and technical information to Enforcement, the Regions and the Program Office for effective implementation of the Superfund program.

### *1986 Program Accomplishments*

The scientific assessment program provided technical assistance to the Office of Waste Programs Enforcement during 1987 in the assessment of exposure, health effects and risk associated with Enforcement lead Superfund remedial activities. Assistance was provided on approximately 20 sites, and activity will continue on several of these during FY 1987.

The environmental monitoring support program responded to a number of requests for technical information and assistance during 1986. These included performance of a geophysical survey at the Marrion Landfill in Region V, a geophysical and soil organic vapor analysis of the Colber Landfill in Region X, and review of possible responsible party reports for the Keystone Landfill in Region III and the Cinnaminson Study Area of Region II.

Engineering provided technical assistance to various EPA Regional offices on the feasibility of using mobile treatment technologies (e.g., the Mobile Incineration System, Mobile Soils Washing System, Mobile *In-Situ* Containment/Treatment Unit) for specific cleanup activities in their jurisdictions. State-of-the-art technology seminars were developed and presentations made in each of the Regions. EPA's Mobile Carbon Regenerator, was prepared for an evaluation to regenerate spent carbon from a treatment system at EPA's Region IX Stringfellow site.

Technical reviews and other advisory activities were provided on the Beacon Heights, McKin, Nashua, and Charles George sites in Region I; Hyde Park/Bloody Run, Love Canal, LiPari and Cinnaminson sites in Region II; the Pepper Steel and Biscayne Aquifer in Region IV; Indiana Harbour and Woodville, WI sites in Region V; Denney Farm and other dioxin sites in Region VII; Rocky Mountain Arsenal in Region VIII, Stringfellow, Iron Mountain, and Celter Chemical sites in Region IX;

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and the Western Processing, Bunker Hill and United Chrome sites in Region X.

A modeling study was completed on the performance of proposed remedial action alternatives at the Western Processing sites in Kent, WA for Region X. A feasibility study was completed on the use of mines for the long-term storage of dioxin-contaminated soils for Region VII and the state of Missouri.

Technical support was provided in the environmental processes area in response to specific requests from the Regions, Enforcement, and States on ground-water sampling, analyses, data interpretation and site-specific modeling.

### ***1987 Program Outlook***

The scientific assessment program will continue to provide technical support to Enforcement and to the Regions by reviewing and/or preparing endangerment assessments.

Environmental monitoring will continue to provide aerial imagery and remote sensing reports for all sites assessed. Assistance in the review and testing of site-specific sampling design, quality assurance procedures and field audit procedures will be provided.

Technical assistance will be provided to EPA Regional Offices on the feasibility of using mobile treatment technologies (e.g., the Mobile Incineration System, Mobile Soils Washing System, Mobile *In-Situ* Containment Treatment Unit) for specific site cleanup activities. State-of-the-art technology seminars will be continued in each Region. Support will continue to be provided to OERR in the development of a technology base in support of legislative mandates relative to a final rule that adjusts reportable quantities for designated CERCLA hazardous substances. Efforts will continue to provide the Program Office, Regions and the states with technical support. Pilot studies will be conducted on the use of Rotating Biological Contactors (RBCs) on leachates from a number of Superfund sites. Technical exchange on new, innovative techniques will continue with other countries through formal organizations, such as the NATO CCMS, to maximize research information generated by outside sources.

Emphasis will be on technology transfer activities such as review and presentation of Superfund technology transfer documents to the Regions and participation in many technical conferences and seminars. In-house studies will be initiated on the application of biological processes to regenerate spent carbon in connection with the Stringfellow site. Innovative/newly developed applications for treatment of contaminated soils and leachates which evolve from site specific (NPL) experiences will be provided to all Regional Offices. An increase

in in-house technical assistance to the Regions is anticipated.

Technical reviews will continue to be provided to Regional Offices. Geochemical and geotechnical assistance will be provided on an extramural basis and an expanded in-house soils testing laboratory capability will be initiated. This capability will provide the Regions with slurry-wall waste compatibility data, as well as information on permeability and other soil characteristics. A modest increase of in-house support will be provided for a transfer of the latest RCRA protocols relating to secure landfill design to Superfund remedial action plan reviews.

Assistance will continue to Agency and State personnel on the use of subsurface models, sampling and testing techniques, and on the application of the bioassessment protocols for determining the toxicity of spilled materials and Superfund site waste samples.

### **ISSUE: Technology Evaluations**

The objective of this research is to develop and evaluate technologies that support emergency actions at hazardous substance releases and remedial actions for cleanup of uncontrolled hazardous waste sites. The technical information supports the implementation requirements of CERCLA to obtain cleanup of the environment, mitigation of health problems, and recovery of cleanup costs.

### ***1986 Program Accomplishments***

A handbook on remedial actions at waste disposal sites was revised and published during 1986. This handbook is the basic technical reference for remedial action technologies. At the request of Region VII, EPA's Mobile Incineration System has operated over the past two years at the Denney Farm site for cleanup of dioxin-contaminated liquids and soils to demonstrate the feasibility of this approach to destruction of dioxin. The Mobile Soils Washing System was designed for water extraction of a broad range of hazardous materials from contaminated soils, and has been prepared for functional system evaluation.

Detailed technical manuals were completed on leachate plume management, systems to accelerate the stabilization of waste piles, cover systems, stabilization/solidification technology, drum handling practices, overtopping control for impoundments, use of foams for hazardous spills, and removal/prevention techniques for hazardous substances releases. Research efforts were initiated or continued in the area of *in-situ* treatment including a field evaluation of electrokinetics extraction, bench evaluation of permeable treatment barriers, bench evaluation of

aphron technology, and laboratory studies of grouts, slurry backfill materials and chemical stabilization techniques.

Two joint EPA-United States Air Force projects were completed to demonstrate the full-scale feasibility of EPA's Mobile *In-Situ* Containment Treatment Unit and to evaluate *in-situ* biological degradation technology.

### 1987 Program Outlook

Efforts will continue to develop and evaluate techniques for remediation of uncontrolled hazardous waste site problems with the greatest emphasis on typical Superfund wastes (e.g., contaminated soil) in two categories: *in-situ* treatment and on-site equipment. Four major technology areas will be developed in each of these categories: extraction processes; degradation/detoxification processes; immobilization processes; and delivery and recovery processes.

Extraction processes efforts will include evaluation of vegetative uptake of organics from contaminated soils, further research in the use of artificial freezing for the treatment of contaminated soils, vapor phase soil decontamination both *in-situ* (soil flushing, biodegradation, vacuum removal, etc.) and with aphron technology.

Immobilization processes activities will include an increased emphasis of solidification/stabilization evaluations, as well as research in the areas of grouting, precipitation and thermal fusion.

Degradation/detoxification processes activities will include additional research focused on *in-situ* processes but with a shift towards developmental activities rather than field-scale evaluations which will be the emphasis of the Superfund innovative/alternative technology demonstration program.

Delivery and recovery processes activities will evaluate the effectiveness of delivery and recovery systems which are essential for effective implementation of most *in-situ* processes.

On-site equipment efforts will be directed towards field demonstrations and evaluations of various mobile hazardous waste control technologies involving flow-through treatment systems for excavated soils and sludges.

Studies will be conducted on the mobile incinerator and other on-site treatment technologies to develop efficient feedstock preparation and handling schemes in the field. Combustion Research Facility Tests will occur on wastes from Hyde Park and Love Canal sites.

A limited program to demonstrate innovative/alternative technologies will be initiated in FY 1987. The objective of this program will be to develop reliable cost and performance data on fully developed cleanup technologies so that their full commercialization can be accelerated and their use

in Superfund cleanups considered. Technologies will be selected by the engineering program for use on sites that are identified by the program office. Demonstrations will be cost-shared with the developer paying for the technology and the demonstration, and the Agency paying for and conducting the performance evaluation phase. The Agency will also publish and disseminate the results of these evaluations.

### ISSUE: Innovative/Alternative Treatment Technology

Program components in this issue fulfill the Agency's responsibilities under Section 311(b) of CERCLA established by the Superfund Amendments and Reauthorization Act of 1986 (SARA) which, in part, establish a comprehensive and coordinated Federal program of research, demonstration, and development to promote commercialization of alternative and innovative treatment technologies to be used in response actions. The program is also intended to provide incentives for development and use of such technologies.

### 1987 Program Outlook

Engineering, in close coordination with the program office, will operate a large-scale demonstration program focused on testing and evaluation of innovative/alternative treatment technologies. The objective is to develop reliable cost and performance data on fully developed cleanup technologies so that their full commercialization can be accelerated and their use in Superfund cleanups considered. The engineering program will select privately developed technologies for demonstration on sites identified by the program office. Technologies will be selected from requests for proposals published in the Commerce Business Daily. Demonstrations will be cost-shared, with the developer paying for the technology and the demonstration, and the Agency paying for and conducting the performance evaluation phase and publishing/dissemination of results.

Also in response to SARA, the engineering program will initiate a development program that will focus on evaluating innovative and emerging alternative technologies developed mostly by the private sector. These evaluations will provide credibility to these new techniques and thereby accelerate their potential for demonstration and commercialization. Input from a Superfund technology user's perspective to optimize the usefulness of the technology will be provided by coordination of our efforts with the program office. Technologies will be selected from responses to requests for proposals in the Commerce Business Daily.

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Monitoring will test and evaluate newly developed, but unproven, innovative monitoring technologies for their applicability to Superfund site assessment and pollutant characterization problems. This will be a cooperative program between developers of the technologies and the Agency. In addition, promising, advanced/innovative monitoring techniques and systems which are not yet ready for demonstration, will be evaluated for their applicability to Superfund sites and further developed so that they can be validated/demonstrated for use in Superfund assessments.

### **ISSUE: Hazardous Substances Research 1987 Program Outlook**

Program components in this issue fulfill the Agency's responsibilities under Section 311(c) of CERCLA created by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This section establishes, in part, a comprehensive and coordinated Federal program of research and development, the purpose of which is to improve the Agency's scientific capabilities to assess, detect and evaluate effects on, and risk to, human health from hazardous substances.

An integrated research program, involving the health effects and scientific assessment offices, will develop data and procedures to fill information and assessment gaps which exist in the various phases of the Superfund public health evaluation process. The health evaluation process includes the assessment of toxicity, exposure and dose assessment and risk characterization. This program will develop: test methods needed to evaluate the hazard potential of waste mixtures; screening techniques for early detection of adverse health effects; and improved measurement of health endpoints particularly non-cancer endpoints such as reproductive effects and neurotoxicity. Predictive techniques that can reduce the uncertainties in risk assessment caused by data limitations will be developed and data will be generated in response to specific requests from the Office of Emergency and Remedial Response. Three research themes will be emphasized: bioavailability/pharmacokinetics; interactions of compounds in chemical mixtures; non-cancer health effects.

The scientific assessment activity under this coordinated program will include research to provide data and methodologies for health risk assessment use throughout the removal and remedial processes for the program, regional and enforcement offices. Efforts will begin on research to understand risks posed to reproductive health resulting from exposure to chemical mixtures, on the development of methods for treatment of available exposure information, on the development

of pharmacokinetic models for the exposure assessment components of risk assessment, on development of a field guide to assist field personnel in the application of risk assessment methods, and on methods to better characterize the risks from chemical mixtures.

Health effects research will provide data and methods in a wide spectrum of health science disciplines to support hazardous substances detection and responses and site management processes. This research program has been jointly designed with the program office to include projects that have near-term, direct applicability to CERCLA waste site issues. In FY 1987, research will be initiated for rapid response toxicity testing of selected waste samples, evaluation of the efficacy of site cleanups which used hazardous waste incinerators by testing the toxicity of residues, development of dose measurement techniques for inhaled compounds to provide microdosimetric and microtoxicological evaluations in risk assessments, development of methodologies for predicting neurotoxic effects from interactions of complex mixtures, utilization of plant sentinel surveillance systems for detecting contaminated sites, and development and use of hemoglobin binding as a dose monitor for human exposure to carcinogens.

Field screening techniques for contaminants in soil, water, sediment and volatile organics in ground water will be developed to accommodate the increasing data requirements associated with RI/FSs. These techniques will allow a more focused, more complete, expedient and cost-effective field effort during remedial investigations. The major advantages include rapid turn-around times enabling cost-saving field decisions, analysis of a large number of samples in the field, ability to redirect and focus sampling efforts thereby increasing the accuracy of estimates of zones of contamination and shortening field schedules, and optimum selection of samples for off-site laboratory analyses.

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

### **Introduction**

Under the Clean Air Act, the Environmental Protection Agency (EPA) has three clearly defined regulatory responsibilities: (1) setting and revising National Ambient Air Quality Standards (NAAQS), (2) setting New Source Performance Standards to limit emissions of NAAQS pollutants, and (3) setting National Emission Standards for Hazardous Air Pollutants, compounds not regulated as NAAQS pollutants but which present a danger to health.

Primary (health-based) and secondary (welfare-based) NAAQS are set to protect public health and welfare from major air pollutants emitted from both stationary and mobile sources. EPA has set NAAQS for six pollutants: ozone (O<sub>3</sub>), carbon monoxide (CO), particulate matter (PM), sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and lead (Pb). Standards for these "criteria" pollutants must be reviewed every five years and revised if necessary. Individual states are responsible for meeting NAAQS, which they attempt to do through the development of State Implementation Plans (SIPs).

In recent years, some additional environmental concerns have arisen. One of these involves threats to the global environment, such as hazards arising from stratospheric ozone depletion and pollution-induced changes in global climate. At the other end of the scale are microenvironments—homes, other buildings, vehicle interiors. Another major issue is radon and its potential for causing lung cancer. For some of these areas, EPA's responsibilities are limited to technical and public assistance. In other cases, research is necessary to ascertain the seriousness of the threat posed and to determine whether environmental regulation is an appropriate response.

EPA does not have specific regulatory authority over radioactive materials. The Agency is responsible for determining public exposure to radioactive materials and for other advisory and public assistance responsibilities associated with radioactive substances.

In support of the above responsibilities, the Office of Research and Development (ORD) provides health and ecological effects data bases, monitoring and modeling methods, risk assessments, emission reduction and mitigation

technologies, and the corresponding quality assurance and technical assistance to develop regulations. In addition, ORD assists states in developing SIPs by providing improved monitoring, modeling, and control technology as they become available.

Research performed through the Air and Radiation Research Committee is managed according to six research "issues." These issues focus on regulatory needs and cut across scientific disciplines and the pollutant-specific structure of the regulatory program. The following discussion of ORD's major accomplishments and program outlook is organized accordingly.

### **Major Research Issues**

**ISSUE: Provide Scientific Support to Develop and Review Primary and Secondary NAAQS**

#### ***1986 Program Accomplishments***

Technical analyses were provided to the Office of Air Quality Planning and Standards (OAQPS) in support of their review of the NAAQS for NO<sub>x</sub>, CO, SO<sub>2</sub> and PM. Comments from the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board were addressed in a second External Review Draft (ERD) of the Air Quality Criteria Document (AQCD) for ozone. This ERD was completed in November 1985. A follow-up CASAC meeting was held in March of 1986 and a final AQCD was completed in September 1986. An addendum for the lead AQCD was prepared to consider blood lead-blood pressure relations. A CASAC meeting was held in March 1986. A final addendum was completed in June of 1986.

Under the new requirements for measuring particulate matter less than or equal to 10 micrometers in size (PM-10), studies are being conducted to develop an appropriate Federal Reference Method (FRM). As part of this effort, a study was conducted in Phoenix, Arizona, to compare the precision and accuracy of two instruments for measuring PM-10. Although the data from this study have not been completely evaluated, preliminary examination indicates that measurement discrepancies result from inlet soiling and the passing of large particles through

the instrument. Vendors have tentatively agreed with these observations and are attempting to correct the problems.

In 1985, ORD developed a method for measuring ambient concentrations of non-methane organic compounds (NMOC) using cryogenic preconcentration. The method was successfully employed in multisite field monitoring projects during the summers of 1984 and 1985. A third field monitoring project using the NMOC method was initiated in the summer of 1986. These field studies were carried out for OAQPS to obtain data needed by that office before considering revisions to the ozone standards. Approximately 20 cities were monitored in each test. Refinements to the monitoring methods have resulted from each of the first two field tests.

As a result of documented visibility degradation in the Western United States, ORD undertook to develop methods to measure the visibility decrease and to identify sources of such impairment. This was accomplished in 1986. In addition, efforts began to implement a similar measurement and identification network for the Eastern United States.

Quality assurance was provided for air programs in an effort to ensure that measurement data are of known accuracy and precision. A report published in 1986 indicated that improvements have occurred in the precision and accuracy of monitoring data obtained in regional and national measurements.

Investigators in the Clinical Research Branch of ORD's Health Effects Research Laboratory demonstrated significant increases in the permeability of the respiratory epithelium in normal volunteers following acute inhalation exposure to ozone. This permeability increase is greatest in those individuals having the largest pulmonary function responses. There is also evidence that the epithelial changes may be associated with local inflammation. To determine if this inflammation arises from acute ozone exposure, additional studies were begun using pulmonary cellular elements derived from the lungs of volunteers by bronchoalveolar lavage. Investigators at UCLA, in collaboration with EPA, studied the respiratory effects of long-term oxidant exposure to determine the association between the chronic effects and the magnitude of acute effects of a single O<sub>3</sub> exposure.

Studies were completed which describe the amount of ozone removed in the nasal passages and in the lungs of individuals while they breathe ozone. These studies provided information which is important for the determination of the dose of ozone reaching target tissues in the lungs and for risk assessment analysis in humans.

Significant increases in airway resistance occurred in a group of moderately exercising

asthmatics exposed to 0.3 ppm NO<sub>2</sub>. This finding is valuable to Agency regulators who must either set a short-term standard for NO<sub>2</sub> or determine unequivocally that no such standard is needed.

Substantial progress was made in a wide-ranging study of the chronic effects of long-term exposure to NO<sub>2</sub> and O<sub>3</sub>. One-week, three-week, and three-month exposure regimens were completed and the data are being analyzed. Additional animals are being exposed for 12 and 18 months. The study focuses on the ability of oxidant gases to cause chronic lung disease, as reflected by biochemical, structural and functional changes in the lung.

