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EPA JOURNAL

Science and the Future

Science and the Future

EPA scientists plot wind direction and speed in air pollution studies by tracking a helium-filled balloon with this instrument, a theodolite.

In this issue EPA Journal takes a look at the future for environmental science, the environment in general and the world.

A distinguished group of leaders in the science and environmental communities offer their views on what scientists should be doing to help solve environmental maladies in the next decade.

Dr. John E. Cantlon, chairman of the executive committee of the EPA Science Advisory Board, discusses the Agency's role in environmental science. Dr. William Rea, a member of the EPA Science Advisory Board, explains the advanced treatment provided for pollution victims at the institution he directs in Dallas, Tex.

EPA Administrator Douglas M. Costle discusses the health research necessary to support the Agency's regulations. An article on ozone protection reports on the efforts, spearheaded by EPA Deputy Administrator Barbara Blum, to convince foreign countries to join the U.S. in curbing the emissions of ozone-destroying chlorofluorocarbons.

Other science subjects in this issue include: a report on EPA's role in monitoring radiation from the Three-Mile Island nuclear power plant; a story about EPA's multi-purpose laboratory in Las Vegas, Nevada; a report on the use of certain flowers to detect pollution conditions, and a look at the possible impact of electric autos on the environment.

An article from Toronto, Canada, reports on the First Global Conference on the Future and quotes many leaders as predicting a shift to the "soft" energy systems such as solar power.

To help balance this presentation, the Journal also carries an article by a nuclear research engineer raising questions about possible dangers in following the "soft" energy path. □

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EPA is charged by Congress to protect the Nation's land, air and water systems. Under a mandate of national environmental laws focused on air and water quality, solid waste management and the control of toxic substances, pesticides, noise and radiation, the Agency strives to formulate and implement actions which lead to a compatible balance between human activities and the ability of natural systems to support and nurture life.

Front Cover: This illustration of stars and exploding gases in the immense distances of interstellar space was prepared by Rob Wood of Stansbury, Ronsaville, Wood.

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Articles

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Pollution's "Invisible" Victims

By Douglas M. Costle,
EPA Administrator

In 1939, a drug manufacturer decided the best way to capitalize on the popularity of the new sulfa drugs was to market one of them in a liquid, non-prescription form. He developed a product called Elixir Sulfanilamide, which combined a sulfa compound with diethylene glycol—a commercial solvent used in making antifreeze and brake fluid.

Because the drug-control laws of the time did not require safety testing, the manufacturer was free to put his product on the market, and he did so—with devastating results. Although only 2,000 pints of the Elixir were produced, and only 93 were consumed, a total of 107 people died from the effects of the solvent.

The public outcry that followed prompted Congress to pass a new Food, Drug and Cosmetic Act—one that, for the first time, gave the Food and Drug Administration the authority to require the testing of new drug products for safety.

Under the circumstances the public's outrage and Congress's response to it were scarcely surprising. The trail from cause to effect, in the case of the Elixir, was a short one. No great breakthroughs in the science of epidemiology were required to follow it. Once it was established that all of the victims had consumed the Elixir, the evidence pinpointed diethylene glycol as the cause of death beyond any reasonable possibility of doubt.

Normally, of course, regulatory issues in the health-and-safety area are not posed in such dramatic fashion. This is especially true for environmental regulation. There, the pathway from cause to effect—from the point where a pollutant is discharged into the environment, to the point where it can be positively connected to particular diseases in particular human beings—tends to be a long and circuitous one.

To be sure, there have been instances where environmental pollution has been directly and dramatically linked to public health disasters. The 1948 atmospheric inversion in Donora, Pa., which claimed 20 lives, is one example; the 1952 inversion in London, whose toll was 4,000 lives, is another. But on close inspection, even these turn out not to be exact counterparts of the Elixir episode. There's no doubt that air pollution was the culprit in both Donora and London—but even today, 30 years after the fact, we still cannot say exactly which pollutants in the air were to blame.

And such episodes are the exception. Most health-related regulation in the environmental field must be written with even less direct evidence of the linkage between environmental contaminants and their victims. The problem is illustrated by the example of cancer, where a series of major obstacles await anyone who wants to prove that environmental pollutant A—even if it a known carcinogen—caused the disease in victims X, Y, and Z.

- First, cancer can remain latent for literally decades before identifiable symptoms begin to appear.
- Second, it can be caused by more than a single agent—as shown, for example, by the fact that asbestos workers who smoke are 30 times more likely to get cancer than their non-smoking fellow workers.
- Third, except in rare instances, the various forms of cancer do not bear the clear imprint of a particular carcinogen.
- Fourth, our society's practices in terms of keeping records of cancer deaths, and their causes, have never been systematized on a national scale.
- And finally, few doctors have been trained to consider environmental pollutants as possible causes of cancer; and thus, they have not looked for evidence of exposure to cancer-causing agents in examining their patients' histories.

Searching for Exact Answers

For other chronic diseases, the difficulty of establishing links to particular pollutants is at least as great as for cancer. And that, quite frankly, poses a problem for us. If we could routinely predict the number of people who were going to get sick from the discharge of a given amount of a pollutant, our regulatory decisions would be better—just as an investor's decisions would improve if economic forecasting were a more exact science, and a farmer's judgments about when and what to plant would benefit from better long-range weather forecasts.

But though we must operate in the absence of scientific certainty, we are by no means without scientific resources. For while we seldom have the kind of proof available in the Elixir episode, we almost always have the scientific equivalent of *circumstantial* evidence. This can take the form, for example, of tests that show how a pollutant affects laboratory animals; or studies of its impact on human beings exposed to it in the workplace, or in food products. Moreover, if we weigh that evidence in a careful and systematic way—the courtroom analogy is giving a suspect pollutant the benefit of due process—we are fully capable of making reasonable judgments about an appropriate degree of regulatory control.

Rather than dealing with this process in theoretical terms, I would like to describe briefly how it has worked in the case of one particular pollutant—carbon monoxide.

Let me pause to emphasize that in choosing carbon monoxide, I don't mean to imply that it is a "typical" pollutant. First of all, there is no such thing; and second, carbon monoxide differs in important respects from other targets of environmental regulation, as I shall explain. But our experience with it does illustrate how we can make the best possible use of the scientific information available to us.

We began our review of carbon monoxide with the certain knowledge that, at high concentrations, it is dangerous. Uncounted numbers of people have proven that fact, in tragic fashion, by asphyxiating themselves on car exhaust.

However, our concern is not the tremendously high concentrations that result when exhaust fumes are piped into a closed vehicle—concentrations of thousands of parts per million of air. Instead, we were worried about the effects at the low concentrations found on busy city streets, which typically fall into the range of 10 to 50 parts per million.

In trying to understand these effects, we were blessed with a wealth of scientific information—in fact, we accumulated roughly 1,000 studies on how carbon monoxide affects human beings and test animals.

However, as scientists know, having a large amount of data about an elusive subject can often be less useful than having a small amount of data about a clearcut subject—the Elixir phenomenon again. One study may contradict another; studies may prove to have flaws of one kind or another; or a single study may provide what seems like a highly significant finding, but its value is limited because no other experiments have duplicated the result.

The Review Process

Thus, in order to develop the best possible *scientific* basis for setting an air-quality standard, we somehow have to sift through the mass of data in hand, weighing each relevant study in turn, and emerging at the end with a document—called the criteria document—that lays out the evidence in a rational and comprehensive way.

Preparing these documents is a massive undertaking, and one that does not lend itself to brief description. But at its core is a process that amounts to sending each bit of relevant evidence out into the harsh world of scientific review—a world that is *extremely* intolerant of sloppy methods or

Clad in protective clothing, a specialist collects sample of hazardous waste for analysis.

unjustified assumptions. This happens, not once, but several times during the preparation of the document. The result is that any scientist with an interest in the pollutant—whether from industry, the academic community or citizens' groups—is given ample opportunity to comment.

Nor does the door close when the criteria document is published in final form. Once a standard has been proposed, we hold public hearings and invite written comment—which puts the evidence on the firing line once again.

Two months ago we proposed, after an extensive health-effects review, a more stringent one-hour atmospheric air pollution standard for carbon monoxide. By way of background, some interesting lessons were learned in the course of preparing the final criteria document for this pollutant.

In 1971, when the first carbon monoxide standard was issued, it appeared the main health problem associated with the pollutant was that it tended to make people less alert. This is a potentially serious problem, considering that drivers are among those most likely to be exposed. However, studies done in the interim suggested that there was a more serious health concern—carbon monoxide's impact on the human heart.

Behind this concern lies the fact that carbon monoxide combines more readily with a blood constituent called hemoglobin

than does oxygen. Since hemoglobin carries oxygen from the heart to the rest of the body, the formation of carboxyhemoglobin, which is what you get when carbon monoxide and hemoglobin combine—forces the heart to pump more oxygen than normal. This in turn leads to an increased incidence of angina—a painful condition that often requires the use of medication, and sometimes requires victims to be hospitalized.

Yet knowing that angina was the principal health effect we needed to be concerned about was not enough. We also had to know how much carbon monoxide the body could handle without aggravating angina. There were several studies suggesting it became a problem when between 2.5 and 3 percent of the hemoglobin had been converted to carboxyhemoglobin. However, one study suggested that the threshold was, in fact, under 2 percent.

The problem facing the Agency was how to weigh *that* study in comparison with *all* the others. This was an issue where we needed the benefit of expert opinion from outside the Agency; and where, as the result of our review procedures, we were able to obtain it.

The Agency has a special panel of scientists, called the Science Advisory Board, whose specific assignment is to provide a check on the scientific foundation underlying the rules we write.

Members of the board with particular expertise in carbon monoxide were asked to review the draft criteria document.

When, as part of this review, they looked at the study in question, they concluded that it had a potential flaw—the fact that there were other contaminants in the air beside carbon monoxide during the experiment. They recommended, therefore, that we not use this particular study in deciding on the likely threshold for the aggravation of angina.

That is a snapshot look at how scientific review works in practice. It should not be viewed as typical. We cannot, either as a matter of law or of common sense, approach the regulation of a pesticide intended for use in one small corner of a single State the same way we deal with an air pollutant found in every city and town in the country.

But whatever the target pollutant, our commitment to establishing a sound *scientific* basis for regulation remains constant.

Making Judgment Calls

Yet, for every pollutant, there also comes a point where the scientific knowledge available can offer only guidance for regulatory decision-making—where policy judgments must be made. In regulating air pollutants, for example, the Clean Air Act tells us to allow for a margin of safety—to set the standard somewhat lower than a strict reading of the evidence might seem to call for. And deciding where to set the margin—although reflecting the scientific evidence—ultimately comes down to a question of judgment.

Our approach in making such judgments has been basically this: If the evidence clearly *suggests* the possibility of health damage, but is not conclusive, we will *assume* that the possibility is real.

Again, cancer offers an illustration: Since medical science has not demonstrated that there is a threshold for carcinogens—a dosage so small it can *never* cause cancer—we assume there is no threshold. That does not mean we strive for the unattainable goal of zero risk in regulating carcinogens. But it does mean we are concerned about these substances even when they are present in the water, the air or in soils at very low concentrations.

Why have we adopted this kind of stance? Simply because if we wait for scientific proof before taking firm regulatory action, we will very likely turn out to have waited too long. Thus, with carbon monoxide, we do not have proof that angina leads to permanent heart damage—but there is evidence that it may, and we must take into account that evidence. And the dangers of delay are demonstrated still more graphically by the new class of pollutants that increasingly concern us—pollutants that are products of the post-World War II chemical revolution.

Handle with Care

This revolution has produced an extraordinary array of substances that, unlike carbon monoxide, have never been known in nature. These substances—synthetic organic chemicals—have helped make our lives more comfortable and more rewarding in many ways. They have saved lives, they have increased crop outputs, and they have generated a vast family of new industrial and consumer materials. But some of them have proven to have unintended and tragic impacts on the lives of people and on the quality of the natural environment—as we learned through our painful experience with Kepone, PCB's, thalidomide and DDT.

We, of course, have only a limited sense how dangerous these substances are. We assume very few will ultimately turn out to be toxic. Yet the universe of substances we are talking about is a large one—an estimated 5 million chemicals are now known to exist, and 45,000 of these are in commercial use. Moreover, the *quantity* of synthetic chemicals has grown exponentially over the past few decades—with production rising from less than 50 billion pounds in 1950 to more than 300 billion pounds by the late 1970's.

If nothing else, those figures argue for treating these substances with a generous measure of caution. As Love Canal taught us, a careless attitude at one period in history may turn out to impose heavy costs—both in financial and in human terms—more than a generation later.

Given the potential for long-term damage, it seems to me the case for a policy that emphasizes protecting health even where the scientific evidence is inconclusive *should* be irrefutable. Yet, as many of you know, it's getting more and more difficult to carry that argument in Washington these days—given the anti-regulatory climate in town.

The counter-arguments vary. At times, agencies like EPA are accused of failing to do their scientific homework properly; at times of stretching their interpretations of the evidence to support unreasonable regulatory measures. But whatever the particular line of argument, the basic message is the same—we should slow down, wait for more evidence, conduct more studies.

We *do* need to improve our scientific understanding of the links between pollution and health—especially in the case of toxic chemicals, many of which didn't exist a generation ago. But we cannot delay writing sensible, balanced rules governing these substances. We know enough to do that. Moreover, if new evidence emerges to suggest the need for changing our rules, we can change them.

In my judgment, it is not the quality of our scientific work—nor our interpretation of it—that makes it difficult for us to meet the arguments of those who would have us move more cautiously. It is rather the fact that only rarely can we identify specific groups of people whose health has been demonstrably affected by environmental pollution. Instead we deal in the statistics from computer-generated probability studies, and in phrases like "excess cancers per million population"—scarcely the stuff of which newspaper headlines and TV documentaries are made.

Yet the threat to human health represented by environmental pollution is not diminished because it lacks the drama of an Elixir Sulfanilamide tragedy. So it seems to me that one of the chief tasks facing all who are concerned with environmental health is quite simply to convey to the public, in the best ways we can, some basic facts about the links between pollution and health: we must say, in candor, that there are limits to what science can tell us about this relationship; but that the more serious limitation is an inability to see the suffering that lies behind the dry projections of injury that science does permit us to make; and that, if this failure of vision can be overcome, the need for firm and farsighted environmental regulation will be very plain. □

Environmental Science in the 1980's

What is the next big task for science in solving environmental problems? EPA Journal asked some members of the scientific and environmental communities what they think. The specific question was:

"As we face the 1980's, what should scientists be doing to help such ills as hazardous waste, toxic poisoning, groundwater contamination, and other threats to the environment?" The answers follow:

Dr. Rene Dubos
Professor Emeritus,
Rockefeller University

Science in the 1980's should focus on *eliminating* waste, rather than cleaning up waste. This is the only way we are going to be able to curb the danger from toxic chemicals in the environment. Specifically, we need to concentrate on changing all industrial operations so there is no waste discharge. For example, I was an environmental advisor to a brewery. My suggestion was to find practical uses for all of the discharges traditionally known as waste. This proved quite possible, with the brewery finding ways to make fertilizer from its "pollution," or animal feed, etc. Or take a large forest products plant I visited in Sweden.

They had no wastes. Everything was being put to some good use, including making natural gas to generate energy. I believe this is going to be the direction in the big chemical industries too. It has to be. There is no other solution. And it is going to take a lot of scientific research to do the job.

Russell W. Peterson
President,
National Audubon Society

For scientists to increase their effectiveness in solving environmental problems, they must recognize and face up to the following:

Threats to the air, the water, and the land are threats to life —to all life, including human life. The impacts of today's exposures may be delayed for years—such as cancer from radiation. The cumulative impact of numerous inconsequential actions over time can be devastating, such as the build-up of acid rain.

To cope with these factors, scientists must try harder to help decision-makers focus on the general interest over the long run. The critical environmental problems of today are the deferred costs of past benefits, the results of reaping the obvious benefits today while deferring the hidden costs until tomorrow. Scientists must learn how to weigh on society's balance both the long-term benefits and the long-term costs, before scaling up a new development. We must put our research and development on a pay-as-you-go basis.

U.S. Senator
Harrison Schmitt
(R-N.M.)

It is particularly important that scientists, especially scientist-legislators, recognize the synergistic roles that science and technology play. We must reach a philosophical and a legislative balance between protection of the environment and utilization of the environ-

ment for the benefit of Americans and mankind in general.

On the one hand, the scientist must gather an understanding of the physical processes and the interactions between those processes within the total earth environment. This understanding permits both the prediction of technology's potential effects on the environment and the prevention of those effects which society deems unacceptable.

On the other hand, the technologist (and lawmaker) must use the expanding base of engineering know-how and innovation to prevent significant environmental problems at their source and to construct a balance between environmental protection by law and environmental control by technology.

As a case in point, the increasing geoscientific knowledge combined with the new technologies of remote sensing make it possible to search for and discover new energy and minerals in remote areas. These discoveries can now be made without any distinctive effects on the wilderness or other environments. Upon discovery, new exploration, mining and refining technologies permit extraction and refining of these resources without significant final effects on the total environment.

