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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The Second National Conference

On The Interagency

Energy/Environment R&D Program

June 6 and 7, 1977

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John
Conference
82 gr. old room
w/ President
haven't had weeks. doesn't
want it, but same as last
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INTRODUCTION

The abstracts included in this publication were written by the participating authors for EPA's Second National Conference on the Interagency Energy/Environment R&D Program.

Each abstract has been provided to assist conference participants and guests in following the context of material presented by the rapporteurs. The full text of each paper, as well as speeches and question/answer sessions, will be printed in the Conference Proceedings.

The abstracts are organized by chapters, which correspond to the conference sessions. In addition, the placement of authors corresponds to the author sequence in your brochure.

CHAPTER I: FUEL PROCESSING

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ABSTRACT

ENVIRONMENTAL ASSESSMENT OF THE FLUIDIZED-BED COMBUSTION PROCESS

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In parallel with efforts by the U. S. Energy Research and Development Administration (ERDA) to develop coal-fired fluidized-bed combustion (FBC) systems for heat, steam and power generation, the U. S. Environmental Protection Agency (EPA) is conducting a contract research and development program aimed at complete environmental characterization of the process. The goal of the EPA program is early identification of any potential environmental problems associated with the FBC process, and timely and cost-effective development of any necessary control technology.

To accomplish this goal, the EPA program is divided into two major areas: environmental assessment and control technology development. Environmental assessment--which is the primary subject of this paper--consists of six key steps, including: (1) identification of current process/environmental background; (2) development of environmental emissions objectives for the process, based ultimately on health and ecological effects of possible pollutants; (3) comprehensive analysis of emissions from operating FBC units, to enable comparison of actual emissions with the goals; (4) assessment of the suitability of available/envisioned control technology to reduce observed emissions to the goal levels, where necessary; (5) analysis of environmental alternatives; i.e., the environmental and cost impact of alternative combinations of control technologies on an FBC system; and (6) identification of control technology R&D needs, based upon the previous steps. One key output of this effort will be Standards of Practice Manuals, and the data base to support New Source Performance Standards, effluent guidelines and hazardous waste standards.

Much effort is being devoted to development of the methodology for conducting environmental assessments. The status of the methodology development, and some initial results of the FBC assessment, are discussed. The major outputs of the control technology development part of the EPA FBC program are also outlined.

ABSTRACT

RESEARCH AND DEVELOPMENT PROGRAMS FOR POLLUTION CONTROL FROM OIL SHALE EXPLOITATION

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There are many areas of oil shale research and development in which the EPA plays an active role. In many cases the EPA shares funding responsibilities with other agencies, a few examples of which are discussed in the paper.

The EPA takes interest in other projects not funded by the EPA, projects whose results can be used for environmental assessment and control technology development. Duplication of effort is thus avoided.

Present EPA research is discussed, and examples are given in the areas of (1) Characterization, Measurement, and Monitoring; (2) Environment Transport Process; (3) Health Effects; and (4) Ecological Effects.

Planned EPA oil shale research and expected outputs are noted.

ABSTRACT

ENVIRONMENTAL CONSIDERATIONS OF SYNTHETIC FUELS

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Synthetic fuels, while offering solutions to problems associated with the utilization of coal, present some new environmental problems. Within the Federal government, these are primarily the responsibility of the Environmental Protection Agency. EPA's past efforts concerned with coal utilization and conversion (including those under its predecessor's name) have spanned over a decade. These earlier programs were involved with historical surveys, pollution control problem definitions, isolated research studies, and pioneering efforts.

EPA's present synthetic fuels program comprises a much more comprehensive approach which addresses the broad scope of high- and low-Btu gasification and liquefaction. The associated longer-term environmental assessment and control technology development contractual arrangements emphasize data acquisition and are supported by research grants to do fundamental studies.

Interagency agreements (e.g. with ERDA) are now providing a more complimentary mesh of environmental and energy concerns. Multi-agency data acquisition and analysis coordination will greatly enhance optimization: best controls at lowest costs and with greatest expediency to meet our Nation's energy requirements.

Past EPA accomplishments included coal characterizations, projections of pollutants, reports on numerous processes, field trips to overseas industrial sites, annual symposia, and reports in such related areas as combined cycles and fuel contaminant removal.

Ongoing activities have produced:

1) Methodologies for accomplishing objectives such as multi-media environmental goals establishment and control approach categoriztion.

2) Initiation of test plans, especially field data acquisition, and analysis by prime contractors.

3) Design and construction of reactor and acid-gas cleanup experimental facilities.

4) An approach to data acquisition, from plant sampling through chemical and biological analyses.

The future will include continued agreements with the public and private sector and establishment of a research data base needed for responsible evaluation of processes and setting of standards.

ABSTRACT

POLLUTION ABATEMENT FOR WASTES-AS-FUEL PROCESSES

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Technology development in the wastes-as-fuel area has progressed to the point that several full-scale systems are operational, under construction, or planned. As operational experience accumulates, the environmental aspects of waste-to-energy processes are becoming more clearly defined.

Pollutant sampling from waste co-firing with coal operations at Ames, Iowa, St. Louis, Missouri, and Columbus, Ohio, have indicated that particulate emissions from such plants increase while SO_x and NO_x emissions decrease. Data on other air emissions such as POM's, hydrocarbons, and trace metallic contaminants have so far exhibited no conclusive trends.

Pyrolysis plants, while less numerous than co-firing or mass-burning operations, emit air pollutants which, even though they are lower in total quantity than those from combustion plants, can be in forms and concentrations that are less easily managed.

In addition to air emissions, effluents such as sluice, quench, and condensate liquid discharges from wastes-to-energy operations are of sufficient magnitude to merit research attention.

EPA (IERL-Cinn. the Fuels Technology Branch) is conducting a research program that is addressing the needs for the abatement and control of air and liquid emissions from wastes-as-fuel plants. Pollutants at several federally- and privately-sponsored plants are being characterized. Through extensive extramural research efforts, the adequacy of existing pollution control approaches is being investigated. Finally, field testing of pilot-scale air and water pollution control processes will be conducted at existing waste-to-energy plant sites to improve the control efficiecy of existing technologies.

CHAPTER II: UTILITY AND INDUSTRIAL POWER

RAPPORTEUR
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ABSTRACT

THE FEDERAL INTERAGENCY FLUE GAS DESULFURIZATION PROGRAM

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One of our major energy-related environmental problems concerns the need to control SO_x emissions from stationary fuel combustion sources. Application of flue gas desulfurization (FGD) processes appears to present the major near-term control strategy which will permit the environmentally acceptable use of our coal resources.

For the past seven years, EPA and TVA have conducted a coordinated comprehensive program directed toward the development and demonstration of reliable, cost effective, and environmentally acceptable FGD technology. In the area of non-regenerable processes producing a throw away sludge, the advanced lime/limestone prototype test program funded by EPA at TVA's Shawnee Steam Plant is particularly important. Supporting efforts by the pilot plant at EPA's Industrial Environmental Research Laboratory in RTP have made important contributions to the program. In addition to these efforts, extensive programs are underway for the near-term commercialization of double alkali processes and to evaluate environmentally sound alternatives for sludge disposal. Regenerable FGD has been a major component of this Interagency Program to develop SO_2 control technology for stationary combustion sources. These processes regenerate the sorbent and produce a marketable by-product. The program has focused primarily on large scale development/demonstation of processes such as magnesium oxide scrubbing to produce sulfuric acid and Wellman-Lord/Allied technology to produce elemental sulfur, in order to accelerate commercialization of the technology. Other activities include laboratory, bench, pilot, and prototype scale evaluations. The overall program has been supported by technical evaluation studies, process and by-product marketing economic studies, monitoring and analysis, and other related work.

Significant non-regenerable and regenerable FGD activities related to utility and industrial combustion source applications are described and status and results are presented.

ABSTRACT

CONTROL OF FINE PARTICULATE EMISSIONS
FROM STATIONARY SOURCES

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The Environmental Protection Agency's R&D program for particulate control is designed to establish engineering design techniques and performance models, and to improve the collection capability and economics of control devices for particulate matter.

EPA is placing increased emphasis on the control of fine particulates which persist in the atmosphere, comprise a variety of known toxic substances, and are a major contributor to atmospheric haze and visibility problems. The objective is the development and demonstration of control technologies capable of effectively removing large fractions of the under 3 micron diameter particles from effluents. The technical approach is to identify capabilities of existing equipment (electrostatic precipitators (ESPs), filters, scrubbers and proprietary devices), to determine deficiencies in present design and operating procedures, and to pursue remedies for the deficiencies through research and development. New concepts and novel devices will be applied as identified and evaluated, and successful advancements in removal technology will be demonstrated.

Actual source tests have shown that both ESPs and baghouses should be capable of controlling fine particulate from a limited number of sources emitting fly ash. It is quite possible that the applicability of ESPs to fine particulate control over a broad range of sources can be extended by developing dust conditioning techniques and by modifying the design of charging sections and collecting electrodes. During 1975 a mathematical model for the design of ESPs was completed; this will allow cost-effective ESP design for specific particulate control technology applications. Also completed was the total characterization of seven ESPs operating on a number of sources ranging from power plants to aluminum plants; results show that ESPs can collect particles of all sizes with high efficiency when dust resistivity is not a problem.

The baghouse is rapidly becoming an important device for the control of particulate from utility boilers burning low sulfur coal where ash resistivity is such that ESPs are difficult and expensive to use. A baghouse on a large utility boiler will be demonstrated in the near future.

Source and laboratory tests have shown that conventional scrubbers are not very efficient collectors of fine particles. Current EPA R&D efforts to improve scrubbers are directed toward more efficient utilization of the energy applied to a scrubber system, and toward taking increased advantage of condensation and other physical phenomena. The advantage of the condensation phenomenon has been successfully demonstrated on the off-gas stream from a secondary metal recovery furnace.

An actual program of soliciting and testing emerging technology has resulted in demonstration of five novel devices and one new concept as good collectors of fine particles. About 40 novel devices and 40 novel concepts have been evaluated.