Studies of natural killer (NK) cells and interferon were developed in 1986. These studies will be valuable in determining the role of NK cells in pulmonary immunology. Further, an animal viral infectivity model was developed that is more analogous to viral infections in man than are conventional bacterial infectivity models. The former model was used to study the effects of O<sub>3</sub> exposure on host defenses. The oxidant dosimetry program produced a refined model for the uptake of ozone in the lungs of animals, thereby improving dosimetry comparisons for the ozone risk assessment to be conducted in 1987.

Two clinical studies of SO<sub>2</sub> were completed. The first study described the concentration-response range of mildly asthmatic volunteers exposed to SO<sub>2</sub> concentrations between 0.25 and 1.0 ppm. Some asthmatics experienced bronchoconstriction at SO<sub>2</sub> levels as low as 0.25 ppm. At 0.75 ppm SO<sub>2</sub>, 50% of the subjects tested had a doubling of airway resistance. This finding can be important in evaluating the margin of safety provided by current SO<sub>2</sub> standards. Another clinical study showed that exposure to a mixture of SO<sub>2</sub> and sulfuric acid mist did not affect mild asthmatics more than exposure to either chemical alone.

The basis for the Agency's position on PM-10 was significantly strengthened by simulations that examined the influence of breathing route and of activity levels (from normal respiration to heavy exercise) on particle deposition in human lungs.

The journal, *Science*, accepted a paper which summarizes current epidemiological, chemical, and toxicologic evidence relating to lung cancer etiology in Xuan Wei, Peoples Republic of China. The toxicologic and chemical evidence is consistent with the epidemiologic hypothesis that indoor smoky coal burning is the prime determinant of lung cancer in Xuan Wei, especially in women. In other epidemiological studies, a series of papers were published in peer-reviewed journals. These studies help elucidate the effects of NO<sub>2</sub>, particles, ozone, and passive smoking on lung function, growth, and respiratory symptoms. Results from the studies of NO<sub>2</sub> and ozone show effects at low

levels and will be included in the criteria documents and OAQPS Staff Papers on these pollutants.

A study of lead neurotoxicity in children aged three to seven years indicated that within the range of 6.3-47.4 milligrams per deciliter of blood there was a significant negative relationship between blood lead level and Stanford-Binet IQ, a measure of cognitive function. The IQ decreased linearly as blood lead increased. An analysis of audiometric data from the second National Health and Nutrition Examination Survey (NHANES-II) was initiated to investigate the relationship of blood lead levels and hearing thresholds. Results indicated that the probability of hearing threshold changes increases significantly with increasing blood lead levels at the frequencies tested (0.5, 1.2, and 4.0KHz). A study of the neurophysiological effects of lead exposure in monkeys was also completed and an article summarizing the findings was accepted for publication. This study, which is part of a larger investigation of the effects of perinatal lead exposure, indicated prenatal or postnatal exposure to lead resulted in abnormal neurophysiological processing of complex auditory stimuli. Electrophysiological recordings from specific auditory areas of the brain showed that lead-exposed monkeys discriminated between different sets of auditory stimuli in an abnormal and immature fashion.

Analysis of the O<sub>3</sub> data taken by the National Crop Loss Assessment Network (NCLAN) showed that substantial dollar losses could be attributed to O<sub>3</sub> damage. In that analysis, water stress during O<sub>3</sub> exposure appeared to influence the results. Field studies were initiated in an attempt to quantify the effects of water stress. When completed, the revised dose response data will be used to assess the need to revise the secondary O<sub>3</sub> standard. Also in 1986, planning was completed for the International Conference on Assessment of Crop Loss from Air Pollutants. This conference, to be held in 1987, will include full reports on the NCLAN research.

As part of a continuing effort to determine the causes of visibility degradation, a new method for measuring light extinction was developed which avoids the sight-path problems of a simple teleradiometer. One study addressed haze trends over Eastern North America during the 1978-1982 mini-recession and concluded that improved visibility and a slight reduction in sulfur emissions were found in the Northeast in the summer season. Substantial increases of sulfur emissions were noted in the Southeast, with no evidence of improved visibility. A semi-empirical approach was developed for selecting chemical and physical rate parameters to be used in a Monte Carlo regional air quality model to estimate source-receptor

relationships. This approach is unique on a regional scale and can be applied to estimate best fit rate constants for the simulation of sulfur transport, transformation, and removal.

Research on the effects of air pollution on galvanized steel showed that the corrosion of zinc results completely from deposited sulfur dioxide. It was also shown that particle deposition accelerates the corrosion of zinc.

### *1987 Program Outlook*

The research program on NAAQS pollutants will remain similar in 1987. Research on the health effects of carbon monoxide and lead will be de-emphasized as the focus shifts toward ascertaining the respiratory, immunologic, and metabolic effects of long-term and peak exposures to oxidants, particularly NO<sub>2</sub>. Also, in anticipation of the need to study the effects of ozone on major deciduous and coniferous forests, work will begin on establishing a laboratory population of suitable trees for future study.

### **ISSUE: Provide Scientific Support to Develop NSPS and SIPs**

#### *1986 Program Accomplishments*

Two promising procedures for sampling source emissions of PM-10 were field-tested. One method involves the use of a modified Hi-Vol sampler with a size selective inlet. The other uses a modified dichotomous sampler. Further testing, evaluation, and refinement are in progress. One of these methods will be chosen as the standard, based on its performance during the evaluations. In a related area, ORD began fabrication of two sampling trains, for use by OAQPS, regions, and states.

Quality assurance was provided to OAR, regions, other ORD laboratories, the World Meteorological Organization, and the World Health Organization on projects supporting development of NSPS and SIPs.

Under the National Audit Program, audits were conducted for seven EPA source reference methods. These were: CO, CO<sub>2</sub>, O<sub>2</sub>, Gas Meter Calibration, SO<sub>2</sub>, NO<sub>x</sub>, and Coal Sulfur and BTU content. This program supports development of EPA regulations and assists regions in determining stack emissions for SIPs.

Two manuals, *An Operation and Maintenance Manual for Fabric Filters* and *Operation and Maintenance Manual for Electrostatic Precipitators*, were completed and distributed to regional and state personnel involved in inspection and permitting of particulate control systems for electric utility coal-fired boilers. An interactive computer model for electrostatic precipitators was developed which allows prediction of electrical operating conditions and particle collection efficiency for any

arrangement of round wire discharge electrodes. A series of source category reports was completed on major sources of PM-10 emissions. These reports contain PM-10 emission factors needed by the states to develop SIPs. The *Sixth Symposium on the Transfer and Utilization of Particulate Control Technology* was held jointly with the Electric Power Research Institute to transfer information and program results to users and other interested parties.

A major achievement in flue gas desulfurization (FGD) research was the development of improved calcium sorbents for low-cost retrofit SO<sub>2</sub> control. Up to 95% SO<sub>2</sub> removal has been achieved in a 50 cfm pilot plant using duct injection of dry sorbent in a humidified flue gas followed by a fabric filter. A Lime/Limestone Flue Gas Desulfurization Inspection and Performance Evaluation Manual was published for use by regional and state personnel involved in inspection and permitting of FGD systems for electric utility coal-fired boilers.

The Office of Air and Radiation currently has two NSPS for industrial boilers in the formal rule-making process—both under court-ordered schedules. Both the NSPS for PM/NO<sub>x</sub> and for SO<sub>2</sub> are scheduled for promulgation in early 1987. For the past year, ORD worked with regulators to review and acquire NO<sub>x</sub> emission test data in an attempt to establish the proposed emission standard based on low-NO<sub>x</sub> burners. However, insufficient low-NO<sub>x</sub> burner test data were available to meet the maximum criteria for standard setting. ORD helped regulators develop an SO<sub>2</sub> standard that is flexible enough to permit the use of "developing technologies" as alternatives to scrubbers. The proposed SO<sub>2</sub> standard includes a "window" for these technologies through a 50% removal and 0.6 lb/10<sup>6</sup> Btu emission limit criterion. This window is an alternative in the proposed SO<sub>2</sub> standard for "developing" technologies to the 90% removal and 1.2 lb/10<sup>6</sup> Btu emission limit based on scrubbers.

Industrial flares are demonstrated to be effective in controlling emissions of volatile organic compounds (VOCs). Source data were developed on the effect of pilot flames on the performance of flares. A technical paper summarizing this data was published in *Combustion Science and Technology*.

An improved mechanism was developed to quantify the atmospheric formation of ozone from its precursors (hydrocarbons and NO<sub>x</sub>). This mechanism will afford increased accuracy in air quality simulation models. The first generation regional oxidant model was evaluated and improvements are being made. When completed, this model will be used to evaluate the impact of various control strategies on ozone air quality for both episodic (one hour to two days) and long-term

(seasonal to annual) concentrations, in support of primary ozone standards.

In support of the proposed inhalable particulate air quality standard, the Regional Lagrangian Model of Air Pollution (RELAP) was completed. RELAP simulates ambient concentrations and wet and dry deposition of sulfur dioxide, sulfates, and fine and coarse particles over the eastern U.S. and southeastern Canada. A user's guide for the second pollution episodic model (PEM-2) was completed. Results of an evaluation of the PEM-2, an urban scale particulate model, showed that background concentrations of particles contribute significantly to urban particulate pollution. Sulfate sources in Philadelphia were apportioned using mathematical and statistical methods.

A comparison of air quality dispersion models and receptor models using urban data sets also demonstrated high background pollutant contributions to urban concentrations. AROSOL, an urban scale aerosol model, was modified to include two modules for conversion of sulfate, thereby allowing AROSOL to be operated either as a lumped sulfate model or as a model which predicts the particle size and composition distributions. In order to improve model accuracy, fugitive emission factors were developed for use with urban and mesoscale particulate models.

Version Six of the User's Network for Applied Modeling of Air Pollution (UNAMAP) program was disseminated to the user community. UNAMAP is a collection of models and data bases on magnetic tape which is made available to the user community through the National Technical Information Service.

Version One of the Meteorological Processor for Diffusion Analysis (MPDA-1) was completed, resulting in a format easily used by air quality dispersion models. An adjustable buoyancy balloon tracer of atmospheric motion (Phase III) was improved. The tracer was developed to evaluate the accuracy of air pollution transport models and has application throughout the atmospheric sciences. A complex terrain workshop was held to review the preliminary version of the SO<sub>2</sub> Complex Terrain Dispersion Model. Several recommendations emerged from the workshop which will be incorporated in future versions of the model.

### 1987 Program Outlook

The goals for this area remain the same for 1987. A major area of emphasis will be research which focuses on the interrelationship between volatile organic compounds (VOCs) and air toxic controls. In addition, remote monitoring systems will be developed, evaluated and applied in areas in which data are needed for SIP evaluation or revisions and for Agency evaluation of the need for new



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standards. In the area of modeling research, ORD expects to complete smog chamber studies of ozone, supporting the development of urban and regional scale ozone air quality models. In addition, a user's guide for an evaluated complex terrain model for stable plume impingement on elevated terrain will be completed.

## **ISSUE: Provide Scientific Support to Develop Regulations for Hazardous Air Pollutants (HAPs)**

### ***1986 Program Accomplishments***

Final comprehensive Health Assessment Documents (HADs) for asbestos and nickel were delivered to OAQPS. External review drafts on beryllium, acetaldehyde and dibenzofurans were released to the public for comment. An addendum was issued to OAQPS on perchloroethylene, and assessments were prepared on gasoline and benzene vapors.

Tier I Health Effects Summaries were prepared for 12 compounds. They are: propylene oxide, phenol, styrene, naphthalene, ammonia, chlorine, zinc/zinc oxide, methyl and toluene isocyanates, xylene, propylene, copper, and mineral fibers. These documents summarize available scientific literature on the health effects of a compound. If a chemical is considered for regulation as a result of evidence presented in a Tier I document, ORD will proceed with the preparation of a comprehensive HAD.

Advanced ambient measurement techniques were investigated, such as combined mass spectrometry, gas chromatography/Fourier transform infrared spectrometry, supercritical fluid chromatography, tunable atomic line mass spectrometry and cryogenic concentration. To improve surveillance and control of industrial sources, techniques such as capillary column chromatography, selective detectors, and portable monitors were investigated. One promising technique involves the use of specially prepared stainless steel canisters to inhibit reactions with pollutants collected. Canister use obviates many of the problems encountered in using solid sorbents, such as Tenax, for sample collection. Canisters have been successfully used in several field projects and the technique will be further explored.

Monitoring for VOCs through the Toxic Air Monitoring System (TAMS) continued throughout the year at Houston, Boston, and Chicago. Validated TAMS data have been supplied to OAQPS and incorporated into their interim air toxics data base. A second monitoring location in each of the above three cities has been selected and monitoring equipment is being installed.

An earlier study which used the Total Exposure Assessment Methodology (TEAM) to measure personal exposures and breath concentrations of VOCs generated data from 600 individuals. The data were partially analyzed in 1986. Indoor and in-vehicle sources were found to be much more important than outdoor sources, even in the extremely concentrated petrochemical refinery areas of northern New Jersey and Los Angeles. The major source of exposure to benzene and styrene was cigarette smoking. Chloroform exposure was primarily due to shower use. Room air deodorizers and moth crystals were the major sources of exposure to para-dichlorobenzene. Exposure to tetrachloroethylene comes mainly from dry-cleaned clothes. Presentation of the results at the annual meeting of the American Chemical Society (Chicago, September 1985) was reported nationwide by the Associated Press and the nationally televised NBC Today Show. An analysis of the risks of organic chemicals in the home was presented at the annual meeting of the Air Pollution Control Association in Minneapolis (June 1986). The carcinogenic risks to these unregulated air pollutants exceeded the risks associated with the regulated hazardous air pollutants by factors of 10-100.

The Total Human Exposure Research Council (THERC) was formed to enhance communication on research projects concerning human exposures to chemicals, including hazardous air pollutants. An important objective of THERC is to develop a strategic, five-year plan for all research on human exposure methodology and assessments conducted by the Agency. As a first step toward this goal, a paper was published which summarizes total human exposure concepts, and a second paper was published which reviews the Agency's research program on total human exposure to environmental pollution.

An Interdivisional Air Toxics Study (IATS) was initiated to study the health effects of inhaled HAPs. Compounds under study were selected based on high production and potential human exposure. As part of this effort, studies of p-xylene, toluene, and phosgene exposures were completed. The results of one of these studies showed a concentration-related response of saccharine aversion to p-xylene in rats, indicating a neurobehavioral response which warrants further investigation.

Important advances were made in developing and validating test methods to determine the neurotoxic potential of HAPs. In particular, studies using discrete lesions in the visual cortex are beginning to elucidate the relationships between neural structures in the visual system and individual components of the flash-evoked potential, which is

commonly used to measure neurotoxicity. The findings of these studies will provide for a better understanding of the neurological basis for neurotoxicity of HAP compounds. Another significant advance in test method development was provided by studies to evaluate nervous system specific proteins (NSSP) as biochemical markers for neurotoxicity. A variety of NSSPs (synapsin I, GFAP, P-38, b-tubulin and N-200) have been shown to respond to prototype neurotoxins in a manner which is consistent with the accompanying cytopathology, thus indicating that NSSPs can be used as biochemical indicators of neurotoxicity.

A study to evaluate the visual function effects of the industrial solvent, sulfolane, was completed and submitted for publication. The results indicated that high dosages were required to produce effects, thereby indicating that the visual system is not particularly sensitive to this compound. These data are in contrast to previous work which has shown that neurotoxic effects such as increased susceptibility to seizures are produced by lower dosage of sulfolane.

More cost effective and better predictive indicators of reproductive dysfunction are being developed to evaluate potential HAPs. A series of papers was published in peer-reviewed journals dealing with reproductive effects of manganese in rats. The results indicated a delay in sexual development in males with no apparent long-term reproductive impact. An evaluation of age dependent gastrointestinal adsorption of  $Mn_3O_4$ , which is a combustion product of the fuel additive methylcyclopentadienyl manganese tricarbonyl (MMT), was conducted to evaluate the fate of inhaled particles translocated to the gut. Results indicate higher absorption and retention in young (pnewanling) rats than in adults, resulting in greater exposure for younger animals and an increased possibility of toxicity.

Two woodstove emission samples showed a dose-related tumorigenic response in the Sencar Mouse Skin Tumor Initiation/Promotion Assay. These two samples are from an airtight woodstove burning oak or a softwood mixture. This finding is particularly important in light of EPA's recent move to regulate woodstove emissions.

A preliminary study of seven potential ethylene oxide control technology concepts for hospital sterilizers was completed. Acid hydrolysis, low temperature catalytic oxidation, and adsorption were selected for follow-up laboratory and field investigation. Laboratory testing and field evaluations will be initiated in December 1986 to define the control capabilities of the three techniques.

A report entitled "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 emission. The report was distributed to OAQPS, all regional offices, and numerous state and local agencies.

Two wood stove emission control technologies are under study: existing catalytic secondary combustors and advanced non-catalytic secondary combustion. The catalytic work is focused on two projects, both of which will be used to determine the degradation in emission control performance over time. Final results will be published following the 1986-87 heating season. The advanced non-catalytic secondary combustion development work is focusing on the use of a small secondary heat source to maintain a stable secondary flame at the low, smoldering burn rates commonly encountered in wood stoves. Lab tests on experimental units of both types retrofitted into an existing stove show that this technique is capable of reducing carbon monoxide and total hydrocarbons by more than 95% compared to this stove's normal emission level.

In 1986, ORD conducted a workshop to foster EPA and industry communication. Partially as a result of this workshop, Prevention Reference Manuals are being developed which will cover how to evaluate processes and facilities for accidental release potential, detailed descriptions of pertinent controls (prevention, protection, and mitigation), and specific evaluations for individual chemicals.

Smog chamber studies can simulate a variety of atmospheric conditions and can provide information that can be used to predict atmospheric lifetimes and daughter products. In 1986, such photochemistry studies were conducted on several candidate HAPs, including acrolein, a compound currently undergoing regulatory assessment.

A study was completed on the mutagenic activity of wood smoke emissions under typical atmospheric conditions. This study indicated that the mutagenicity of wood smoke emissions was enhanced under conditions simulating sunlight.

The results of a field measurements program on HAPs were published. This report summarizes the atmospheric concentrations of a variety of HAPs observed in selected U.S. cities.