As a second illustration, the increasing knowledge about oceanic, atmospheric and biological processes, combined with new technologies, make possible the ultimate control of hazardous materials. For example, hazardous wastes can become resources through advanced chemical and nuclear separation processes. Toxins produced in manufacturing can be destroyed at their source through destructive laser and catalytic chemistry processes. Significant ground water contamination, both natural and man-made, can be eliminated through new chemical and biological processing.

However, present regulatory and tax law make it nearly impossible to create the balance that is now scientifically and technically possible. The above illustrations are particularly important in view of the apparent conflict between our environmental law and our dangerous dependency on imports of crude oil (45 percent dependent), most strategic minerals (65 percent dependent) and essential technological products.

As we look into the future, it is clear there will be no future unless scientists and legislators work differently than in the past. They must begin to anticipate environmental problems and efficiently work around or solve such problems rather than only trying to treat the multitude of side effects after they are upon us.

There are those who would advocate a limit on the use of new technology, a limit in fact

on National growth, in order to avoid problems. Such a course is not open to us. As the only protector of freedom in a hostile world, our Nation just does not have that luxury.

Rep. George E. Brown, Jr.
(D-Calif.)

The involvement of scientists with regulatory administrators and policy makers in the careful planning of sound research programs, which are then funded at an adequate level, can provide answers to almost any question involving the introduction, transport, transformation, and health and ecological effects of environmental pollutants, whether it be hazardous waste, toxic substances, or the common by-products of human activities introduced into air, ground, or water. Far more important, however, is the involvement of science and scientists in the process of formulating the fundamental societal objectives, goals and strategies which determine if we continue to be an inefficient, waste producing, life-threatening, materialistically oriented society, constantly defending ourselves against our own excesses, or a more benign society embracing more creative goals.

Scientists need to be involved in formulating and answering questions like the following:
Are we to continue being a 'waste' producing society, one in which generation of unwanted by-products is inherent in the production process?
Do we want to add new risks, as the price for new technologies, and if so, what amount of risk are we ready to accept as a society? And finally, what burden of shortages or hazards do we ask future generations to bear as a result of our choices?

I hope we ask our scientists to help us build a society in which waste is not the end of a process, but rather the beginning of a new cycle; where renewable resource technologies back up and replace, to the degree possible, existing technologies which are based on non-renewable resources; and finally, where risk is clearly defined, understood, and acceptable.

Janet Welsh Brown, Ph.D.
Executive Director,
Environmental Defense Fund

In addition to the obvious ones (carbon dioxide buildup, the effects of acid rain, the need for safe disposal of nuclear waste), there are some specific topics, not as often discussed, that require scientific research in the 80's: the effects of diminishing genetic diversity among both plants and animals, the correlation between deteriorating air quality and morbidity, detailed analyses of the energy/food ratio at every stage of the food chain. There are also some crosscutting concerns that should, for purposes of sustaining economic yield and preserving our environment, be built into most research designs.

Applied research on the environment should be concerned more with efficient end-use of all resources. American policymakers are beginning to recognize this need with respect to energy—that conservation and cogeneration can produce the equivalent of new productive capacity—but have yet to develop the same efficiency with respect to water, and to all waste problems—sewage, solid and toxic. *Using less* of finite resources and *recycling more* should be the economic and environmental goal of the 1980's research.

Much of the scientific research needed in the 1980's should be economics and social science research. We must develop more widely accepted methods of quantifying the costs of both degradation and the protection of the environment. For instance, the need to document the cost of air pollution on various sectors of the economy (the effects of acid rain on forestry, agriculture, recreation industry), and comparative cost of cleaning coal, burning it cleanly and efficiently, and using alternative energy resources. We also need research on the institutional and psychological barriers to changing wasteful habits and environmentally obsolete technologies. Social science research can provide the insight required to overcome such barriers.

And wherever possible, the transnational character of environmental developments deserves consideration when designing research.

Irving J. Selikoff, M.D.
Professor, Environmental Sciences Laboratory,
Mount Sinai School of Medicine

There is an unhappy legacy of inattention, of research not done, observations not made, data not sought. And, as a result, precautions not taken nor controls set in place, during decades in which industry mushroomed in size and complexity, far outstripping natural buffers of space and time. Our omissions have inevitably been accompanied by failure to identify characteristic clinical syndromes associated with multiagent, interacting, chemical exposures, making it much more difficult to provide the necessary quantitative data for evaluation of human health effects of environmental contamination, often at low-level, over the long term. Worse, these inadequacies allowed the malfunctions to enter the structure of our economic life; it's not easy now to replace asbestos in brakes, nor benzidine-based dyes, nor to develop improved methods of chemical waste disposal, nor to avoid acid rain, nor even to prevent the addition of new toxic agents to our industrial life.

We have much to do, to recoup as rapidly as possible. Since we can't do everything, a scientific priority is to set scientific priorities, to focus on those factors which are the most serious and affect the largest number of people (cancer, reproductive hazards, disabling chronic disease, life-shortening illness).

The data sought should be those which will assist in prevention for, at the moment, diagnosis is neither easy nor early, and treatment often ineffective or at best palliative. Dose-response evaluations should accompany all probes; yes-no answers are increasingly inadequate for regulators. For this, we must learn to extrapolate much better from animal and in-vitro (test tube) tests to man, else we will have our country a vast human laboratory.

Vincent T. DeVita, Jr., M.D.
Director,
National Cancer Institute

In my view, a pressing need for the 1980's is to identify environmentally-related causes of cancer and to define their relative contributions to this disease. Since most forms of cancer are probably multicausal in origin it is important to regard the environment to be everything to which people are exposed—directly or indirectly, intentionally or unintentionally—and to include both natural and synthetic agents. Thus, research on environmentally-related causes of cancer must consider the general and workplace environments, as well as personal habits, lifestyle, and all other external factors that may influence the risk of cancer.

As the relative importance of various environmental factors is determined, we must make concentrated efforts to apply this knowledge toward the prevention of cancer. Of particular importance in the 1980's will be research on the identification of environmental agents that by themselves do not cause cancer, but may be promoters. An important area of research will be to continue to learn about individual susceptibilities to cancer. Finally, a subject that cannot be ignored in any decade, smoking cessation programs must continue with renewed inspiration and vigor.

Dr. Donald N. Langenberg
Deputy Director and
Acting Director,
National Science Foundation

NSF recognizes the great importance of environmental problem areas. A key to the solution of such problems is the acquisition of fundamental knowledge about the factors underlying or related to them. This includes greater knowledge of the exact chemical and physical processes involved, the methods of dispersion and transportation in the environment, the nature of the threatened ecosystems, the processes and rates of degradation of contaminants, and the social-economic factors underlying these activities. Much of this knowledge may best be gained through interdisciplinary approaches to the problems. Substitute industrial processes to replace those that now produce hazardous by-products, for example, can be achieved only through the use of information growing out of broad, in-depth studies of alternative materials and processes and thorough, accurate, basic knowledge.

Dr. Eugene P. Odum
Director,
Institute of Ecology,
University of Georgia

Scientists, especially ecologists, environmental chemists, and toxicologists, should join with engineers, economists, and political scientists to form teams to seek holistic "cures" (as contrasted with piecemeal or one problem/one solution approaches) to the environmental "ills" caused by toxic wastes, since in almost all cases problems are economic and political as much or more than they are technological. It can be suggested that two lines of attack be taken simultaneously, namely (1) finding means to reduce the output of poisons (and eliminate entirely the most deadly ones from the general environment) by redesigning industrial processes to be less wasteful with more efficient recycling and removal technology, and (2) to design total waste management systems that couple artificial treatment with the assimilative capacity of natural systems such as rivers, wetlands, etc., that are the ultimate "tertiary" treatment facilities.

Dr. Richard M. Krause
Director,
National Institute of
Allergy and
Infectious Diseases

We should not forget the classic lesson learned a half century ago when the cause of disease in a cluster of asthmatic patients was found to be linked to highly allergenic dust emanating as waste from a nearby castor bean mill. More recently, a similar episode occurred when dust from a soybean factory contaminated air in its vicinity. We have identified a number of other industrial agents of hypersensitivity responsible for occupational asthma, including platinum salts from soldering flux, coffee bean dust in processing facilities, mold products disseminated from building air conditioning and humidification tanks, and exposure to chemical vapors (notably toluene diisocyanate and trimellitic anhydride) in the plastics industry.

And we have even been reintroduced to earlier microbial problems with the highly allergenic *Bacillus subtilis* as a detergent additive and cause of respiratory problems among both plant workers and housewives. Finally, some air pollutants that are derived from the combustion of coal, gas and oil products have major adverse influences on the prevalence of respiratory diseases in the community.

Because the true magnitude of the problem is still poorly understood, epidemiologic research is required to determine the prevalence, types and causes of occupational asthma and related respiratory diseases in many industries. Similar studies are essential to determine the role of environmental pollution in the cause of these diseases. In particular, the separate roles played by the many components of industrial-photochemical pollution must be evaluated.

Dr. George M. Woodwell
Director,
Ecosystems Center,
Marine Biological Laboratory
Woods Hole, Mass.

In the 1980's the role of the scientific community in environmental concerns will grow more important daily: First, it will be to recognize environmental problems and articulate the solutions. Most problems of the environment are alleviated by limitation of the human population, a point which cannot be advanced too often. But the impoverishment of the Earth's biotic resources through toxification and mismanagement is the overriding environmental issue of the next decade. The causes include the accumulation of carbon dioxide in air, the acidification of rain, and the spread of pests.

Second, it will be to participate in the governmental process: The time when science and government could proceed independently has long passed. Virtually every decision of government treats in some way the management of resources. A much higher intensity of interest and activity on the part of the scientific community is appropriate. The interest extends to development of new research as well as to thought, analysis, and direct advice to governmental agencies.

Third, it will be the development of a new science for closed systems for the support of man. The complete closure of man's supporting systems is, of course, not possible. Nonetheless, there are a growing number of environmental problems for which no intermediate solution exists. The problems are either resolved *in toto* or not resolved at all. The management of toxins presents many examples. The solution is a major effort to close man-dominated systems so that they do not leak toxins or otherwise pollute air or water. The systems available for revision range from houses to whole cities; from ships to industrial complexes. The challenge is large, requires development of a new science, and the need is urgent.

Thomas R. Pickering
Assistant Secretary, Bureau
of Oceans and International
Environmental and Scientific
Affairs, Department of State

Science and technology must rise to the challenge in the 1980's if the overpopulated, resource-scarce situation projected by the recently-released Global 2000 report is to be averted. Attention must be directed now to:

- development of alternative energy sources and food production techniques, particularly for developing country use;

- design and introduction of low-cost methodologies and techniques for increasing the efficiency of use of water, energy and wood products in industrial and municipal operations, and for reducing waste products;

- significant improvement in our knowledge of the direct and indirect health effects and risks associated with industrial chemicals, as a necessary basis for gaining international cooperation on regulatory and control measures; and

- understanding large-scale dynamics and exchange mechanisms in the atmosphere and oceans, to enable us to evaluate threats to global processes with greater certainty.

There are, in addition, specialized global issues with important political, economic and social implications which require the attention of the international scientific community: nuclear plant safety and radioactive waste disposal; acid rain, carbon dioxide buildup in the atmosphere; expansion of deserts and the desertification process; and wildlife extinction and narrowing of the genetic resource base.

Dr. Robert Harris
Member,
President's Council on
Environmental Quality

In the face of mounting evidence of chemical contamination of air, groundwater, sur-

face water, and land resulting from improper hazardous waste practices, the greatest challenge to scientists is the development of appropriate biological testing procedures for assessing the risk posed by complex mixtures of substances. Interactive effects, particularly synergistic effects among two or more chemicals within complex mixtures, are likely to negate hazard assessments based on the testing of the individual components in the mixture. This challenge goes well beyond the classical toxicologist, and reaches out to the biochemist and the molecular biologist to develop non-invasive techniques for measuring responses to target macromolecules *in vivo* (living animal). Without adequate methods of assessing risks we will be unable to efficiently allocate the public's resources to ameliorate these problems.

Dr. Edward Wenk
Professor of Engineering and Public Affairs
Program in Social Management of Technology,
University of Washington

People have always lived with danger. The 1980's, however, pose threats to survival at an unprecedented scale in jeopardizing human habitat, human health, and the human spirit. Virtually all of these threats involve technology and all have been on the social agenda of government policy. The most salient of such actions was the National Environmental Policy Act of 1969. Among other features, it set a national mandate for stewardship of the environment. And it built into the administrative process the requirement for impact analysis, to look before we leap. Considerable progress was made in the decade of the 1970's

Now, we find loss in commitment to environmental values. But even more specifically, we find that the political apparatus appears deaf to a range of warning signals about the future. When making decisions under stress, leadership opts for short-term solutions without balanced consideration of long-term consequences. The challenge is even more compelling in a new era of scarce resources and in a contentious social environment where fractionation by single-issue advocates threatens a spirit of consensus.

The scientist has a special responsibility to help in matters of public choice that involve environmental health and conservancy, in the first instance, by providing technical information to facilitate informed debate on what constitute acceptable risks. This social choice depends on a base of fact and on understanding of our limits to knowledge. The scientist must thus help a public confronted with technical complexity, frustrated by feelings of impotence and vulnerability.
Beyond its classical role of acquiring and extending knowledge, the scientific community should contribute to both public understanding and to critical discernment, to help the non-specialist grasp the technical foundations of modern life that were created to benefit society but which ironically are eroding our margin for survival.

Dr. Emil M. Mrak
Chancellor Emeritus of the University of California, Davis,
Former Chairman of the Science Advisory Board of EPA

The concern about man-made chemicals hazardous to the health of human kind and its environment is one of the most pressing issues of the day. Naturally this concern is reflected

in legislation, such as the Toxic Substances Control Act, designed to protect against such hazards. One of several complicating factors in enforcing this law is the fact that, since 1968, our ability to detect traces of toxic substances in our food, water and other substrates has increased from parts per million to parts per trillion. Although this is a millionfold increase in analytical sensitivity, our knowledge of the significance of these trace amounts has increased very little.

The public protection in banning the use of any suspected chemical, until it is proven safe, seems a logical precaution. It suffers one critical weakness, however, for unless it is coupled with an evaluation of the effects upon our food and fiber supply that would result from the non-availability of chemicals that have long been in use, the cure could be worse than the malady.

This leaves one viable alternative: what has been the effect upon human health from the past exposure to chemicals? It is, of course, impossible to selectively study the effects of only one among the many chemicals used on a normal human population, but a class of chemicals could be studied. Modern pesticides, which must be toxic to be effective, have been in widespread use for over thirty years and are one of the public's major concerns. Some agricultural communities have had much heavier exposure to a succession of pesticides during this time than have many non-agricultural communities. During this same thirty years, the average age-adjusted mortality rates, from all causes, have declined by over 20 percent. Where has this decline occurred?

Health profiles of such exposed and relatively non-exposed populations have not been compared adequately in spite of the fact that so-called community pesticide studies have taken place and a sampling of our national health has been carried out since 1959. There is, therefore, a great need for epidemiological studies on farm workers in California and the Southwest. This could be done by adding a comparative study to the Health and Nutrition Examination Survey, thereby determining what, if any, measurable health impairment has resulted from pesticide usage. Such a research study is direly needed and should be given a high and key priority.

Dr. John T. McAlister, Jr.
Professor of Engineering-Economic Systems,
Stanford University

Among the greatest environmental challenges of the1980's will be the implementation of statutes and decisions made in the 1960's and 1970's.

Now that the Nation has set for itself a goal of greater energy independence, especially by emphasizing the development of hydrocarbons in frontier areas, this challenge seems certain to be all the more arduous. States and regions will continue to shift environmental burdens away from themselves and those that produce energy will attempt to keep it for themselves to shift new economic activity to their turf.

Symptomatic of the problem is the response to a question posed by Representative Morris Udall in a speech to the Nation's Governors. Who among them, he asked, would volunteer their States to be the repository for the Nation's hazardous wastes. None did.

Where might the answer to these challenges be found? In part, at least, in an overlooked, poorly developed, but inevitable technology. This is the human technology of planning. Not a planning of imposed blueprints and fiats but a planning technology of concepts, modules, and systems that can be adapted to the constitutional strengths of a Federal structure and the rich diversity of a democratic society.

In the 1980's, as in the past, the science we most need to fulfill the promise of environmental protection is the knowledge to develop a planning technology linked to our democratic/Federal process. □

Who Owns the Future?

By Charles D. Pierce

Toronto—The new revolutions in political, economic and social structures and value systems sweeping the globe will have a major impact not only on the future of millions of people but on the natural environment as well.

The unfolding of these current and looming momentous changes was described by several speakers at the First Global Conference on the Future held recently. More than 5,000 persons from 40 countries attended the sessions in this stunning and cosmopolitan metropolis on the Canadian shore of Lake Ontario.

"It is clear that a massive evolutionary shift is underway, based on a radically new set of environmental and resource conditions, and that these conditions are driving human societies into domestic transitions and a new configuration of global order," stated Hazel Henderson, a noted and provocative writer on the future.