ABSTRACT

STATIONARY SOURCE CONTROL TECHNOLOGY FOR NO_x

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Nitrogen oxides (NO_x) have been identified among the atmospheric pollutants having the greatest potential for adverse effects on human health and welfare. Since passage of the Clean Air Act of 1970 the EPA has placed high priority on controlling NO_x emissions from both stationary and mobile sources to meet prescribed National Ambient Air Quality Standards. Estimates indicate that 11.6 million tons or about 50.4 percent of NO_x emissions in the U. S. in 1974 came from a wide variety of fossil fuel burning stationary combustion sources. Therefore, as part of EPA's overall plan to control this pollutant, a research and development program was established in the Industrial Environmental Research Laboratory-RTP to develop and assess improved control techniques for the abatement of NO_x emissions from stationary sources. The objectives are to develop information to support regulatory groups in preparing NO_x standards and to develop control technology to assist equipment operators and manufacturers in meeting future standards.

Two main approaches for NO_x control making up the program are:

1) Combustion modification (CM), which is based on alteration of combustion conditions to minimize formation of NO_x, and

2) Flue gas treatment (FGT), which involves processes to remove NO_x from the flue gas.

Combustion modification has received primary emphasis in the program as the most cost effective approach to achieving substantial NO_x control for a wide variety of sources. Flue gas treatment is currently seen as a method to supplement combustion modification where a high degree of control is required.

This paper discusses the status of these program areas, updating technical highlights of the past year's effort. The primary conclusions are: (1) that, based on recent studies, a large potential exists for significant reductions of NO_x emissions in the post-1980 period because of improved CM technology which will become available for a wide variety of sources, and (2) flue gas treatment technology, based to a large extent on developments in Japan, is being extensively characterized and should be available by 1985.

ABSTRACT

ENVIRONMENTAL MANAGEMENT OF EFFLUENTS AND SOLID WASTES
FROM STEAM ELECTRIC GENERATING PLANTS

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Since 1975 the Federal program for the environmental management of effluents and solid wastes from fossil-fueled power plants has focused on: flue gas desulfurization (FGD) waste disposal and utilization; quantitative characterization of effluents including ash; water concervation and treatment; conditioning of effluents to meet guidelines; impacts of intake structures; advanced cooling system technology; and waste heat utilization. Numerous projects under the EPA/TVA Interagency Agreement contribute to this program.

Progress in the program has been significant. Many characteristics of FGD wastes have been quantified. Prolonged ponding of FGD wastes poses potential water pollution and land-use hazards; stabilization processes can reduce these by lessening the permeability and solubility of major coonstituents. Waste disposal costs, which can reach 20 percent of the FGD system cost, can be reduced with more efficient and economical dewatering equipment and reduction of water volumes by oxidation of wastes to gypsum. A preliminary technical document, potentially useful for setting FGD waste disposal standards, has been prepared. Coal ash characteristics have been detailed in a comprehensive report. Water recycle/reuse studies have shown more efficient water use methods than conventional ones, often without significant added expense. Alternatives to chlorination for bio-fouling control in cooling systems, while in some cases favorable ecologically, tend to cost more. A system for treating blowdown operates with better heat transfer performance and less energy input than corresponding conventional systems. A state-of-the-art report on intake technologies has been prepared. The program to evaluate performance of a series flow, wet/dry cooling tower has resumed after a landmark decision permitting governmental acquisiton of the tower which is on non-governmental land. The optimized design of dry cooling towers and water consumption control in arid regions and vapor plume emission control in humid regions with wet/dry towers are described in recent reports. Soil heating to extend the crop growing season and enhanced biological recycling of nutrients in manure for accelerated algae and fish production are promising uses of waste heat.

CHAPTER III: EXTRACTION AND BENEFICIATION

RAPPORTEUR:
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ABSTRACT

RESEARCH AND DEVELOPMENT PROGRAMS FOR POLLUTION CONTROL FROM MINING AND TRANSPORTATION OF SOLID FUELS

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Mining operations of one form or another impact every part of the United States. The environmental problems associated with extraction of the resources of this Nation are likewise of national concern. The Environmental Protection Agency has active research and demonstration programs to deal with the problems associated with both energy and nonenergy resource recovery. This paper deals only with the programs for mining and transporting fuel (coal and uranium) materials.

Various cooperative efforts involving EPA, ERDA, USDA, USGS, TVA, and the Bureau of Mines are currently underway. These are to assess mine sites, study groundwater, demonstrate haul road design, document reclamation, etc. Final reports published by EPA, such as the manual for "Erosion and Sediment Control" are impacting environmental design and control techniques of both industry and government. Even given the huge strides already accomplished in the field of controlling mining pollution, there are still many problems to be overcome. The results of present R&D efforts will point out the direction of continuing research.

Air really impossible

aquifer devastating to reduce infiltration

Western mines, also drought and erosion, rain storms. trouble w/ aquifers

Uranium solvent leaching problem

Varies by region: can't remove organic sulfur chem. coal cleaning costs are uncertain $5-10/yr. $/t

ABSTRACT

COAL CLEANING PROGRAM STATUS

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Physical and chemical coal cleaning are capable of removing major quantities of pollutant elements from coal prior to combustion. Pollutants of concern include sulfur and a number of potentially hazardous accessory elements. Sulfur exists in two principal forms: organic sulfur which is bonded to the coal structure and inorganic sulfur, generally in the form of pyrite. Similarly, potentially hazardous accessory elements are associated with the mineral and organic constituents of coal.

EPA sponsored programs have identified the degree to which a number of physical and chemical cleaning techniques can be used to remove sulfur and accessory elements from coal. Physical cleaning techniques are only effective in removing elements associated with mineral matter. Chemical treatment is capable of removing the accessory elements associated with mineral matter and coal organic structure.

The IERL-RTP coal cleaning program includes a wide range of activities from basic coal research to the demonstration of commercial coal preparation processes. This coal cleaning program contains three subprograms for (1) the assessment of pollution from coal cleaning, coal transportation and coal storage, (2) the development of physical and chemical processes for removing contaminants from coal and (3) the development of pollution control technology for coal preparation processes. In addition to contract R&D directed by IERL-RTP, cooperative projects are conducted with the U.S. Bureau of Mines, the U.S. Geological Survey, the Energy Research and Development Administration, the Tennessee Valley Authority, and the Electric Power Research Institute.

Basic studies on coal and coal wastes from the Illinois Basin have been established: the relative organic and inorganic affinities of major accessory elements; the mineralogy and associations between the major minerals and accessory elements; and the effects of coal properties and environmental factors in the leaching of accessory elements from coal residues. An overview study on pollution from coal preparation processes is nearing completion and plans are being made for environmental tests at commercial coal preparation plants.

Physical coal cleaning is widely used to remove ash from coal. It has not been previously as an SO_2 emission control technique. Chemical coal cleaning processes are all in the development stage. Projects sponsored by EPA have identified the gravimetric sulfur reduction potential of over 500 U.S. coals. The use of froth flotation, oil agglomeration, microwave treatment, high intensity magnetic separation, aqueous ferric salt leaching and $Ca(OH)_2/NaOH$ leaching for desulfurization have also been evaluated. Projects to develop and demonstrate these desulfurization techniques are being supported. Major projects are in progress to develop performance and cost data on commercially available coal and mineral beneficiation equipment which can be used for desulfurization. Finally, a demonstration test program to evaluate the use of physical coal cleaning as a SO_2 emission control strategy has been started at the 1600 MW Homer City Power Complex operated by the Pennsylvania Electric Co.

The subprogram to develop coal cleaning pollution control technology is in its assessment phase. Projects to evaluate and develop improved pollution control technology will be initiated as the need for improved pollution control methods are identified.

trace elements in coal

ABSTRACT

EPA SPONSORED RESEARCH AT THE U. S. BUREAU OF MINES

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Much of the coal preparation research conducted by the U. S. Bureau of Mines has been, and continues to be, sponsored by the EPA. Today, the EPA funds the sulfur reduction potential studies which have been ongoing since 1965. Also, much of the cost of the design of a new coal preparation process development facility has been borne by the EPA.

In addition to these Bureau in-house activities, many EPA funded contracts are let through, and monitored by, the Bureau of Mines. There are presently nine such outside contracts covering a wide spectrum of coal preparation research activities. Included in this paper is a discussion of the current status of the Bureau's in-house EPA funded research, and a brief description of the outside contracts along with the most recent developments in each.

ABSTRACT

FOREST SERVICE MINING RECLAMATION RESEARCH

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Surface Environment and Mining Program
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The Forest Service is attempting to develop a revegetation technique on a regular basis. Experimental plots have been established in Appalachia, the Midwest, Southwest, and Northern Great Plains. Non-mining water products are also being tested as amendments to improve coal and oil shale spoils for plant establishment. Application of municipal sewage sludge to a large strip mine in Illinois is being evaluated. Although industry is beginning to use the revegetation technique developed, there is some resistance to using sewage.

The effect of mining on water quality is a major concern. Water quality in mining water shed is being investigated in Appalachia, and the suitability of ponds as aquatic habitat for wildlife is being studied in the Northern Great Plains.

Much of the impact of mining is associated with transporation systems. Models are being developed to predict the amount of run-off and sediment, yields for the mine roads, and their effect on water quality.

Information about quality of overburden is essential for planning proper spoil placement for subsequent reclamation. Effective core drilling designs for laboratory techniques to evaluate overburden are being demonstrated in Wyoming.

Successful reclamation depends on the chemical and physical characteristics of overburden and proper redisposition of spoils. Information on physical transformation of overburden materials, design of mine waste dumps, erodability, of spoils by wind and water, and a computer program to integrate environment constraints with engineering components are being developed.

A computer system to store and retrieve bibliographic references on mining and reclamation have been established at the University of Arizona. SEAMALERT is a computer produced literature citation bulletin published as part of this effort.

oil shale spoil NOT used for reclamation
Roads are a big problem

could improve crop plants
of strip mining

ABSTRACT

PROTECTION OF SOIL AND WATER RESOURCES ON
LAND DISTURBED BY MINING

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North Central and Northeast Regions
Agricultural Research Service
U. S. Department of Agriculture
Mandan, North Dakota and Morgantown, West Virginia

With partial support from EPA, the Agricultural Research Service, U. S. Department of Agriculture, is conducting research to develop technology that will enhance vegetative growth and thereby greatly reduce runoff, erosion, sedimentation, and pollution problems. This approach is particularly pertinent since almost all land disturbed by mining will be returned to some type of vegetative cover.