## **Integrated Air Cancer Program**

Data collected during 1985/86 sampling in Raleigh, N.C. and Albuquerque, N.M. were analyzed. Two manuscripts were reviewed and submitted for publication. One of these describes effective techniques for measuring the mutagenic activities of gas and particulate-phase photo-oxidation products from wood smoke. The other evaluates the effectiveness of specially coated

silica gel cartridges for sampling aldehydes and ketones in the air. Bioassay data were used in the source receptor modeling analysis for the first time. Results from the Albuquerque site show that an average of 50% of the ambient particulate mutagenicity was from wood stoves and 50% from automobiles.

### ***1987 Program Outlook***

Hazardous air pollutants are an agency priority for 1987 and 1988. Several areas will be experiencing growth. One of these is total human exposure monitoring. Efforts will be made to adapt the Total Exposure Assessment Methodology to meet the requirements of the Agency's Air Toxics Strategy. Ambient and source measurement methods will be improved to provide accurate data for use in characterizing source emissions and ambient concentrations of HAPs.

Another growth area is municipal waste research. Health effects studies will be initiated in an effort to determine the risks associated with emissions from municipal waste incinerators. Research will also be initiated to develop efficient, cost-effective ways to eliminate or control hazardous emissions from municipal waste combustors.

The issue of accidental releases will be addressed in several ways. A study of hazard identification and evaluation techniques will begin as will preparation of reference manuals for key hazardous chemicals. Technical support will be provided to regions and states to assist in preventing such releases or reducing the hazards once such a release has occurred.

## **ISSUE: Provide Scientific Support to the Mobile Source Regulatory Program**

### ***1986 Program Accomplishments***

As recommended by EPA's Science Advisory Board, validation of the Simulation of Human Air Pollutant Exposure (SHAPE) and the NAAQS Exposure Model (NEM) began, using field data collected during the Denver-Washington, D.C., carbon monoxide exposure study. These models predict human exposure frequency distributions by modeling human activity patterns and the concentrations associated with particular microenvironments. A paper was completed providing preliminary information on the field performance of SHAPE and its validation using the Denver data base. Additional analyses of the Denver data base were conducted to determine the relationship between fixed monitoring stations and microenvironmental CO concentrations. Additional

analyses were completed which related CO exposure profiles to estimated carboxyhemoglobin levels and measurements of CO in the breath of subjects. A model for calculating the CO concentrations in the passenger compartment of motor vehicles moving in traffic was tested using the field data from the Washington, D.C., microenvironment study. A field study was conducted in Honolulu to measure CO exposures while people engage in activities such as automobile and bus commuting, jogging, shopping, eating in restaurants, and office work. The findings suggest that human exposure to motor vehicle exhaust in some microenvironments can be a problem even in Hawaii, which otherwise has relatively clean ambient air.

Exposure to carbon monoxide elevates levels of carboxyhemoglobin (COHb) in the blood. COHb, therefore, is a good indicator of CO dose level. In 1986, a study was completed which showed that an effects threshold for COHb apparently exists and lies between the 4%, and 6% COHb levels. This conclusion was drawn because the investigators were unable to detect significant physiological or symptomatic changes in patients with ischemic heart disease when exposed to CO sufficient to cause COHb levels of 4% but symptoms were significantly increased when the COHb was 6%. Another study of CO toxicity was completed in 1986 which showed that CO exposure diminishes hand-eye coordination. These findings are important for evaluating whether the margin of safety provided by the current CO standard is adequate.

A major study was completed on the impact of methanol fuels on evaporative emissions from a car fueled with 85/15 unleaded gasoline/methanol. Although the data are still being analyzed, the results are expected to have an impact on decisions about the feasibility of methanol as a popular-use vehicle fuel.

Research was conducted to characterize organic emissions from motor vehicles operated at reduced ambient temperatures. The results showed that formaldehyde emissions did not increase in gasoline or methanol fueled cars running at idle. It is hypothesized, however, that further studies, under actual operating conditions, will show increased formaldehyde levels as temperatures drop.

### ***1987 Program Outlook***

The overall approach will remain the same, particularly in the area of exposure monitoring. A new research effort will be undertaken, initially through the Health Effects Institute, to determine the health effects of aldehydes, especially

formaldehyde, from motor vehicles. In 1988, this effort will be expanded to include an in-house component. In addition, research will be conducted to determine the emission rates of hydrocarbons from gasoline during vehicle refueling. Studies will also be done to characterize the emissions from diesel powered vehicles equipped with advanced emission control technologies.

**ISSUE: Provide the Scientific Data to Determine the Impact of the Quality of Global and Microenvironments on Public Health and the Environment**

***1986 Program Accomplishments***

**Integrated Indoor Air Research Program**

EPA has taken a second look at its indoor air research program and has initiated several changes as a result. ORD and the Office of Air and Radiation are working closely to develop a long-range plan for indoor air. OAR established a new indoor air policy staff to assist in guiding indoor air research and decision-making. A review of EPA's plans for the indoor air research program was conducted by the Science Advisory Board (SAB). The results of this review will be available in early 1987 and will be used to guide the program in the future. The SAB was also asked to review ongoing efforts in indoor air research and their comments were highly favorable. Major program accomplishments are highlighted below.

Work was begun on an extensive bibliography of the world literature on indoor air and total human exposure, emphasizing concentrations measured in indoor microenvironments. The bibliography will be completed in 1987. EPA also developed the computerized Bibliographic Literature Information System (BLIS) to search and retrieve abstracts of the indoor air quality literature rapidly using an IBM personal computer. EPA sponsored or participated in technical meetings to advance knowledge and understanding of indoor air quality problems.

In conjunction with the federal interagency Committee on Indoor Air Quality (CIAQ), a statistical design was developed for a nationwide field survey of concentrations of volatile organic compounds (VOCs) and combustion products in homes. Although the design was completed, implementation of the nationwide field survey was not performed, and a smaller-scale pilot survey was designed as an initial step to test hypotheses and to evaluate, develop, and refine measurement methodologies and instruments.

Protocols were prepared for a chamber study designed to replicate and extend earlier findings regarding the neurobehavioral and pulmonary

physiology effects of inhaling VOCs. Additional research on neurobehavioral effects of VOCs was begun in several areas including: (1) development of a portable olfactometer, (2) study of the possibility of trigeminal sensitivity in Sick Building Syndrome responders, and (3) development of a neurobehavioral test battery for use in evaluating children.

The exposure portion of a clinical study of children with parents who smoke was completed, as were analyses of nicotine in indoor air, blood and urine cotinine, air and urine mutagenicity, COHb, particulates, and organics. A pilot field study was initiated which examines the levels of nicotine in children of smoking parents and evaluates indoor levels of nicotine and other pollutants in the homes where the children live. A second pilot field study was completed of the mutagenicity of emissions from several in-home combustion sources, including convective and radiant kerosene heaters, gas stoves, fireplaces, and cigarettes. The data are being analyzed and will be published within one year.

Preliminary studies of organic compound emissions from kerosene space heaters were completed in 1986. Measurements were made of products of incomplete combustion, and bacterial mutagenesis bioassays were conducted on emission samples. The results suggested that emissions of carcinogens may be significant for certain heater types under specific operating conditions.

Laboratory studies of organic vapor emission rates from selected indoor building materials and consumer products were conducted and reported in 1986. Sources studied include a floor adhesive, caulking compound, particle board, acrylic floor wax, moth crystals, and paints. Interlaboratory comparisons of formaldehyde emissions were conducted as part of a long-term effort to standardize emission testing procedures. Several papers on testing procedures and results were presented and published.

A prototype version of a computerized data base on sources of indoor air pollutants was developed and distributed for review by a small group of indoor air quality researchers and the regulatory office in 1986. A revised version will be distributed for general use in 1987.

**Radon Mitigation**

Field testing to develop and demonstrate low-cost techniques for reducing radon concentrations in homes was continued. Some of the radon-reducing techniques being tested are: various natural and forced ventilation methods, air pressure equalizing methods, drain-tile suction, block-tile suction, block-wall ventilation, and sub-slab suction. The

techniques selected for testing in each home vary according to type of house, foundation, local geology and meteorology, and other factors. Through 1986, 30 homes in eastern Pennsylvania and 10 homes in Clinton, New Jersey have had radon reduction techniques installed. Reductions in most homes have ranged from 90% to 99+%. Based largely on the experience in eastern Pennsylvania, a brochure for homeowners and a technical manual for installers of radon mitigation techniques were issued in August 1986. These will be updated in 1987, based largely on results from ongoing field projects in Pennsylvania, New Jersey, and New York. A Radon Mitigation Test Matrix was developed and is being refined to better define the size of the future program needed to recommend mitigation methods for all housing types on a national basis. Initial estimates show a need to perform mitigation studies on about 600 existing houses and 100 new houses to meet this objective. The Radon Mitigation Demonstration Program is being rapidly expanded to meet these objectives within a reasonable timeframe.

#### **Stratospheric Modification**

Initiation of studies on control technology and strategies for controlling ozone depleting substances resulted in identification of sources for which additional studies need to be conducted. National and international workshops were held on control strategies for stratospheric modification. A workshop was also held specifically on N<sub>2</sub>O emissions from combustion. This workshop helped to define analytical approaches for measurement of N<sub>2</sub>O and examined the relative strength of various emission source sectors. The available data indicate that stationary combustion sources are the major contributors of N<sub>2</sub>O emissions. Existing information has been summarized and evaluated and will be incorporated into the information provided to the EPA Administrator for use in decision-making.

#### **1987 Program Outlook**

The immediate priority for the indoor air program is to complete a research needs assessment. A preliminary plan for this assessment was presented to the SAB in September 1986 as the cornerstone for ORD's long-term strategy for studying the problems associated with indoor air pollutants. As this study progresses, research will also continue on developing improved monitoring and measurement methods, characterizing source emissions, developing control technologies, and assessing the health effects from VOCs and indoor combustion products.

The level of effort in the radon mitigation program will remain stable. Stratospheric

modification research will be increased, to include a new research effort to ascertain the extent to which changes in global climate may be due to man-made pollutants. Interim results are also expected from studies of the biological effects of increased UV-B radiation resulting from reduction of stratospheric ozone.

#### **ISSUE: Provide Monitoring Support for the Department of Energy Off-Site Monitoring Program**

##### ***1986 Program Accomplishments***

Each year, ORD provides technical assistance to the Department of Energy in the form of radiation safety monitoring, long-term hydrological monitoring, a human surveillance investigation program, and maintenance of a radiation data base. ORD also provides radiochemical analyses of environmental samples for regions, states, and contractor laboratories. Support to both of these activities continued in 1986 with a stable level of effort.

##### ***1987 Program Outlook***

No changes are expected in this program in 1987.

#### **FY 1986 Deliverables**

##### **ISSUE: National Ambient Air Quality Standards**

- Air Quality Criteria Document on Ozone and Other Photochemical Oxidants (9/15/86)
- Air Quality Criteria Document for Lead (6/30/86)
- Proceedings of an International Symposium on Aerosols (8/28/86)
- Report on Externalization of Methods to Model Visibility Degradation (5/12/86)
- Comparison of Precision and Accuracy Data from SLAMS and the National Audit Program in CY-83 (12/31/85)
- Annual Report on the CY-84 Ambient Air Audit Program (12/31/85)
- Annual Report on the CY-84 National Audit Program (12/31/85)
- Annual Report on the QA Program for the SLAMS Network: CY-83 (12/31/85)
- Report on Audits of Laboratories Making Source Measurements (12/12/85)

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- Journal Article on Changes in Pulmonary Epithelial Permeability in Man (8/25/86)
  - Journal Article on Sensitivity of Neonatal Versus Adult Rats to Ozone and Nitrogen Dioxide (9/30/86)
  - Model of the Regional Uptake of Gaseous Pollutants in the Lung (7/25/86)
  - Journal Articles on Effects of Air Pollution on Symptoms, Lung Function and Lung Function Growth of Children (6/24/86)
  - Journal Articles on Dose Effects Function of CO on Compensatory Tracking (9/26/86)
  - Journal Articles on the Influence of Breathing Mode and Activity Level on the Regional Deposition of Particles in Man (2/28/86)
  - Task Force on Environmental Cancer and Heart and Lung Disease (8/27/86)
  - NAS Study of the Feasibility of Conducting Epidemiologic Research on the Criteria Air Pollutants (12/31/85)
  - Project Report on the Health Effects Institute Cooperative Agreement (9/30/86)
  - Article on Semi-Empirical Evaluation of Regional Scale Source-Receptor Relationships (2/28/86)
  - Article on Recommended Parameters for Use in Regional Visibility Models (11/27/85)
  - Article on Visibility Improvements Due to a Decrease in SO<sub>2</sub> Emissions During the 1981-82 Mini-Recession (9/30/86)
  - Final Report on Field Verification of Wind Screen Model for Storage Piles (7/31/86)
  - Mathematical Modeling of Single Droplet Trajectories in Combustor Flow-Field-FCR Task 1 Draft Final Report (9/29/86)
  - Report on Evaluation of OH Reaction Rate Protocol for Determining Reactivity of Organic Compounds (9/29/86)
  - Report on Numerical Simulations of Photochemical Air Pollution in the NE United States (6/27/86)
  - Report on Development and Evaluation of an Improved CBM Mechanism for Urban and Regional Modeling (1/15/86)
  - Report on EPA Regional Oxidant Model: ROM-1 Evaluation for 3-4 August 1979 (5/21/86)
  - User's Guide for Interim (Linear) Regional Particulate Matter Model (2/14/86)
  - Report on First Cross Appalachian Tracer Experiment (CAPTEX) on Long Range Transport of Air Pollutants (4/10/86)
  - Report on CDM 2.0 (Climatological Dispersion Model) User's Guide (11/12/85)
  - Develop and Distribute UNAMAP Version 6 (9/2/86)
  - User's Guide: A Multiple Source Gaussian Dispersion Algorithm Using On-site Turbulence Data (1/27/86)
  - Report on Pollution Episodic Model (PEM) Evaluation Against Philadelphia Data Base (2/10/86)

#### ISSUE: New Source Performance Standards and State Implementation Plans

- Status Report on Amendment to 40 CFR Parts 50 and 53 with Respect to PM<sub>10</sub> (6/25/86)
- Final Report on Pilot Scale Cement Kiln Test to Evaluate Applications of NO<sub>x</sub> Control Combustion Modification (12/26/85)
- Interim Report on VOC Destruction Efficiency of Industrial Flares (8/27/86)
- Final Report on Evaluation of a Selective Catalytic Reduction System of NO<sub>x</sub> Control on a Stationary Diesel Engine (1/31/86)
- Final Report on Application of Reburning on Gas- and Oil-fired Package Boilers (10/31/85)
- Report on Local and Regional Contribution to Urban Particulate Matter (7/31/86)
- Report on the Incorporation of SO<sub>2</sub> Photochemical Oxidation Model into AROSOL (7/23/86)
- Report on Air Parcel Marker System. Phase III—System Testing (5/20/86)
- MDPA-1: A Meteorological Processor for Diffusion Analysis User's Guide (1/29/86)
- Report on EPA Complex Terrain Modeling Workshop (8/15/86)
- Final Health Assessment Document for Nickel (9/15/86)

#### ISSUE: Hazardous Air Pollutants

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- Final Health Assessment Document for Beryllium (4/1/86)
  - Tier I Health Effects Summary for Hydrogen Sulfide (6/30/86)
  - Tier I Health Effects Summary for Chlorine (4/30/86)
  - Tier I Health Effects Summary for Zinc Oxide (3/15/86)
  - Tier I Health Effects Summary for Styrene (3/7/86)
  - Tier I Health Effects Summary for Phenol (2/18/86)
  - Tier I Health Effects Summary for Ammonia (4/30/86)
  - Tier I Health Effects Summary for Propylene (4/29/86)
  - Tier I Health Effects Summary for Methyl Isocyanate (7/31/86)
  - Tier I Health Effects Summary for Toluene Diisocyanate (4/15/86)
  - Tier I Health Effects Summary for Propylene Oxide (4/15/86)
  - Tier I Health Effects Summary for Xylene (7/31/86)
  - Tier I Health Effects Summary for Copper (7/30/86)
  - External Review Draft Health Assessment Document for Dibenzofurans (7/15/86)
  - External Review Draft Health Assessment Document for Hydrogen Sulfide (9/15/86)
  - Final Report on Woodstove/Fireplace Emissions (11/15/85)
  - Internal Report on Options for Externalizing the HAP QA Repository (5/15/86)
  - Journal Articles on Mutagenicity, Carcinogenicity and DNA Dosimetry of Polycyclic Organic Matter from Air (3/26/86)
  - Journal Articles on Metabolism, Mutagenicity, and Carcinogenicity of Selected PAHs and Nitro-PAHs Found in Air (9/30/86)
  - Report on the Effect of HAPs (Organic Vapors) on Lung Host Defenses in Animals (3/31/86)
  - Interim Report on Control Technology for Reduction of Hazardous/Toxic Emissions (6/2/86)
  - Draft Final Report on Effectiveness of Woodstove Combustion Chamber Modifications (9/29/86)
  - Complete Facility for Wood Stove Lab Certification Tests (9/29/86)
  - Complete a Detailed Plan for Phase II of the Radon Mitigation Research Plan (3/26/86)
  - Radon Reduction Approaches for Detached Houses: Technical Guidance (4/30/86)
  - Provide Engineering Evaluation and Technical Assistance to EPA for National and International Workshops (9/12/86)
  - Report on the Identification, Screening, and Measurement of HAP Concentrations in Ambient Air (9/30/86)
  - Report on Primary Photochemical Processes of Acrolein (12/24/85)
  - Draft Final Report on Residential Wood Combustion Emission Laboratory Measurements from Phase I IACP Field Study (12/20/85)
  - Report on Atmospheric Transformation of Emissions from Residential Combustion Under Winter-time Conditions (7/23/86)
- ISSUE: Mobile Source Pollutants**
- Report on New Fuels/Additives Registered in FY'85 (12/19/85)
  - Complete a Model of Human Exposures Inside Vehicles on Highways (3/28/86)
  - Article on Characterization of Emissions from Late Model In-use, Light-duty Vehicles (10/23/85)
  - Article on the Impact of Low Ambient Temperature on the Emission Rate of Formaldehyde from Motor Vehicles (9/29/86)
  - Develop Procedures for Measurement of Hydrocarbon Emissions During Vehicle Refueling (12/12/85)
- ISSUE: Global and Microenvironmental**
- Journal Article on the Effects of UV-B Radiation on Competitive Interactions (9/30/86)