"This New World order is inevitable, even if keepers of the old order, in the fear of change and loss of their power, try to stem the tides of change by acts of desperation, violence and nuclear war."

She noted that "there is an inevitable trade-off in evolution between adaptation and adaptability. Past success constrains future success. This is evolution's most interesting and challenging riddle at many biological levels. . . . Growth creates structure, then structure inhibits growth. Nothing fails like success.

"Anthropologists would state it as the Law of the Retarding Lead: those cultures most successfully adapted to the past and present will be overtaken by those less committed and over-specialized. Religious views would restate the same proposition as simply, The Last Shall Be First."

Among others addressing the conference who painted a picture of a world in transition were Indira Gandhi, Prime Minister of India; Willis Harmon, Associate Director of the SRI International Center for the Study of Social Policy; Rufus E. Miles Jr., a senior fellow at the Woodrow Wilson School, Princeton University; and Rashmi Mayur, international co-ordinator for the First Global Conference on the Future.

Gandhi sent a message to the conference in which she charged that "we are imprisoned in the old thought processes, pursuing the same old greeds and desires. Action plans will fructify only if our thinking breaks through these barriers and our vision stretches into the 21st century.

"The issues that affect Africa and Asia now and will continue to do so for years to come are well known and oft debated. But the world is dominated by the developed affluent nations, who know the world's great wrongs but do not act."

Noting that despite the natural resources of the developing world, "this huge segment of humanity is condemned to poverty," she asked: "If these millions cannot be assured of their basic essentials, what meaning can discussion on the protection of our environment or of preserving the ecological balance or of saving wildlife have for them?

"Can we ever hope to achieve a world free of tension if the greater proportion of humanity lives in want, while a small, affluent minority monopolizes the benefits of modern technology?"

Perennial Wisdom

Willis Harman, Associate Director of the SRI International Center for the Study of Social Policy, told the conference that a "perennial wisdom"—a set of premises that is compatible with the many cultures around the globe—can be found.

"On the foundation of such a set of premises, and on no other, can be built a global order in which the core values of all cultures will be preserved—in which the great juggernaut of the world industrial economy will not ride roughshod over the less materially focused cultures."

"On this foundation can be built a global understanding of the spirituality of humankind that will avoid the bitter religious conflicts of the past. On this foundation industrial society can evolve toward solution of the dilemma of the alienation, goallessness, and emptiness of a predominantly materialistic society." Harman said that "at the deepest level, all people share a common interest and a common destiny—a destiny that far transcends the greed and fear, the pain and conflict around which so much of our society is constructed."

Commenting on the theme at the future conference of "Thinking globally, acting locally," Harman said that the proposition that "there is a sound basis for thinking globally and acting locally, and for so guiding society's decision-making process may sound much too idealistic and impractical for serious consideration.

"It no doubt seemed impractical to many, when two centuries ago, the Founding Fathers of the United States of America proposed that a new nation be built on precisely this same foundation. . . ."

Rufus E. Miles Jr., a senior fellow at the Woodrow Wilson School, Princeton University, warned that society is suffering from "energy obesity" and explained why he believes that smaller quantities of energy at higher prices "will turn us in a healthy direction."

Because of our energy fat, Miles said that "collectively, we face the prospect of social heart attacks, arterio and athereosclerosis and inability to perform at anywhere near our full potential.

"If we understand this and are prepared to regard the adjustments that are necessary as giving us the probability of becoming stronger, more vital, and healthier members of a society that should have a much greater life expectancy than our current phase of civilization, the potential trauma can be converted into an exhilarating experience."

Miles said that the declining supplies of energy will help develop a new ethic which will be more vital to the future of our society than any technological breakthrough can be possibly be. He described this ethic in the form of five propositions:

1. Man is a fragile and *dependent* species. The fauna and flora of the earth can live without him or her but neither he nor she can live without them. Man, as a species, must carefully preserve and replenish the biosphere or he will perish.

2. Diversity is nature's first line of defense against evolutionary retrogression. Extremes of energy use and human popula-

Toronto's modern skyline on the Lake Ontario waterfront includes the 1,815-feet high CN (Canadian National) tower (left), one of the world's tallest structures.

tion jeopardize the earth's diverse ecosystems and extinguish great numbers of species. If continued, they will end biological evolution.

3. The survival of human society depends heavily on the strength of the small cohesive units of family and community. Massive energy consumption has a strong centrifugal effect on both institutions, and is inimical to the further social evolution of humankind.

4. The special human values of open, democratic societies are vitiated by the centralization and bureaucratization that result from very high energy use. The essence of open societies can only find expression through the cooperative action of people in manageable communities, not through large bureaucratic hierarchies.

5. Open societies can develop durable foundations only by emphasizing the quality of human relationships, not growth in the consumption of goods and energy, beyond the essentials for health; by conserving the natural and physical resources of the earth; and by assuring a fair distribution of both employment and the essentials of life as well as universal opportunity for education, health, the arts, and recreation.

Survival Ethic

Miles said, "This is what I call a survival ethic. It may not seem that many people share it in comparison with the number who want simply to continue their search for a so-called higher standard of living, meaning compulsive consumption of transient pleasures. But let me give you some evidences of the attitudinal changes that are taking place and the reasons for my assertion that our energy future will be determined more by a combination of necessity and ethical beliefs than by technology.

"Ethics derive from either an intellectual or an intuitive understanding that a certain form of behavior—one that we label ethical—is essential to the survival of the group, and group survival is essential to the survival of the individual. Even primates in the wild develop ethics in that an individual will die for the survival of the group. Once certain ethical principles are embedded in the traditions of a society, they have a marked effect on individual behavior and on the laws and policies of the society. Ethical principles are never static, however. They are constantly changing and the changes are motivated first and foremost by the instinct for survival."

Discussing the necessity for protecting the biosphere, Miles said, "Rachel Carson deserves more credit than she has yet received for elevating the consciousness of the American people concerning the thoughtless and inexcusable devastation of the earth's fauna and flora through the use of destructive pesticides. She changed the way people perceived their relationship with the biosphere on which we are so dependent for life. Her work sparked the movement that culminated in the enactment of the Environmental Policy Act in 1970."

"It is hard to believe that the National Environmental Policy Act has been in effect for only a decade. Its 'impact statements' have already altered the course of our society, and they reflect a different social ethic than that which was dominant in the first seventy years of this century. The groundwork was laid by a minority of dedicated people whose perception of the survival of the group extended not only to the whole of humanity but to the whole of the natural kingdom, and with a long time perspective."

"The next phase of this evolution of ethics," he said, "will concern itself more

explicitly with energy and the modes of social behavior that will be conducive to survival. What we are beginning to observe and will be observing much more is a change that is simultaneously brought about by the necessity of cutting down on our use of energy because there is less of it to go around, and also by the joy of knowing that there are numerous ways in which we can contribute to the reconstruction of our society to make it more livable, even with far less energy, for our children and grandchildren.

"I have deliberately emphasized the ethical motivation, because once people understand it, there is no limit to the ways in which it can stimulate the imagination and make people realize that there is no point to bemoaning what their governments fail to do, or do wrong; the place to begin is in one's family and community. The leadership that will guide us successfully into the civilization of tomorrow will be a bottom-up leadership, not a top-down leadership. I cannot emphasize too strongly that we are going through a period of change in social ethics and mores in which it must be a minority of perceptive people who will have to do the leading. I am not an expert in the social dynamics of other societies, but I suspect that this may be nearly as true in many other societies as it is in the United States.

"Already millions of people perceive that their survival, and that of their children and grandchildren—and, indeed, the survival of the biosphere—are inescapably dependent on changing our life styles so that we are less dependent on Persian Gulf oil, or any other kind of oil. We must not be driven into a nuclear holocaust in an effort to keep Persian Gulf oil flowing—as if World War III could keep anything flowing. Adjusting to a lower energy level does not necessarily mean hardship and discomfort. It can mean a society that changes its preoccupation from compulsive consumption to a slow but steady improvement in the quality of human relations and the nurture of the biosphere. This is the direction in which I believe we are slowly and inexorably moving. I can see the green shoots of that new civilization developing. I hope they gain a firm foothold before they are trampled to death by the dinosaurs of mammoth industrial and government hierarchies that will some day die of their own excessive size and inability to adapt to a changing world."

Dramatic Change

Mayur, the global conference's international coordinator, declared that "three centuries of the industrial order dominated by western countries is on the verge of dramatic changes. During the last two decades of the 20th century, the Third World countries, with massive population growth, will demand an increasing share of the world's depleting resources.

He said that there "is an unprecedented explosion of human energies in the Third World cities. People are clamoring for goods, services and ideas they never dreamt of in their placid villages, and the momentum of their force seems uncontrollable."

He warned the prognosis of the global future would be tragic if planning and development efforts are not directed towards assuring these people a place in the mainstream of humanity.

"For the next quarter century," he said "the developing countries will face several crises, but all of them will be products of increasing demand at the same time resources are declining. Western countries are not likely to reduce their demand or share the planetary resources. It is in the context of this human reality that the search for new world order must occur.

"Yet human life," he said, "is unique and has unlimited potential, which can be realized by exploring, creating, and designating those systems of existence which go beyond the accepted limitations of the past, such as war, exploitation, inequality, poverty, and deprivation. All these and other limitations are man-made. They are the product of greed, unconcern, mismanagement, vanity, and sheer idiocy."

Mayur called for an effort "to initiate a new renaissance of man's spirit in harmony with himself, with all societies in their rich variety and with the environment."

In her address, Henderson said, "Instead of embracing and capitalizing on the inevitable dawning of a new Solar Age, most countries are still hurling resources into yet another costly detour—into non-renewable energy technologies.

"The Soviet Union, France, Germany and Britain are still backing into a nuclear future, looking through the rear-view mirror while the U.S.A., its nuclear program stalled by wary Wall Street investors and insurance companies, has now committed $20 billion tax funds into a wasteful, inept boondoggle in synthetic fuels from coal. This hailed, not incidentally, by big oil companies who will benefit, and thus recapture most of the some $24 billion windfall profit tax enacted by the Congress.

"Thus the costly detour through the non-renewable energy past, at the behest of dinosaur industries, continues to prevent adaption to the future. Meanwhile, the so-called less-developed countries of the world's sun-belt are free to leapfrog the unsustainable technologies and proceed straight to the Solar Age," she declared.

Henderson called for a New World Order based on the following five principles:

- "The value of all human beings.
- "The right to satisfaction of basic human needs (physical, psychological and metaphysical) of all human beings.
- "Equality of opportunity for self-development for all human beings.
- "Recognition that these principles and goals must be achieved within ecological tolerances of lands, seas, air, forests and the total carrying capacity of the biosphere.
- "Recognition that all these principles apply with equal emphasis to the future generations of humans and their biospheric life-support systems, and thus include respect for all other life forms, and the Earth itself.

"Historically," she said, "human development can be reviewed as many local experiments at creating social orders of many varieties, but usually based on partial concepts, i.e. these social orders worked for *some* people, at the expense of *other* people, based on the exploitation of nature. Furthermore, they worked in *short*-term, but appear to have failed in *long*-term. Today, all these experiments of local and partial human development, when seen in a planetary perspective, have been failures in one way or another. . . ."

She said, "the aspirations for a new World Order are not only based on ethical and moral principles, important as these emerging planetary values will be for our species' survival. The need for a new World Order can now be scientifically demonstrated. We see the principles of interconnectedness emerging out of reductionist science itself, as basis, and the concomitant ecological reality that redistribution is also a basic principle of nature. Since all ecosystems periodically redistribute energy, materials, structures through biochemical and geophysical processes and cycles, therefore all human species' social systems must also conform to principles of redistribution of these same resources that they use and transform."

Thus, she said, "the new World Order can be founded both on scientific and ethical principles. We are discovering the new World Order in science and remembering that we know it already, since these same five principles are found in all religious, spiritual traditions. Ethical principles have become frontiers of scientific inquiry. Morality, at last, has become pragmatic; while so-called idealism has become realistic."

The global conference was sponsored by the World Future Society, headquartered in Washington, and the Canadian Association for Future Studies. The next global conference is scheduled for 1984 in Bombay, India. □

Charles Pierce is Editor of the EPA Journal.

On The Cutting Edge

By Truman Temple

One day two years ago Dr. Lawrence Plumlee, medical science advisor at EPA Headquarters for the previous eight years, made a momentous personal decision to quit his job in Washington.

For years he had felt tired, depressed, and achy on days when the city's air pollution was bad. He had moved from the Maryland border of Northwest Washington to a townhouse one block from the Agency to avoid the daily drive through auto fumes. He had special vents installed in his office so that the positive air pressure would reduce the amount of tobacco smoke drifting in. At his own expense he had installed air cleaning equipment.

These measures helped temporarily, but they did not arrest his downhill slide in health. He often felt as if he had a bad hangover, and his muscles and joints ached. At times he had trouble concentrating. Although his job as advisor to the Deputy Assistant Administrator for Health and Ecological Effects required him to attend many conferences, he cut back sharply on travel because he found that the tobacco fumes, fumigants, and cleansers impregnated in hotel drapes and carpets aggravated his symptoms. In fact, the only time he really felt well was when he moved to New Hampshire on extended leave to get away from the city. Over the years he had watched his weight gradually drop from 135 to 93 pounds.

And so Dr. Plumlee, a graduate of Johns Hopkins Medical School, with post-graduate training in the physiology of environmental stress and lengthy research experience in this subject at Walter Reed Army Institute of Research, gave up his government career and moved to the Ozarks.

Today he lives in the town of Sulphur Springs, Ark., where the air is clean and the nearest city is 50 miles away. As he puts it, "I had become so ill that although I loved my job at EPA, it didn't seem feasible to continue. It's difficult to put a price on health."

Dr. Plumlee is an example of a rapidly growing group of people who find that they are overloaded from our polluted environment. It is becoming known that all humans have to deal with this increase in environmental load just to function. Some authorities estimate that perhaps as much as 40 percent of the population are adversely affected by some aspect of environmental pollution at one time or another.

Dr. Plumlee owes part of a new outlook on life to the Environmental Control Unit of the Brookhaven Medical Center in Dallas, Texas, where he receives treatment. The unit, directed by Dr. William Rea, a member of EPA's Science Advisory Board, has gained international attention in caring for patients with acute sensitivities to chemicals and other substances. Dr. Plumlee has gained back some weight and has begun to improve under the unit's care. He shares the enthusiasm of many patients for the scientifically valid but non-traditional approach of the unit, which employs special methods in diagnosing the causes of "environmental overloads" and protecting patients from those substances that afflict them.

"I'm very fortunate to be here," Plumlee declared to this writer during a recent visit to the unit.

Dr. Rea's methods of diagnosis and treatment show a sharp departure from established ways of testing for other more conventional illnesses. "Toxicologists, whose focus is the study of homogeneous strains of rats and mice, simply don't appreciate that safety factors of 100 or 1,000 such as are used today for common chemicals do not protect a sizable number of people," Plumlee commented.

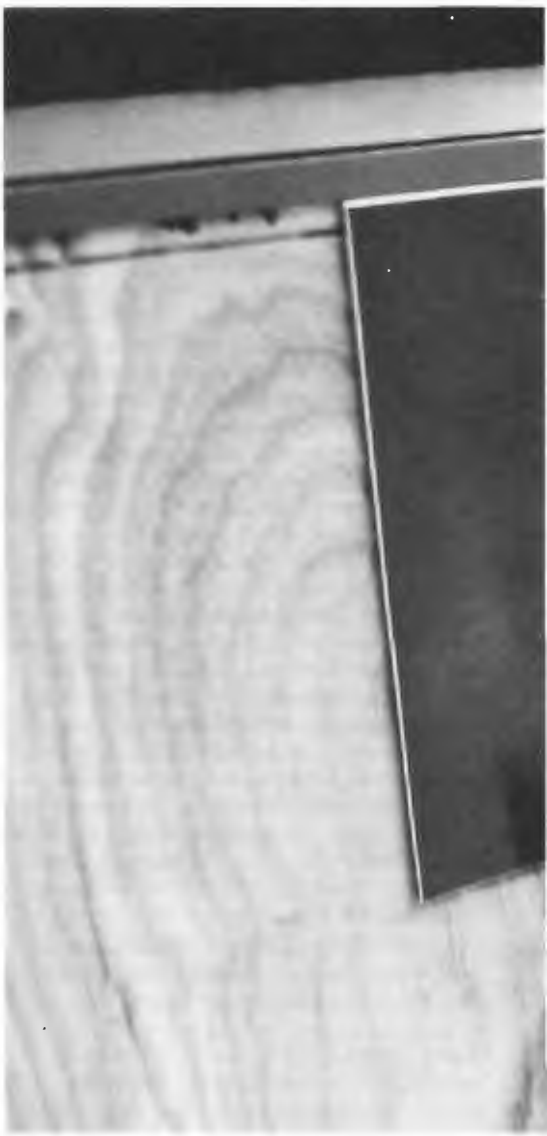
The Dallas facility was established by Dr. Rea after he drew upon his knowledge of his own health problems, studies of work by Dr. Theron Randolph, and his own background as a cardiovascular surgeon, to extend the innovative approach to the ills of what has been called our "chemical society." Dr. Rea had become an established specialist in thoracic surgery in Dallas. But after several years of practice, he found that fumes from the anesthesia in the surgery room were making him ill. Even giving a patient a bronchoscope exam left him with headaches, since the patient was breathing anesthesia fumes into the physician's face. Worried about his ability to continue work, he determined which substances affected him and after avoiding them for months, he found he was able to tolerate these same chemicals better.