Physical and chemical properties of spoils which are most restrictive to plant growth have been identified. In Appalachia these include acidity and related problems, plant-nutrient deficiencies, coarse texture, and steep slopes. In the West, factors which reduce the efficiency of conservation and use of the limited precipitation received were most restrictive - high exchangeable sodium, salinity, nutrient deficiencies, and steep slopes.

Environmental degradation resulting from mining is best reduced by careful control of grades on reshaped spoils and by establishment of vegetative cover. Several studies have indicated relative adaptability of various plant species to different types of spoils and climates, and their nutritional and water requirements have been assessed. It is often practical to enhance vegetative cover by saving and spreading the original soil material over spoils after shaping. Runoff, erosion, and sedimentation problems on mined land are similar to those on unmined land, except freshly spread topsoil is more erosive. The K-factor in the Universal Soil Loss Equation often underestimates erosion on mined land. Various amendments and waste materials can be used in reclaiming mined land, but all have certain limitations and restrictions.

Need to develop lean advantageous plants growth. Can be made West could possibly be changed

CHAPTER IV: INTEGRATED TECHNOLOGY ASSESSMENT

RAPPORTEUR:
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ORD/Office of Energy, Minerals and Industry
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ABSTRACT

INTEGRATED ASSESSMENT OF ENERGY DEVELOPMENT IN THE WESTERN U.S.

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Large scale energy development in the Western U.S., while an integral part of most plans for boosting this Nation's domestic energy production, will cause significant environmental, economic and social problems in the development areas. Prevention or reduction of these problems is hampered by an intricate, overlapping and ill-coordinated policy system for dealing with development and its impact.

The Office of Energy, Minerals and Industry, U.S. Environmental Protection Agency is sponsoring a three year Technology Assessment of Western Energy Resource Development to identify and evaluate the adverse impacts of large scale development and policies for mitigating them. The Assessment has substantially completed its first phase, the impact evaluation, and has confirmed many previously held beliefs and cast doubt on some others. For instance, it has tended to confirm the belief that development would create severe air pollution problems in many areas, while casting doubt on some of the previous high estimates of water usage associated with synfuel development.

The study will now concentrate on policy analysis. A significant portion of this work will involve parametric analysis to identify variables that control impacts, and identification and evaluation of alternative means of controlling these variables. In addition, an ongoing effort at thoroughly understanding the policy system - the political/institutional/economic system that dictates the rate and pattern of development - will be continued.

ABSTRACT

ELECTRIC UTILITY ENERGY SYSTEMS ITA

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Environmental and financial models of the development, operation and associated air quality impact of the U.S. electric utility system through the year 2000 have been developed and applied in the first year of this multi-year program. These models reflect the financial decision-making processes which occur within utility firms aggregated to the state level. Scenarios which consist of selected environmental constraints, national energy policies and economic climates are utilized in the models to modify utilities' planning and operating behavior. The financial and environmental consequences of these scenarios are described and analyzed in some depth.

Potential problem areas which are either currently experiencing high concentration of aerosol sulfates or are likely to experience high future sulfate concentrations due to power plant emissions are identified. This is accomplished by combining the prediction of high emission counties or air quality control regions for sulfur and nitrogen oxides with specialized meteorological analysis. Extreme persistence wind conditions, air parcel trajectories and average tracks of synoptic-scale stagnating anticyclones are utilized to develop simple source-receptor relationships for connecting emission sources with probable impacted areas.

Lastly, a discussion of efforts to apply these models to current analysis requirements is given, along with an indication of what directions future expansions of the model will take.

ABSTRACT

OHIO RIVER BASIN ENERGY STUDY

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EPA has been directed to conduct "an assessment of the potential environmental, social and economic impacts of the proposed concentration of power plants in the lower Ohio River Basin. The study should be comprehensive in scope, investigating the impacts from air, water and solid residues on the natural environment and residents of the region." The ORBES study is being performed through a unique arrangement with six universities located in the four states of the lower basin. Planning for the construction of power plants is proceeding at a rapid pace within the basin with the result that interest in this study has been high since its inception.

Scenarios of alternative demand levels and technological responses have been constructed. The environmental, social and economic consequences, which fulfillment of these hypothesized alternative futures might bring to the region, have been identified and categorized regarding intensity of impact. Breadth of analysis has been emphasized over depth of analysis in the first year.

Early results of these scoping studies are presented. A selection of results is discussed in terms of possible mitigation measures or other policy options which may be necessary to avoid significant adverse consequences to specified localities or the region as a whole. Preliminary findings suggest that severe constraints on power plant developments might be reached within the next twenty years if moderately high growth rates are experienced over this time interval and a concentrated pattern of development continues.

A brief discussion is given of the challenges and opportunities that are presented by the ORBES organizational structure. Also included is a description of the EPA/ORBES efforts to encourage a broad range of interest groups to interact with the researchers throughout the project. These experiences have been valuable in the planning for ORBES-Phase II, which will continue for another two years.

ABSTRACT

INTEGRATED ASSESSMENT

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TVA's Integrated Assessment research program is designed to develop methodologies to improve and accelerate the analysis processes for forecasting energy needs, planning and designing energy systems and evaluating environmental and socioeconomic impacts. Three specific research tasks are underway.

These include:

a. Development of a method for predicting how much, when and where electric power will be needed;

b. Given alternative systems implied by the above projections, develop improved models for expressing the residuals produced from each alternative;

c. Given the residuals, develop better methods for impact analysis and reiterative cost analysis -- in particular explore the use of interactive computer graphics as a vehicle for expediting analysis procedures.

A computer simulation model has been developed to make long range forecasts of economic and demographic factors including population, labor force, households and employment. Recent improvements in the basic model consist of expanding the model's ability to predict manufacturing conditions at the two-digit SIC level of detail and to account for changes in migration patterns. The model has been applied successfully to TVA power service area covering all or part of seven states.

Potential difficulties arising from an attempt to predict residual production using the output from TVA's Integrated Power Systems Planning Model have been reviewed. Transformation relationships for sulfur dioxide and gross particulates have been developed which can be used to estimate residual production from specific generating facilities based on fuel and equipment characteristics and the level of power production.

Several types of applications have been developed which demonstrate that computer graphics can be used to reduce cost and time of analysis and improve decision making for impact assessment. Applications include the display of environmental data, the analysis of socioeconomic impact indicators, and the interactive analysis of computer models which predict environmental transport and impact of residuals.

ABSTRACT

STATUS OF AN INTEGRATED ASSESSMENT
OF COAL DEVELOPMENT

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The project "Economic and Social Consequences of Coal and Oil Shale Development" assesses the effects of alternative public policies toward coal on the future locational patterns of coal mining, transportation, and usage throughout the U.S. and the specific flows of coal involved. Also assessed are the use of land and water and economic activity such as agriculture. Impacts on rural people and communities and State revenue flows can be assessed by companion research in ERS, once a locational pattern of coal activity is projected.

A large linear programming model using about 90,000 bits of data is the integrating mechanism. Although it is an optimizing model, seeking a least-cost solution to combining all coal system resources, the project does not seek some theoretical "best" pattern of coal development. Rather, the objective is to compare many public policy alternatives toward coal development and usage, given physical and economic constraints. These alternatives are to be compared under common ground rules that the economy is as efficient as possible in carrying out each hypothetical alternative; hence the optimizing model.

Each run of the model will yield a distinctive pattern and level of coal activity by location in some future year for each alternative policy scenario and set of constraints, given some projected level of total demand for coal. Successive model runs under alternative scenarios will yield other patterns. Then, by comparing these different patterns, certain effects can be attributed to a policy alternative. Tradeoffs among effects on large and small regions--interregional tradeoffs--can be identified. Policymakers would then be better informed in choosing among alternative policies toward coal.

The model is being developed region by region, and will then be assembled as an interregional model. The Western States regional model will be running early this fall, with Interior, Appalachian, and Gulf regional models to follow before the national model is put together.

Alternative policies to be assessed will concern such variables as sulfur dioxide emission standards, reclamation requirements, and natural gas pricing, as well as others. Through consultation with EPA and other agencies, as well as within USDA, we will assure that alternative policy scenarios to be assessed are as realistic as possible.

ABSTRACT

INTEGRATED SYSTEMS SIMULATION OF
LOCAL COMMUNITY IMPACTS IN THE
NORTHERN GREAT PLAINS

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The research is conducted by the Economic Development Division of the Economic Research Service, USDA. The focus is on application and evaluation of analytical methods of estimating local economic impacts. Of special interest are rapid growth rural communities in the Northern Great Plains. The final goal is the estimation of elements affecting the net fiscal impacts on local government services in an integrated simulation system.

Computer models of the tax systems of Montana, Wyoming, North Dakota and South Dakota are of immediate interest. For a given project, these models calculate the direct revenues and intergovernmental transfers flowing to schools, cities, counties, and the State. The practical applications of the tax models are for (a) preparation of environmental impact statements, (b) evaluation of the effect of each tax, and (c) revision of laws by each State.

The other part of the project is the estimation of employment, population, and income. Statistical techniques are applied to secondary data. Results confirm two important conclusions regarding rapid development. First, local multipliers for employment and income are different for each county. The multipliers depend upon (a) the type of basic activity, (b) the location in economic space, and (c) the level of activity in adjacent counties. The second major conclusion is that wage levels must increase in order to attract and retain a larger labor force. Local wage inflation can occur. If it does, then the costs of local government services increase. Thus the two most important impact elements at the local level deserving analytical study are the population change and the degree of local wage inflation which accompany rapid development.

ABSTRACT

METHODOLOGY FOR THE ANALYSIS
OF THE IMPACTS OF ELECTRIC POWER PRODUCTION IN THE WEST

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This report describes the progress achieved in the first year of a project to develop methodologies for analyzing the impacts of electric power production in the West. The project objective is to design a computer-based tool to help decision makers analyze some of the crucial environmental, social, and economic impacts -- particularly the following impacts which involve conditions that are unique to the West:

1) The boom town impacts that result from the construction and operation of power plants near small, isolated towns in the sparsely populated West;

2) The reduction in visibility caused by the fossil fuel emissions from power plants operating in the pristine West.