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- Journal Article on Dose-Response of Marine Ecosystems to UV-B Radiation Simulating 0-15% Stratospheric Ozone Depletion (9/30/86)

**ISSUE: Provide Radiological Support to  
DOE**

- Annual Report on Off-Site Surveillance Around the Nuclear Test Site (5/14/86)
- Annual Report of the Radionuclide Intercomparison Studies (6/24/86)
- Report to Headquarters on Externalization of Quality Assurance (5/13/86)



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## ***Projected FY 1987 Deliverables***

### **ISSUE: National Ambient Air Quality Standards**

- Update Evaluation of PM/SO<sub>x</sub> Health Effects: Addendum to the PM/SO<sub>x</sub> Air Quality Criteria Document (1/31/87)
- Status Report on Evaluation of PM<sub>10</sub> Monitoring Methodology (12/30/86)
- Status Report on Evaluation of Improved NMOC Methodology (12/30/86)
- Annual Report on Monitoring Support Provided in FY'86 (12/30/86)
- Interim Report: Establishment and Preliminary Results of the Eastern Visibility Network (12/30/86)
- Interim Report on the Status of the Visibility Program: FY'86 (12/30/86)
- Annual Report for CY'85 on the QA Program of the SLAMS Network (12/30/86)
- Annual Report on the CY'85 National Ambient Air Auditing Program (12/30/86)
- Report on the Reference and Equivalence Methods Program (12/30/86)
- Annual Report on the National Source Monitoring Audit Program (12/30/86)
- Journal Articles on the Effects of O<sub>3</sub> and NO<sub>2</sub> on Pulmonary Host Defenses in Animals (6/30/87)
- Journal Article on the Immunologic and Biochemical Response of Volunteers to O<sub>3</sub> and NO<sub>2</sub> (9/30/87)
- Series of Reports on Various Aspects of Indoor NO<sub>2</sub> and Particulate Exposure (6/30/87)
- Journal Articles on Pulmonary Function and Symptoms in Asthmatic Volunteers Exercising in Sulfur Dioxide and Sulfuric Acid (9/30/87)
- Reports on Health Effects and Sources of Summertime Haze in the Northeastern U.S. (3/31/87)
- Journal Articles on Mutagenicity and Carcinogenicity of Air Samples from Xuan Wei, PRC (9/30/87)
- Project Report on the Health Effects Institute Cooperative Agreement (9/30/87)

- Article on the Use of Streaker to Measure Aerosol Composition and Absorption with One-Hour Time Resolution (9/30/87)
- Journal Article on Small Particle Soiling of Building Materials (9/30/87)

### **ISSUE: New Source Performance Standards and State Implementation Plans**

- Final Draft Report on Multistage ESP Using Prechargers and Collectors with Large Diameter Electrodes (5/30/87)
- Report on Fundamental and Bench-Scale Evaluations of Promising Dry Injection Sorbents and Additives (6/30/87)
- Final Report on Transfer Efficiency Measurement Method for Spray Painting in the Surface Coating Industry (3/30/87)
- Project Reports on Reduction of VOC Emissions from Surface Coating Operations via Process Modifications (9/30/87)
- Interim Report on VOC Destruction via Catalytic Oxidation (9/30/87)
- Report on Field Measurements of Background VOCs (9/1/87)
- Report on Results of Simulated Emissions Control Impacts on Seasonal Ozone Statistics (9/30/87)
- Report on Validation of Second Generation Model Based on Complete NEROS Data (6/30/87)
- Report on Evaluation of Alternative to CBM Chemical Mechanism for Use in Urban Air Quality Simulation Models (3/30/87)
- Report on Development and Evaluation of Advanced Lagrangian Model (6/30/87)
- Report on Regional Scale Photochemical Module and Sulfate Formation (3/30/87)
- Evaluation and Assessment of UNAMAP (4/30/87)
- Article on the Evaluation of Receptor Modeling Results in Philadelphia (10/30/86)
- Development and Delivery of User's Guide for PEM-2 Pollution Episodic Model (11/30/86)
- User's Guide for Evaluated Complex Terrain Model for Stable Plume Impaction (8/30/87)

- Report on Mesoscale Dispersion Study Using Tracer Released from 1000 Foot Meteorological Tower in Beijing (3/1/87)

## ISSUE: Hazardous Air Pollutants

- Experimental Procedures: Measurement of Survival of Recombinant DNA Molecules in Air (10/30/86)
- External Review Draft Health Assessment Document for Acrolein (10/15/86)
- External Review Draft Health Assessment Document for Acetaldehyde (11/30/86)
- External Review Draft Health Assessment Document for Phosgene (10/15/86)
- Tier One Health Effects Summary for Mineral Fibers (10/1/86)
- Tier One Health Effects Summary for Ethyl Chloride (10/15/86)
- Tier One Health Effects Summary for Methyl Methacrylate (10/15/86)
- Tier One Health Effects Summary for Maleic Anhydride (10/15/86)
- Final Health Assessment Document on Dibenzofurans (10/30/86)
- Project Report on Validation of a Method for Measuring Cadmium (1/30/87)
- Report on Development of New Sampling and Analysis Techniques for Ambient HAPs (12/30/86)
- Status Report on Sampling Conducted at Three Locations (12/30/86)
- Internal Report Summarizing Quality Assurance for HAP Projects in FY'86 (12/30/86)
- Journal Articles on Neurotoxicological Assessment of Hazardous Air Pollutants (3/31/87)
- Journal Articles on the Development and Application of Micromutagenesis Methods to Identify Carcinogens in Ambient Air (10/31/86)
- Interim Report on Wood Stove Catalyst Longevity for Pollutant Reduction in Developing Regulatory Alternatives (10/30/86)
- Final Report on Efficiency Degradation of Wood Stove Catalysts (12/31/86)

- Report Describing the Engineering Program and Data Base Control of Major Accidental HAP Releases (6/30/87)
- Report on Performance of HAP Control Under Transient Conditions (1/31/87)
- Report on a Literature Review Update of More Than 150 Volatile Organic Compounds (5/30/87)
- Report on Atmospheric Depletion Rates of Selected HAPS Consistent with Clean Air Act Requirements (12/31/86)
- Report on Screening High Volume Emissions for Potential HAPS Formed as Transformation Products Using SARS (10/30/86)
- Report on Gas/Aerosol Phase Distribution and Structure of Chemical Species in the Atmosphere Which May Prove Hazardous to Humans (4/1/87)
- Report on the Status of the Integrated Air Cancer Project (12/30/86)
- Journal Articles on the Development and Evaluation of Methods to Apportion the Mutagenicity of Ambient Air to Sources (10/31/86)
- Interim Report on Methods for Determining Wood Smoke Source Emissions (9/30/87)

## ISSUE: Mobile Source Pollutants

- Report on New Fuels and Additives Registered in FY'86 (12/30/86)
- Status Report on Population Exposure Activities (12/30/86)
- Article on the Impact of Low Temperature on Emissions from Late Model Motor Vehicles (9/1/87)
- Article on the Impact of Methanol Fuels on Evaporative Emissions (1/30/87)
- Report to Evaluate FTIR as a Tool for Measurement of Exhaust Methanol and Formaldehyde (9/30/87)
- Article on Evaluation of Emissions from Diesels Equipped with Advanced Emission Control Technology (9/30/87)
- Article on the Emission Rate of Mutagenic Gasoline Hydrocarbons (3/30/87)

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#### ISSUE: Global and Microenvironmental

- Final Report on Evaluation of the Effectiveness of Residential Radon Mitigation for Building Code Officials, Home Builders, and Home Owners (9/30/87)
- Journal Article on the Nature of UV-B-Related Changes in Competitive Balance and Mechanisms Involved (9/30/87)
- Journal Article on the Effect of UV-B Radiation on Energy and Carbon Cycling Through Plankton Species to Economic Species (8/31/87)
- Biennial Report to Congress on Stratospheric Ozone Modification (11/30/86)

#### ISSUE: Provide Radiological Support to DOE

- Annual Report of Off-Site Surveillance Around the Nuclear Test Site: CY'86 (7/30/87)
- Annual Report on the Intercomparison Program for Radiation Quality Assurance (12/30/86)
- Annual Report on Radiation Standards and Reference Materials: 1986 (12/30/86)

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## **Multimedia-Energy Research Committee**

### **Introduction**

The multimedia energy research and development program provides the scientific and technical information necessary to guide 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; and (2) to expand EPA's knowledge of the performance, reliability, and cost of the limestone injection multistage burner (LIMB) control technology.

### **Acid Deposition**

Research on acid deposition (acid rain) is coordinated through the National Acid Precipitation Assessment Program (NAPAP), which is administered by the Interagency Task Force on Acid Precipitation (ITFAP). The term "acid rain" means 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 (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), hydrogen chloride, sulfuric acid, nitric acid and certain sulfate and nitrate compounds. The objective of acid deposition research is to develop the necessary data to fully understand the sources and characteristics of acid deposition; the extent of damage or potential damage; and the corrective measures used to diminish the problem of acid deposition.

### **Major Research Issues**

#### **ISSUE: Man-Made Emissions**

Estimates of high-quality emission data bases and historical emission trends are needed to establish the basis for scientific assessments and policy development. Detailed emission data bases are required for operation of the Regional Acid Deposition Model (RADM). State-of-the-art emission models are needed to develop projections of future emission trends and costs of alternative control strategies.

### **1986 Program Accomplishments**

The 1980 Emissions Data Base and Inventory was completed. Cooperative efforts with 48 States to develop the 1985 Emission data base are well underway. A report on emission trends for SO<sub>2</sub> and NO<sub>x</sub> from 1900 to 1980 has been published as have other supporting studies for developing a comprehensive emission data base and inventory. A quality assurance and quality control plan for the NAPAP Emission Inventory has been published.

### **FY 1987 Program Outlook**

The program will continue to develop emissions data bases derived from mass balance calculations, new source tests, New Source Performance Standards (NSPS), and literature reports. We will continue to develop and test models specific to major source sectors (e.g., utilities, other industrial sources). These models are responsive to policy options and will be used to analyze cost-effective strategies.

### **ISSUE: 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 scientifically acceptable, yet simplified models, to meet assessment and policy needs.

### **1986 Program Accomplishments**

The preliminary evaluation of the full Regional Acid Deposition Model (RADM) using the Oxidation and Scavenging Characteristics of April Rains (OSCAR) meteorology and wet chemical deposition data were reported. The gas-phase chemistry module was compared with both smog chamber data and the more complex chemical mechanisms. The RADM cloud processes and aqueous-phase chemistry module was subjectively evaluated against limited field data and more complex models. Because of lack of appropriate data, the dry deposition module was not evaluated. Much larger and extensive data bases are required to test the system thoroughly. Several sensitivity tests were also conducted in which emissions in the Ohio Valley were theoretically reduced by 50% and 90% and resultant calculated deposition patterns were analyzed.

A detailed operational plan and feasibility analysis for the intensive field studies and the atmospheric model evaluation effort was completed. Draft performance evaluation statements and data quality objectives were provided for nine experimental tasks required for the operational and diagnostic model evaluation field studies. The report indicates that the operational evaluation of RADM is feasible and the diagnostic evaluation of the model is currently being ascertained. Proposed management and technical approaches are also provided.

The Regional Lagrangian Model of Air Pollution (RELMAP) has been applied and evaluated for the entire year of 1980 as part of the International Sulfur Deposition Model Evaluation (ISDME). Assessments have been made of the sensitivity of the predictions of SO<sub>2</sub>, SO<sub>4</sub>, and total sulfur wet deposition to the process rates; i.e., the modeled rates at which SO<sub>2</sub> transforms to SO<sub>4</sub> and SO<sub>2</sub> and SO<sub>4</sub> wet/dry deposition occur. The RELMAP sensitivity studies also address single-layer versus multilayer model applications.

### ***FY 1987 Program Outlook***

The program will conduct sensitivity testing on the advanced version of the Regional Acid Deposition Model (RADM) using existing monitoring data bases. We will evaluate and refine the advanced version of RADM using field study data. Once completed, RADM will be used to calibrate Lagrangian models, develop control strategies, perform source-receptor analysis, and assess materials damage.

### ***ISSUE: 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 analysis; (2) evaluate atmospheric models such as RADM and (3) determine exposure in effects studies.

### ***1986 Program Accomplishments***

The deposition monitoring research program is providing the deposition data on wet precipitation through the National Trends Network (NTN). This 150-station network operated at full capacity in 1986. A series of data reports covering the first four years of operation of the deposition were published.

Since dry deposition may account for a larger proportion of total deposition than wet deposition, implementation of a dry deposition network was begun with a 5-station dry deposition pilot network. A contract was awarded for installation of the first 30 sites of a more extensive network (up to 100 sites) and field evaluations of proposed concentration monitors were conducted.

### ***FY 1987 Outlook***

Work will continue on the establishment of an operational dry deposition network and on the development of an analytical method which more precisely measures dry deposition. Dry deposition characterization and measurements will lead to a better determination of deposition velocities. An additional 15 dry deposition monitoring sites will be deployed expanding the network to a total of 45 sites.

### ***ISSUE: Aquatic Effects***

Acidic deposition is believed to be a major contributing factor to chronic depressions of pH and possible episodic depressions in aquatic systems. Effects which may result include effects on fish and other aquatic organisms and on drinking water quality. The population-at-risk of 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 status of surface waters and watersheds including episodes; (2) the chemical and biological changes to those resources; and (3) the rate of change resulting from current and 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.

### ***1986 Program Accomplishments***

The National Surface Water Survey (NSWS) addresses the current status of resources. Results of Phase I activity are nearing completion with the recent publication of data and analysis of the Eastern Lake Survey and Stream Survey (Pilot), and the imminent release of the report on the Western Lake Survey. The Stream Survey (Mid-Appalachian Region) report will be released in 1987.

The rate of change of systems is being investigated by the Direct/Delayed Response Project. Three different levels of modeling activities will supply target loading predictions by region. Results of analyses based on empirical relationships and single-factor response times for the Northeast and Southeast will be released in 1987. Verification of prediction of the Direct/Delayed Response Project (DDRP) will be undertaken with field and pilot level manipulations of watersheds as part of the Watershed Manipulation Project (WMP). The research plan for this project was developed and reviewed in 1986 so that manipulations can begin within 1987.

Long-term monitoring provides the ultimate verification of model predictions by producing information on water quality trends especially in sensitive systems. The Long-term Monitoring

Project was evaluated and redesigned based on the results of the Eastern Lakes Survey to maximize its applicability to detecting changes in sensitive surface waters.

### *FY 1987 Program Outlook*

Support will continue for the National Surface Water Survey (NSWS) to allow us to determine the temporal chemical and biological variability of sensitive aquatic resources. We will continue the DDRP which will allow us to predict short-, mid-, and long-term responses of surface waters to acidification. The WMP will be continued to allow us to corroborate the DDRP model predictions at current and altered acid loadings.

### **ISSUE: Forest Effects**

Since the early 1980's, various adverse changes in forest condition have been observed in the United States. Apparently increased mortality has been observed in high elevation stands of red spruce and balsam fir. Also there is some indication that annual increment growth is reduced in these stands. These observed symptoms are non-specific and could be caused by several different factors or combination of factors. Acidic deposition and its associated pollutants have been implicated as causal factors.

### *1986 Program Accomplishments*

A joint EPA/U.S. Forest Service research program, the Forest Response Program (FRP), was established in 1985 to investigate: (1) extent of damage to forest ecosystems which might be caused by acid deposition, (2) cause and effect relationships and (3) dose response relationships. During late FY 1985 and FY 1986, the FRP established the Spruce-Fir, Southern Commercial, Eastern Hardwoods and Western Conifer, research cooperatives. Also, the National Vegetation Survey was implemented and a Synthesis and Integration Team was established. All of these activities have produced detailed research plans which have passed peer-review.

*Spruce-Fir Research Cooperative:* Following peer review in March 1986, a meeting with the Federal Management Group (FMG) was held and, as a result of that meeting and subsequent reprogramming, 21 projects were funded in FY 1986. These projects are addressing the question of extent of forest damage and investigating most of the major hypotheses of cause and effect related to the impact of atmospheric deposition on forests.

*Southern Commercial Forest Research Cooperative:* In FY 1986, three controlled exposure laboratory studies were funded at Texas A&M University, Oak Ridge National Laboratory (ORNL), and North Carolina State University (NCSU).

Controlled exposure-field research was conducted in FY 1986 at ORNL and at the Duke Forest Primary Research Site. In mid-March a request for proposals was issued with two objectives: (1) to study plant physiology in natural stands on the Duke Forest and stand representation of the region; and, (2) to study the feasibility of field fumigation techniques. Two projects have been identified for funding. Four secondary research sites have been identified and will be established in FY 1987. Planning for the development of a central testing facility began in FY 1986 on a site at the Forest Service greenhouse facility in Macon, GA.

*Eastern Hardwood Research Cooperative:* The Eastern Hardwoods Cooperative initiated three projects in FY 1986. These concentrated mainly on the spatial extent and temporal development of adverse changes in forest condition in eastern hardwood species. Also included are studies concerning the effects of atmospheric deposition on physiological and nutritional processes.

*Western Conifers Research Cooperative:* Seven projects were funded by the Western Conifers Cooperative in FY 1986. Similar to Eastern Hardwoods, the thrust of this cooperative is problem definition. The concentration of effort in FY 1986 was on resolution of questions on extent of damage with a smaller effort addressing effects mechanisms.

*National Vegetation Survey:* Fourteen projects were undertaken by the National Vegetation Survey in FY 1986 exploring the questions of the temporal development and spatial extent of changes in forest condition. These include both analysis of available data, field observations and two studies along known deposition gradients.

*Synthesis and Integration:* A computerized data base system was developed to track outputs and status of FRP projects. The data base will be expanded to include key bibliographic information as well as pertinent non-FRP project data. Two research projects were initiated, both dealing with the assessment of physiological characteristics for use in developing models of whole-tree processes and with the evaluation and development of statistical techniques for the analysis of dendrochronological data.

### *FY 1987 Program Outlook*

We will expand the collaborative research with the Forest Service on the effects of acid deposition and other air pollutants on spruce/fir forests in the eastern U.S. and southern commercial forests. Quantitative research will continue on eastern mixed hardwood forests and western conifers. We will continue to cooperate with the Forest Service in the design and implementation of studies to determine the extent and magnitude of forest

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productivity decline, and will initiate a design to meet long-term monitoring needs.