The experience prompted him to plunge into a field that appeared at first to be entirely different: How the uniqueness of each person is brought out dramatically, often manifested as disease, by the manner in which people react to ordinary environmental factors. However, it fitted perfectly into his specialty in cardiovascular surgery since that knowledge could be applied in solving many of the perplexing problems he faced. It gave some answers in many instances to such illnesses as intractable phlebitis, uncontrollable arthritis and lung failure.

One of the most helpful sources of information was Dr. Randolph, a Chicago specialist in internal medicine and allergy who had studied more than 20,000 cases of petrochemical hypersensitivity during the last three decades. Dr. Randolph, who received an Environmental Quality Award in 1976 from EPA Region 5, found many people whose illness was directly related to common chemicals that seemingly did not affect the general population despite daily exposures of both groups.

After two years of consultation with Dr. Randolph, Dr. Rea campaigned among his colleagues and the public and supervised the creation of a 26-bed environmental-control unit at the Dallas medical center in 1975.

Among those physicians who joined Dr. Rea's staff after learning of his work



was Dr. Robert Stroud, a rheumatologist, editor of the Journal of Allergy and Clinical Immunology, and formerly on the Allergy and Clinical Immunology Research Committee, National Institute of Allergy and Infectious Diseases.

To enter the Brookhaven Environmental Control Unit is to walk into a different world. It is sealed off from the rest of the center by double glass doors. The air used for heat and air conditioning is specially filtered. The rooms are constructed of aluminum, steel, ceramic tile and porcelain surfaces. Floors are stone or hard vinyl. Curtains are all-cotton. A patient who wants to read a paperback book uses what resembles the nuclear industry's "glove box" where the books are contained under glass and the patient handles them with protective gloves built into the compartment. (The paper and ink contain several chemicals that can cause allergic reactions, so they are isolated like some dread bacillus.)

Despite this seemingly cold decor, patients find the unit a relief to enter because they are protected from a host of substances to which exposure results in physical and mental misery. For some, it is the only kind of environment in which they can live and breathe comfortably. Indeed, Dr. Rea remarked to this writer during a recent visit, "Did you notice how I hung around in there while talking to you? It's because I feel so much better in those rooms." Although the average healthy person is unaware of it, a number of synthetic fabrics, soft plastics, and construction materials give off fumes that cause a whole spectrum of reactions in many individuals. Part of the treatment is to remove from the patient's environment those materials likely to undergo this "outgassing."

What causes certain people to develop *hypersensitivity* to the various chemicals in our society?

Dr. Rea explains it with what he calls his "full barrel" analogy.

"Those patients with chemical overexposure are somewhat like a barrel being filled up," he says. "When the barrel finally overflows, you begin to see symptoms. But something else happens. Once the overflow load is reached, you don't need a lot of a chemical pollutant to produce these symptoms. Just a minute amount, even one or two parts per billion either inhaled or swallowed, is enough to trigger very serious reactions."

To get an idea of how overloaded these patients are, one only has to read a sign at the portal of the unit: "Do not enter this area if you are wearing perfume, hair spray or aftershave lotion." One whiff is enough to cause some patients to go into convulsions, become unconscious, or experience other symptoms such as skin rashes, bruise marks, labored breathing, muscle contractions, and irregular heartbeats. As one nurse remarked, "If a woman walked through here wearing cologne, she'd leave a trail of bodies on the floor."

Although it is known that exposure to some chemicals greatly increases a person's risk of cancer, chemicals can trigger other diseases such as arthritis, bronchitis, phlebitis, an impairment in reading ability known as dyslexia, and even in rare instances multiple sclerosis. And as our industrial society develops more and more chemical products, the medical profession is having to grow ever more sophisticated in dealing with chemical victims.

As Dr. Rea puts it, "Medical environmental technology is about 100 years behind environmental technology. The environmentally contaminated situation present today would be similar to the time when people were rubbing manure into wounds, or physicians were doing pelvic examinations after a post mortem." What his hospital unit does, among other things, is to put patients into a relatively unpolluted world where all the contaminants they are exposed to daily are removed. That itself is a departure from medical routine, because as Dr. Rea points out, offending substances are readily found in the average hospital, ranging from polyester draperies and carpets to the plastics found in telephone wire (not to mention nurses wearing hair spray).

The typical new patient at the Brookhaven unit must remove all cosmetics before entering and don 100 percent cotton clothing. All medications are halted, and the patient takes no food so that his body processes can return to normal metabolic balance and stability by elimination or neutralization of toxics, or recover from immunologic and enzymatic distortion. Even drinking water is specially filtered to remove chlorine and pesticide

Sign at entrance to Environmental Control Unit at Brookhaven Medical Center, Dallas.

residues. The fasting may continue for days until symptoms fade away. During this period the patient may undergo severe withdrawal symptoms in the absence of foods or chemicals that have been in his or her environment, much as an alcoholic suffers during a "drying out" period.

After years of study, Dr. Rea and his colleagues have worked out to an astonishing degree the many controls that must be imposed to keep the Brookhaven unit free of contaminants. Walls are made of glass and cement blocks, painted with a "low outgassing" paint that had been allowed to dry up to one year to eliminate any volatile petro-chemicals. Floors are of terrazzo tile or hard vinyl, also allowed to age. Beds and furniture are all metal or hardwood. Bed linen and curtains are 100 percent cotton laundered in pure non-detergent vegetable or animal soap. Filters of activated charcoal and other substances at the entrance eliminate any odors or fumes that might come through the doors. Even the hospital beds are hand-cranked, since electric motors give off invisible but troublesome fumes.

The Brookhaven unit maintains its own kitchen for the preparation of chemically less contaminated foods. It contracts with private growers to assure the quality of the farm products and constantly tests samples of the produce. The unit also uses brands of mineral water since tap water contains chlorine and other unwanted chemicals. The table where these brands are kept resembles a gourmet counter, with bottles of Perrier from France, Fiuggi from Italy, and Bru from Belgium.

All patients during diagnosis and treatment are kept in the unit for at least 16 days. When the symptoms disappear, usually after several days of fasting, and the patient is able to sleep all night, he or she is given chemically less contaminated foods that have not been subject to pesticides or synthetic fertilizers, to see if it is the food itself or the chemicals used by farmers that causes the reaction. If the patient comes through this test without a noticeable reaction, regular commercial food is tried next. Such products, Dr. Rea points out, have been contaminated by synthetic sprays, herbicides, preservatives, artificial colorings and sweeteners, and wax and plastic wrappings, and have been cooked on gas stoves in synthetic pots and pans. So there are many ways in which foreign substances can affect patients, and reactions are closely observed and monitored.

In addition to testing them with foods, physicians expose patients in a separate chamber to small quantities of chemicals and record their reactions. This is usually done by putting an open jar containing a so-called safe ambient dose of a chemical, as defined by government and industry, near the patient. Such a dose is equal to what the person would encounter in daily life. The exposures are done in a double blind manner, that is, using a procedure where the patient doesn't know which of the samples contain a chemical or an inert, harmless substance.

"Glove box" enables patients to read while shielding them from chemicals in paper and ink in books and journals.

Other tests include exposure for a few minutes to a stove pilot light of natural gas, cigarette smoke, perfume, pine scented floor wash, and chemicals found in carpets, foam pillows, and polyester clothes which a person would contact daily at home or work.

The task is complex, for as Dr. Rea never tires of explaining, the amount and scope of pollution that has crept into the environment is enormous.

"Most public water systems are overloaded with synthetic chemicals that increase the exposure to synthetics from 1,000 to 10,000 times," he says. He points to EPA studies of the 83 largest cities showing all their water supplies to be chemically contaminated. "Ninety-four percent of the commercial food has pesticide in it, and the average individual ingests an estimated one gallon of food additives per year," he adds.

The most polluted place in the environment appears to be the average home, with its many synthetics, foam rubber in beds and chairs, and often-encountered gas heat.

The combination of these substances at home with a polluted work environment produces a massive increase in body load that the individual has to handle just to function each day, he emphasizes. This often becomes too great for people with certain hereditary and acquired traits, results in increasing individual susceptibility, and paves the way for inflammatory diseases, he explained.

"It is insufficient to have sick people get to feeling better; they must be helped to discover for themselves that their illness has been caused, and how. This gets their attention and helps them become responsible for completing the testing and retesting on their own after leaving the Environmental Unit," he stated.

After the Brookhaven doctors have determined which substances have provoked reactions in a patient, the next step is to draw up a program of avoidance so that the individual can get back to leading a normal life. For some, it's merely a matter of restricted diets and avoiding certain chemicals. For others, it may be an elaborate and costly change in their dwellings, a job change, or even a move to a remote location far from industry and traffic. In one case, a woman who had been teaching in Los Angeles moved to a mission school in Guatemala. She felt so much better working there that she now comes back to the United States only on summer vacations. She has lost all her chemical sensitivity and is pursuing her Ph.D.

Another patient told this writer her solution was to change her home completely. She removed all carpets since they contained formaldehyde to which she was sensitive. She got rid of all spray cans around the house. She even switched to a special brand of lipstick made of beeswax.

To the outsider, it can be a disturbing experience to see how a sensitized person reacts to invisible pollutants. Consider the case of one attractive woman who formerly had worked as a nurse in South Carolina. A year ago local authorities had sprayed her neighborhood for mosquitoes following a hurricane, and the pesticide affected her so profoundly that she began having seizures.

"Every time I went outside the house I wound up in a hospital," she explained. "I slept constantly. I was working in a surgery room, but I became ill there. I underwent personality changes and became irritable, nervous, almost paranoid."

The woman now works on Dr. Rea's staff as well as receiving treatment there. She

was relating her experiences to this writer in a calm, cheerful manner when someone dropped a small vial in the corridor outside the room. Within seconds the woman began writhing in pain, slumping in her chair and trembling. Dr. Rea stepped to an oxygen tank, handed her the hose, and turned it on. Within two minutes she was back to normal and talking again. The cause of the distress: A small container of extract of sesame, used to test other patients, had accidentally tipped over. Although the odor would not have been detected by a normal person nearby, it was enough to bring on her seizure.

"It is critical to the appreciation of this scientific and conservative method of study to understand that the principle of symptom suppression in the form of drugs, medicines and injections is very nearly incompatible with the success of this procedure. Drugs must be used with great caution, and their use generally prolongs the diagnostic periods. They must be used with great care and under strict supervision later, in the rehabilitation phase," one colleague of Dr. Rea observed.

In dealing with severe cases of chemical overload, Dr. Rea sometimes encounters patients so damaged by environmental pollutants that their general resistance to illness is lowered. They have recurrent infections, colds, influenza, and asthma attacks. "We have found changes in the immune and biological amplification system in many patients," he declares. "Over 50 percent of our patients are T-lymphocyte-depressed, and another 25 percent have poor functioning T-lymphocytes. At times many other lab tests are abnormal." (T-lymphocytes are white blood cells produced by lymph tissue. They can kill off tumors and are thought to be part of the body's immune system.)

For a number of these patients, Dr. Rea has been working in collaboration with Dr. Amanullah Khan, also a member of EPA's Science Advisory Board, in another advanced field—the use of transfer factor to raise a patient's general resistance.

Transfer factor was discovered in 1955 by Dr. H. S. Lawrence of New York University. Scientists do not entirely understand the nature of this substance, but it seems to help transfer some people's immunity to disease to others. It is stored in the white blood cells and released when the body is invaded by something foreign such as a skin graft, bacteria or cancer cells. It then activates disease-fighting white cells which in turn attack foreign substances. Dr. Khan, who is Chairman of the Department of Immunotherapy at the Wadley Institutes of Molecular Medicine in Dallas, explained that transfer factor is obtained by using an experimental machine known as a Celltrifuge, which pumps blood from the body and under centrifugal force separates it into various components.

"We have found that transfer factor improves cellular immunity in a patient," Dr. Khan said, "such as asthmatics who have frequent infections." The substance also is used to treat a number of other illnesses including virus infections. The Wadley Institutes are particularly well equipped in this field as their central blood bank is the largest of its kind in the Southwest, serving 36 hospitals.

Dr. Khan is working with a technique to determine whether a patient's white blood cells react to environmental pollutants by noting the level at which a pollutant interferes with the person's natural immunological system." We test the ability of a patient's white blood cells to produce interferon. If it's not normal, we know there may be a defect in the resistance to invasions," he explains. "We can use it as a test to screen carcinogens, which inhibit a cell's ability to produce interferon." (Interferon, discovered in 1957, is a chemical produced naturally by the body that acts to help the human system defend itself against viruses. It is being tested widely as a weapon against cancer.)

Dr. Lawrence Plumlee (left) with Dr. William Rea at Environmental Control Unit, Dallas.

The method at Wadley to measure interferon levels has attracted attention because it is easily set up, has also been tested in laboratory equipment by others against a variety of industrial chemicals, is sensitive to low levels of pollutants, and can be applied cheaply to large numbers of patients simultaneously since the process makes use of a computer. Physicians estimate the cost for the immunological procedure could run as low as $5 per test series. Observers believe this approach could be a valuable supplement to the medical profession's other far more costly ways of dealing with suspected chemicals. (Assessing the long-term or chronic effects of a chemical is a notoriously difficult task. A single test for a chemical's cancer-causing ability, for example, may take up to three years and cost $250,000 or more.)

What lies in the future for our "chemical society"? As of now, it seems certain that the caseload for specialists like Dr. Rea won't get any smaller. Already several patients from the Love Canal chemical disposal site have been treated at the Brookhaven unit, and many similar sites pose potentially similar hazards. Dr. Rea's innovative approach has attracted patients from as far away as England, Australia, Canada, Hawaii, and the Bahamas. Some 85 percent of those suffering from migraines and vascular headaches are reported improved, as are 80 percent of rheumatoid-arthritic cases, he reports.

The result of all this is, in his words, that "demand is just ferocious." More than 1,000 patients have been treated at the unit, and it is booked ahead to next January, with a waiting list of patients seeking admission. The Brookhaven unit is planning to add 50 more beds, although it already is the largest of five such environmental-control units in this country. (The others are in Zion, Ill. where Dr. Randolph works; Whiteville, N.C., Denver, and Watertown, S.D.) Word of their techniques has spread abroad, and a similar unit has now been set up in England by Dr. Richard Mackarness, author of *Eating Dangerously: The Hazards of Hidden Allergies* (Harcourt Brace Jovanovich, 1976).

Although the layman may regard the patients at Brookhaven as rare, isolated examples of human sensitivity to environmental stress, some medical authorities feel that these patients are a kind of early warning system for the whole population. "They are one end of a spectrum that includes us already," declares one specialist, "since most of us are now affected to one degree or another by traffic fumes, monosodium glutamate in our food, by migraine headaches, by rough, inflamed hands from detergents, by pesticide allergies, and so on." And with the large number of chemicals being added to our environment each year, authorities are growing more concerned about the ability of the general population to accommodate to this increase in pollutants.

Physicians have a number of sophisticated devices for special therapy that seem futuristic to the layman. There is a machine to perform plasmaphoresis, for removal of plasmas from the blood, and another for leukophoresis, to remove white blood corpuscles. Using this technology, specialists may some day pump blood from a patient into a chamber where they can remove unwanted chemicals.

"But to tell you the truth," observes Dr. Rea, "nothing seems to be quite as good as simply getting the chemical load of a patient down with the methods we now use. What we need is clean air, clean food, and clean water." □

Truman Temple is Associate Editor of EPA Journal.

Campaign To Protect Ozone

The Environmental Protection Agency's efforts to alert other countries on the hazards of ozone depletion caused by continued emissions of chlorofluorocarbons are beginning to show results in a number of areas.

The issue, which has taken several years to gather momentum because of its complex nature, is now the focus of major and concerted attention by several international organizations.

Deputy Administrator Barbara Blum, who has chaired meetings of regulators from several nations dealing with the problem as early as April 1977, sounded the call to action last spring in Oslo, Norway. In a move designed to show U.S. leadership in reducing these emissions beyond earlier actions to end the use of chlorofluorocarbons as aerosol propellants, Blum announced that the U.S. was beginning the development of regulations to freeze future production of these chemicals to present levels.

Recently EPA released a massive report by the Rand Corporation that analyzed a number of control options, focusing on the economic effects of controlling the chemicals. The report includes sections on all their remaining major uses in the U.S. including rigid and flexible urethane foam production, solvent applications, refrigeration and air conditioning, and miscellaneous specialty uses.