Additional impacts that have been addressed include public health effects from fossil fuel pollutants, occupational health and safety, and the risk of accidental release of radioactive pollutants from nuclear power plants. The scale along which most of these varied impacts are compared is dollars.

As an example, the report includes a demonstration showing how the methodologies can be used to calculate impacts associated with the 1985 expansion plan of the electric utilities belonging to the Western Systems Coordinating Council (WSCC). The report concludes with a discussion of the usefulness of the results and a description of the work to be undertaken later in the project.

This work supported by the Environmental Protection Agency, LASL Project R260.

CHAPTER V: HEALTH EFFECTS

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ABSTRACT

DETECTION AND EVALUATION OF POTENTIAL HEALTH EFFECTS ASSOCIATED WITH HAZARDOUS AGENTS FROM ALTERNATE SOURCES OF ENERGY

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An integral part of energy-related health effects research is the development and utilization of methods which facilitate the detection and evaluation of the potential health effects associated with exposure to hazardous agents. These methods encompass the following King-Muir objective areas: 1. To identify hazardous agents associated with energy technologies; 2. To develop more sensitive and rapid biological methods to evaluate dose and damage to man; and 3. To determine the processes of damage, repair, recovery, protection and amelioration in biological systems exposed to hazardous agents.

The human population exposed to energy effluents can be divided into two classes: those exposed to high concentrations of effluents due to their close proximity to energy production facilities and those exposed to low concentrations or background levels of these effluents. In the case of high exposure, both man and environment must be closely monitored for changes in concentrations of pollutants and the potential for inducing toxic, mutagenic and carcinogenic effects. In the case of low level exposure to pollutants the environment must also be constantly monitored for chronic toxic and genotoxic effects, and then risk assessments made.

The monitoring of both the human population and the environment requires the use of sensitive and rapid test systems both *in vitro* and *in vivo* which can detect: alterations in concentrations of pollutants; alterations in normally occurring biological and biochemical processes; and the appearance of genotoxic effects.

This report will summarize health effects related research funded through OEMI for FY 76 in terms of the program described above and make recommendations for future emphasis.

ABSTRACT

INTERAGENCY REPORT ON ANIMAL TOXICOLOGY

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The interagency program for *in vivo* toxicology was established for the purpose of evaluating the toxicological hazards of effluents, waste streams and products of extraction, processing conversion and utilization of the various energy technologies by acute and chronic exposure of whole animal models by appropriate exposure regimens.

Progress during the past year has been accomplished by improvement of the biological models for more precise dose response determination, and development of greater sensitivity.

Interaction studies are under way which will determine the influence of the combined effect of pollutants and of interaction of pollutants and biological disease factors.

Closer integration between the toxicological program and the technologies involved is evolving for the purpose of selection of test material from relevant effluents, waste streams, etc. from the processes according to their priority ranking and for getting the toxicological input back to the technologies.

A more systematized biological plan is being evolved which will furnish relevant data for evaluating the utility of *in vitro* test systems in energy programs as a whole and correlation with available clinical and epidemiological data.

ABSTRACT

CONTRIBUTIONS OF INTERAGENCY
ENERGY/ENVIRONMENT PROGRAM
TO UNDERSTANDING METABOLISMS AND MECHANISMS IN BIOLOGICAL SYSTEMS

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The major objectives of this segment of the Health Effects Program are three-fold. First, to improve the capabilities of extrapolated dose-effect experimentally derived information to predict critical results of health for man. Second to provide mechanically, data that can transcend species variation by establishment of generalized mechanism of damage and repair at the cellular and molecular level. Third, to develop the biological and biochemical methods and systems to accomplish these objectives. Underlying these objectives is the need to define the pattern of deposition, distribution, and metabolism which determine chemical dose at the cellular level of critical organic and biological and physical factors influencing toxicity.

Effects involve all of the major classes of fossil energy-related pollutants (polycyclic aromatic hydrocarbons, aliphatics, and alicyclics), gases, particulates, and trace and heavy metals.

Since the thrust of this portion of the program is developmental in nature and highly diversified in terms of methodology, it is difficult at present to summarize in terms of the ultimate objective, namely, improvement of capability to predict health risk to man.

Nevertheless, some highlights can be reported: 1) it is clear that carcinogenic hydrocarbons (polynuclear aromatic) bind to DNA and cells that have produced repair enzymes can partially counteract the damage, 2) it is possible to evaluate repair in vivo in critical organs as well as in vitro cell cultures, 3) data is becoming available that suggest that similar types of molecular damage and repair are involved that lead to mutagenesis and carcinogenesis, 4) chelating agents that are effective for therapy against deposition of trans uranic elements are also effective against heavy metals such as Mercury and lead.

Other interesting studies are under way and will be summarized.

ABSTRACT

CLINICAL AND EPIDEMIOLOGICAL RESEARCH RELATED TO ENERGY

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Since 1974, EPA's Health Effects Research Laboratory (HERL) in Research Triangle Park, North Carolina, has pursued a broad based, multidisciplinary research program to identify and quantify potential health consequences of modified and alternate energy production technology. The program has been designed to determine the specific effects of pollutants emitted from fossil fuel fired sources, served as a vehicle suitable for gathering health intelligence as the basis for regulatory standards, and help identify emerging energy technology having the fewest threats to public health.

Although animal and cellular oriented studies are a major part of the energy related research effort, the main health contribution of HERL's energy program are from clinical and epidemiological studies. Both clinical and epidemiological work conducted at HERL can be subdivided. The first aspect of clinical studies is the establishment of a research facility specifically designed to generate and access the effects of hazardous substances. The second part of the clinical program is the use of the facility to determine if an effect will occur when humans are exposed to a specific agent.

With regard to epidemiological research, the first aspect of the HERL program is the development of good statistical and data collection techniques. The second and most important part of the effort is the planned application of these techniques on specific populations exposed to potentially harmful substances emitted from energy sources.

ABSTRACT

CURRENT STATUS OF EXTRAPOLATION RESEARCH

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Two major problems are encountered whenever human risk resulting from exposure to environmental carcinogens is estimated using data generated in a laboratory setting. The first problem involves risk extrapolation to low, environmental dose levels that lie well outside the experimental (observable) range. The second arises because of the need to extrapolate from various animal species to man.

Guess and Crump have developed a new statistical model for extrapolating risk estimates associated with high dose level animal experiments to the low environmental levels likely to be encountered by the general population. They have used their model to analyze data on known carcinogens as well as data from simulation studies, and their research has provided new insight into the linear-nonlinear debate about the shape of dose-response curves in the environmental exposure region. Practical aspects of their studies have a direct bearing on the regulatory decision making process.

Research into the question of species-to-species extrapolation is also being promoted under the inner agency agreement. A review of the carcinogenesis literature has been initiated for the purpose of quantifying species differences in response to exposure to carcinogenic compounds and for deciding how these differences might best be taken into account in the extrapolation process.

Support has also been given to the establishment of a computerized catalogue of published teratology studies (ETIC). To date over 7500 references have been entered into the system. In addition, preliminary steps have been taken to develop a Teratology Data Bank.

CHAPTER VI: ATMOSPHERIC TRANSPORT AND FATE

RAPPORTEUR:
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ABSTRACT

PROJECT MISTT
MIDWEST INTERSTATE SULFUR TRANSFORMATION AND TRANSPORT

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Increasing energy needs will require additional combustion of coal with the resulting release of SO_2 into the atmosphere and subsequent conversion to sulfate. Because of the adverse environmental effects of sulfates, information is needed relating anthropogenic emissions of SO_2 to atmospheric sulfate levels. Reduction in urban SO_2 emissions have been accompanied by an increase in rural SO_2 emissions, mostly from power plants with tall stacks located outside cities. The Transformation-Transport Hypothesis holds that SO_2 emissions from these rural power plants are transformed into sulfates in the atmosphere and transported over long distances to urban areas. Project MISTT was designed to test this hypothesis.

The MISTT technical approach is to measure the transformation of SO_2 to sulfates in polluted air masses undergoing transport-power plant plumes, urban plumes, and stagnating anticyclones. This is done mainly with aircraft. The experimental measurements are used to guide the development of models of the transformation, transport, and removal processes and to test the Transformation-Transport Hypothesis.

The results of Project MISTT have confirmed the Transformation-Transport Hypothesis for power plant and urban plumes which have been followed for 300 km. Limits have been set on the transformation rates and the critical parameters which control the conversion rates identified.

The rate of conversion of sulfur dioxide to sulfate aerosol in the plume is low near the point of emission, but increases to several percent per hour as ambient air mixes with the plume. Tall stacks reduce ground-level concentrations of sulfur dioxide, resulting in a reduction of the amount removed by dry deposition. Thus, tall stacks increase the atmospheric residence time of sulfur dioxide, which leads to an increase in atmospheric sulfate formation. In urban plumes, which are well-mixed to the ground near the source, sulfur dioxide is removed more rapidly by dry deposition. These sulfate aerosols may be transported over distances of several hundred kilometers and produce air pollution episodes far from the pollution source.

ABSTRACT

AEROSOL FORMATION/TRANSFORMATION PROCESSES
IN PLUMES OF COAL-FIRED POWERPLANTS

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Cloud nuclei within a supersaturation range 0.3 percent to 1.5 percent were measured in coal-fixed powerplant plumes. Two mechanisms of formation have been identified. First, submicron flyash particles show a preferential surface concentration of sulfur and chlorine in comparison to their matrix elements, e.g., aluminum and silicon. The relationship between concentration of surface deposited matter and inverse particle diameter suggests that S and Cl are absorbed and oxidized on flyash particles after volatilization in the high-temperature zone of the boiler. This leads to the formation of cloud nuclei even before a sulfur gas-to-particle conversion takes place. Second, a gas-to-particle conversion process takes place after the effluents leave the stacks. Rates of formation are of the order of 10^{14} to 10^{16} nuclei per second at distances from the stacks between 10 and 100 kilometers. The measured rate of decrease of SO_2 with time, corrected for diffusional losses based on empirical plume profiling, results in a conversion rate of SO_2 to SO_4 of less than one percent per hour.

Ice nuclei were measured upwind and within the effluent plume of coal-fired powerplants. Results indicate that plume particles do not act as ice nuclei between the temperatures of -10 and -20° C in the deposition and/or condensation-followed-by-freezing mode, nor do combustion gases in the plume deactivate natural ice nuclei.