#### **ISSUE: Effects on Materials**

The Materials Effects research is directed towards (1) understanding the quantitative relationships between the various forms of acidic deposition and the resulting damage rates to materials, and (2) identifying the geographical extent of materials-at-risk.

#### ***1986 Program Accomplishments***

As a result of major program and project reviews conducted with NAPAP, the materials research program was reconstructed. A major initiative was the development of a research program to determine the effects of acid deposition on paint/substrate systems.

A preliminary physico-chemical model of acid deposition on galvanized steel was prepared. This model demonstrated the ability to predict damage in the field from information gathered in the laboratory. Additional laboratory and field studies are being conducted to refine and test the model. Field studies on other common metals are in progress at five materials exposure sites. Initial results of the field study were published that indicate the sensitivity of metal surfaces to acid deposition changes over time, as a corrosion layer is formed. This has led to the development of a model of deterioration based on the formation of a carbonate layer as a rate-controlling step in deposition.

The Materials Inventory Data Base was extensively reviewed and recommendations prepared for future work on extrapolating the data to other metropolitan areas.

#### ***FY 1987 Program Outlook***

The program will continue to determine those materials and resources at risk and to develop data bases and methods for differentiating the effects of acid deposition from those of other sources of pollution. Damage functions will be developed for selected materials at field sites so that we can determine if widely used building materials deteriorate as a result of acid deposition. An assessment of the effect of acid deposition on the service life of materials and life cycle costs will be undertaken.

#### **ISSUE: Assessments**

What existing mechanism(s) would best integrate acid deposition research information to provide policy-makers with the ability to formulate timely and cost-effective decisions for dealing with acid deposition issues?

#### ***1986 Program Accomplishments***

At the beginning of 1986, the assessment responsibility was transferred from a staff at EPA to a staff at NAPAP. Ongoing activities were concluded. Draft assessments in the areas of emissions, atmospheric processes and source/receptor relationships, deposition and air quality, aquatic effects, forest effects, and health and visibility were completed. In-house analyses to support EPA programs continue in these areas, using products of the assessment program such as a geographical information analysis system.

#### **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 deposition precursors. The LIMB emission reduction technology is designed to be retrofitted to large and small existing coal-fired boilers.

#### **Major Research Issues**

##### **ISSUE: 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.

#### ***1986 Program Accomplishments***

In 1986, work continued on the development of high surface area sorbents and sorbents treated with "promoters" to improve the sulfur capture ability of the LIMB technology. The design phase of the wall-fired full-scale LIMB demonstration was completed. Also, we continued the laboratory and pilot-scale research of the LIMB process to improve engineering knowledge of the effects of operating parameters and systems variables associated with NO<sub>x</sub> control and SO<sub>2</sub> capture. As a result of a Congressional add-on to the LIMB budget, we initiated a competitive procurement for a tangentially fired full-scale LIMB demonstration.

#### ***FY 1987 Program Outlook***

In 1987, we will complete the boiler modification of the wall-fired LIMB demonstration at Ohio Edison's Edgewater #4 site. After modification we will begin a full year of testing at the site. We will evaluate proposals for the tangentially fired demonstration and continue to support pilot-scale work. Startup for the tangentially fired demonstration is projected for 1989.

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## **FY 1986 Deliverables**

### **ISSUE: Man-Made Emissions**

- Proceedings: Second Annual Acid Deposition Emission Inventory Symposium (November 1985), EPA/600/9-86/010, Radian Corporation, April 1986.
- Quality Assurance and Quality Control Plan for the NAPAP Emission Inventory, EPA/600/8-86/025, August 1986.

### **ISSUE: Atmospheric Processes**

- Preliminary Evaluation Studies with the Regional Acid Deposition Model (RADM), February 1986.
- Regional Eulerian Model Field Study and Evaluation: Proposed Management and Technical Approaches, August 1986.

### **ISSUE: Deposition Monitoring**

- Final Report: Development of Methods for Collection and Analysis of Precipitation, June 1986.
- Precipitation in North America 1984: Annual Data Summary, September 1986.
- Annual Report: Spatial Temporal Analysis 1984, September 1986.
- Report on Status of Western Core Sites for Dry Deposition Measurement, July 1986.
- Report: Siting Selection for Dry Deposition Network, December 1985.
- FTIR Determination of Ammonium and Sulfate Ions, September 1986.

### **ISSUE: Aquatic Effects**

- Direct Delayed Response Project, September 1986.

Volume I: Executive Summary  
Volume II: State-of-the-Science  
Volume III: Appendices (for State-of-the-Science)  
Volume IV: Implementation Plan  
Volume V: Appendices (for Implementation Plan)

- Characteristics of Lakes in the Eastern United States, Volume I, II, III, EPA/600/4-86/007a, b and c, June 1986; National Surface Water Survey: National Stream Survey, Phase I Pilot Survey, EPA/600/4-86/026, June 1986.

### **ISSUE: Terrestrial Effects**

- Completed Peer Review of Forest Survey Plan, April 1986.
- Research Plan for Spruce-Fir Cooperative, April 1986.
- Research Plan for Southern Commercial Cooperative, April 1986.
- Research Plan for Western Conifers Cooperative, April 1986.
- Research Plan for Eastern Hardwoods Cooperative, April 1986.
- Progress Report from the Southern Commercial Cooperative, April 1986.
- Progress Report from the Spruce-Fir Cooperative, April 1986.

### **ISSUE: Materials Effects**

- Report on U.S. EPA Workshop on Acid Deposition Effects on Portland Cement, Concrete, and Related Materials, February 1986.
- Supplemental Statistical Analysis of North East Materials Inventory Data Base, September 1986.
- Report on Development of Acid Damage Functions, September 1986.
- Report: Evaluation of Existing Paint Damage Data, September 1986.

### **ISSUE: Limestone Injection Multistage Burner (LIMB)**

- Status Report on EPA LIMB Development and Demonstration Program, EPA/600/8-86/036, October 1986.

## **Projected FY 1987 Deliverables**

### **ISSUE: Man-made Emissions**

- Preliminary 1985 Point Source Emissions File (1/31/87)

### **ISSUE: Atmospheric Processes**

- Report on Urban and Mesoscale Modeling Methods for Pollutants for Material Damage Assessment (12/1/86)
- Report on Chemical Module for the Second Generation Eulerian Model (RADM-2) (2/1/87)



- Report on Sulfur Species Engineering Assessment Model and Evaluation Against RADM (3/30/87)
- Report on Review of Existing Mesoscale Models for Use in Complex Terrain (3/30/87)
- User's Guide for a Mesoscale Acid Deposition Model for Assessments Including Model Evaluation Report (6/30/87)
- Detailed Design, Logistics Documentation and Sampling and Analytical Manuals for the Model Evaluation Field Study (9/30/87)

#### ISSUE: Deposition Monitoring

- Annual Report on the National Monitoring QA for NTN Network, CY 85 (12/30/87)
- Site Survey for the Western Core Site (2/28/87)
- Final Report: Development of Real-Time Acid Precipitation Monitor (3/30/87)
- Final Contract Report on Development and Evaluation of Dry Deposition Monitors (3/30/87)
- Annual Data Inventory Report, CY 1986 (4/30/87)
- Siting Plan for Dry Deposition Stations in the Southeast. Deliver Final Report (5/30/87)
- Analytical Differences Between Snowfall and Rainfall (9/30/87)
- Trends Analysis of Wet Deposition Data (9/30/87)

#### ISSUE: Aquatic Effects

- Provide Final Report on the Results of the Western Lake Survey (12/30/86)
- Report on Analysis of Aquatic Long Term Monitoring Data (12/31/86)
- Final Analytical Methods Manual for Western Lake Survey—I (2/28/87)
- Report on the Application of Flow Injection Technology for the Determination of pH in Low Ionic Strength Waters (7/30/87)
- Final Report on Critical Evaluation of Biological Sensitivity Indices (8/30/87)
- Final Report on Results of NSS-MA/SE National Stream Survey (8/30/87)

- Project Report on Regional Rates of Surface Water Acidification and Direct/Delayed Response (9/30/87)
- Report on Evaluation of QA/QC in the NSWS (9/30/87)
- Final Report on Cistern Drinking Water Survey (9/30/87)

#### ISSUE: Forest Effects

- Annual Research Plan for Eastern Hardwood Cooperative (3/31/87)
- Forest Research Plan National Progress Report (9/30/87)
- Report on Findings of Mountain Cloud Chemistry Project for 1986 (9/30/87)

#### ISSUE: Materials Effects

- Research Plan for Determining the Effects of Acid Deposition on Exterior Coatings (2/28/87)
- Field Sampling for Materials Inventory Validation (4/30/87)
- Laboratory Study of Acid Deposition of Damage Mechanisms on Galvanized Steel (9/30/87)

#### ISSUE: LIMB

- Final Reports on LIMB Engineering Processes Analysis Studies Relating Development Results to Industry Comm. Requirements (2/28/87)
- Completion of Boiler Modification and Initiation of One Year LIMB Wall-Fired Demonstration (7/31/87)
- Draft Report on Initial LIMB T-Fired Prototype Testing (9/30/87)
- Plan and Implement the 1987 Joint EPA/EPRI Symposium on Dry SO<sub>2</sub> and Simultaneous SO<sub>2</sub>/NO<sub>x</sub> Control Technologies (9/30/87)

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## ***Interdisciplinary Research Committee***

### **Introduction**

The Interdisciplinary Research Committee plans those programs in the Office of Research and Development (ORD) which cross all media. Quality assurance oversight activities ensure that the data are of known and documented quality, and that they meet the requirements established by the responsible office or laboratory. Risk assessment management efforts include the development of risk assessment procedures for ensuring the consistency and technical competence of the overall risk assessment program. ORD manages a series of new intra-agency workgroups which have developed guidelines for carcinogenicity, mutagenicity, developmental toxicity, exposure assessment, and assessment of chemical mixtures. Exploratory research provides solutions to environmentally related problems which require a basic or fundamental understanding. ORD is particularly interested in long-range strategic research issues addressing emerging environmental problems. Consequently, in addition to the research conducted through the laboratories, ORD supports research conducted through its research grants and centers programs. Efforts carried out under the auspices of the interdisciplinary program also include centralized support for the production and dissemination of information products, and provide a technology transfer program to synthesize information and develop methods of data presentation. Finally, regulatory support efforts serve to identify major regulatory issues early in their development and bring together ORD experts and key regulatory staff to discuss the state of the applicable science.

### **ISSUE: Manage and Implement Exploratory Research Grants Programs and Research Centers Program**

This program is designed to broaden and enhance the Agency's environmental, scientific and engineering knowledge base and assure the application of science basic to the solution of environmental problems.

The Research Grants Program is divided into five environmental program areas: health, biology,

engineering, air physics and chemistry, and water physics and chemistry. This program division results in research on a number of such broad topics as the identification and characterization of hazardous contaminants in various media (air, water and soils); understanding of 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 in hazardous waste sites; and development of new technologies for industrial wastewater treatment.

Investigator-initiated research applications are solicited by an annual "Request for Applications" (RFA). The RFA is a mechanism by which proposals are solicited for a one-time competition in a narrowly defined, high-priority research area. Grants are awarded on technical merit, potential relevance to the Agency's long-range research goals and contribution to a balanced research program in ORD.

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: ground water, hazardous waste, environmental epidemiology, marine science, industrial waste, municipal waste, intermedia pollutant transport, and environmental risk assessment. Support for each center is provided through a cooperative agreement with EPA. Each center's research program is managed by a center director and 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 staffed by scientists and engineers from industry, government and academia. At least two scientists from EPA laboratories are members of each SAC.

### ***1986 Program Accomplishments***

In the Research Grants program, 405 research applications were reviewed by *ad hoc* peer review panels; 139 were approved for scientific merit and evaluated by in-house scientists for agency relevance. Fifty-four new proposals were awarded and funding for 49 others was continued. Abstracts of the new grants awarded in FY 1986 were

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published and widely distributed. A workshop on genetic toxicology featured the completed work of EPA grantees. Some major scientific accomplishments of the Research Grants Program are highlighted below; a complete annual report, an FY 1986 abstract of new awards and an FY 1986 bibliography of published articles from funded grants are available from the Office of Exploratory Research upon request.

### *Major Scientific Highlights*

- Validation of an *in vitro* fish model technique for investigations of metabolism, carcinogenesis, and chemical toxicity for better quantitative risk assessment and extrapolation from animal data to man.
- Establishment of animal models to demonstrate correlation between UV-B radiation and the onset of melanoma.
- Studies are in progress to elucidate a mechanism for UV-B radiation effects on plants. Efforts are focused on the efflux of specific ions (calcium, potassium, etc.) from cells and the influence of environmental stresses (such as temperature and nutrients) on the UV-B damage.
- The biological detoxification of complex industrial mixtures shows promise in the engineering of microorganisms which can degrade both polychlorinated biphenyls and chlorobenzoates. Under study is the mechanism for inserting engineered plasmid genes into suitable bacteria for amplification and subsequent degradation of industrial sludges, wastewaters and contaminated soils.
- Development of a new bonded phase for gas chromatographic separation of 18 priority pollutants which are difficult to separate in other systems.
- Demonstration that oxygen depletion in sewage receiving waters is due mainly to microbial utilization of organic carbon rather than to nitrification.
- Development of a method, based on supercritical fluids, to separate polyaromatic hydrocarbons (e.g., benzo-a-pyrene) from particulate water and sorbent traps
- Establishment of a model for the production of  $H^+$ ,  $NO_3^-$  and  $SO_4^{2-}$  in atmospheric water droplets for use in acid precipitation studies.
- Development of an effective treatment method for removal and control of radon indoor air pollution. A promising technique is the use of granular

activated carbon (GAC) to reduce concentration of radon and other radionuclides in household water supplies.

- Testing of new, cost-effective drinking water disinfection processes. Alternate techniques to chlorination, such as the use of ozone, anion exchange resins and the coagulation of submicron particles methods are being investigated.

In the Research Centers Program, minor changes were made in several project officer assignments to provide maximal coverage of centers by the various ORD laboratories. Each center was assigned a lead ORD laboratory responsible for conducting interacting center-ORD laboratory studies. Detailed explanations of 1986 accomplishments may be found in the Research Centers annual reports.

There were 313 deliverables in the centers program in FY 1986, including 99 journal articles, 28 books or bound proceedings, 47 book chapters, 123 project reports, and numerous conferences, workshops and seminars. Following is a representative listing:

- Field measurements and laboratory analyses in concert with EPA's Ada, Oklahoma Robert S. Kerr Environmental Research Laboratory (RSKERL) confirmed natural degradation of hydrocarbon plumes in ground water.
- Development of stable biofilms of phototropic microorganisms used to detoxify organic compounds using specific compounds (sodium alginate, for example).
- An extensive investigation on the volatilization of chloroform and trichloroethylene from bath and shower water showed that inhalation of these compounds during showering and bathing is a significant route of exposure.
- Two new analytical methods were developed to characterize organic aerosols for use in source allocation models. Both methods were successfully field-tested as part of the California Air Resources Board's analytical method intercomparison study.
- A workshop on environmental risk assessment led to alteration in the environmental scoring methods being developed by the Office of Policy, Planning, and Evaluation.
- Isolation of two new bacterial species which are capable of degrading chloroaromatic compounds. Experiments showed that these species are capable of using trichloroethylene as their sole source of carbon and energy.

- Research on the solubility of gasoline in water showed that gasoline octane enhancers increase their solubility in water, increasing spill or leak hazard.

### *1987 Program Outlook*

During FY 1987, the Research Grants Program will release a minimum of three RFAs: (1) mechanisms of immune alterations induced by environmental pollutants; (2) effects of air pollutants on forests; and (3) studies of ozone depletion and global climate modification. Five to ten grants per RFA will be awarded. Applications from individual investigators will continue to be peer reviewed and evaluated for relevance to EPA's mission. Emphasis will continue on improvement in quality of research; coordination with the Agency's research planning process; broad dissemination of results of completed grants, and coordination with other Federal agencies. A workshop, "Concepts in Inhalation Toxicology," will be cosponsored by the Research Grants Program during FY 1987. Other seminars and workshops featuring the completed work of grantees will be held in Agency laboratories and other locations.

Oversight and management of the Research Centers Program will emphasize attention to new trends, discoveries or leads coming from ongoing studies. An annual summary report of the results obtained by each of the centers will be prepared for evaluation of the effectiveness of the center to

respond to new research needs. Recommendations for reorienting existing centers will be prepared when appropriate. Symposia and workshops will be held to disseminate information from center studies.

### **ISSUE: Manage and Implement Distinguished Visiting Scientists Program**

The Distinguished Visiting Scientists Program (DSVP) is designed to identify senior visiting scientists who will conduct research in ORD laboratories on a temporary basis, usually one to three years. The intent of the program is to enhance the Agency's scientific competence and quality, to improve relations between EPA and the scientific community, and to increase the visibility of research in ORD laboratories. During the DSVP assignment, EPA provides technical and administrative support as needed.

### *1986 Program Accomplishments*

During FY 1986, five new DSVP researchers were selected, bringing the total of active DVSP researchers to nine. The five new researchers were selected from a peer review process of 36 candidates. Their names, areas of research, project areas and relevant EPA laboratories are listed below.

Winners of the 1986 DVSP Competition

Applicant (Institution)	Field(s)	ORD Laboratory	Project Area(s)
Michael Overcash (North Carolina State)	Environmental Engineering	HWERL-Cincinnati	<ul style="list-style-type: none"> <li>● Engineering methods for source reduction of toxics and hazardous wastes.</li> </ul>
Guenther Stotzky (New York U.)	Biology Microbial Ecology	ERL-Corvallis	<ul style="list-style-type: none"> <li>● Ecotoxicology</li> <li>● Fate of genetically engineered organisms.</li> </ul>
Richard Dick (Cornell)	Civil Engineering	WERL-Cincinnati	<ul style="list-style-type: none"> <li>● Classification of sludges via physical properties.</li> <li>● Sludge management.</li> </ul>
Charles Wurrey (U. of Missouri, Kansas City)	Physical Chemistry	EMSL-Las Vegas	<ul style="list-style-type: none"> <li>● Measurement methods for isomers of dioxins and dibenzofurans.</li> </ul>
Richard Hawkins (Utah State U.)	Civil Engineering Watershed Science	ERL-Corvallis	<ul style="list-style-type: none"> <li>● Responses of watersheds to acid deposition.</li> </ul>

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## 1987 Program Outlook

The DSVP will continue as in 1986. The scientists selected to participate will be renowned in their fields of research. Involvement of these visiting scientists in the day-to-day activities of ORD laboratories will result in exchanges of information beneficial to both EPA and the scientific community and will enhance the reputation and credibility of EPA research.