Blum headed the U.S. delegation at the Oslo conference, a two-day gathering of seven nations and the Commission of the European Communities. The participants were the United States, Canada, Norway, Denmark, Sweden, the Federal Republic of Germany, and The Netherlands. She followed up this with a series of bilateral meetings in London, Rome, Dublin and in Brussels, where she met with representatives of the European Economic Community (Common Market). In Great Britain her discussions with senior government environmental officials and environmental groups included a press conference at which she emphasized the urgency of the problem.

The question of ozone depletion generated by chlorofluorocarbon emissions now has been placed on the agenda for a meeting of the Environment Committee of the Organization for Economic Cooperation and Development (OECD) in Paris December 2-4. Last month the Committee convened an international group of scientists to prepare a report for use by policymakers on stratospheric ozone depletion and the ensuing expected effects, including health, biological, climatic and economic aspects. Dr. Herbert L. Wiser, Principal Physical Science Advisor in the EPA Office of Research and Development, was one of the authors of the report.

Meanwhile the Coordinating Committee on the Ozone Layer of the United Nations Environment Program (UNEP) has scheduled a meeting November 10-14 in Bilthoven, The Netherlands, to discuss international assessment of scientific aspects of the problem and prepare recommendations for further action to the UNEP Governing Council. Dr. Wiser assisted UNEP in the preparation of this report. It is expected that the report, to be distributed throughout the United Nations, will have a significant impact, particularly in presenting the problem to the developing nations and in accelerating world-wide action.

The reason for world-wide concern about the effects of continued emissions of chlorofluorocarbons is that the ozone layer, located in the stratosphere about 10 to 30 miles above the Earth, acts as a shield preventing most of the biologically harmful solar ultraviolet radiation from reaching the Earth's surface. Scientists are concerned that even a relatively small loss of this ozone shield would have serious effects on human health and other life on Earth. According to a National Academy of Sciences report in December 1979, crop yields are likely to be reduced as a result of a reduction in the ozone layer. Also, the larva and juveniles of fish and algae and phytoplankton and microscopic organisms at the base of the marine food chain have been shown in research studies to be affected by an increase of ultraviolet radiation. The potential impact of chlorofluorocarbons in the atmosphere on climate, with a possible warming of the average global surface temperature, also is a matter of concern, though small when compared to the potential impact on climate expected from increasing carbon dioxide.

According to scientists, after chlorofluorocarbons are released into the air from sources such as spray cans, leakage from refrigerators and air conditioners, and industrial emissions, they slowly migrate into the stratosphere. There, high energy

Aerosol spray can

Photo © 1980 AEROSOL AGE, reprinted with permission

ultraviolet rays disassociate the chlorofluorocarbon molecules, releasing chlorine atoms and other chemical species. In essence the chlorine and chlorine oxide (an intermediate product) serve as catalysts destroying ozone molecules with which they react. Each chlorine atom may be involved in many tens of thousands of such reactions before being washed out of the stratosphere as hydrochloric acid.

(Other important reactions involving the interactions between the ozone or oxygen cycle, the chlorine cycle, the nitrogen cycle, the hydrogen or hydroxyl cycle, and to a lesser extent the carbon cycle also take place. All of these reactions—and there are some 150 of them—participate in the determination of the amount of ozone present on balance, some enhancing and some ameliorating ozone depletion.)

Scientists have devised theoretical models, supported by atmospheric measurements and including many of the above atmospheric reactions, predicting ozone depletion. Estimates vary on precisely how much ozone will be lost and what the effects of such loss will be to life on earth, but the estimates agree closely enough that the prospect has resulted in international concern.

One serious consequence of this ozone depletion would be a large increase in skin cancers. According to the 1979 Academy report, a loss of 16.5 percent in stratospheric ozone would raise ultraviolet exposure at mid-latitudes by about 40 percent. There are now about 300,000 cases of non-melanoma skin cancers annually in the United States, according to the National Cancer Institute. Scientists believe that several hundred thousand additional cases could occur annually in the U.S. if appropriate measures are not taken to curb emissions of chlorofluorocarbons. Non-melanoma cancers rarely cause death but are considered serious, require medical care, and can cause disfigurement. Persons with fair complexions and outdoor workers are more susceptible to them, especially in southern latitudes where ultraviolet rays are more intense. Melanoma, a relatively rare form of skin cancer which is frequently fatal, has complex causes which appear to be at least partially related to ultraviolet exposure. The Academy report estimated that several thousand additional melanoma cases per year in the U.S. might result if chlorofluorocarbon emissions were to continue at the 1977 release rate.

Advanced technological countries such as Canada, the United Kingdom, France and the Federal Republic of Germany are conducting scientific studies of the atmospheric aspects of the problem, as is the World Meteorological Organization. A number of countries have taken measures to regulate chlorofluorocarbons. Canada, Sweden, and Norway have taken actions to control their use as aerosol propellants, and the Dutch government last year required that such spray cans carry a warning label concerning ozone depletion effects. The European Economic Community also has called for a reduction of at least 30 percent from 1976 levels in these aerosols by each of its nine member nations by next December.

Effective October 15, 1978 EPA banned the non-essential uses of chlorofluorocarbons as aerosol propellants and subsequently banned processing them for these uses and distribution in interstate commerce. The Food and Drug Administration that year also banned manufacture or packaging of food, drug, or cosmetic products containing these chemicals as propellants, and last year prohibited the marketing of such products. These actions by the two agencies virtually eliminated the use of chlorofluorocarbons as propellants in aerosol spray products in the United States. A few propellant uses still are permitted for specialized areas such as medicine, but they represent only 2 to 5 percent of the total chlorofluorocarbons previously used in spray products. The U.S. Consumer Product Safety Commission also was involved in regulatory decisions and called for a "cap" on the production capacity of chlorofluorocarbons.

"The United States has gone the farthest so far in attempting to deal with this problem," declares "Tex" Harris, Director of EPA's Office of International Activities. "But this is truly a planetary issue and requires well-coordinated international action."

The 1979 National Academy report declared that if all countries decided to take action comparable with that taken by the United States and Sweden in eliminating nonessential uses of these chemicals as aerosol propellants in spray cans, "between one third and one half of the world's present chlorofluorocarbon releases would be avoided. Such a reduction would be a great step forward in decreasing the threat to the world's food supply, even though the magnitude of this threat is uncertain, and its advantage would far outweigh the relatively small costs of substituting alternative propellants and devices."

The Academy warned, however, that this action alone would not address the long-term aspects of the problem. Other uses of the chemicals are increasing throughout the world at such a rate that if not curbed, they will eliminate the savings in total emissions from the aerosol reductions in seven to ten years, according to the report.

Some industrialized nations, while recognizing the scientific validity of the ozone-depletion theory, have declined to pass laws banning the uses of chlorofluorocarbons as propellants on the grounds that there is not yet experimentally measured evidence that the ozone layer has been reduced. But the Academy report rejected this approach, declaring:

"A reasonable projection for the 'wait-and-see' policy, with decision triggered by a crucial depletion, involves exposure about 20 years later to at least twice that depletion as well as continuing exposure to at least the crucial depletion for several decades more. This is clearly not a prudent strategy."

The reason for this delayed effect is that because of the long residence time of chlorofluorocarbons in the troposphere (the portion of the atmosphere below the stratosphere) and their slow movement to the stratosphere itself, present and past releases of these chemicals will influence ozone depletion for decades to come, the report explained. In addition, a significant portion of chlorofluorocarbon use results in "banking" of the chemicals in products such as foam insulation and refrigeration equipment with emissions delayed for years or even decades, since chlorofluorocarbons escape very slowly from these materials or equipment.

"Imposing a production ceiling in the United States is neither the first, nor the last, step to control chlorofluorocarbons," Blum declared at the Oslo conference last spring. "In 1978, EPA and other U.S. government agencies issued rules to phase out the aerosol propellant uses of the substance in products such as deodorants, pesticides and furniture polish.

"The action I am announcing today," she told Oslo delegates, "conveys the urgent and deep concern of the U.S. about the threat chlorofluorocarbons continue to pose. Our country is moving forward now because we believe that chlorofluorocarbons comprise one of the leading international environmental issues of the decade."

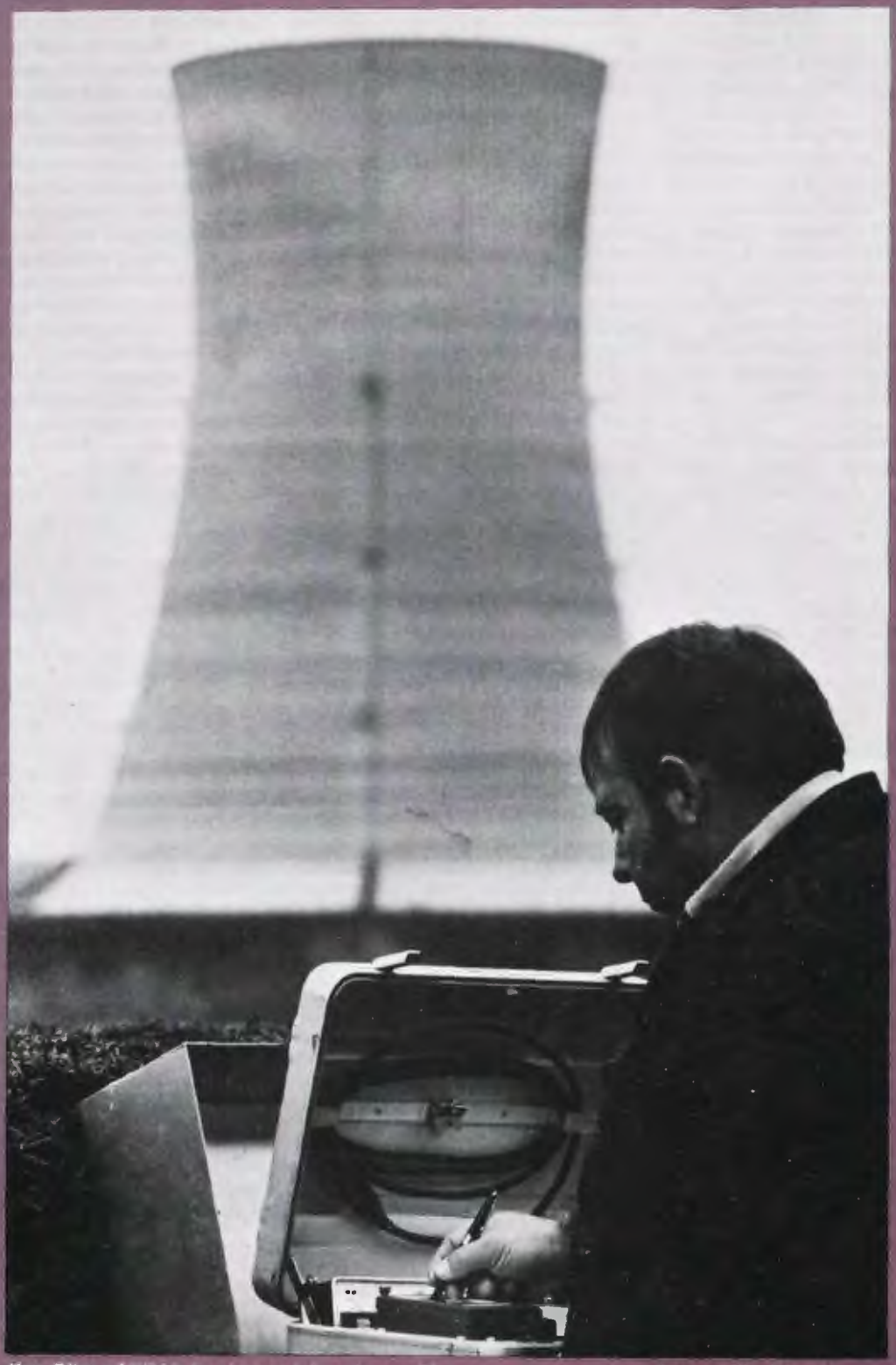
In summing up the international aspects of the whole question, the 1979 Academy report stated:

"The ozone problem is a global one. Chlorofluorocarbons emitted anywhere on earth will ultimately cause reduced concentrations of stratospheric ozone globally. Consequently, no one nation alone can solve this problem. . . .

"Without comparable action abroad, the United States can have only a modest impact on global chlorofluorocarbon emissions, one that could be quickly offset by increases in worldwide use of them. U.S. regulation of these emissions would make the most effective contribution to the preservation of stratospheric ozone if based on a strategy of synchronous or tandem domestic and international action. Ultimately, nothing less than global action can deal with this problem, although substantial improvement could result from coordinated action of the primary producer nations." □

EPA's Role At Three Mile Island

By Christine Perham



Ken Giles of EPA's Las Vegas laboratory with a gamma recorder at Three Mile Island.

When mechanical failure and human error resulted in the now-famous accident at Three Mile Island in Middletown, Pa. March 28, 1979, EPA swiftly began monitoring operations to ensure that public health was protected from the discharge of radioactive materials into the environment from the crippled reactor.

Within hours, EPA's Office of Radiation Programs began what became daily sampling at three stations located closest to the damaged reactor. By March 30, as the implications of the accident became clearer, the Nuclear Regulatory Commission notified EPA of the seriousness of the malfunction.

Three days after the first glimmering of trouble in the reactor, a team of 19 technicians from the Office of Research and Development's Environmental Monitoring Systems Laboratory in Las Vegas were in Pennsylvania with monitoring equipment and a specially-equipped plane for more intensive monitoring. Volunteers from EPA's Region 3 office in Philadelphia and the Chesapeake Bay Program also began taking samples from the Susquehanna River and the Chesapeake Bay.

The staff from Las Vegas had to move 10,000 pounds of radiation monitoring and sampling equipment more than 2,000 miles, and the logistics were complicated by an airline strike—but they managed within 24 hours of being called.

The continuous monitoring network that Agency staff set up began operation on Sunday, April 1 with 11 stations and two days later expanded to 31. Technicians placed 12 monitoring stations in a relatively circular pattern within a three-mile radius of the reactor. They located 10 additional stations within a six or seven mile radius. Nine more monitors were set in populated locations more than seven miles from Three Mile Island. These 31 stations remained in operation throughout the month of April until EPA officials were convinced that the situation had stabilized and there was less threat to public health and safety.

At each site scientists collected information from an air sampler, a gamma rate recorder, and a thermoluminescent dosimeter. The air samplers measured particulate contamination from air drawn through paper and charcoal filters. The gamma rate recorder measured radiation levels and displayed the results on a tape read-out. The thermoluminescent dosimeters are small squares of crystalline material that recorded total exposure from gamma radiation.

Cramped Quarters

At first, EPA established an analytical laboratory in nearby Harrisburg to process samples while staff members were working out of temporary quarters in Capitol City airport and later two trailers parked just outside the high-security area on the Island itself. Eventually the Agency rented office space in a small shopping mall in Middletown amidst a small hardware store, credit office and bookstore in order to improve the public's access to Agency representatives. Desks, telephones, computer terminals, laboratory space and a briefing room were set up there to help the staff process and relay information.

After positioning the air monitoring stations, the staff had many other tasks to pursue. Scientists in the research plane flew two missions to make measurements of airborne radioactivity and to track the very narrow plume from the reactor. At other times the plane was on emergency standby to track and sample radioactivity in case the accident suddenly became critical. Compressed air samples were taken at on-the-ground locations for noble gas analysis. (So-called noble or inert gases are a group including krypton. The presence of krypton in excess of normal background concentrations would have indicated a leak from the reactor.)

EPA set up two water sampling stations on the Susquehanna River below the plant and three more downstream on the Chesapeake Bay. The staff began testing drinking water samples for contamination two days after their arrival, one week after the accident.

One staff member noted, "You can imagine what we were up against. We had to find all the wells and reservoirs. There wasn't even a central source of information to tell us where these things were." Scientists located 21 surface sources of drinking water and gave these spots top priority in the sampling because the danger of radiation contamination was considered to be highest there.

Other aspects of the environment required immediate attention as well. Technicians working from aerial photographs located 570 dairies within 25 miles of the disabled reactor. On April 5, EPA started sampling milk from nine selected dairy farms. In order to get a full picture of the environment, EPA and the other Federal agencies also collected samples of water, vegetation, air, and river sediment for study.

Scientists and Ecopolitics

As scientists and engineers worked feverishly to control the mechanical aspects of the TMI situation, the overtones of "ecopolitics" continually had to be dealt with. One example involved a sampling device, designed to set off an alarm when it detected a given level of radioactivity in the discharge to the river from a low-level waste storage tank.

The monitor alarm was set to trigger a

Erich Bretthauer, Director of the Nuclear Radiation Assessment Division at EPA's Environmental Monitoring Systems Laboratory in Las Vegas, briefs the press at Middletown, Pa. near Three Mile Island.

device that automatically dialed a certain phone number, which in turn tripped portable beepers worn by scientists on the scene. In the early days after the accident, this alarm went off with disturbing frequency, but scientists found no corresponding "peak" of radiation on the recorded print-out at the monitor. Coincidentally someone notified the news media about the large number of alarms from the power plant monitor. Agency staffers inferred that someone had learned the alarm number and was dialing it for nefarious reasons. They changed the phone number and the alarms stopped. (In fact, EPA scientists now report that the water contained no appreciable levels of gamma radiation contamination.)