Radiometric measurements in the spectral window (8-14 μm) region resulted in a transmissivity of 0.82±0.01, an extinction coefficient of 0.99±0.04 per kilometer, and a cooling rate of 0.64±0.1 centigrade per hour.

ABSTRACT

TRANSPORT AND TRANSFORMATION OF SULFUR OXIDES
IN THE TENNESSEE VALLY REGION

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The Tennessee Valley Authority (TVA) is conducting a study under the Federal Interagency Energy/Environment Research and Development Program administered by the Environmental Protection Agency, to evaluate the contribution of the TVA power system to ambient concentrations of sulfate in the air. Experiments are being conducted (1) to determine the rate at which sulfur dioxide (SO_2) is converted to sulfate aerosol (SO_4) within the plume of one power plant isolated from other sources of atmospheric pollutants and (2) to determine the sulfur loading imposed by the entire power system on airmasses that traverse the Tennessee Valley region.

As part of this study, concentrations of SO_2 and SO_4 were measured in the plume of a 2600-MW coal-fired power plant. The ratio of SO_2 to SO_4 was determined at the stack and at distances from 10 to 105 km downwind from the plant. No correlation was found between values for this ratio and the time of plume travel. The average values for the ratio were 0.014 for samples from the plume and 0.0025 for samples from the base of the stack. Little (about 1 percent) atmospheric oxidation of SO_2 was observed, and apparently most of this oxidation occurred in the immediate vicinity of the power plant.

An instrumented air craft and ground-based aerometric and meteorological networks were used to measure SO_2 and SO_4 fluxes. Several airmasses were sampled on nine days in February and March of 1976 as they entered the 300- x 300-km study region from the directions of the prevailing winds (south through west) and again as they left the region. High volume samplers at eight ground sites collected samples for 9-hour average concentrations.

In preliminary results, the sulfate flux in air entering the area averaged 31 ug m^{-2} sec^{-1}, and the sulfate flux in air leaving the area averaged 47 ug m^{-2} sec^{-1}. However, additional studies, planned for the summer of 1977, must be completed before any general conclusions can be drawn from these results. The rate at which SO_2 is converted to SO_4 will be determined for a wider variety of meteorological and plant-operated conditions, and two aircraft will be used to measure simultansously the sulfate flux in airmasses entering and leaving the region.

ABSTRACT

SULFATE REGIONAL EXPERIMENT

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The Electric Power Research Institute (EPRI) is supporting a research program to define the relation between emitted primary pollutants (e.g., SO_2) and regional, ambient concentrations of secondary products (e.g. sulfates). Emphasis will be particularly on identifying the contribution of the electric power industry to ambient sulfate levels in the northeastern United States. This project, the SUlfate Regional Experiment (SURE) will be conducted over three years at a cost of about $5.5 million.

Part of the stimulus for SURE is the concern that utilities may be required to reduce SO_2 emissions in order to meet an ambient sulfate standard. The relationship, however, between SO_2 emissions and ambient sulfate concentrations is obscure, at best. Present studies seem to indicate that the formation of sulfates is a regional problem, tied not just to SO_2, hence no simple relation exists between SO_2 emissions and regional sulfate levels. If so, a control on SO_2 emissions may not be a realistic means of effecting sulfate reduction.

The SURE program comprises four main elements: (1) a ground monitoring network of 54 randomly distributed stations throughout the Northeast; (2) a program of measurements of air quality using airplanes; (3) a detailed emissions inventory; and (4) a modeling program. Nine ground stations will operate continuously over a 2-year period. The remaining 45 will operate continuously for one month out of each of the four seasons of the year. At all ground stations, a wide range of chemical and meteorological parameters will be measured. Emphasis is on sulfur compounds; however, measurements will also include nitrogen species, ozone, and trace metals in suspended particles. The airborne work will serve as a limited supplement to the ground network in an attempt to give a 3-dimensional validity to any conclusions drawn from the measurements made on the ground. The emissions inventory will include SO_x, NO_x, suspended particles, and hydrocarbons from power plants, other industry, homes, and surface transportation. Emissions will be reported as daily averages for each season. The modeling effort is designed to yield a relation which predicts ambient concentrations of pollutants in terms of local emissions. Data for the model will be drawn from SURE and also from other studies.

ABSTRACT

THE MULTI-STATE ATMOSPHERIC POWER PRODUCTION POLLUTION PROGRAM*

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The Multi-State Atmospheric Power Production Pollution Study (MAP3S) is a major atmospheric research program of ERDA's Division of Biomedical and Environmental Research (DBER). The goal of the MAP3S program is to develop and demonstrate an improved, verified capability to simulate the present and potential future changes in pollutant concentration, atmospheric behavior and precipitation chemistry as a result of pollutant releases to the atmosphere from large-scale power production processes, primarily coal combustion. A major motivation of this program is to be able to provide those agencies charged with the task of meeting the nation's energy needs with the knowledge required to assess alternative strategies for generating power while ensuring ample protection of human health and adequate preservation of the natural environment. Since coal is the most abundant domestic fossil energy resource and since electric power production is a major and growing sector of our energy economy, this study focuses on the effects of emissions from coal fired electric power plants, particularly in the high population, energy intensive northeastern quadrant of the United States. Research projects are underway to measure present sulfur oxide concentrations and composition to assess the potential for long range transport, to investigate transformation processes in plumes from point and urban sources, to sample precipitation chemistry and understand scavenging mechanisms, and to develop numerical models that can simulate future air quality on sub-continental scales given patterns of anticipated combustion emissions.

*Work performed under the auspices of the U. S. Energy Research and Development Administration under Contract No. W-7405-Eng-48.

CHAPTER VII: MEASUREMENT AND MONITORING

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ABSTRACT

AIR QUALITY DATA INTEGRATION IN THE WESTERN ENERGY RESOURCE DEVELOPMENT AREA (WERDA)

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The vast energy reserves in the Western United States coupled with the projected demands through the end of the twentieth century have raised concern regarding the potential impact on the environmental quality of that area. In addition to low-sulfur coal, other major resources such as oil shale, uranium and geotherms are in abundance in the West. The Federal Government in meeting its responsibility for providing for energy resources and in environmental planning must have available an air quality baseline from which trends can be assessed and impacts associated with energy development activities identified.

In response to this need for information, a major interagency program has been initiated to develop and integrate air quality data throughout the western region. A network of existing monitoring stations located in rural areas has been selected to provide the necessary air quality baseline and trend data. Most widely monitored is TSP although recently an effort to obtain sulfate and nitrate data from many of the stations has been initiated. The concept of a western energy-related network is enhanced through the uniform application of a quality assurance program on each of the participating laboratories, now numbering 17. Also, the current and pending legislation restricting the deterioration of visibility in the nation and particularly in pristine areas has resulted in the initiation of programs to develop methodology and monitor visibility and visibility-related parameters in the West.

The data developed during these studies will assist Federal planners in assessing the environmental acceptability of the various types, patterns and magnitudes of energy resource development and production activities.

ABSTRACT

WATER QAULITY DATA INTEGRATION IN THE WESTERN ENERGY RESOURCE DEVELOPMENT AREA (WERDA)

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The objective of the water quality data integration program is to provide uniformly validated environmental quality baseline and trend data in those geographical areas of the West potentially to be impacted by energy resource development and production activities. Participating with the U.S. Environmental Protection Agency in this effort are elements of the U.S. Geological Survey. Several other agencies of the Federal Government are cooperating in the study.

Water quality over the entire WERDA is being assessed and intensive studies of major basins and water systems where energy-related impacts are likely have commenced. A network of strategically located stations reporting to the Environmental Protection Agency's national water quality data base (STORET) has been identified. A quality assurance program specifically designed for this energy program has been initiated and includes each of the laboratories participating in the study.

These data will serve as a reference point from which future energy-related (or any other) environmental degradation can be measured and upon which national policy decisions and planning can be based.

ABSTRACT

WATER MONITORING IN ENERGY DEVELOPING AREAS

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Presently the Water Resources Division of the U.S. Geological Survey operates a network of 6200 water monitoring stations nationwide of which 590 are in the energy developing Rocky Mountain and Northern Great Plains States. Of these, 73 are funded entirely or partially via EPA funds. These water monitoring stations are establishing the baseline water quality, sediment and flow conditions against which future assessments of impacts can be made. This paper will report on three of the 22 projects involved in the Interagency Energy/Environment R&D Program with the USGS: initial water quality data for the Chaco River basin, New Mexico; oil shale areas of Colorado and the southeastern area of Ohio where both surface and underground mining are active.

ABSTRACT

WESTERN COAL AND OIL SHALE - GROUNDWATER
QUALITY MONITORING RESEARCH AND DEVELOPMENT

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An important concern of the Environmental Protection Agency is the impact of Western coal and oil shale developments on groundwater quality and the manner in which these impacts should be monitored. A project to provide the answers is being conducted under a research contract. Two field areas, one relating to each resource, are being intensively studied. Results are to be presented in documented form suitable for adaption to other Western areas.

The project has been underway about six months. Significant progress has been made on the first task, which relates to collection and evaluation of data on hydrology, geology, and potential pollutant sources.

An additional research need which concerns the oil shale aspect of the project has been identified. At the time of contract execution, it appeared oil shale would be developed by conventional mining methods followed by surface retorting; therefore, the study area was selected on this basis. Since that time, however, interest in that development will be by modified in situ methods. The problem of including a study of the in situ developments in this project is twofold. First, the planned in situ developments are in northwest Colorado instead of in Utah where the study area is established by contract terms. Secondly, the cost for studying groundwater effects and monitoring methods related to in situ processes will be higher than the amounts provided in the project for study of oil shale developments by surface retorting. A proposal for expanding the effort has been prepared and is awaiting approval and funding by the Environmental Protection Agency.

ABSTRACT

MONITORING PROJECT

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During the summer of 1975, the National Aeronautics and Space Administration (NASA) and the U.S. Environmental Protection Agency (EPA) entered into a five-year project for the purposes of transferring hardware and software techniques for processing remotely sensed digital data which would enable EPA to establish and maintain a fully operational energy-related overhead monitoring system. The NASA's Earth Resources Laboratory (NASA/ERL) at Slidell, Louisiana, and the EPA's Environmental Monitoring and Support Laboratory at Las Vegas, Nevada (EPA/EMSL-LV), were designated to implement the five-year plan.