### ISSUE: Manage the Agency's Quality Assurance Program

A significant portion of EPA's budget is spent on collecting environmental data. Quality assurance (QA) activities play an integral role in the planning and implementation of environmental data collection efforts and in the evaluation of the resulting data. By means of their QA programs, EPA organizations can enjoy substantial resource savings, collecting only needed data and assuring that the collected data are of the requisite quality.

Quality assurance is the process of *management* review and oversight at the planning, implementation, and completion stages of an environmental data collection activity to assure that data provided by a line operation to data users are of the quality needed and claimed. Quality assurance should not be confused with quality control (QC); QC includes those activities required *during* data collection to produce the data quality desired and to document the quality of the collected data (e.g., sample spikes and blanks).

Quality assurance programs consist of specific activities conducted before, during, and after environmental data collection. During the planning of an environmental data collection program, QA activities focus on assuring that the quality of the data needed by data users has been defined, and that a QC system has been designed for measuring the quality of the data being collected. During the implementation of a data collection effort, QA activities ensure that the QC system is operating and that problems found by QC are corrected. After environmental data are collected, QA activities focus on assessing the quality of the data obtained. Here, one determines whether the data obtained are adequate to support data-dependent regulatory decisions or research hypotheses.

The Quality Assurance Management Staff (QAMS) is charged with overseeing the quality assurance activities of the Agency.

## 1986 Program Accomplishments

The basic elements of the Agency's mandatory quality assurance program are specified in EPA Order 5360.1. These include:

- requiring QA in all Agency-supported data collection activities,

- defining Data Quality Objectives,
- developing quality assurance program and project plans,
- conducting audits,
- implementing corrective actions based on the audits,
- establishing achievable data quality limits for methods cited in EPA regulations,
- developing technical guidelines for assessing data quality, and
- providing for QA training.

Since the issuance of EPA Order 5360.1 in April 1984, QAMS has been intensively involved in preparing guidance on these key QA program components. Beginning in FY 1986, QAMS has begun a transition from the guidance phase to interactive implementation support. QAMS wants each Agency data collection organization to possess the knowledge, resources, and management support that are essential to effective QA program implementation.

Specific FY 1986 priorities included:

1. *Quality Assurance Program Plans*—Each Agency data collection organization needs an approved Quality Assurance Program Plan formalizing and documenting the management structure, policies, and procedures of its quality assurance program. QAMS has worked with individual organizations in order to assure that their Program Plans are carefully designed and well implemented. By the end of FY 1986, both the pace and the quality of Program Plan submissions to QAMS had improved.
2. *Data Quality Objectives*—Data Quality Objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data needed to support a regulatory decision or research hypothesis obtained from a particular data collection activity. QAMS has placed strong emphasis on the development of Data Quality Objectives, since they are essential precursors to the design of a meaningful QA/QC program for data collection. In FY 1986, QAMS pursued the following emphases related to DQOs:
  - working directly with individual programs to help them develop solid DQOs for selected data collection activities,

- in cooperation with the Office of Policy, Planning, and Evaluation, developing an Agency-wide tracking mechanism for DQO preparation, and
- preparing a training workshop on DQO concepts and procedures.

QAMS' overall goal has been to direct the attention of senior management to the importance and value of the DQO process.

3. *Management Systems Audits*—Comprehensive auditing is critical to the success of the Agency's quality assurance program. Although there are several major categories of QA audits, the one which QAMS emphasized most in FY 1986 is the Management Systems Audit (MSA). The MSA is a tool for measuring the implementation of a QA program against the individual organization's management structures and standards described in its approved QA Program Plan. QAMS' FY 1986 accomplishments in this area were threefold:
  - QAMS provided formal guidance as well as informal support and training to Agency organizations carrying out their own internal Management Systems Audits.
  - QAMS conducted an extensive independent MSA of the Region V quality assurance program. (A report on this audit will be available early in FY 1987.)
  - QAMS commenced a comprehensive analysis of the difficult conceptual problems associated with quality assurance audits focused on Office of Research and Development activities

All of these achievements were directed at the ultimate goal of making MSAs a routine but powerful oversight tool for identifying the strengths and weaknesses of Agency QA program operation.

### 1987 Program Outlook

During FY 1987, QAMS' transition from the guidance phase to implementation support will continue. The long-term goal is to institutionalize line management responsibility for assuring the quality and utility of the Agency's data collection programs. Specific FY 1987 priorities include:

1. Establish the DQO process as the first key step in designing major new data collection programs.

2. Assure that all Agency data collection organizations are supported by program plans.
3. Establish both internal and external management systems audits as a standard and effective element of the Agency's QA program.
4. Implement a comprehensive QA training program/workshop to meet the information needs of all participants in the Agency-wide QA program.
5. Implement an alternative method validation procedure to take advantage of data collected during laboratory QC analyses.
6. Analyze the procedures for developing QA project plans, and make subsequent revisions to clarify responsibilities and streamlining the review process whenever appropriate.

Fulfillment of these priorities will enhance EPA's progress toward its ultimate goal of assuring scientifically and legally defensible environmental data in support of its regulatory, enforcement, and research objectives.

### ISSUE: Assure Uniform Risk Assessment

EPA's scientific assessment program provides uniform Agency-wide guidance to assure the consistency of exposure and risk assessments to support regulatory decision-making.

Final risk assessment guidelines will be published on carcinogenicity, mutagenicity, developmental toxicity, complex mixtures, and exposure. Additional guidelines on reproductive effects, systemic toxicity and pharmacokinetics are under development. A new Agency-wide Risk Assessment Forum provides a mechanism for interoffice exchange on science issues in risk assessment; advises the Agency on precedent-setting cases and important environmental risk assessment issues, and recommends revisions or updates to the risk assessment guidelines. A computer-housed electronically communicated catalogue of Agency risk assessment and risk management information on chemicals will be managed by the scientific assessment program.

### 1986 Program Accomplishments

Five risk assessment guidelines were approved by the Administrator and were published in Vol. 51 of the *Federal Register* on September 26, 1986:

- Guidelines for Carcinogen Risk Assessment, pp. 33992-34003.
- Guidelines for Estimating Exposures, pp. 34042-34054.

- Guidelines for Mutagenicity Risk Assessment, pp. 34006-34012.
- Guidelines for the Health Assessment of Suspect Developmental Toxicants, pp. 34028-34040.
- Guidelines for the Health Risk Assessment of Chemical Mixtures, pp. 34014-34025.

The guidelines and the public comment were reviewed favorably by the Science Advisory Board, and revisions requested by the Science Advisory Board were made. An ad hoc Agency-wide group is working on an implementation plan for the new guidelines. In FY 1986, the Agency continued work on separate guidelines for male infertility and female infertility, scheduled proposal in the *Federal Register* for FY 1987, and initiated work on new guidelines on the use of measurement information in exposure assessments, and on pharmacokinetics.

The Reference Dose (RfD) Workgroup on acceptable daily intakes completed and made public risk assessment information on 98 chemicals.

The Integrated Risk Information System (IRIS), a computer-housed electronically communicated catalogue on Agency risk assessment and risk management information for chemical substances was developed and implemented. Risk assessments for non-carcinogenic health effects for 98 chemicals have been input into IRIS. IRIS contains information (toxicity and regulatory) in a chemical specific format and chemicals are selected for inclusion based on both their toxicological properties and their occurrence in the environment. IRIS was designed especially for Federal, State and local environmental health agencies as a source of the latest information about Agency health assessments and regulatory positions for specific chemicals

### **1987 Program Outlook**

Risk Assessment Forum activities for FY 1987 are as follows.

- The RfD workgroup will complete and make public risk assessment information on approximately 200 chemicals in addition to those completed in FY 1986.
- A draft report on several issues involved in assessing carcinogenic risk from oral exposure to arsenic is nearing completion and being readied for a peer review workshop in early FY 1987.
- A draft report on the appropriate safety or uncertainty factors for cholinesterase inhibitors will be ready for review in early FY 1987.

The following reports were completed and are being published:

- Interim risk assessment procedures for mixtures of chlorinated dibenzodioxins and dibenzofurans.
- Formal report on "Proliferative Hepatocellular Lesions of the Rat: Review and Future Use in Risk Assessment (neoplastic nodules)." All internal and external reviews are completed and it will be printed early in FY 1987.
- Interpretation of Neoplastic Nodules

The IRIS activity is expected to include risk assessments for noncarcinogenic health effects for approximately 200 additional chemicals and carcinogenic health effects for 100 chemicals.

### **ISSUE: Technical Information Product Management/Technology Transfer**

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

### **1986 Program Accomplishments**

In 1986, CERI continued to provide support to 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 assessed the status of research and regulations, discussed with the Research Committees their priorities for disseminating material, developed innovative information transfer mechanisms, and ensured that information on improved technology and management practices was distributed to appropriate audiences to comply with EPA regulations. All information on products was developed using a team of participants from ORD, EPA program offices, and private industry.

In 1986, CERI developed and published two manuals, two handbooks and a variety of brochures and information tools for the technological and regulatory communities.

The design manual, *Municipal Wastewater Treatment*, provides a comprehensive source of

information to be used in the design of disinfection facilities for municipal wastewater treatment plants. The manual includes design information on halogenation/dehalogenation, ozonation, and ultraviolet radiation.

The manual entitled *Fabric Filter Operation and Maintenance* is slanted toward the concerns of the plant environmental engineer responsible for long-term control strategies, O&M plans, preparation of bid specifications, and performance trends analysis. The document also presents information to enable plant personnel to recognize potential problem areas as well as existing problems, their underlying causes, and their solutions. The information provided should help EPA field personnel to determine if the fabric filter is operating within the applicable regulations, to judge the effectiveness of the plant's O&M program, and to assess the causes of poor fabric filter performance.

The handbook entitled *Permit Writer's Guide to Test Burn Data—Hazardous Waste Incineration* was developed for State and Federal permit writers and others concerned with the permitting and testing of hazardous waste incinerators. The handbook summarizes the test results from hazardous waste burns conducted at 23 full-scale stationary incinerators. In addition to the incinerator data, the handbook also presents the results of hazardous waste test burns at 11 lime, cement, and aggregate kilns and 11 industrial boilers.

The handbook entitled *Stream Sampling for Waste Load Allocation Applications* discusses sampling strategies that will facilitate the fine tuning of water quality models for allocating waste loads.

Other publications produced this year describe radon reduction techniques for detached houses, nitrogen oxide control for stationary combustion sources, the technology of sequencing batch reactors, the causes and control of activated sludge bulking and foaming, and the National Pretreatment Program. These publications help industries and municipalities to understand applicable regulations and the available technologies to satisfy those regulations.

In addition to publications that aid EPA constituencies, CERL develops seminars to transfer information to appropriate users. In 1986, the seminar series stressed current technologies for treating hazardous waste in keeping with RCRA and CERCLA regulations. These seminars were intended not only to transfer information but to establish lines of communication so that the Office of Solid Waste, the Office of Research and Development, EPA Regional Offices and the states could avail themselves of all resources for accomplishing their missions.

## 1987 Program Outlook

In the ensuing year, CERL plans to realize 11 projects in hazardous waste treatment and disposal, ground-water contamination, drinking water and air pollutant regulations, and municipal treatment of wastewater, each of them calling for seminars or guidance documents, depending on audience needs. As an example, CERL plans to address the problems associated with RCRA regulations that pertain to the contamination of groundwater by hazardous wastes migrating from sites where they are stored. Since site owners must control releases of these wastes they need to know how to investigate and assess whether corrective action is required and what technological alternatives are available and appropriate for resolving the problem. CERL is therefore conducting 10 technology transfer seminars and developing an associated publication that addresses preliminary assessments, site investigations, and corrective action alternatives. The information will be targeted at owners and operators of hazardous waste sites, as well as federal and state regulatory officials who are involved with administering RCRA regulations.

## ISSUE: Regulatory Support

The Office of Regulatory Support (ORS) was established in FY 1986 to sharpen ORD's focus on regulatory development in the Agency and to serve as a bridge between scientific/technical expertise and regulatory decision making. ORS' primary function is to identify major regulatory issues early on in their development and bring together ORD experts and key regulatory staff to discuss the state of the applicable science. By helping to delineate the areas of relative certainty and uncertainty, and by identifying areas of research which hold promise, ORS seeks to improve the ability of ORD to make a very direct and timely impact on regulatory decisions.

## 1986 Program Accomplishments

- Created a new organizational unit comprised of seven professionals and a director from diverse regulatory and scientific backgrounds.
- Established strong working ties with key staff in EPA program offices.
- Organized several workshops to bring regulatory and scientific personnel together to reach an understanding of the applicability of selected research to critical regulatory decisions.
- Provided weekly status report to ORD senior staff on key legislative and regulatory development activities.



- Organized information on all ORD workgroup activities.
- Represented ORD on the Agency steering committee and the Administration Risk Management Council.
- Organized briefings for the AA on all options selection reviews and related regulatory decisions.
- Represented ORD in critical Agency-wide task groups including the integrated chlorinated solvents strategy, CERCLA Title III planning, Superfund health program development, etc.
- Developed a series of issue papers informing ORD of regulatory and technical issues on the Agency regulatory agenda.

### *1987 Program Outlook*

ORD has identified the following regulatory items as those which will warrant significant ORD involvement in the coming fiscal year. Staff will employ a variety of means to ensure ORD's participation in the deliberations leading to regulatory decision-making.

### *Resource Conservation and Recovery Act*

- Leaking underground storage tanks: regulations for tanks
- Restriction of land disposal of certain hazardous wastes—solvents and dioxins; California list—and establishing the framework for EPA's land disposal program.
- Air emission regulations for hazardous waste treatment, storage and disposal facilities.
- Proposed reinterpretation of mining waste exclusion—smelting/refining.
- Corrective action at Federal facilities.
- Corrective action regulations for underground storage tanks.
- Criteria for classification of solid waste disposal facilities and practices (revision).
- RCRA location standards for hazardous waste treatment, storage and disposal facilities.

### *Superfund (CERCLA)*

- National Contingency Plan—Hazard Ranking System revision.
- Title III Emergency Planning and Community Right-to-Know.

- Research, Development, Demonstration and training amendments.

### *Clean Water Act*

- Sewage sludge use and disposal regulations.
  - Regulations to implement recommendations of the Domestic Sewage Study.
- Comprehensive revision to ocean dumping regulations.

### *Safe Drinking Water Act*

- Proposed National Primary Drinking Water Regulations: inorganic and organic compounds and microbiological contaminants.
- Final National Primary Drinking Water Regulations: maximum contaminant levels for volatile organic chemicals found in drinking water.
- Proposed National Primary Drinking Water Regulation: surface water treatment criteria.
- List of contaminants occurring in public water systems which may require regulation.
- Criteria for state implementation of wellhead protection program.

### *Clean Air Act*

- National Ambient Air Quality Standards: carbon monoxide, particulate matter, sulfur oxides, nitrogen oxides, ozone.
- National Emissions Standard for Hazardous Air Pollutants—organics.
- Control of excess evaporative emissions/fuel volatility.
- Gasoline marketing control strategy.
- Treatment, storage and disposal facility area source air emissions—RCRA standards.

### *Toxic Substances Control Act*

- Testing rules and standards, Section 4—various.
- Biotechnology rule—significant new use rule; pre-manufacturing notification and reporting requirements.

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### *Federal Insecticide, Fungicide, and Rodenticide Act*

- Strategy for regulation of inert ingredients in pesticide formulations.
- Special and routine reviews of registration/reregistration.

### *Cross Media Issues*

- Strategy for control of municipal waste combustion.
- Stratospheric ozone protection plan.
- Agency indoor air quality policy.
- Air toxics strategy.
- Risk assessment guidelines implementation.
- Integrated Environmental Management Program.
- ORD Regional Communication Study.
- Regulatory endpoints for environmental risk assessment.
- Implementation of chlorinated solvents integration strategy.

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## **Water Research Committee**

### **Introduction**

EPA's water research program provides the knowledge and methods required to protect our Nation's freshwater and marine environments, to ensure the continued safety of our drinking water supplies, and to implement the most cost-effective wastewater treatment technologies. Demands on water supplies are increasing while chemical contamination from toxic wastes and waterborne diseases are posing major threats to some localities. Traditional methods and strategies to measure and control pollution effects, especially from organic chemicals, may no longer provide the level of assurance demanded by the public. In order to meet the challenges of increasingly complex contaminants in water, research must develop effective approaches to assess a growing number of potentially harmful mixtures of organic, toxic and chlorinated organic compounds. Water management is becoming more complicated, and regulators in both the federal and state sectors require greater scientific certainty as a basis for their decision.

In this context, EPA's health effects research is important to the development of both drinking water and ambient water quality regulations. The engineering research program's evaluation, development and transfer of innovative treatment technologies to municipalities, industry and private landowners assists in the implementation of cost-effective alternatives. EPA is also accelerating its research into the toxic impacts to fish, wildlife and their ecological systems. Finally, the necessity for credible research and monitoring data is a cross-cutting issue of significance to the entire research program.

Water research activities will continue to provide support to the Agency in the following areas: developing revised and new drinking water Maximum Contaminant Levels and Health Advisories; developing Criteria Documents and the scientific underpinnings of ambient water-quality regulatory policies; assisting the Regions and States to meet the burgeoning demand for toxicity-based National Pollutant Discharge Elimination System (NPDES) permits; providing technical support to the municipal wastewater construction

program in pretreatment, sludge, infiltration/inflow and protecting ground water resources.

The six topics described in this report represent the principal concerns in the water research area. Specific research outputs supporting each topic appear in the final section of this water research committee report

### **Major Research Issues**

#### **ISSUE: 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. 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 allocation 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. Measurement of toxic concentrations of chemicals in water, sediment and tissue is required. Speciation of elements, metallic compounds, and PCBs by GC/MS are to be included in these measurements.