Getting the device installed underscored another human relations problem at Three Mile Island. EPA staff members developed within weeks the system which continuously monitored radionuclides in the contaminated water, since some feared that contaminated water from the plant would be discharged to the river.

The system uses a sodium iodide crystal, which is sensitive to radiation, to monitor radiation levels in the effluent and then record results on a strip chart. Effluent passes through a tank shielded by lead bricks to reduce background radiation from impacting the crystal. A separate tank retains additional water samples for further testing by EPA and the State.

Staff members noted that Metropolitan Edison was less than cooperative to this effort at first. "We had to bring it over in a boat," said one scientist, since the company controlled access to the island over two bridges. Now the company allows Agency scientists free access to the island and to the device, which is enclosed in a metal shed in the shadow of the damaged reactor.

Historic Role

At the time the Three Mile Island crisis erupted a year and a half ago, many outsiders were unaware that EPA had an involvement in radiation. The fact is, however, that EPA's Offices of Radiation Programs and Research and Development have maintained nationwide radiation sampling programs and monitored the fallout from nuclear testing for years. The Agency received its primary mandate to manage radiation protection through the Reorganization Order #3 of 1970, which created EPA, and the National Environmental Policy Act of 1969. Six other laws, including amendments to the Atomic Energy Act of 1954 and the Clean Air and Water Acts, give EPA responsibility for protecting public health from radioactive contamination.

As EPA Administrator Douglas M. Costle declared at the outset of the crisis in Pennsylvania, "It is of the utmost importance to the Federal Government that people and the environment be protected from unnecessary exposure to ionizing radiation from radioactive material that may be released from Reactor #2 at Three Mile Island. We are working with other involved Federal agencies to provide the best possible information from environmental radiation monitoring."

Initially EPA was a quiet partner in the Federal presence at Three Mile Island. Information about what was happening in and around the reactor reached the public through the Nuclear Regulatory Commission, Metropolitan Edison, and the Pennsylvania Department of Environmental Resources. Metropolitan Edison conducted its own environmental surveillance program, as did the State.

As the hazards of the situation became more apparent, however, the public feared the possibility of a nuclear core meltdown, a drastic increase in temperature in the reactor that could breach the containment building and release massive amounts of radiation into the atmosphere.

On April 13, 1979, the White House designated EPA as the lead Federal agency to develop a long-term monitoring plan and coordinate all Federal environmental monitoring in the area. EPA immediately approved a preliminary monitoring plan and started to put it into action.

Assistant Administrator for Research and Development Stephen Gage outlined the aims of the long-term surveillance program. The plan would 1) provide a measure of the radiological quality of the environment around the power plant, 2) help keep people informed about radiation levels, 3) confirm and check on how well we could control radioactive releases to the environment, and 4) ensure equipment was ready in case of an accidental release. He added that plans would be assessed periodically to ensure they were appropriate for the changing operations at TMI.

Gage named Erich Bretthauer, Director of the Las Vegas Laboratory's Nuclear Radiation Assessment Division, to manage the emergency project. His staff routinely monitors fallout from nuclear weapons testing, and their expertise has proven invaluable at Three Mile Island. "In the past we've not been geared up for this sort of thing, because there was more emphasis on nuclear armaments," said Bretthauer. "But our people responded admirably to the situation."

The results of the sampling have been reassuring. EPA scientists found only very low levels of radiation in the area. The total maximum radiation exposure, according to a White House-sponsored report on Three Mile Island, is roughly equivalent to the amount of radiation a person would absorb from living in a brick rather than a frame house, or by moving to an area at higher altitude like Denver, Colo. where the natural background radiation is higher.

When the first threat from the emergency passed, EPA scaled down its efforts at Three Mile Island. The staff shrank from its emergency level of 31 to five scientists and technicians who maintained the 18 remaining monitoring stations. Staff members prepared six volumes of environmental information for the President's Commission on the accident.

An interagency analysis concluded that the accident did not raise radioactivity far enough above background levels to cause even one additional cancer death among the people in the area. They found no contamination in water, soil, sediment or plant samples.

According to Charles Cox, Public Health Service on-site coordinator at Three Mile Island, out of over 800 milk samples collected from local dairy farms during the period of March 29 to April 20, 1979, a total of 69 were reported to have trace amounts of radioactive contamination, the highest level being 36 picocuries per liter. He stated that this level of activity was less by a factor of 35 to 40 than that measured in the fallout from Chinese nuclear testing in October 1976 which passed across the United States. The levels measured after the TMI accident were far below the protective action level, which according to Public Health Service guidelines is 12,000 picocuries per liter. Since March 1980 the Service has curtailed its milk monitoring, but is prepared to reinstitute its sampling program in the event of an unexpected release from the reactor. Currently the Commonwealth of Pennsylvania's Department of Environmental Resources is sampling milk as part of its routine surveillance program.

Gold Medal Award

Administrator Costle in December 1979 awarded the EPA Gold Medal to the team from Las Vegas for their dedication during the emergency. He cited their efforts as an example of the commitment of 'bureaucrats' to the ideal of public service. But the Agency's mission there was far from over. In some respects it had hardly begun. As the utility moved ahead with efforts to clean up the damaged nuclear reactor, EPA continued to coordinate the government involvement in the cleanup. The long-term surveillance plan was updated twice to reflect changes in operations as each aspect of the cleanup presented a different challenge to the Agency.

For instance, local residents had become increasingly critical of the way cleanup activities were being monitored by the

Continued to page 29

A Spectrum of Missions

Measuring the effects of radiation from underground nuclear explosions and analyzing the toxicity of hazardous wastes from Love Canal are just two of the varied monitoring and sampling functions by one of EPA's most unusual laboratories.

On any given day, a visitor to EPA's Environmental Monitoring Systems Laboratory in Las Vegas, Nevada might encounter or learn of one or more of these unique activities:

- A technician adjusting a telephotometer used to measure how well the visibility in our National Parks is being protected.

- Specialists aboard a plane fitting equipment that can bounce laser beams off the earth from 10,000 feet altitude to obtain information about airborne particles.

- A scientist running hazardous waste samples from foundries through a mass spectrometer for analysis.

- A photo-interpreter pinpointing the extent of damage from a spill of toxic chemicals.

Although it is unlikely that an outsider could witness all these sights in a single visit, they illustrate the breadth of scientific endeavor that the laboratory encompasses as it rounds out its 27th year in Nevada. During the past decade, the facility has demonstrated an ability to keep its research tracking closely on the changing environmental problems that preoccupy the Agency, whether they are in contaminated air or water, hazardous wastes, radiation from a malfunctioning nuclear plant, or concerns about pollution from future energy development in western States.

"We must be in the mainstream of EPA's programs," declares Glenn E. Schweitzer, laboratory director. "Unless we can demonstrate the relevance of any given research to EPA's mission, we don't move into an area."

The laboratory began its career specializing in radiation monitoring back in 1953, long before EPA was created, to detect and measure radioactivity that might be released to public areas from nuclear tests. Over the early years, as an arm of the U.S. Public Health Service, the facility devel-

Dave Nielsen of Las Vegas laboratory operating a laser fluorosensor aboard a helicopter.

oped methods and equipment measuring extremely small amounts of radioactivity, using aircraft, stationary instruments on the ground, mobile units, laboratory analysis of samples, and livestock on a special farm on the Nevada nuclear Test Site.

The laboratory to this day has retained its expertise in this subject. After the Three Mile Island crisis erupted a year and a half ago, some 30 specialists from the Las Vegas facility quickly were moved to the scene at Harrisburg, Pa. EPA was named lead agency for environmental monitoring of the site. (See separate article in this issue on p. 18.)

Following are some examples of the many other areas of environmental research and monitoring that the laboratory pursues.

Quality Assurance

When the Love Canal disaster first surfaced in upstate New York, scientists were faced with a number of challenges in dealing with the complex mixture of hazardous chemicals at the site. They still don't know exactly how many chemical compounds are buried there, but they're looking into a list of some 150 different ones.

As the dimensions of the problem become apparent, researchers realized that a program would have to be organized to make sure sampling and analysis of the hazardous wastes were uniform and done in a standardized way, following a precise methodology.

"To give you an idea of the difficulties," explains Dr. Eugene Meier, Director of the Quality Assurance Division at the Las Vegas laboratory, "the levels at which chemicals are hazardous to humans vary enormously. Some like dioxin are so toxic that they're dangerous at one part per trillion concentrations, where other compounds are much less toxic and require analysis at parts-per-million levels."

Then there was the problem of the media in which the waste was dumped. In bodies of water, sampling is relatively straightforward and produces accurate results because the medium is homogeneous, and methods for analysis have been tested and standardized. But sampling in landfill sites containing hazardous waste is far trickier. For example, waste in soils is a difficult problem because the soil is in many layers and is heterogeneous. How can EPA determine how well the sampling and analysis is being done at such a site? The answer is to set precise controls on the process.

One of the outgrowths of the Love Canal case has been an estimate that there are up to 50,000 potentially hazardous waste sites around the Nation. The magnitude of dealing with such a possibility has brought a major shift in the Las Vegas laboratory's emphasis. Its historic involvement in monitoring and remote sensing has continued, but the laboratory also is now heavily involved in hazardous waste monitoring problems, with a large part of its resources in the current fiscal year devoted to this area.

Costs run high in the sampling of chemicals. Positive analysis for dioxin, for example, can range from $950 to $2,000 per sample at the parts per billion level. (By contrast, some other compounds run around $100 per sample partly because they occur at a higher concentration and are easier to do.)

EPA now has a prime contractor gathering and labelling samples from Love Canal, storing them in a "bank" and shipping them to subcontractors and EPA laboratories for analysis. This phase of Love Canal investigations is expected to be completed in December. The Las Vegas facility has about 50 percent of the work load due to the scope of its sampling program.

The pressures of analyzing hundreds of samples of hazardous wastes has brought home another realization to laboratory managers: There currently are simply not enough commercial analytical laboratories (contractors) equipped to handle the large number of samples coming from the Agency's hazardous waste program. Officials expect this situation will improve, and the cost per sample will decline as industry responds to the need and EPA's research and development expertise shows the way to improved technology. Meier points out that sampling and analysis work associated with the development of effluent guidelines a few years ago ran as high as $1,500 to $2,000 per sample but now has dropped to the $400-$800 range because of increased competition among laboratory subcontractors, improved methods, and better equipment.

Back in 1973, for example, it took one technician one day to do an analysis using mass spectrometers. Now the same person can do up to 20 a day, as electronics and computers have improved. The gas chromatograph-mass spectrometer was in its infancy seven years ago, but now is the most commonly used device in analysis of organics, according to Meier. Next in line: advanced techniques using high pressure liquid chromatography or HPLC, useful because it functions at room temperature whereas gas chromatography requires a compound to be made volatile from heat. (These new methods are required for those compounds that are non-volatile or decompose at higher temperatures.)

Airborne Detectives

As part of its numerous other monitoring activities, Las Vegas laboratory has developed highly sophisticated methods of measuring air pollutants over cities and regions, using aircraft as airborne platforms. Monitoring from aircraft has the advantages of perspective, speed, wide-area coverage, and access to remote areas that cannot otherwise be reached easily, according to Dr. David McNelis, Director of the Advanced Monitoring Systems Division.

One of the major concepts in this field is remote sensing, as opposed to "contact sensors" such as instruments with probes that can be lowered into lakes to take water measurements. Remote sensors "sense" a condition from afar, and are divided for convenience into two varieties. The passive types read electromagnetic signals from some source such as a heated plume from a power plant or reflected solar radiation from the earth's surface, such as those signals picked up by Landsat satellite.

Farm In The Desert

To the outsider, one of the most unusual aspects of the Environmental Monitoring Systems Laboratory in Las Vegas has been its experimental farm, located 120 miles from the main laboratory at the northeastern section of the vast Nevada nuclear Test Site. Bounded on three sides by 7,000-foot peaks, this desert oasis has been home to dairy and beef cattle, horses, goats, pigs, and even chickens.

Over the years observers may have been startled to learn that the aircraft and off-road vehicles cruising the area were neither military nor associated with underground nuclear tests but rather scientists and technicians tracking a large herd of deer to map their movements. The herd migrated from its high summer home each December or January and moved to lower ranges by unknown routes, and EPA has kept track of them by both electronic and visual aids attached to the animals as they browsed across the Nevada Test Site.

On the farm itself, scientists have used some 20 acres of irrigated land for growing feed crops for cattle and also some test plots for growing vegetables while exposing them to various pollutants through the soil, water, or the air. The facility has been especially useful in the past for studying pollutant pathways and relationships of exposure and dose, especially when backed by the chemistry and biology laboratories, greenhouse, and environmental simulation chambers at the main facility in Las Vegas. In addition the farm has a milking barn containing special equipment to prevent cross-contamination of milk, as well as shops and a storage area.

Despite the presence of highly-trained scientists, the farm has retained a wilderness flavor that is surprising to eastern visitors. Coyotes in the past have eaten not only goats kept there but also have invaded the farm's watermelon patch. Kangaroo rats and field mice and wild rabbits have all made nuisances of themselves at certain seasons, and overhead hawks and buzzards can be seen circling in the summer heat.

Back in the early 1960's the laboratory was called upon to do research on how radioactive materials found their way to humans. A major concern at that time was radioiodine in the food chain, which began with nuclear fallout to the soil and made its way through forage to cow's milk. Since rainfall at the Test Site averages only around 6.5 inches a year, scientists have grown crops such as alfalfa and hay at the farm, irrigating them with water pumped from a mile-deep well. The cows were fed carefully measured amounts of radioactive material along with this fodder, and their milk and wastes analyzed, as well as samples of their blood. The resulting data have been used to develop reliable methods of predicting the potential hazard to humans and to develop countermeasures reducing the quantity of radioactive substances entering the food chain.

Twice a year the farm, which is managed by a private contractor, also has rounded up a herd of about 60 Hereford beef cattle allowed to roam the Test Site, grazing on desert vegetation. Scientists would then sacrifice several animals and examine their tissues for radioactive residues and any radiation effects. To date, findings show the animals to be entirely normal. The Department of Energy, which has worked closely with EPA at the site, periodically has brought in area ranchers for an inspection tour to reassure them that livestock may safely graze in this region.

One of the steers, Big Sam, has had a surgically installed opening and tube leading into his forestomach for most of his life. From time to time a sample of the food there is painlessly removed to see which types of vegetation he has been eating on the range. Laboratory personnel also have collected tissue samples from wild species in the area including bighorn sheep, mule deer, small mammals and birds. The species serve as biological indicators of any radioactive fallout and as monitors of radionuclide uptake by wild animals. In cooperation with the Nevada Department of Fish and Game, EPA also has captured mule deer and fitted them with collars containing miniature radio transmitters to map the herd's migration patterns, according to Dr. Donald D. Smith, a veterinarian on the laboratory staff.

A number of scientists and members of the EPA Science Advisory Board believe the farm could have a promising future in an expanded role.

"It's a unique facility," declares one official, "isolated, surrounded by mountains, with guards at the gates of the Test Site, so you could safely handle hazardous materials here, for example, and study how they find their way into crops. Probably there's no other place in the United States where you have the ability to work with hazardous materials in such protected, remote surroundings. We don't know much about the organic chemicals we're encountering now and how they get to humans. A lot of people grow their own food near thousands of waste sites around the country. Even at Love Canal people had gardens. And we need to know more about how these chemicals get into the food chain. The farm would be an ideal place in many ways to study this subject."

Big Sam, a steer at the experimental farm north of EPA's Las Vegas laboratory, has surgical opening in its side to permit scientists to monitor his stomach contents.

A Spectrum of Missions

Continued from page 23

Active sensors generate their own signal and read the return "signature" signal, and it is this kind of system that has stirred such interest in recent years.

"The program here has designed a number of advanced instruments," explains Dr. Pong Lem, an environmental engineer with the laboratory. "There is not a whole lot of commercial equipment available to do our kind of work. So part of our role is to make these special tools for monitoring, show that they're valuable, and pass them on to the private sector to pick up on the ideas. We've found that even before we prove out something, we attract industry because they see the potential."

One of these concepts, now in a "third generation" level of development at the laboratory, is lidar (for light detection and ranging), used to map airborne particulates. It probes the atmosphere beneath an aircraft much the same way a depth sounder operates beneath a ship. A light pulse is emitted by a laser pointed toward the earth. As it travels downward striking air molecules and suspended particles, light is scattered back to the aircraft's sensing devices. Measurements of this scattered light can then be used together with navigational information to determine the size and location of pollutant plumes. EPA engineers have improved the system in recent years so that the laser can now be fired ten times every second, compared with once every 12 seconds in an older model, thus greatly increasing the system's ability to define a plume's dimensions.

A related method of monitoring known as differential absorption is designed to look for a specific pollutant. Scientists know that different substances absorb different frequencies or colors of light, and this airborne system uses two lasers to detect specific gaseous pollutants in the air. One laser is adjusted to a frequency that can pass unchanged through a pollutant such as sulfur dioxide. The other is set so that it is absorbed by the pollutant. The difference in the two beams after they bounce off the earth and are collected by a telescope in the aircraft indicates the amount and distribution of the pollutant.