The project has been divided into three phases. Phase I was an 18-month segment, during which existing remote sensing data acquisition, analysis, and information producing capabilities of NASA were applied to digital data acquired by both LANDSAT and aircraft over coal strip mines in the Western United States. A data processing system was defined, assembled, and transferred to the EPA/EMSL-LV in January 1977. Key EPA personnel also received training in the use of a similar data processing system during November and December 1976.

Suggested analytical procedures and multispectral data applications were documented in the NASA/ERL report "Western Energy Related Overhead Monitoring Project - Phase I Summary (July 1, 1975 - December 31, 1976)." The report is being reviewed at the EPA/EMSL-LV to determine the usefulness and quality of the suggested procedures.

During Phase II, the procedures recommended to the EPA will be applied, verified, and evaluated using current data sets as well as future data sets made available through an intensive field program now underway at the EPA/EMSL-LV. Research and development activities continue, in parallel, with objectives to investigate new procedures for solving complexities associated with processing data on strip-mining activities. General descriptions of the Phase II research and development tasks call for developing 1) a rectification/registration system for multispectral scanner classified data, 2) a classification system for determining rehabilitation potential of surface-mined lands, and 3) a signature bank of vegetation species associated with various ecosystems found in the Western United States.

NASA/ERL and EPA/EMSL-LV development activities tested by pilot studies will result in state-of-the-art procedures converging into a final set of recommendations and future requirements. Ultimately the EPA/EMSL-LV will transfer this technology to interested EPA Regional Offices and other potential users.

ABSTRACT

REMOTE SENSING OF SULFUR DIOXIDE EFFECTS ON VEGETATION

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Air Quality Research Section
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A project is underway to develop and refine remote sensing techniques and instruments for monitoring the effects of sulfur dioxide (SO_2) emissions from large coal-fired power plants on vegetation. The techniques include (1) spectroradiometry, with a scanning spectroradiometer owned by the National Aeronautics and Space Administration (NASA); (2) photographic recording of plants exposed to SO_2 in a fumigation chamber; and (3) a series of overflights for aerial photography and multispectral scanning, in cooperation with NASA and the Environmental Protection Agency, of areas exposed to SO_2 in the vicinity of Widows Creek Steam Plant in northeastern Alabama and Shawnee Steam Plant in western Kentucky.

Digital and manual techniques for processing images are used in the project. A system for analyzing color images has been useful for enhancing image detail such as the boundaries of areas exposed to SO_2 emissions. Digital processing of imagery from Landsat will be attempted as soon as improved sensors are orbited by NASA and suitable coverage of power plant sites is obtained.

ABSTRACT

POLLUTANT MEASUREMENT METHODS DEVELOPMENT
SUPPORTED BY ENERGY FUNDS

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Comparative measurement of pollutants in ambient air comprises the most direct index of the effectiveness of control measures. As the production of energy predominates among pollution sources, EPA's Environmental Sciences Research Laboratory, as an important part of its contribution to Energy research and development, has undertaken an intramural program designed to provide new and improved measurement techniques judged relevant to the nation's effort to overcome its energy deficit.

Principal pollutant targets of this program include sulfur dioxide, sulfate, sulfuric acid, organic vapors, and fine particles. A rational approach was developed for each target pollutant, leading in each case to the evolution of a tangible product which offers a markedly improved capability for meaningful measurement. These products and their developmental histories will be described.

ABSTRACT

MEASUREMENT STANDARDS FOR AIR POLLUTION MONITORING AND CONTROL ASSOCIATED WITH ENERGY PRODUCTION AND USE

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In accord with the overall mission of the National Bureau of Standards to provide standards of measurement and means for making measurements consistent with those standards, NBS scientists are participating in the EPA administered program on environmental aspects of energy production and use by developing measurement methods and Standard Reference Materials (SRM's) for air pollution monitoring. A new instrument for monitoring atmospheric particulates containing sulfur has been developed which combines electrostatic precipitation with flame photometric detection as its principle of operation. Standard Reference Materials (SRM's) applicable to the measurement of stack concentrations of SO_2 have been developed and progress has been made on similar standards for NO_2. SRM's for CO in air in the concentration range of 10 to 50 ppm are also near completion. Methods are being investigated to develop SRM's for the X-ray fluorescence analysis of particulates on filter papers. To this end, techniques for fabricating glass microspheres of known composition have been developed and sputtering techniques for producing thin films of known composition have been investigated.

ABSTRACT

ENERGY RELATED RESEARCH IN
AIR MONITORING METHODS

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The Measurements Research Program at the National Institute for Occupational Safety and Health involves development of methods and instrumentation for sampling and detection of air contaminants in the worker's environment. In areas related to energy technology, the Measurements Research Program presently entails work on six projects:

(1) Evaluation of Personal Sampling Devices in Cold Environments

(2) Development of a Fibrous Aerosol Survey Monitor

(3) Development of a Miniature Gas Chromatograph

(4) Development of a Portable Microwave Spectrometric Analyzer

(5) Development of a Personal Filter Sampler Fiber Counter; and

(6) Development of a Personal Sampling and Analytical Method for H_2S.

ABSTRACT

DEVELOPMENT AND EVALUATION OF IMPROVED RADIOLOGICAL ASSESSMENT CAPABILITIES

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A project has been initiated which is designed to improve radiological surveillance procedures regarding both sampling and radiochemical analyses on samples. Further, models used to calculate radiological impact are being evaluated and refined. A "Handbook for Analytical Quality Control in Radioanalytical Laboratories" has been issued for use within TVA and is being revised for nationwide distribution. A report titled "Least-Squares Resolution of Gamma-Ray Spectra in Environmental Monitoring," in which the use of sodium iodide detection systems is discussed, has been prepared and the results of the study are in routine use. The study of germanium detector systems is nearing completion, with a report to be issued this year. Preliminary studies on environmental monitoring schemes are underway. Finally, data are being collected for use in analytical model refinement, with the collection proceeding according to plume detection methodologies developed as part of this project. As a result of conducting this project, a cost--effective means of monitoring the environmental transport of nuclear power plant releases and of realistically assessing the impact of electric power generation from nuclear units will be proposed.

ABSTRACT

CHEMICAL CONSTITUENTS FOUND IN
WASTES FROM COAL CONVERSION
AND OIL SHALE PROCESSING

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To determine composition of energy-related industrial wastes for planning and developing monitoring methods, Research Triangle Institute, under an EPA contract, analyzed wastes from coal and oil shale gasification projects. Pertinent literature and current project plans were reviewed to avoid work duplication. After information gaps were identified, waste samples from coal conversion and oil shale processing activities were collected and analyzed. Except for mercury, chemical elements present at concentrations of $\geq$1 mg/kg in solids and $\geq$10 μg/l in liquids were detected and measured with spark source mass spectrometry; mercury was determined by the cold-vapor atomic absorption technique. Specific organic components at concentrations of $\geq$1 μg/l were identified and quantitated with gas chromatography-mass spectrometry.

The 45 analyzed samples were obtained from a low BTU coal gasification pilot plant from in-situ coal and oil shale gasification projects in the United States. Approximately 70 chemical elements were detected frequently, and in some samples, more than 200 organic compounds were identified.

Under another EPA contract, work underway at Gulf South Research Institute will provide analogous information about effluents from these and other types of energy activities. The review of literature reports and related current projects will be updated periodically.

ABSTRACT

ERDA: DIVISION OF BIOMEDICAL AND ENVIRONMENTAL RESEARCH
CHARACTERIZATION, MEASUREMENT AND MONITORING PROGRAM

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A brief discussion of the total ERDA, BER program in characterization measurement and monitoring research will be presented. Current and planned activities aimed at the analytical characterization of effluents and emissions from various energy technology processes will be addressed.

A description of the scope, content and objectives of the measurement and monitoring research program will also be provided.

The remainder of the paper will include brief summary statements of the specific projects supported through the interagency energy/environment program.

ABSTRACT

MEASUREMENT STANDARDS FOR WATER MONITORING ASSOCIATED WITH ENERGY PRODUCTION AND USE

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Washington, D. C.

In accord with the overall mission of the National Bureau of Standards to provide standards of measurement and means for making measurements consistent with those standards, NBS scientists are participating in the EPA administered program on environmental aspects of energy production and use by developing measurement methods and Standard Reference Materials (SRM's) for water pollution monitoring. Projects currently underway include the development of an SRM consisting of eighteen trace elements in water, the development of methods for the measurement of trace elements in sea water, the development of SRM's for the measurement of organic compounds in water and sediment and the development of methods for measuring polar organic compounds in water and for coupling liquid chromatography with mass spectroscopy for the identification of organic compounds in water. Methods for determining the chemical form (speciation) of trace elements in water are being investigated as are methods for determining the depth profile of trace elements in individual sediment particles using ion microprobe analysis.

ABSTRACT

DEVELOPMENT OF WATER-RELATED TECHNIQUES AND INSTRUMENTATION: U.S. GEOLOGICAL SURVEY

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The U.S. Geological Survey has been active in environmental monitoring for many years and assistance to numerous Federal, State, and local agencies is commonplace. As part of its monitoring activities, the Survey has taken a leading role in the development, testing, and application of methods, techniques, and instruments for measuring water-related constituents and characteristics. Geological Survey activities under the Interagency Energy/Environment R&D Program have been concentrated in four project elements including (1) development of methods for characterizing and monitoring levels of chronic toxicity, (2) development of instrumentation for high-volume analysis of petrochemicals and associated compounds, (3) development of bedload samplers for measuring stream sediment, and (4) development of flumes and weirs and other devices and techniques for measuring sediment-laden stream flows.

While emphasis has been placed on the arid and semi-arid regions of the west, the developed methodologies will have application in all energy-important areas. Due to the nature of the continuing research, final results still are inconclusive but advances in the state-of-the-technology are increasing and improved definitive methodologies will be available in the near future.

ABSTRACT

STANDARDIZATION AND INTERCALIBRATION TECHNIQUES
FOR MARINE MONITORING

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This program is directed at developing appropriate mechanisms whereby the measurement uncertainties associated with environmental data can be defined and controlled within prescribed limits. These data quality provisions applied to environmental monitoring programs result in "qualified data" -- data with known error bands and a defined relation to accepted standards.