#### **1986 Program Accomplishments**

During FY 1986, the health research program continued to develop and evaluate health effect bioassays for the National Pollutant Discharge Elimination System/Water Quality Based Approach (WQBA) permitting program. Research has been conducted to enhance our knowledge of collection, concentration, and bioassay techniques for evaluating the health effects of wastewater effluents. Modifications to existing protocols for the Salmonella mutagenicity assay and the Chinese Hamster Ovary cell cytotoxicity assay have increased the sensitivity for detecting these biological endpoints in whole wastewater samples. Using this modification, mutagenicity and toxicity were detected in wastewater, and these effects

were not previously detected using the standard protocol. A preliminary finding has demonstrated that over 80% of the mutagenic activity of wastewater effluents was identified in the particulate matter. Determination of the physical state of mutagenic components of wastewater would have a significant effect on the assessment and management of the disposal options to protect human health.

A site has been selected on the York and James Rivers to study the relationship between microbial indicators of water quality and disease in clam and oyster consumers. Background measurements of various microbial indicators have been made in the harvesting waters and in the shellfish meats prior to beginning the human clinical study. OMB approval to conduct the human clinical study was obtained in the last quarter of the year.

Manuals were published for the identification of marine invertebrates and phytoplankton. Improved alternative media for total coliform bacteria were developed and validated in an interlaboratory study. Mammalian cell culture methods for virus analysis were updated and published to replace dated material in the existing (1984) USEPA Virology Methods Manual

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 were provided for use by Regions

In the area of monitoring and quality assurance, three reference calibrations were added to the repository of biological toxicity testing systems, single laboratory precision/accuracy testing was performed for biological and chemical test procedures; and reference materials and performance audit materials were supplied to support freshwater analysis. Performance evaluation studies were conducted for trace metals, minerals, nutrients, PCBs, pesticides, volatile organics, cyanides, residues, and oil and grease. Biological quality control samples, calibration standards, and other quality control samples were distributed

The environmental processes and effects program has completed several major projects in 1986. These include completion of: a report on analytical components of a field study to test wasteload allocation (WLA) models; workshops on selected WLA models and the development of user's manuals for two models; a map of aquatic ecoregions for the coterminous United States and a report on methods to measure bioaccumulation from pollutants in sediments. Several case studies using toxicity tests of complex effluents were finished. An evaluation was conducted of the

toxicity factor model to derive site-specific criteria, and evaluation of site-specific ammonia criteria for a field site was carried out. Ambient water quality criteria were completed for nickel, Dursban, pentachlorophenol, dissolved oxygen, toxaphene, selenium and zinc. In addition, several ambient water quality advisories were also prepared.

### *1987 Program Outlook*

The health research program will continue to generate data which is suitable for performing assessments of the potential health effects from wastewater effluents. Assessment of the relative potency of a given wastewater effluent will be based on biological data in comparison with relevant reference chemicals and environmental mixtures for which there are documented effects. A report on the evaluation of health effect bioassays methods for testing wastewaters will be published

The human clinical study to determine the relationship between microbial water quality indicators and disease in shellfish consumers will begin. The first year will concentrate on oysters. In FY 1988, clams will be used in the clinical studies

In the scientific assessment area, 10 human health chapters for Ambient Water Quality criteria documents will be prepared. Ten water quality advisories will also be developed for OW. Reviews of four 301(g) variance requests will be completed. Response to technical assistance requests will continue.

The monitoring and quality assurance program will continue to emphasize the generic instrumental approach in order to provide the most cost-effective methods possible. This will include continuing work on GC/MS and HPLC/MS methods for organic chemicals, ICP methods for metals and ion chromatography for specific ion and metals speciation in ambient waters, municipal sludge, sediments and biological tissue. Research will continue the development of an on-line fiber optics toxic analyzer

A manual containing five standardized, short-term chronic effluent toxicity test methods for marine organisms will be published. Standardized methods will be developed for specific human pathogens such as Salmonella, Hepatitis A virus and rotavirus in sludges, waters and wastewaters. Additional reference toxicants and other biological reference materials will be developed and distributed

The environmental processes and effects program will continue to develop, improve, simplify, and test data bases and wasteload allocation models to implement the water quality based approach. The Center for Water Quality Modeling will maintain and provide model codes, user manuals, training and user assistance. In addition,

work on the national atlas and maps of aquatic ecoregions will continue.

Toxicity test methods for aquatic life will be developed, improved, 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. Freshwater and marine specific chemical aquatic life criteria and advisories will be developed as needed. The research program will develop, modify, and apply experimental knowledge-based expert systems for environmental assessment needs.

Research will be conducted to strengthen the scientific and technical data base to support the Agency's effort to reduce the loss or degradation of the wetlands. Improved methods will be developed to assess individual and cumulative impacts of wetland conversions as well as effective means of mitigating impacts.

The cooperative ecological research with the People's Republic of China will continue in FY 1987 to address the impact of contaminants on freshwater organisms, and will be at the stage in which field verification of methodologies will be emphasized.

## ISSUE: Wastewater Treatment Technology

This issue focuses on the identification and evaluation of technologies to improve the reliability and cost-effectiveness of municipal and industrial wastewater treatment facilities. This research emphasizes the technical area in support of the development and implementation of regulations for the management of sludge produced by waste treatment plants. Standardized analytical methods and quality assurance practices are needed to support these efforts.

### *1986 Program Accomplishments*

In the scientific assessment area, a quantitative risk assessment for the land application/distribution and marketing sludge disposal option for pathogens was initiated using a revised version of the Sandia Lab fate and transport model. Qualitative pathogen risk assessments for sludge landfilling and ocean disposal options were completed.

In the engineering area, major accomplishments included five Regional seminars on evaluation of I/A projects for the 100% modification/replacement

program, and the completion of eight I/A technology evaluations. The Process Design Manual for Disinfection was published and distributed at the October 1986 WPCF conference. Five Regional seminars on "Improving POTW Performance Using the Composite Correction Program Approach" were presented. Ten Design Information Series reports were produced. Toxics Interference Manual for Municipal Wastewater Treatment was prepared in support of pretreatment regulations. Assessment of the capability of six alternative treatment technologies for the control of toxics in marine waste discharges and a survey of toxics reduction on six Ohio municipal wastewater treatment plants were conducted. Reports were completed on evaluations of enhanced chemical oxygen demand (COD) removal in pharmaceutical wastewater, pilot anaerobic biological treatment of pulp mill evaporator foul condensates, evaluations of granular carbon treatment of pesticide manufacture wastewater, toxic reduction evaluations at a multipurpose special chemical plant with the development of a modified Walsh fractionation procedure to identify toxics, and alternatives to toxic organic paint strippers.

The engineering research program continues to support the development of sludge regulations. Technical support was provided to revise the draft regulations on the pathogen content of sludge for land disposal. A paper entitled "Basis for Risk Reference Dose for Dietary Cadmium Intake" was published.

In the health effects area, research activities were directed toward determining the health effects of pathogens, organic and inorganic chemicals in sludge. In addition, HERL has had major input to ECAO's efforts to provide risk assessment models for pathogens in sludge.

A study of the pathogen content of D&M sludge products was initiated in FY 1986 to evaluate the regulatory needs for the safe use of composted sludge. Municipal sludges which are marketed or otherwise distributed to the public as soil amendments or fertilizer will be analyzed for both organic and inorganic priority pollutants. Six composite samples from each of two major cities will be analyzed as well one composite sample from each of 24 smaller cities. In addition to priority pollutants, the mass spectra of the chromatograms will be examined for other substances which occur frequently or in high concentrations. A report on this study will be completed by September 1987.

In addition, research results on the leaching of viruses from sludge, survival of enteric viruses during sludge storage, and determination of the stability of viruses in sludge extracts were published. These data will be useful in conducting pathogen risk assessments.

A final report on the Lubbock Infection Surveillance Study describing the relationship between land application of wastewater and infections in an exposed population was published in 1986. The data from this study will be useful in determining the risks of infectious disease to humans living near wastewater land application sites. The final report from the Ohio Farms Sludge application study was completed, and three separate sections reported on: (1) Health Effects; (2) Tissue Metal Residues; and (3) Estimation of Cadmium Intake.

In the monitoring and quality assurance areas, a report reviewing and updating the "Guidelines Establishing Test Procedures for Analysis of Pollutants" was published in the Federal Register. A report on "Systematic Approach to Methods Development for RCRA Appendix VIII Analytes" was made at the Industrial Wastewater "Annual Symposium on the Analysis of Pollutants in the Environment."

### *1987 Program Outlook*

In the scientific assessment area, identification of five second round Hazard Indices/Environmental Profiles and one Pathogen Prototype Criteria document for viruses will be initiated. The scientific assessment program will respond to the SAB and public comments on land application chemical risk assessment methodology. The pathogen land application/distribution and marketing risk assessment methodology and a bacteria prototype document will be delivered to OWRs.

In the engineering area, technology evaluations in support of the 100% modification/replacement program will be continued. The design, cost and performance information will be developed for sludge stabilization and dewatering processes, and the evaluations of sludge management alternatives. Work on improved design procedures and parameters to correct design deficiencies and improve performance and compliance of POTW will be conducted toward the completion. Toxicity reduction evaluation protocols and case histories, and approaches to enhance toxics removal in wastewater treatment will be conducted. Work will be initiated on the engineering data base and managerial techniques needed by states to apply a system engineering approach in implementing the water quality control programs. Evaluations of treatment technologies will be continued to assist the Industrial Technology Division in the development of BAT limitations, and on toxicity reduction evaluations for use by permitting authorities in writing best professional judgment (BPJ) NPDES permits. Work in toxics to be conducted includes assessment of treatment mechanisms and the fate of toxics during

wastewater treatment, pilot study on acclimated and un-acclimated wastewater, evaluation of industrial wastewater treatment methods for the removal of pharmaceutical chemical oxygen demand (COD) in powder activated carbon treatment (PACT) wastewater treatment, the removal of phthalates from plastic molding and forming wastewaters, and ammonium from tungsten wastewater. A data base on the kinetics of removal of toxics by sorption, volatilization, and biodegradation will be developed. Methods to facilitate evaluation and prediction of the consequences of disposal of various wastes into the freshwater and marine environment will be evaluated and determined.

In FY 1987, HERL plans to develop a computer simulation method based on Kjellstrom and Nordberg's kinetic model of cadmium metabolism in the human being that will allow predicted population frequency distributions of accumulated renal cortex cadmium. Expected cadmium injection levels resulting from various sludge usage scenarios recently developed by HERL and MERL staff will be used to predict the effect of the increased cadmium in the food supply.

A field study to determine the survival of *Ascaris* ova in sludge amended soil will be completed in early FY 1987. Further studies on the infective dose of enteric viruses will continue into mid-FY 1988.

The monitoring and quality assurance program will review, update and distribute the annual report on "Guidelines for Establishing Test Procedures for the Analyses of Pollutants." Research to evaluate and standardize HPLC/MS methods for sludge matrices is planned. Plans to assist the regions in evaluation and improvements of flow measurement techniques and equipment are being made. Supercritical fluid extraction techniques for field preparation of samples will be investigated.

Rapid, advanced techniques will be evaluated and standardized to detect and monitor toxicity entering municipal waste treatment plants and to measure toxicity reduction during waste treatment processes.

Research will be conducted to identify and determine the distribution of unlisted chemicals in industrial wastewater. Compounds that can be identified by empirical mass spectra matching, as well as those that elude identification by this technique, will be included.

### **ISSUE: Marine, 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, the 301(h) waiver program and the NPDES program. Technology-related research in this area focuses on

correlations between the type of treatment and the resulting environmental impacts following disposal and is expected to be 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 Offices, the Regions and the International Joint Commission under the US/Canada Water Quality Agreement.

### ***1986 Program Accomplishments***

In support of EPA's ocean disposal activities, effects and exposure methods were evaluated. Emphasis was given to the development of a wasteload allocation model for municipal sewage sludge at the 106-mile ocean dumping site. The correlation of laboratory and field bioaccumulation data for pollutants from dredged material was completed. Researchers supported the 301(h) waiver program for ocean outfall discharges by providing technical assistance, as part of a national task force, for several applicants nationwide. Methodologies were developed/evaluated for use in predicting and assessing the effects of emission products from the at-sea incineration of hazardous wastes. An inter-laboratory comparison of toxicity from selected drilling fluids was conducted. A report on the desorption of toxic metals from sludge to marine waters was also completed.

EPA's Great Lakes program was supported through the development of a documentation manual for a phytoplankton simulation model, completion of a study of biological effects along a chemical gradient, and the development of a source-fate-transport-exposure toxicity model for a Great Lakes area of concern (Raisin River). A high level of technical assistance was also provided to the Great Lakes National Program Office, the Regions and the International Joint Commission.

### ***1987 Program Outlook***

The marine research program will continue to develop and test assessment procedures for evaluating the impact 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 tissue residues and biological effects. The program will also continue to evaluate the impacts of drilling fluids and produced waters on the marine

environment. Research to develop a procedure for evaluating alternative technology options and their impact on the viability of ocean dumping will continue. Technology related research in this area will focus on the desorption of toxic organics from sludges to marine waters and on the fate of toxic organics and metals during treatment.

The estuarine research program will be developing generic procedures for conducting wasteload allocations in estuaries. These procedures will be used to help make better source control decisions in the NPDES and construction grants programs.

Great Lakes research will study the transport, fate and effects of toxics. Emphasis will be given to problems related to in-place pollutants. In addition, substantial technical assistance will continue to be given to the Office of Water, the Great Lakes National Program Office, and the Regions.

The Office of Water is developing a Near Coastal Waters Strategy. The goal of this strategy is to maintain, and where possible, enhance environmental quality of near coastal waters. A research plan will be developed which is responsive to the needs expressed in the strategy.

### **ISSUE: 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 risk in human populations exposed to various drinking water contaminants, and providing criteria documents summarizing the relevant scientific data to support the health risk assessment.

### ***1986 Program Accomplishments***

In FY 1986, 10 and/or 90 day toxicity studies were completed for the following compounds: tetrahydrofuran; 1,2-dichloropropane; 1,2,3-trichloropropane; ethylene glycol; chlorobenzene; 1,3-dichlorobenzene; and 1,2-dichloroethane. The data from these studies will be used by ODW to develop Maximum Contaminant Level Goals (MCLG) in support of drinking water standards.

Trichloroethylene (TCE) has been reported to increase the incidence of liver cancer in mice, but not rats. Evidence suggests that the species sensitivity to TCE resides in its ability to induce peroxisome proliferation in mice, but not in rats. Mice were shown to be sensitive to trichloroethylene and trichloroacetic acid (a by-product of TCE metabolism) induction of

peroxisome proliferation while rats were insensitive. Both species were sensitive to dichloroacetic acid, while monochloroacetic was inactive in either species. Cytotoxicity studies using primary cultures of rat and mouse hepatocytes reflected the sensitivity to the TCE metabolites seen for peroxisome proliferation induction *in vivo*. These data support the idea that mouse liver sensitivity to induction of peroxisome proliferation by trichloroacetic acid in part underlies the carcinogenicity of trichloroethylene in that species.

Chlorine dioxide and chlorite were evaluated for effects on neurobehavioral development of rat pups. Rat pups were indirectly exposed (via their dam's drinking water) to various levels of these compounds. The development of locomotor activity of the rat pups was tested in a home cage apparatus from 14 through 21 days of age. Pups exposed to both compounds exhibited delays in the development of locomotor activity when compared to controls.

A study to determine the carcinogenic and tumor promoting activity of dichloroacetic acid, trichloroacetic acid and trichloroethylene administered in the drinking water to B6C3F1 mice was completed. The results indicate that both dichloroacetic acid and trichloroacetic acid are hepatocarcinogens. Not only are these chlorinated acetic acids contaminants of drinking water, but trichloroacetic acid is a major metabolite of trichloroethylene and perchloroethylene. Therefore, our results might also explain the hepatocarcinogenic activity of trichloroethylene and perchloroethylene, which are industrial contaminants of ground and drinking water.

The study of health effects associated with point-of-use granular activated carbon (GAC) filters in the home is nearing completion. Preliminary results from that portion of the study dealing with by-pass GAC home filters indicate that there is no excess illness or infection in a study group who used this type of filter relative to a group that did not use GAC filters. The data from this portion of the study were very similar to that observed with faucet type GAC filters, where no excess illness or infections were linked to filter use.

A two-day training session detailing *Giardia* Immunofluorescent Antibody techniques was conducted. Representatives from Regions I and X, the Pennsylvania Department of Environmental Resources and the University of Pittsburgh attended the session.

The re-evaluation of the Aluminum Drinking Water Criteria Document (DWCD) initiated some minor revisions. Future action on this document awaits direction from the Office of Drinking Water (ODW). Public comments on all 28 Phase II documents have been received and reviewed and

appropriate responses have been delivered to ODW.

Three Phase IV drinking water criteria documents on disinfectants and disinfectant by-products were externally peer reviewed (chlorine and by-products; chloramines and ammonia, chlorophenols). A workshop was conducted on all eight of the Phase IV documents. The eight Phase V documents have been revised and prepared for external review. The 30 health advisories for Section 1445 unregulated VOCs were revised to incorporate comments received from OHEA and internal ECAO-CIN reviews (rough external review drafts).

### 1987 Program Outlook

In FY 1987, the health effects program will conduct 10 and 90 day subchronic toxicity studies on: 1,2-dichlorobenzene, epichlorohydrin, 1,1,1-trichloropropanone, chloropicrin, monochloramine, chlorine, monochloroacetic acid, 2,4,6-trichlorophenol, and 90 day studies on dichloro- and trichloroacetic acids.

In order to resolve the questions relating disinfection of drinking water to cardiovascular disease, the following studies will be initiated: a second pigeon study on the primary disinfectants to independently repeat the previous study, an animal study on chlorine, chlorine dioxide, and chloramine. Human clinical studies on the disinfectants and cardiovascular disease parameters will be completed as well as the currently ongoing epidemiology study.

To determine the role of MX as a possible mutagenic by-product of disinfection, *in vivo* tests will be conducted to determine the mutagenicity and tumorigenicity of MX. This data will be important in validating the results of *in vitro* studies and will directly support development of an MCLG for this disinfection by-product.