A third approach, called laser fluorosensing, operates on the principle that some substances fluoresce or light up when stimulated by a beam of light of given frequency. Because the color and intensity of the fluorescence varies according to the substances being illuminated, scientists can use it to identify them. The advantage of course is that researchers don't need 1,000 samples to identify pollution and can simply fly over a lake, for example, aim the laser at the water's surface, measure the fluorescent signal returned to the aircraft, and calculate pollutant levels from the signal intensity.

Among the passive remote sensing techniques that have been used by the laboratory are thermal infrared scanning, which records the temperature differences in bodies of water beneath an aircraft and has been used to show waste discharges. The scanner is so sensitive that it shows differences as small as one degree Centigrade. Scientists also use multispectral scanning to identify classes of objects on the ground from the light frequencies they reflect. This technique can be used to help determine from high altitude whether strip-mined land has been properly reclaimed by identifying the vegetation it supports.

Visibility In Parks

As reported earlier, the Las Vegas laboratory has been working in close cooperation with the National Park Service to keep track of how the Nation's National Parks are maintaining their splendid vistas of mountains and canyons. (EPA Journal, June, 1979, and March, 1980). Since long-range visibility of these landscapes requires clean air, the Clean Air Act Amendments of 1977 provided that the air quality in such pristine areas—the so-called Class 1 areas—be protected. Establishing a base line of visibility and determining how best to make such measurements is part of the job.

"Our task is to weed out the poor techniques and set up a network of devices so we can characterize seasonal variation, and regional and local causes of visibility impairment," explains Robert Snelling, head of Integrated Monitoring Systems which handles the visibility program. "Next January we will have two years of accumulated data under our belt," he adds, "and we're now trying to find out which of the various industries located near these pristine areas are the major sources of pollution."

The two years of data were gathered using some two dozen telephotometers, telescopes with electronic devices on one end that measure contrast in landscapes. Specialists also have used 40 samplers at various sites in eight Western States to measure particulates. At Canyonlands National Park in Utah, a whole complex of instruments is being operated by a contractor because this location has a number of suitable targets and also is believed to be impacted by the Four Corners power plants and other sources. Among the instruments at various locations is the multiwavelength telephotometer which scientists use to look at various parts of the color spectrum to see if contrasts in color are more meaningful than ordinary contrasts. Another device employed is the nephelometer, which pulls air through an instrument and measures how the light is scattered. Technicians can extrapolate from this on how particulates are scattering light in the atmosphere. Other aids include stacked filter units which measure coarse and fine particles, sun radiometers which look at how much radiation the sun produces on a clear day in an area, and photo and meteorological data.

The visibility program by the laboratory will probably require another two years of work to obtain a full understanding of the effects of air pollution on the park system. Ultimately, officials assume that the National Park Service, because of its direct involvement in this problem, will become the lead agency for future studies. □

Science and EPA

An Interview with Dr. John E. Cantlon, Chairman, Executive Committee, EPA Science Advisory Board

Q What do you think will be the major environmental challenges of the 1980's?

A Let's consider things that have a long term research requirement. Waste management in its broad sense focusing primarily on how to clean up groundwater probably is going to require more effort, more adrenalin. Love Canal and all of its thousands of duplicates across the country have elevated public awareness to this problem. And the chemical, geological, and epidemiological complexity of the questions involved will make this a tough, decades-long problem.

It's remarkable that we know so very little about the movement of many toxic materials in groundwater and through soils. If you put a pulse of contaminants in the air, that material settles or is washed out as the air mixes globally. But when you put a pulse of toxic material in groundwater, the movement and transformation are very slow. The material is passing through a very complicated physical mixture of water and soil particles which range all the way from very fine clays to coarse boulders, and the physics of the material's behavior is complicated. Much of the soil in the United States is heterogeneous in which you have particles from very different kinds of rock, from igneous granites to sedimentaries like limestone and in the surface zones, organic matter. Each of these has a different chemistry, which means big differences in the degradation, movement, and recombination of materials.

Also, we know virtually nothing about the amounts, origins or subterranean behavior of exotic organics that are natural in groundwaters. Currently we read mass spectrometers and see blips indicating organics but we don't know if these chemicals are natural, manmade or degradation or recombination products of manmade materials.

Another approach to the management of wastes would be to develop new technologies or processes that avoid particularly unattractive waste material. This will be largely an industrial effort that EPA can encourage without direct involvement, although programs in technology assessment can trigger others' efforts. We need to explore the joining of technologies like urban solid and liquid waste disposal, and recreational land use and water cleanup technologies. The coupling of energy generation and solid waste disposal is already gathering some momentum.

Meanwhile, Congress, industry and many public interest groups are raising another challenge, namely whether we are prudently spending our limited environmental quality funds. Are we getting the greatest risk alleviation or other benefit per dollar spent that we can? It is a predictable challenge after the 1970's, which were an environmentalist's dream. This relative benefits question is an area that will be pursued with great vigor in the next decade and probably with an increased Congressional and industry oversight. Very tough questions will be asked, and getting good answers will be difficult.

Q What are some other issues?

A Another challenge will be improving the epidemiological base on which we try to assess health effects. The simple facts are that we have poor data on how many people are ill and what makes them ill. Adequate data are not being routinely gathered so they can be interpreted for many categories of environmental regulatory decisoins. For each environmental question we must initiate a new epidemiological study. As we move closer to a more uniform national health care system whether public or privately based we may be able to accumulate epidemiological data that will help us find answers to some of these environmental health effects questions.

Public appreciation of the relationship between smoking and cancer has been an exceedingly intractable matter, for example. You will find industry people who insist the human data don't show a causal relationship. Thus, improving epidemiological data won't end controversy in environmental decision-making, but having widely acceptable epidemiological data will represent an important forward step.

Another quite different area would be assessment of environmental damage to things other than human beings. For instance, the impact of acid rain on vegetation, lakes, and streams—that's going to be a decade-long kind of problem. We're just beginning to understand the matter of acid precipitation. We must consider the total fall-out of acidic material, not just that which comes with rainfall. There's even acidic particulate fall-out on days when there is no rain or snow.

What is the impact of acid rain on plants, and conversely, to what extent does vegetation filter acidic pollution out of the air? What does a natural forest system do to inactivate acidic material? Some good research is going on at Oak Ridge National Laboratory in this area.

Of course, acid rain is almost entirely the product of the combustion of fossil fuels. We are now facing a situation where the U.S. could become the coal and oil-shale Saudi Arabia of the world in these fuels. We have a larger percentage of the world's coal and shale oil than Saudi Arabia has of the world's oil supply. If coal replaces oil and gas globally, other Nations will probably be coming here to get fuel.

Q What about the "greenhouse effect?"

A This question will have to be addressed with great vigor. You refer, of course, to the carbon dioxide problem. It's very important. A small increase in the amount of that common product of fossil fuel combustion getting into the upper atmosphere is theoretically capable of changing the thermal balance of the earth. This could precipitate a situation in which the global temperature would rise a few degrees.

There is clear evidence that the carbon dioxide percentage is rising; there is some evidence that suggests global temperatures are increasing. The cause of the temperature increase is unknown. There could be other solar-terrestrial dynamics that would change the temperature, irrespective of changes in carbon dioxide, but

the theoretical calculations of a so-called greenhouse effect from carbon dioxide look pretty convincing.

This issue will need to have greater attention because a rise of roughly two degrees Celsius in the world temperature would result in melting the polar ice caps. If this ice melts, then most of the major coastal cities would be flooded by the seas including Washington, D.C., Miami, and New York City, and Baltimore, some portions of the West Coast and a large section of the Gulf Coast. Changes in the climatic belts would also occur. You would have warmer crop-growing areas well into Canada and Siberia, and you would have substantial expansion of the world's deserts. It is very difficult to predict what these shifts would do to world power balances, human food supplies, and human environmental stress.

Another disconcerting aspect of the carbon dioxide question is that three-fourths of the world's surface is ocean, and the oceans are a sort of flywheel in that global temperature will not change until you've significantly changed their temperature. It is estimated that a 30-to-40-year lag in world temperature warm-up would occur as the ocean temperature slowly increases. Thus, even after you put enough carbon dioxide into the atmosphere to guarantee that the ice caps will melt, it will still be 30 to 40 years before the event will take place because of the slow pace in warming the oceans.

Q What about the issue of health and environmental risks in modern society?

A Public understanding of risk is an area needing much attention. It's quite clear that people have different perceptions of risk. As a consequence, the public does not react the way it would if it had a better picture of risk. If people had such a broad picture, they might react in ways that made better sense regarding how they want government to alleviate risk and which risks require earliest attention. This whole idea needs attention.

We could expand on the matter of whether or not the Government should address risks to its citizens. Clearly I think it has to, and governments far back in time have addressed risks ranging from fire hazards to epidemics to incursions by raiders to unemployment. By the way, the lack of jobs may cause as many deaths as any currently identified environmental risk. So the state of the economy like the state of the environment is important in considering a society's menu of risks.

It's clear from a number of studies that the death-injury statistics are not what people look at when they think about risk. As an industry, nuclear energy is far less risky than fossil fuel energy. The number of deaths from the mining and transportation of coal and the impact from emissions of organics, sulfur, nitrogen, heavy metals, and radioactive materials from coal combustion on people and property are much greater than the impact of uranium mining and transportation, and the side effects of uranium mining and its tailings, the injuries and deaths in purifying uranium, the transfer of these materials to reactors, operating and even deactivation of reactors. But if you ask individuals from almost any group, except highly technical people, about the risk of nuclear versus fossil fuel, the answer is normally the reverse of the facts.

So, the level of public understanding about risk is very poor. Risk is a very difficult subject to convey to people with average educational preparation. I would rank improving public understanding of risk as one of the major environmental challenges.

Q Would you briefly describe what the EPA Science Advisory Board is and its relationship to EPA?

A The Science Advisory Board is a collection of seven standing committees: Environmental Measurements, Health Effects, Clean Air, Ecology, Environmental Technology, Pesticides, and Pollutant Movement and Transport; and four ad hoc committees: Risk Assessment, Economics, Air/Cancer, and Innovative and Alternative technologies; and one standing subcommittee: Toxic Substances. Those committees address the particular areas and provide an external scientific peer review of the Agency's activities in those areas. They provide an external source for scientific judgment.

Q What would you name as the top research and development priorities for EPA today?

A In the short-term, looking at the question from a media perspective, volatile organics and air quality is a major concern.

Volatile organic means that the material goes into the gas phase and is therefore distributed through the air. And an *organic* compound is any compound whose backbone is composed largely of carbon atoms. Examples are straight chain or ringed hydrocarbons. Take the Love Canal situation where there are drums of materials that have been buried in the ground. The drums eventually rust and rupture, releasing organic compounds, many of which are volatile. When the contaminated soil gets warm, these materials evaporate much like gasoline evaporates from your gas tank when you are filling it. If those fumes happen to include carcinogenic materials which are carried by the wind to other places, people can be exposed who have not been appropriately warned and for whom education has not been provided. We need better technology for measuring volatile organics so that we can more accurately identify risk zones.

In groundwater we need to understand the basic geohydrology, movement, transformations and fate of toxic materials put into the ground.

In potable surface waters, probably the hottest short-term item is to get a better grasp of the health consequences, if any, of the short-chain organic compounds that are chlorinated in water treatment plants during the process of killing the bacteria and the viruses that occur naturally in most waters. If the bacteria and viruses in wastewater are killed with chlorination in one city, such as Cincinnati, downstream in another city these same waters are the source of potable waters which are again chlorinated before distributing. The question is, how important are very low levels of those short-chain, chlorinated hydrocarbons that are formed by the very act of making the water safe by killing infectious bacteria and viruses? Since the cost of removing short-chain hydrocarbons is substantial, this is a very tough problem right now.

Risk assessment needs attention. Before you can teach people to understand risk assessment and to think with greater vigor about risk, we must obtain better agreement in the professional community about how to measure it and how to express the results. From a technical perspective the professionals in the risk assessment area need to develop and share measurement techniques so there is better predictability concerning peoples' understanding of risk statements. EPA needs to have a better basis for choosing a particular risk assessment measure so the public, the regulated industries, and environmental groups all agree: "Yes, that's an acceptable choice of method," instead of arguing about it.

Q What about the relationship of pollutants to health problems?

A The difficulty in assessing health effects is that many risks to human health are based on experiments with animals, usually mice and rats. We know from animal studies that at certain levels of concentration you can induce cancer, or a bronchial problem, with a particular chemical. The doses typically are at levels substantially above the levels to which human populations are likely to be exposed. While one can demonstrate that the effect can be

produced, it is more difficult to defend a particular ambient concentration as the standard that should be set for human exposure.

When you consider real environmental situations where people are exposed, chemical levels are apt to be very, very low. As a consequence you may have to extrapolate to a very, very large human population before you would expect to get any effect. The health effects question needs a great deal of study and elaboration, and until we learn a great deal more about it, we are going to have problems in getting agreement on standards, especially when pollutant control technologies are very costly.

Lastly is the whole business of protocols for short-term tests. Ways must be designed for speeding up the development of agreed upon procedures for testing specific compounds with specific animals.

Q What about long-term priorities?

A These include the carbon dioxide problem and the acid rain problem, which we've already discussed. Another is the impact of toxic materials on multiple species systems, such as all of the living things in a lake, or all of the plants and animals in a forest. Also looming on the horizon are human and animal behavioral health effects. For instance, the impairment of learning in young people by exposure to lead is thought by some experts to be a serious problem that needs attention. The study of the impact of various compounds—everything from agricultural fertilizers to the trihalomethanes, the materials that are used as refrigerants on the ozone layer is a long term effort in which EPA has been involved. Indeed, the whole problem of upper atmospheric chemistry and its sensitivity to air pollution needs attention.

Q The controversy several months ago over a study of possible chromosome breakage in Love Canal residents seemed to reinforce a view that studies should be reviewed by independent scientists, so-called peer review, before being made public. How do you feel about this?

A The quality and credibility of scientific data and interpretations from data are benefited by peer review. In this case an EPA Enforcement Division was preparing a legal case against a chemical company. When one approaches a lawsuit the object of the game is to win. When, however, you're addressing questions of science, the object is to make as clear an exposition of truth as is possible, including an assessment of the degree of confidence one can place in any judgment about the meaning of the data. The study that was commissioned appears to have proceeded through a chain of people, with A delegating to B who delegated to C who then subcontracted to E to provide a study. That protocol and the resulting data and interpretations not only lacked peer review, the study design lacked an adequate control group. In other words, the group examined were human beings in the Love Canal area. But no other group was studied with identical procedures to provide a point of comparison. One of the fundamental principles in science is that unless you have adequate controls, you have nothing definitive.

Secondly, experts in the field feel that the chromosome examinations did not follow the best procedure for eliciting the information being sought. So, the people who have looked closely at this study consider it to have been poor science. A contract was let to a research group without having an adequate set of specifications and a procedure to insure they were followed. Any time an agency does that, it's bad. But, in this case, information was leaking to the press and to the individuals being sampled. Unfortunately, there was no scientifically valid information to give them but both parties responded as though the results had validity.

It was almost a classic case of how not to do an operation. We have recommended some actions internally. I think there are ways to reduce the likelihood of a similar event. The basic configuration of a sound study design has to be stipulated up front and the contractee has to agree to conduct the study in a way that will provide sound results that will be useful to the Agency. The study design, the data and interpretations from the data should be peer-reviewed by competent groups before they are released to the press.*

Q What are the areas where you think EPA's research and development have done an outstanding job?

A The air modeling and monitoring program down in Research Triangle Park, N.C., has been first rate science. This is a very tough area where the objective is to find what happens when you put a pulse of pollutant into the air at a particular point, where it goes, and what the physics of that process is.

Also, the health effects people have done some really outstanding work. The quality of some of their research will stand up anywhere in the world in terms of scientific quality. Obviously, not all of it, e.g., we were just citing the Love Canal study. But in the EPA health effects laboratories there is some first rate research. EPA's labs also have strength in the area of biology and ecology of pollution. There has been some particularly good work in water biology related to pollution.

Q Should EPA put more emphasis on quick tests for cancer?

A There is a large group of people who would prefer that we never experiment on human beings. There is a somewhat smaller group who would prefer that we never experiment on whole animals. The emergence of these quickie test techniques are ways to get away from testing on animals. But colonies of human or animal or bacterial cells simply do not respond the way a whole mouse or rat or monkey does because the cell colonies don't have kidneys, eyes, a liver, a brain, a gut, a stomach, or lungs, and both collectively and individually those organs behave differently to different combinations of compounds. There is no way that the quickie techniques will ever replace whole animal research. It just won't happen. However, preliminary screening and much basic research will be much enhanced by cell culture techniques.

I would much rather defend whole animal research going all the way up to primates than I would experimenting with human beings. Of course, we used to test with humans—both prisoners and military personnel used to be used for testing. In today's improved science and moral climate, we are more sensitive to the risks than we were even 30 years ago.