The various standards under development can be categorized by area of use; i.e., laboratory, interlaboratory or transfer, and field. In each case, the development is directed towards providing a product needed to define or reduce the uncertainty levels in a particular portion of the overall environmental measurement process. A laboratory standard for dissolved oxygen and laboratory methods for the simulation of the dynamic environment encountered by current sensors are currently nearing completion. Techniques and transfer standards for conductivity/temperature/depth and precision pressure sensor intercalibrations are also nearing completion.

Several investigations are in progress which seek to define the comparability of results obtained between different approaches to the measurement of chemical properties of marine waters. The trend has been to develop direct measurement (in-situ) systems to replace analytical laboratory methods in water analysis. The in-situ approach has several advantages; the most significant is probably cost per measurement. The accepted standards, however, are still defined in terms of analytical methods. To enjoy the benefits of in-situ monitoring without the loss of data quality, it is necessary to demonstrate the traceability of the newer methods to the existing standards. The results of such demonstration then serve as a basis for defining the quality of data obtained from the in-situ measurements in terms of recognized standards.

ABSTRACT

EPA/NASA ENERGY-RELATED REMOTE AND IN SITU SENSING INSTRUMENT DEVELOPMENT

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This project was established under the Energy Memorandum of Understanding between EPA and NASA dated May 2, 1975, to develop advanced and improved instrument techniques for measuring environmental parameters associated with powerplants and other pollution sources. The project contains five tasks which were mutually developed to assist with the timely development of instruments and technology needed for energy-related environmental problems. The objectives of the five tasks are as follows: Task 1. - Raman Lidar - To evaluate Raman lidar for remote measurement of the concentration of SO_2 at a powerplant stack exit. Task 2. - Plume Dispersion Studies - To apply aerosol scattering lidar techniques to the study of plume dispersion under various atmospheric conditions. Task 3. - IR DIAL - To develop and apply the tunable infrared (IR) differential absorption lidar (DIAL) technique to the remote measurement of molecular plume effluents. Task 4. - Laser Heterodyne Detector - To evaluate the use of the laser heterodyne detector technique as a means to increase the sensitivity of long-path continuous wave absorption measurements using diffuse reflectors. Task 5. - HCl Monitor - To develop and deliver to EPA an improved in situ HCl chemiluminescent monitor evaluated at concentrations as low as 5 ppb HCl in ambient and polluted air. This paper discusses the progress to date and plans for these five tasks.

ABSTRACT

LIDAR TECHNIQUES FOR ANALYZING AND TRACING PARTICULATE POLLUTANTS FROM ENERGY PRODUCTION

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Particulate pollutants from energy-related sources disperse and mix with natural aerosols. Both remote sensing and in-situ identification, measurement and tracing techniques are required for impact assessment, prediction of climate variation and estimation of the character, concentration and dispersion of particulate pollutants arising from man's activities. In-situ sampling may provide specific identification, concentration estimates and size-distributions, but ground and aircraft vehicles cannot economically establish correct average measurements over large periods of time, are impractical for the study of drift, and unfeasible for the measurements of fluctuations. Lidar remote sensors, on the other hand, may be developed, with somewhat diminished accuracy, to identify, measure concentrations and size distributions, and are the economical instrument of choice to measure these quantities and their fluctuations over large volumes and extended time periods. Improvement of lidar techniques is required to increase accuracy of identification, and measurement of size distribution, shape factors and concentration. Theoretical and experimental investigations of depolarization effects, multi-spectral backscatter and absorption, and inelastic scatter are the most promising technique to achieve the required improvement for measurements from ground and aircraft. The first phase of depolarization field studies and the expansion of the lidar capabililities to two wavelengths have been completed. The depolarization technique has been used in the impact assessment program at Colstrip, Montana to distinguish stack emission from dust newly risen from strip coal mines.

ABSTRACT

DOPPLER LIDAR FOR MEASUREMENT OF POLLUTANT TRANSPORT

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Doppler lidar measures the small-scale boundary layer wind field by frequency analyzing the signal backscattered from aerosols. The purpose of this joint research program is to develop and test operational techniques for the high-resolution measurement of atmospheric wind, turbulence and aerosol backscatter aspects of pollutant transport.

Four environmentally-relevant measurement problems provide the focus for our research. In atmospheric diffusion the lidar can serve as a mobile, high tower to determine wind profiles for various meteorological and terrain conditions. To determine urban ventilation factors, both a wind profile above the urban area and the thickness of the mixed layer must be measured. If properly measured and interpreted, backscatter from a stack effluent can indicate the effluent flow rate. Knowledge of the wind speeds associated with localized atmospheric vortices such as dust devils and waterspouts can help in designing secure energy-related structures such as power facilities.

Results to date include both technique refinement and field measurements such as wind profiles to a range of 1 km and height of 200 m, velocity spectra of vortices, FM-CW lidar ranging, three-component velocity measurements, and plume backscatter. Planned research includes aerosol profiling, range extension, and more efficient data processing.

ABSTRACT

AIRBORNE ACTIVE REMOTE SENSING OF POLLUTANTS

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Active remote sensing systems interrogate a pollutant remotely and then infer characteristics of the pollutant based on the interaction of the interrogating signal and the pollutant. Systems to be discussed in this paper all utilize lasers to produce the interrogating signal and all operate in a downward mode from airborne platforms. These systems offer distinct advantages in cost per measurement considerations and in obtaining the often necessary synoptic view.

The first system discussed is the downward looking LIDAR, a device which ranges aerosol scattering in the atmosphere below the plane. The device has particular utility in determining the dimensions of point source plumes for model input. An operational downlooking LIDAR has been tested which features a real time display of the LIDAR return signals.

Ground and flight testing of a prototype earth reflected differential absorption system for ozone monitoring suggests great utility in studying long range oxidant transport problems. A modification to the current system would enable use in mapping selected tracer gases simulating point source plumes. A system for monitoring SO_2 is being designed and a computer simulation model has been created to optimize component selection, system response, and display options.

Laserfluorosensing techniques are presently being evaluated for use in monitoring the presence or effects of environmental pollutants. The concentration of surface water chlorophyll a in algae is presently being monitored using a helicopter-borne laserfluorosensor. A completed study has indicated that the use of laserfluorosensing techniques to detect pollutant induced stress in leaf tissue of commercial crops is not feasible. Lastly, laboratory feasibility studies are nearing completion on correlations between induced fluorescence emissions from organics in surface waters and total organic carbon. An airborne system is being designed which will map and quantify surface water total organic carbon based on such a correlation.

CHAPTER VIII: ECOLOGICAL EFFECTS

RAPPORTEUR:
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ABSTRACT

XENOBIOTIC METABOLISM IN MARINE SPECIES EXPOSED TO HYDROCARBONS

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Several investigators (e.g. Lee *et al* 1972, Korn *et al* 1976, Statham *et al* 1976) have demonstrated that most fish species bioconcentrate pollutants, including hydrocarbons, from their aqueous environments. Hydrocarbons are slowly metabolized by fish, and excreted in urine and bile. The initial metabolic product is an alkene or arene oxide which is usually more toxic than the parent hydrocarbon. The alkene or arene oxide may be further metabolized by epoxide hydrase or glutathione S-transferase, or rearranged nonenzymatically to an alcohol or phenol which is usually conjugated before being excreted. We have studied the effect of hydrocarbon pretreatment of some fish species on the enzymes involved in hydrocarbon metabolism, paying particular attention to the polycyclic aromatic hydrocarbons.

Our studies showed that repeated injection of a 3-methylcholanthrene (3-MC) or dibenzanthracene (DBA) into flounder, skates, or sheepshead, but not stingrays, caused a 10- to 35- fold increase of aromatic hydrocarbon hydroxylase (AHH) activity in hepatic microsomes. No induction of epoxide hydrase or glutathione S-transferase was observed in these studies. Hepatic AHH activity in sheepshead remained elevated for at least four months after a single dose of 3-MC, but epoxide-metabolizing enzymes were not induced at any of the time points or doses studied.

Studies in progress include the *in vivo* metabolism of selected components of crude oil in representative marine species, and further elucidation of the role of induction in the metabolism and toxicity of xenobiotics.

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ABSTRACT

CHEMICAL CHARACTERIZATION AND AQUATIC BIOASSAYS OF ENERGY DEVELOPMENT PROCESS EFFLUENTS

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Process effluents from energy development programs are very frequently complex mixtures of numerous chemical constituents which may individually or collectively be toxic to the aquatic biota. Thus, the assessment of these effluents in terms of toxicity, the identification of the toxic principals, the delineation of the environmental stability characteristics of these entities, and the ultimate development of quantitative impact predictions are complicated research problems of major importance.

To characterize the potential impact of energy development processes on the biophysical environment, the present program has utilized chemical and biological assessment methods in a coordinated, feedback mode of operation. Bioassays run on effluents, and nondestructively separated fractions thereof, have been used as means of focusing the chemical analysis efforts on those of most consequence. Chemical characterization of the toxic effluent fractions has subsequently permitted the design of further bioassay experiments indicative of which constituents are the primary toxicants. As the chemical and biological assessments of each effluent are completed, the results are used in combination with field evaluation data to develop impact predictions and/or appropriate control strategies.

The approaches described above will be discussed with emphasis on the unique aspects of the characterization and interpretation methods and techniques used.

ABSTRACT

EFFECTS OF CHEMICALS USED IN OFFSHORE WELL-DRILLING OPERATIONS

Literature on the effects of chemical use in offshore well-drilling operations on marine organisms is very limited. Policy decisions are currently based on static, 96-hour LC50 determinations, observations of divers, and theoretical models of pollutant dispersion. A limited research program on drilling-fluid constituents has been initiated at the Gulf Breeze Laboratory to provide a better data base as one component in the prediction of the relative hazard of using alternative drilling mud constituents and to develop more relevant laboratory methods for xenobiotic evaluation.

This paper discusses the hierarchically arranged methodology used for testing the effects of selected chemicals. Tiered screening processes were used for sequential testing of compounds. From the initial set of compounds, two were selected for further study; barium sulfate and pentachlorophenol. Static toxicity tests were conducted with larval stages of three marine/estuarine species, eastern oyster, grass shrimp and pinfish in a laboratory environment. Bioconcentration effects up to 80 times that measured in the exposure water were observed.