The microbiology research program will conduct a study to determine the risk of infectious diseases in populations using point of entry drinking water treatment devices. Infectivity data will be developed for an additional 20 heterotrophic organisms isolated from in home granular activated carbon filters. A feasibility study will be conducted to determine if a population can be identified to determine the health significance of low levels of viruses in finished drinking water. Research on identifying *Giardia* cysts in water supplies and determining their viability and infectivity will continue.

Twenty-eight Phase II documents will undergo quality assurance/quality control (QA/QC) checks for submission as final documents. The aluminum document will be finalized pending guidance from ODW. Phase IV documents will incorporate all external review comments (Public/Workshop).



Phase V documents will undergo external review and final drafts will be prepared. Health advisories will be prepared as final External Review Drafts.

### **ISSUE: 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 by-products. 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 analytical methods and mandatory quality assurance areas, 10 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 measurements 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 1986 Accomplishments***

A report on the cost and performance for treatment of synthetic organic chemicals was produced to assist Phase II regulations. Evaluation of inplant trihalomethane control technology was completed to provide cost and performance information. An interim report on the inactivation of microbial agents by chemical disinfectants was produced. Evaluations of silicate and phosphate compounds for their ability to inhibit corrosion of different pipes were completed.

About 15 final reports were produced to provide information on such topics as trihalomethane control techniques, removal of radium from drinking water, and the control of dioxins from a granular activated carbon regeneration furnace.

About 25 presentations were made at national and international meetings on EPA research activities in VOC removal techniques, distribution system problems, virus and bacteria inactivation by disinfection, and the effective operation of water filtration plants.

In support of the revised Primary Drinking Water Regulations, analytical "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water" were developed. These include packed wide-bore and capillary GC and GC/MS methods for the nine volatile organic chemicals (VOCs) and the 51 Section 1445 VOCs requiring monitoring. A method employing the wide-bore column and the photoionization and electrolytic conductivity detectors in series is being evaluated for determination of all 60 compounds. The laboratory continued to support the National Inorganics and Radiochemical Survey and is developing analytical methods for the National Pesticides Survey.

Drinking water certification training courses were offered to regional and state personnel in chemistry and microbiology. On-site laboratory evaluations were made in response to regional requests.

The Presence-Absence test, a rapid, inexpensive method for detecting coliform bacteria in finished drinking water, was evaluated. State-of-the-art reports were prepared for methods for several microbiological parameters under consideration for proposed regulation of maximum contaminant levels.

### ***FY 1987 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 waterborne 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 operation criteria, and institutional and pricing policies will also be studied. Field scale evaluations of granular activated carbon (GAC) technology and additional treatment technology data for new chemicals under the Safe Drinking Water Act

Amendments will be initiated in support of regulation developments.

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 including synthetic organic chemicals (SOCs) which have been established. Final standardized methods for these SOCs and the pesticides for the underground water survey will be published. The program will also conduct laboratory certification for the 10 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 radiochemicals analysis of drinking water.

Research will begin on the development and standardization of rapid, inexpensive new methods, such as gene probes and monoclonal and polyclonal antibody methods for detecting and quantifying pathogen microorganisms in water supplies and finished drinking water.

## ISSUE: Ground Water

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 contaminated 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 for the costs of methods for *in-situ* cleanup of already polluted aquifers.

### 1986 Program Accomplishments

A number of significant scientific advances were reported. "Aerobic Degradation of Halogenated Methanes, Ethanes, and Ethylenes by a Natural Gas-Stimulated Microbial Community" reported the discovery of a method by which trichloroethylene and other important ground water contaminants may be degraded in place. "Behavior of the Hepatitis A Virus in Subsurface Systems" and "Predictive Models for Pathogens in Ground

Water" described our increasing knowledge about potential contamination of underground water supplies from surface sources. "Physical and Chemical Components of Dispersion" provided important new information about a significant problem in ground-water contaminant models.

Two major reports were published: *EPA Ground-Water Research Programs*, and *Ground-Water Quality Protection—State and Local Strategies*.

Training efforts continued with basic ground-water hydrogeology courses taught at five EPA Regions, and the publication of a Training Manual on Ground Water Contaminant Modeling. Other important information transfer efforts also continued with support of the International Ground-Water Modeling Center and the National Ground Water Information Centers.

### 1987 Program Outlook

The program will continue to focus on studies of subsurface processes such as sorption, biotransformation, redox, hydrolysis, and ion exchange. Research to evaluate the cost-effectiveness of aquifer restoration methods, such as the one described above for trichloroethylene, will also continue.

Major outputs are expected to support the current regulatory emphasis on determining the safety of deep-well injection of wastes. Research is underway on fluid front movement from Hazardous Waste injection wells, interaction of injected fluids with injection zone materials, and mechanical integrity test methods.

Emphasis will also continue on technical assistance and information transfer. Training of Regions is expected to continue for several years, and support of the International Ground-Water Modeling Center and the National Ground Water Information Center will also continue.

Research resulting from the wellhead protection provision of the Safe Drinking Water Act Amendment is being proposed.

In the monitoring and quality assurance 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.

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## Environmental Results and Projected Output

### ISSUE: Water Quality Based Approach/ Permitting

#### *FY 1986 Results*

- Report on Evaluation of Metals Dissolution for Chromium.
- User-Friendly IBM PC Computer Programs for Solving Sampling and Statistical Problems.
- Development of Methods for Collection and Analysis of Precipitation.
- Report on Methods for Distinguishing Compounds of Mercury.
- Third Quarter/Annual Alternative Test Procedure (ATP) Application Report.
- Equivalency Applications Received, Notice and Comments Published in Federal Register, Final Notice Published in Federal Register.
- Methods for Selected Synthetic Organic Compounds—Summary Report.
- Evaluation of Method 200.1, Determination of Acid Soluble Metals.
- Recommendations to the Office of Drinking Water on Analytical Procedures for Virus Monitoring of Drinking Water.
- Status Report on "Virus Recoveries from Retrofitted Aerobic Sludge Digestors," submitted to Wastewater Research Division, Water Engineering Research Laboratory, Cincinnati.
- Report to Wastewater Research Division, Water Engineering Research Laboratory, Cincinnati, on indigenous viruses isolated from sludge digestors undergoing different feeding protocols.
- Annual Report on the Repository for Toxic and Hazardous Materials.
- Annual Report on Quality Control Samples Program.
- Annual Report on Referee Analytical Services.
- Annual Report on the Traceability to the National Bureau of Standards.
- "Methods for Synthetic Organic Compounds (SOCs)."

- Report on analytical components of field study to test WLA models.
- TOXIWASP Workshop—Annapolis, MD.
- QUAL—Ile Workshop—Boston, MA
- User's manual for metals including enhancements to MEXAMS with tutorial.
- Map of aquatic ecoregions of the conterminous United States.
- Journal article on methods to measure bioaccumulation resulting from sediment toxicants.
- Report on case studies on toxicity tests of complex effluents to predict aquatic community impacts—Ohio River, Wheeling, WV, Skeleton Creek, Enid, OK, Naugatuck River, Waterbury, CT, and Kanawha River, Charleston, WV
- Report on feasibility of toxicity factors model to derive site-specific criteria.
- Journal article on field evaluation of site-specific criteria for ammonia.
- Ambient Water Quality Criteria for Nickel, Dursban, Pentachlorophenol, Dissolved Oxygen, Toxaphene, Selenium and Zinc.

#### *Projected FY 1987 Outputs*

- Delivery of 10 Water Quality Advisors (human health portions) to the regions on unregulated chemicals found in ambient water.
- Preparation of 10 human health documents of Ambient Water Quality Criteria on presently unregulated chemicals.
- Review of up to four 301(g) CWA, variance requests for program office acceptance process.
- Response to technical assistance as requested.
- Quality Assurance Support of Regional, State, Municipal Monitoring by Preparation and Distribution of Calibration Materials.
- Evaluation and Validation/Standardization of Monitoring Methods for Monitoring Methods: Chemical, Biological, and Physical.
- Development/Improvement to Monitoring Methods: Analysis of Sludge and Wastewater Contaminated by Non-Gas Chromatographic/Mass Spectrometer Analyzable Pollutants (Dye Formulator).

- Health Effects Bioassay Methods Manual for Determining Whether Receiving Streams Meet Water Quality Standards.
- Report on framework for application of ecoregional approach to water quality standards setting.
- Report on the relationship between lipid content, body burden, and thermodynamics calculation of bioaccumulation.
- Report on updated documentation for QUAL-Ile including uncertainty analysis.
- Training courses, through the Center for Water Quality Modeling, including QUAL-Ile, WASP 4.1, EXAMS II and CYNTOX.
- Journal publication and guidance relative to toxicity persistence
- Report on the feasibility of using complex effluent toxicity to allocate wasteload at an estuarine site.
- Report on toxicity characterization at a field site.
- Journal article on the life cycle toxicity of AI, low ca, and low pH to fathead minnows.
- Report on use of toxicity factors for Copper Criteria.
- Ambient Water Quality Criteria for 10 compounds.
- Ambient Water Quality Advisories for 10 compounds.
- Journal article describing algorithms for estimating photochemical rate constants from chemical properties.
- Report on design of a decision support system for freshwater wetlands.
- Report on experimental approach to testing of mitigation projects.
- Process-based ecosystem model of water quality functions of freshwater wetlands.
- Report on approach for assessing the cumulative impacts of wetland loss.
- Internal report on application of water quality criteria and effluent toxicity tests in the control of toxic chemicals in China.
- Internal report on application of models for conventional and toxic pollution assessment in China.

- Internal report on joint US-China studies on pollutant transformation processes.

## ISSUE: Wastewater Treatment Technology

### *FY 1986 Results*

- Initiation of a quantitative risk assessment for the land application/distribution and marketing sludge disposal option for pathogens.
- Completion of qualitative pathogen risk assessments for sludge landfilling.
- Completion of qualitative pathogen risk assessments for sludge ocean disposal options.
- Regional seminars on evaluation of I/A projects for the 100% modification/replacement program
- Evaluation reports on eight I/A technologies.
- Process design manual for wastewater disinfection.
- Regional seminars on "Improving POTW Performance Using the Composite Correction Program Approach."
- Series reports on design information.
- Toxics interference manual for municipal wastewater treatment.
- Assessment of the capability of six alternative treatment technologies for the control of toxics in marine waste discharges.
- A survey of toxics reduction of six Ohio municipal wastewater treatment plants.
- Report on evaluations of enhanced COD removal in pharmaceutical wastewater.
- Report on pilot anaerobic biological treatment of pulp mill evaporator foul condensates
- Report on evaluations of granular activated carbon treatment of pesticide manufacture wastewater
- Report on toxic reduction evaluations at a multipurpose special chemical plant with the development of a modified Walsh fractionation procedure to identify toxics.
- Technical support to revise the draft regulations on the pathogen content of sludge for land disposal.
- Report on the current frequency of occurrence of toxic pollutants in industrial wastewater.

- Report on the results of a feasibility study to determine the best tool for database management system (DBMS) construction.

### *Projected FY 1987 Outputs*

- Revision/refinement of five environmental profile documents to be utilized by OWRS for screening of chemicals for possible regulation under CWA 405(d).
- Delivery of the pathogen land application/distribution and marketing risk assessment methodology for health-based criteria to OWRS.
- Delivery of Bacteria Prototype Document for Deriving Criteria for Bacteria in Sludge to OWRS.
- Report on the Occurrence of Microorganisms in Distribution and Marketing Sludge Products.
- Technology evaluations in support of the 100% modification/replacement program.
- Report on the design, cost and performance information for sludge stabilization and dewatering processes.
- Evaluations of sludge management alternatives.
- Improved design procedures and parameters to correct design deficiencies and improve performance and compliance of POTW.
- Toxicity reduction evaluation protocols and case histories, and approaches to enhance toxics removal in wastewater treatment.
- Evaluations of treatment technologies to assist the Industrial Technology Division in the development of BAT limitations.
- Toxicity reduction evaluations for use in writing best professional judgment (BPJ) NPDES permits.
- Reports on the removal of phthalates from plastic molding and forming wastewaters, and ammonium from tungsten wastewater.
- Development of data base on kinetics of removal of toxics by sorption, volatilization, and biodegradation.
- Report on performance of capillary column data using the VAX 785 computer.

## ISSUE: Marine, Estuaries and Lakes

### *FY 1986 Results*

- Development of wasteload allocation model for municipal sewage sludge at the 106-mile ocean dumping site.
- Correlation of laboratory and field bioaccumulation data for pollution from dredged material.
- Technical assistance in support of 301(h) waiver program for ocean outfall discharges, and to national and international offices with Great Lakes concerns.
- Development and evaluation of methods to assess effects of emission products from hazardous wastes incinerated at sea.
- Inter-laboratory comparison of toxicity from selected drilling fluids.
- Development of source-fate-transport-exposure toxicity model for Great Lakes area of concern—the River Raisin.

### *Projected FY 1987 Outputs*

- Development and testing of procedures for evaluating impacts of ocean dumping/ocean outfall discharge of wastes.
- Evaluation of significance of bioaccumulation processes, tissue residue, and biological effects of contaminants in wastes to be ocean-disposed.
- Evaluation of impacts of drilling fluids on marine environments.
- Development of procedures for conducting wasteload allocations in estuaries to support NPDES and construction grant programs.
- Elucidation of problems related to in-place pollutants in Great Lakes; technical assistance to national and international offices with Great Lakes concerns.
- Development of research plan to respond to Near Coastal Waters Strategy.

## ISSUE: Health Effects Drinking Water Documents

### *FY 1986 Results*

- Preparation of 30 draft Drinking Water Health Advisories on unregulated VOCs.

- Disposition of public comments received on Phase II DWCDs and Agency response document.
- Three final draft documents of the Phase IV documents on disinfectants and disinfectant by-products.
- Eight external review drafts of Phase V chemicals.
- Report on the Percutaneous Absorption of Chemicals in Drinking Water.
- Published International Symposium on the Health Effects of Disinfectants and Disinfectant By-Products.
- Published a Review of the Occurrence and Significance of Viruses in Drinking Water.
- Published an Annual Summary of Waterborne Disease Outbreaks.
- Report on Parameters Governing the Volatilization of Trichloroethylene into Indoor Air from a Laboratory Model Shower.

### *Projected FY 1987 Outputs*

- Finalization of 22 Phase II DWCD for MCLGs/MCLs proposal 1988.
- Incorporation of external review comments and updating 16 Phase V documents for MCLGs/MCLs proposal 1989.
- Updating three Phase IV DWCD on disinfectant and disinfectant by-products for FY-90 regulation.
- Report on Cancer and Reproductive Hazards of Principal Contaminants in Drinking Water.
- Report on Target Organ Toxicity of Major Chemical Contaminants in Drinking Water.
- Report on Cardiovascular Disease Risk Factors in Populations Supplied with Chlorinated and Nonchlorinated Drinking Water of Varying Hardness.
- Determination of Virulence and Growth Conditions of Legionella.

## **ISSUE: Drinking Water Technology**

### *FY 1986 Results*

- Provided and distributed 55,000 quality control and performance evaluation samples for chemical, radionuclide, and microbiological analysis of drinking water.

- Conducted methods validation studies for organic, inorganic, and microbiological analysis of drinking water.
- Evaluated 10 regions and personnel for capabilities to provide quality data in support of the NIPDWR's monitoring (laboratory certification) program.
- Evaluated alternate test procedures for chemical, microbiological and radiochemical analysis of drinking water.
- Report on the treatment of synthetic organic chemicals in drinking water.
- Report on the inactivation of microbial agents by chemical disinfectants.
- Report on investigation of treatment modifications other than the use of alternate disinfectants for the control of trihalomethanes.
- Report on investigation of design scale-up suitability for air stripping columns for the removal of volatile organic chemicals from groundwater.
- A report on the evaluation of the presence of dioxin and furans in all effluent streams from the fluidized-bed GAC reactivation furnace.

### *Projected 1987 Outputs*

- Provide methods development and analytical procedures to produce precise and accurate total measurement systems for chemical, radiochemical and microbiological analysis.
- Develop and distribute quality control (QC) and performance evaluation (PE) samples for drinking water laboratory certification and evaluation programs.
- Conduct laboratory evaluation for 10 regions for laboratory certification program.
- Evaluate alternate test procedures for drinking water analysis.
- Overview Agencywide mandatory quality assurance program for drinking water.
- Report on removal of radium from drinking water.
- Report on removal or prevention of disinfection by-products and precursors.
- Report on concentration times time (Cxt) values for Hepatitis A and coliphage inactivation.

- Report on carbon usage rate data for determining the cost of removal of specific organics on Phase II Regulatory calendar.
- Report on carbon usage rate data for determining the cost of removal of specific organics on Phase V Regulatory calendar.
- Report on inexpensive low-tech removal methods for radon.
- Report on performance and cost information on a full-scale ion exchange plant for nitrate removal.
- Report on field evaluation of packed tower aeration for the removal of volatile organic contaminants from groundwater.
- Report on the performance of air stripping and granular activated carbon for removal of volatile organic contaminants from groundwater.

## ISSUE: Ground Water

### *FY 1986 Results*

- Evaluating initial methods for constructing monitoring wells with hollow stem augers.
- Investigating use of fiber optics for monitoring contaminants in groundwater.
- Annual report on source variability affecting ground-water monitoring.
- Described a method by which trichloroethylene and other important ground-water contaminants may be degraded in the subsurface.
- Described how a number of viruses survive and move in ground water.
- Provided new evidence on the nature of dispersion, the most important problem in ground-water contaminant transport modeling.
- Provided a description of important strategies for State and local ground-water protection programs.
- Provided a consolidated description of current ground-water research.
- Provided materials and conducted training in ground-water modeling.
- Continued other important information transfer efforts, including the International Ground Water Modeling Center and the National Ground Water Information Center.

### *Projected FY 1987 Outputs*

- Report on the use of hollow stem augers for constructing monitoring wells.
- Report on developing methods for mapping fluid movement from injection wells.
- Field testing techniques for locating abandoned wells.
- Report on development of fiber optics for monitoring ground-water contaminants.
- Computer code and documentation for predicting organic chemical solubility in mixed solvent systems.
- Article on adaptation of subsurface microbes to degrade organic pollutants.
- Report on study of Class I injection wells.
- Report on cement bonding of injection wells.
- Interim report on the use of ground-water models in wellhead protection.