This project is designed to provide research results for some areas in which an understanding of the effects of drilling muds in the Gulf of Mexico is lacking, including:

1) estimates of the distance that active rigs need to be from coral reefs in order to minimize potential effects from emissions;

2) effects of mud on resident rig marine life;

3) advisability of aquaculture near platforms;

4) recommended distance from rigs for seafood harvesting.

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ABSTRACT

THE MARINE ECOSYSTEMS RESEARCH LABORATORY: A FACILITY FOR THE INVESTIGATION OF EFFECTS AND FATES OF POLLUTANTS

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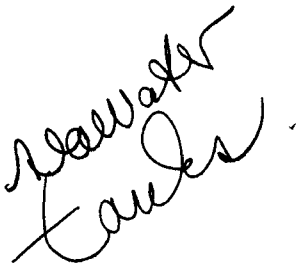
A full and quantitative understanding of the fate and effects of pollutants in real ecosystems requires the ability to carry out controlled experiments. At the Marine Ecosystems Research Laboratory, University of Rhode Island, a series of 12 meso-scale microcosms has been set up. These are outdoors in fiberglass tanks 5.5 m high and 1.8 m in diameter.

The ecosystems maintained in these tanks are intended to be typical of the N. E. coast of the United States, and are therefore coupled benthic-planktonic systems. Each tank contains about one ton of sediment and about 13 cubic meters of seawater from Narragansett Bay. The tanks can be run either flow through or as batches. The normal flow through rate results in a turnover time of 30 days. The tanks are stirred; the stirring rate is adjusted to provide a level of turbulence similar to that in the Bay. The tanks can be heated or cooled, and can be operated all year.

Results of the first six months of operation indicate that the biological and chemical behaviour of the systems, while showing some anomalies, was generally quite similar to that in Narragansett Bay. In particular, the phytoplankton abundance and species composition were similar to the Bay, with the peaks and crashes of phytoplankton abundance in the Bay having their counterparts in the tanks.

Experiments using oil as a pollutant are now underway. We are obtaining quantitative information on the effects of relatively low chronic levels of oil on the phytoplankton, zooplankton and benthos. In addition we are obtaining quantitative information on the fate of the oil in these systems.

Microcosm research provides an essential intermediate scale of observation between the beaker and the natural systems.



Sox
Nox
on crops
forests

ABSTRACT

EFFECTS OF COAL-FIRED POWER PLANT EMISSIONS ON TERRESTRIAL ECOSYSTEMS

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Anthropogenic emissions of substances to and subsequent deposition from the atmosphere has increased greatly during recent decades. Atmospheric pollutants are imported, transported, exported, accumulated, and often changed before they are deposited. Pollutant effects may be beneficial or detrimental; acute or chronic. Both general and specific information about the state, structure, and function of the terrestrial environment is essential for determining the extent of changes that are induced by man's activities. Efforts to prevent or solve environmental problems are more likely to succeed if they are based upon a thorough knowledge of the processes that occur in the ecosystem and if this knowledge can be integrated with other factors that affect the environment, including economic, technological, and sociological considerations.

The research needed to provide this required knowledge of ecological effects and impacts of atmospheric emissions should be approached on three levels--the species, the community, and the ecosystem--and the results of studies on these levels synthesized into an integrated approach. Studies conducted at the species level generally deal with one or two species and are conducted under highly controlled conditions; while research at the community or ecosystem level involves increasing complexities and reduced control of many variables. Present research efforts at the species level include controlled exposure studies to determine the impact of simulated ground-line concentrations of sulfur dioxide and nitrogen dioxide on the productivity of plants. Studies at the community level are conducted under field conditions to duplicate communal relationships among plant species. An air exclusion system has been developed which allows plants to grow under ambient conditions and only operates under exposure conditions. A radioisotope technique using labeled soil sulfur is being evaluated as a method to determine plant accumulation of atmospheric sulfur. A third effort underway at the community level utilizes a specially developed microcosm system to evaluate the effects of acid precipitation on plants and soils. A forested watershed provides an excellent means of evaluating the integrated response of the ecosystem level. Two forested watersheds one located near a power plant and the other located in a background setting are being compared in order to quantify the integrated response at the ecosystem level.

The synthesis level carries environmental research to a final level of complexity, which integrates ecological considerations with economic and sociological data to evaluate the total environmental complex. To provide relevant information on the complexities of ecosystems and the observed or anticipated responses of ecosystems to environmental perturbations, a balanced approach must be taken to the research hierarchy discussed previously.

on terrestrial ecosystems

ABSTRACT

EFFECTS OF PRUDHOE CRUDE OIL SPILLS ON COASTAL TUNDRA PONDS

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Detailed and long-term studies on the ecological effects of and recovery from controlled crude oil spills have shown marked changes in species composition and slow recovery to pre-spill conditions. The rate of oil degradation is slow near the frozen arctic ocean, which may increase the exposure time of soluble compounds to pond organisms. Initially, the smaller volatile compounds go into solution (less than 2 percent of the oil by weight, max. 14-17 mg/l without agitation) inhibiting algal photosynthesis and killing zooplankton. Changes in algal composition occur and remain changed for years so long as the zooplankton grazing is reduced. Zooplankton colonization occurred every year and yet densities remained low and *Daphnia* did not live through the summer for five years following a whole pond spill.

Invertebrates living on the surface or on emergent vegetation were caught mechanically in the floating oil scum. Little direct mortality caused by soluble compounds could be shown experimentally or observed in situ. However, those chironomids (Diptera) which mate on the pond surface and egg masses attached to vegetation were vulnerable to entrapment in the floating oil scum. Since the chironomids had long life cycles, up to seven years, loss of one or two annual cohorts may be evident in the ponds for may years. Metamorphosis of fourth instar chironomids was seriously reduced in the year following the spill. Chironomid species composition in an oil treated pond remained markedly different from control ponds after seven years.

Long-term changes in phytoplankton, zooplankton, chironomids and other aquatic invertebrate species composition would not be expected in warmer climates where similar organisms have many generations per year. However, the multi-year or univoltine life cycles in the artic macroorganisms near Barrow, Alaska mean that potential accidents with crude oil will leave long-lasting effects. Few visual effects and the lack of change of rates of metabolism of the whole system, suggest that removal of the floating, black scum of oil by suction or a boom might be the best treatment to minimize damage during the ice-free period.

ABSTRACT

MECHANISMS OF RESISTANCE TO
SULFUR DIOXIDE IN GREEN PLANTS

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Although inheritable differences in susceptibility of plants to SO_2 toxicity have long been known, the mechanisms responsible for these differences are still being sought. In this study, two cultivars of Cucurbita Pepo (squash and pumpkin) and two of Cucumis Sativus (cucumbers) were exposed to SO_2 at various concentrations. Absorption of SO_2 and degree of injury were measured. The four cultivars differed as much as five-fold in being susceptible to injury to SO_2 when compared on the basis of the external concentration of SO_2 to which they were exposed.

However, they all had equivalent susceptibility when compared on the basis of SO_2 absorbed. It is concluded that the principal factor responsible for varietal differences in resistance to SO_2 is the rate of SO_2 absorbed.

Young leaves of all four cultivars sustained much less injury than did mature leaves, when compared on the basis of either external SO_2 concentration or SO_2 absorbed.

It is concluded that the resistance mechanism characteristic of young leaves operates after SO_2 has been absorbed and therefore, reflects a biochemical difference between young and mature leaves.

ABSTRACT

ECOSYSTEM CHARACTERIZATION - AN APPROACH TO
COASTAL NATURAL RESOURCE PLANNING AND MANAGEMENT

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Man is at the threshold of the era of integration. Problems we face today are so complex and wideranging that solutions require a "holistic" approach. The principal strands of the new web of understanding are supported by the three disciplines of technology, scociology and bio/ecology; together they comprise our environment. Bio/ecological components can range in scope from systems as large as the biosphere or as small as the gene. This paper suggests a midlevel, ecosystem approach to developing information which will benefit planners, decision makers and researchers. The concept of ecosystem characterization is not very profound or complicated and can be defined as a description of the important components and processes comprising an ecosystem and an understanding of their important functional relationships. Strong emphasis is placed on systems understanding through structured integration of information from the diverse physical and biological sciences.

The approach involves the delineation of the physical boundary of the system, preparation of a functional conceptual ecosystem model, information synthesis and analysis using the model as the "blueprint," preparation of a pilot characterization report and a final ecosystem characterization report which stresses functional understanding. The process brings together in an information appendix, most of the relevant information about the system.

The Fish and Wildlife Service presently has four coastal ecosystem characterization studies underway using EPA Interagency Energy/Environment R&D Program funds. Two are located on the Atlantic coast, one on the Gulf coast and one on the Pacific coast. The earliest is scheduled for completion in July of 1977.

ABSTRACT

ASSESSMENT OF INSTREAM FLOW NEEDS

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Energy development decisions have been forecast to make extensive demands on water supplies which currently furnish habitat for fish, wildlife, and endangered species. Improving the capability to predict the quantity of water which must remain in streams to maintain their dependent natural systems is a complex and difficult task recently undertaken by the U.S. Fish and Wildlife Service with support from EPA and others.

The initial assessment of the state-of-the-art of methodologies for determining instream flow needs has been completed. Methodological, research, and data gaps have been identified. A multi-year effort has been initiated to close the methodological gaps. Supporting research projects to establish critical biological relationships and the necessary bibliographic and factual information systems are also underway. The framework for a data base of identified water quantity needs for the highest priority streams in the 17 Western States has been developed and 6 states have already completed the first phase of the project.

To provide a focus for the many divergent activities on-going in this area, a Cooperative Instream Flow Services Group has been established. This group is furnishing support and assistance to Federal and state agencies developing, testing, and applying methodologies for determining instream flow needs.

A simulation model that predicts the effects of altered stream flows has recently been developed, and will likely be tested as part of the Water for Energy Assessment Program being conducted by the Water Resources Council. If successful, the model will be a useful tool for alternative site selection and trade-off evaluation.

Water demand for energy vs what must be left for ecosystem

how do you get people to use them.