The short answer is yes, we should rely more on the simple, short tests, but we cannot be maneuvered into a position in which we have to forego tests on whole animals. Some animal rights people have said they would like to design computer modeling instead of using any living thing. In the first place there are no computer models in the world that can approach the complexity of a single cell. It is a hopelessly naive supposition that single cells or bacterial colonies can ever substitute for whole animals. Behavior, for example, is influenced by toxic materials. It is just as naive to assume that because a mouse or a rat responds in a particular way, people will respond identically. The animal model isn't perfect but it is much closer than computer models or colonies of cells. We are obligated to do the best job we can in estimating risk to humans and to the planet's ecosystems. □

This interview was conducted by John Heritage, Managing Editor of EPA Journal.

Dr. John E. Cantlon is Vice President, Research and Graduate Studies at Michigan State University. He has served as Chairman of the Environmental Studies Board, National Academy of Sciences, since 1977.

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Plants As Pollution Sentinels

By Carolyn Worsley

Carolyn Worsley inspecting a flower on Tradescantia, *a potential air pollution monitor.*

Most coal miners are familiar with the "canary in the cage" technique for detecting dangerous levels of gaseous air pollutants in underground mines.

The suddenly silenced chirps of a caged canary signaled to miners in years gone by that the air around them would soon be too dangerous for them, too, to breathe.

This relatively-successful technique has encouraged scientists over the years to search for animals and other organisms that might also serve as sentinels against slower and more subtle changes in environmental surroundings.

The U.S. Environmental Protection Agency, under an Interagency Agreement with Brookhaven National Laboratory in Upton, New York, is studying special strains of common plants that are sensitive indicators of the presence of mutagenic environmental contaminants, displaying mutations soon after exposure that are visible under a microscope and in some instances with the naked eye.

EPA's Health Effects Research Laboratory in Research Triangle Park, N.C., is evaluating the use of plants for environmental mutagen detection. The most advanced research in the area has been in air pollution research with *Tradescantia*, a hybrid of the spiderwort plant that grows wild in certain parts of this country.

Tradescantia looks like a normal houseplant with its long, grassy leaves; waxy, knobby stems; and tiny bluish-lavender flowers. But the behavior of special laboratory strains of this plant in polluted air proves it is more than ordinary.

"When exposed to a mutagen before the plant blooms, mutated cells in the hairs on the *Tradescantia* stamen turn from a normal blue to pink," said Dr. Shahbeg Sandhu, a research biologist with EPA who has been involved with research in this area.

These mutations, called "pink events," are visible under a microscope. The mutations appear five to 17 days after exposure to mutagens.

As with any bioassay, researchers must be cautious in evaluating potential harm to human health based on the results of the test because of the dissimilarities between humans and other organisms. "Although it's difficult to compare plant mutations to possible human effects," Dr. Sandhu said, "we must assume that a substance capable of turning blue cells to pink in flowers might also cause harm to people."

EPA, under the technical direction of Dr. Carl Hayes, and the National Institute of Environmental Health Sciences, under the guidance of Dr. Frederick de Serres, collaborated in 1976 to sponsor preliminary field trials with *Tradescantia*. Brookhaven National Laboratory, which pioneered the *Tradescantia* stamen hair bioassay research, conducted the studies.

In the field trials, researchers tested *Tradescantia*'s utility for on-site monitoring of air pollutants from inside a specially-designed trailer permitting direct sampling of outside air. The study took researchers to several large industrial cities throughout the country where higher-than-normal cancer rates already had been documented. In addition to concurrent controls inside the trailer in which control plants were exposed to filtered air, a control study was conducted in "clean" air in the Grand Canyon.

"Results of those tests showed a noticeable increase in the occurrence of pink events in the industrial cities," Dr. Sandhu said, "while the incidence of color change was quite low in the Grand Canyon tests."

EPA and Brookhaven will take *Tradescantia* to eight sites around the country this coming year to monitor for ambient air quality to verify further the plant's monitoring capabilities.

Seeking Chromosome Breaks

Under a separate grant at Western Illinois University in Macomb, researchers are developing a test which involves observing *Tradescantia* for chromosomal damage from mutagens, which would indicate a higher level of damage than the gene mutations.

A positive response for tests for chromosomal abnormalities, such as the micronucleus test, in combination with gene mutations, may indicate a greater risk to humans than may be indicated by gene mutations alone. The micronucleus test has an advantage over the stamen hair test with the ability to store exposed material in slides for future examination, thus eliminating time pressure that's present in scoring stamen hair mutations.

Tradescantia has been demonstrated a useful, inexpensive and time-saving monitoring tool. But EPA is trying to develop additional plant bioassays that may be more adaptable than *Tradescantia* to a variety of field situations.

EPA is sponsoring research at the University of Illinois at Urbana for the development of a corn bioassay. When exposed to mutagens, mutations occur in the genes that control the starch composition of seeds of certain strains of corn; pollen grains are the functional unit for the expression of these genes. Researchers can observe the mutations by staining the pollen with an iodine solution and counting the incidence of mutants. "Normal pollen grains stain black; mutants stain reddish brown," Dr. Sandhu said.

Like counting the number of pink events that occur in the stamen hairs of *Tradescantia*, counting the incidence of pollen mutants in corn is also time-consuming. EPA is trying to automate this process also.

Washington State University in Pullman is trying to develop a similar test with barley. "Also, barley looks promising for use in tests for chromosomal damage because its chromosomes are large and easy to view under a microscope," he said.

Arabidopsis, a tiny green plant with long, slender stems and flat, circular leaves that's a member of the mustard plant family, also shows promise for use in mutagen detection, particularly because of its size, short life-cycle and extreme versatility.

"*Arabidopsis* can grow anywhere at any time," Dr. Sandhu said. "It can grow in water, in a defined medium and a test tube, in greenhouses, or in fields—and it doesn't die in winter."

"Our goal is to develop a battery of mutagen-sensitive bioassays, including plants, for monitoring environmental quality," Dr. Sandhu said. "We need a battery of bioassays because no single test system can detect all of the chemicals that may be harmful to people."

"With a large battery of plants and other short-term detection tests monitoring the environment simultaneously," Dr. Sandhu said, "we can be more confident of the mutagen detection capabilities." □

Carolyn Worsley is a Public Information Assistant at EPA's Environmental Research Center at Research Triangle Park, N.C.

utility and Federal Government. Many people questioned the credibility of Metropolitan Edison and the NRC. The White House received several requests for an independent agency to be put in charge of monitoring and reporting radiation levels around Three Mile Island. Although EPA had been continuously monitoring the situation, the Agency's presence was masked because all information was funneled to the public through NRC and the State.

In response to those reports, on March 5, 1980, the White House expanded EPA's role by designating it the lead agency for reporting as well as coordinating the Federal monitoring program. Assistant Administrator Gage assigned Matt Bills, Associate Deputy Assistant Administrator, Office of Monitoring and Technical Support, to coordinate EPA activities and continued Erich Bretthauer as project manager.

Venting Krypton

The next phase of the cleanup was beginning. Several months after the accident, Metropolitan Edison applied to the NRC for permission to vent the radioactive gas that had accumulated inside the containment building. The gas, krypton 85, had to be removed before workers in protective gear could enter to assess the extent of damage to the reactor. Venting was set to begin June 28 and to continue until the krypton was removed. Local anti-nuclear groups petitioned the U.S. District Court of Appeals for an order to halt the venting until a public hearing could be held on the safety of the procedure, but the appeals court denied their petition.

The approved venting plan called for controlling the flow rate of krypton so that a person standing at the boundary of the nuclear power plant would be exposed to no more than 15 millirems of beta radiation to the skin. Federal authorities felt that dispersal and dilution of the radioactive gas would keep people in the area from experiencing untoward exposure, and EPA's monitoring system was set up to ensure that these safety standards were upheld.

The expanded responsibilities came as EPA was gearing up to deal with the venting operation. While the Agency had no direct control over the conduct of the venting, acting only as an observer and monitor, the surveillance plan called for round-the-clock sampling to keep a constant watch for any excessive levels of radiation. The Office of Research and Development brought in additional personnel to help with the monitoring and also borrowed staff from the Department of Energy and Public Health Service. The Agency opened the Middletown office at this time to provide a better base for scientists to work from and to give citizens improved access to information.

Tracking The Plume

On a large wall-map of the area surrounding Three Mile Island, EPA scientists plotted the trail of the krypton. The map is divided into 16 pie-shaped wedges radiating out from the power plant, with colored dots showing the location of permanent sampling sites. Other markers show the placement of the mobile sampling units, which were kept constantly informed of changes in the direction of the plume by radio contact.

The markers on the map represented two pick-up trucks and trailers bearing the EPA seal and the legend "EPA TMI Monitoring Team." Following the prevailing winds and directions from the Middletown office, a team of researchers would pull the trucks and their trailers off the road near a farm field or a ranch house. Soon the sound of generators and compressors would fill the air as the scientists forced air samples into containers that looked like yellow watermelons. The contents would later be tested for concentrations of krypton.

EPA's two teams were stationed on the east and west banks of the Susquehanna opposite the power plant. A monitoring team from the Nuclear Engineering Department at Pennsylvania State University took measurements at locations further out to provide an independent check of EPA's samples. The data obtained by Penn State researchers also served as an assurance that the krypton plume was dispersing as predicted and not touching in high concentrations at remote locations.

Establishing a Dialogue

Representatives from EPA and NRC met with many interested citizens in the TMI area to explain the responsibilities and actions of their agencies prior to the venting. In almost 40 meetings they sat down with elected officials, school boards, doctors, citizen groups, and anti-nuclear organizations. Matt Bills negotiated a meeting of TMI Alert members with officials of EPA, NRC, and the State. The group's staff director later wrote to EPA, "I do not know if anyone 'learned' from the meeting; it did prove that a dialogue can be held between us all. In the long run that may be the most important benefit of our efforts."

Local people were not just observers of the venting operation. The State trained some 40 volunteers to help with surveillance activities. They assisted in air sampling activities and collected data from sites around the area.

Senior citizens pitched in to help during the venting as well. Through the Senior Environment Employment program EPA supplemented its staff in Middletown with 13 retired people who helped with the monitoring, administrative, and information tasks.

The krypton venting continued rapidly without incident and was completed July 12. Company officials stated that the amount of krypton actually released was closer to 43,000 curies than the 57,000 they had first estimated.

Off-site readings of radiation were well below Federal safety standards throughout the venting. Analyses of EPA samples showed lower readings than originally expected. This was "probably due to the lesser amounts (of krypton) in the containment" than originally calculated, said project manager Bretthauer. He added, "We detected nothing in the environment except krypton 85."

EPA's conduct of the krypton monitoring system was praised by Middletown Mayor Robert G. Reed, who said the Agency "did an excellent job." He said that the presence of EPA staff and the citizen monitors "helped to relieve the frustration and stress as far as the townspeople were concerned."

With the end of the venting, the extra staff members have returned to their regular jobs and the EPA Middletown office is back on its regular schedule. Bretthauer wound up his tour as project manager and was replaced by Dr. Bill Kirk, a radiologist from ORD in Research Triangle Park, N.C. Before leaving, Bretthauer said, "The pattern we've established will continue, with slight changes in emphasis. The air monitoring will be less in the spotlight, water monitoring will become more important." The next major phase of TMI cleanup will be to filter and dispose of contaminated cooling water from the reactor.

Bill Kirk and Matt Bills have initiated a new series of meetings and briefings with people who live downstream of the power plant. When asked how long EPA would be involved at TMI, Bills said, "We've taken a 5-year lease on the building in Middletown. I expect we're in for a long haul. There's a great deal of work left to be done."

The long hours, the anxiety and the conflicts are over for the present. Most of the scientists, students and senior citizens have returned to their normal duties, each with the knowledge that their efforts have not gone unrecognized. A message from the White House, sent to them last July 4, declared:

"Your dedication and personal commitment in carrying out a sensitive and difficult task are appreciated by the President." □

Christine Perham is Assistant Editor of EPA Journal.

REGION 1

U.S.-Canadian Accord

Officials from the United States and Canada have signed an agreement which will permit construction to begin on an international sewage treatment facility. William R. Adams, Regional Administrator, and U.S. Senator Patrick Leahy were among the U.S. officials present at the signing of the intermunicipal/international agreement between Derby Line, Vt. and Rock Island, Quebec (which were previously united before the U.S.-Canadian boundary was drawn).

Since the two communities shared a water system and it was more economical to enlarge a single facility than constructing two, it seemed only logical and more efficient for Derby Line to tie into the Rock Island facility and share the costs of cleaning up the river.

The total project cost is $1,500,000. The Rock Island plant will be upgraded and expanded to accommodate the additional flow and accomplish the phosphorus removal. Derby Line will construct about 9,700 feet of sewer lines and related structures to transport the domestic and industrial waste across the border.

REGION 2

Approval Given

Region 2 has approved an application by the Consolidated Edison Company to burn higher sulfur oil in three of its New York City boilers for one year. The fuel oil will have a maximum sulfur content of 1.5 percent; current air pollution control regulations in New York City limit fuel to no more than 0.3 percent sulfur. However, one condition of EPA's approval is that Con Edison convert several major consumers of fuel oil to natural gas to avoid clean air violations.

Con Edison has described its proposed use of higher sulfur fuel as a test to demonstrate that the utility could burn coal in the same three units without violating clean air standards. But EPA Regional Administrator Charles Warren made it clear that the Agency's approval covers only the one-year test burn. "Any future proposal to convert these units to coal will be subject to thorough review under city, State and Federal air pollution regulations."

"We have just completed a decade of hard-won progress toward clean air in the New York metropolitan area," said Warren. "EPA does not intend to jeopardize that progress by allowing coal conversions that will increase emissions of pollutants and violate clean air standards."

REGION 3

Chemical Cleanup

Neville Chemical Company, located on Neville Island in Allegheny County, Pa., and the Pennsylvania Department of Environmental Resources recently signed a consent decree that requires the firm to clean up its site.

Equipment, storage-capacity, and operating problems in its plant have resulted in the firm's contaminating groundwater and discharging inadequately-treated wastewater into the Ohio River.

The decree, which climaxes nine months of intensive negotiations between Neville and the Department, details a timetable for the company to follow to bring it into compliance with State and Federal regulations by December 31, 1984.

Under the agreement, Neville agreed to institute a comprehensive clean-up plan, reclaim contaminated groundwater on its site, minimize infiltration, reseed the area, install a dry groundwater monitoring well to collect the infiltration plus a detention basin as a fail-safe mechanism for its cooling waters, and post a $200,000 letter of credit to guarantee its obligations under the decree.

REGION 4

Public Hearing

A public hearing scheduled for this month will give south Florida citizens an opportunity to express their concerns about a controversial landfill operated by the city of North Miami. Such a hearing is provided for in the Clean Water Act.

Regional Administrator Rebecca W. Hanmer will act as the hearing officer.

The 291-acre tract to be discussed includes 103 acres of wetlands and lies just west of Biscayne Bay, which has been designated an Aquatic Preserve by the State of Florida.

The facility was permitted in 1976 to accept clean fill material only. Later, the city sought to modify its permit and convert the site to a sanitary landfill where garbage could be deposited. The EPA opposes issuance of the new permit, citing environmental damage already occurring to mangrove wetland areas and Biscayne Bay.

Leachate samples taken by the Dade County Department of Environmental Resources Management show lakes in the landfill area to be grossly contaminated. One lake had an ammonia concentration in excess of 500 parts per million.

Several million cubic yards of solid waste, including garbage, have been placed at the site since the original permit was issued four years ago. Eventually, the city intends to use the filled area as a public recreation facility which would include two 18-hole golf courses.

REGION 5

PCB Complaints

An administrative law judge in Chicago issued a ruling recently that assessed $35,000 in civil penalties against Briggs and Stratton Corporation of Milwaukee, Wis., for improper handling, labeling and storage of polychlorinated biphenyls (PCB's). The suit was the first of eight such complaints filed so far by Region 5 against firms for violations of regulations governing the manufacture, sale, use and disposal of PCB's.

Regional Administrator John McGuire said EPA is considering similar PCB complaints against 36 other Midwestern companies. "PCB compliance is a major priority in Region 5, and we are tackling it by significantly increasing the number of our plant inspections," McGuire said.

REGION 6

Containment Complete

The Coast Guard recently announced the completion of containment efforts, as authorized by Section 311, at the Motco hazardous waste disposal site in LaMarque, Texas. PCB's, benzene and other hazardous substances have been found on the site. From time to time they have overflowed or seeped into nearby ditches. They also posed a danger to groundwater. The Motco site was vis-

ited last January by Deputy Administrator Barbara Blum, Regional Administrator Adlene Harrison, and other Federal officials. The visit drew widespread media coverage and focused attention on the threat posed by abandoned sites to public health and safety.

Toxics Removed

The Sabine River Authority has removed 15 drums of chemicals including 2-4-5-T and 2-4-D from a disposal pit located 300 yards from a lake that provides 20 percent of the water supply for Dallas and its suburbs.

Sabine claims that current and former employees used the chemicals at Lake Tawakoni from 1972 to 1977 as part of a vegetation control program, and that they buried the chemicals in 1978.

Tests by the Texas Department of Health showed no dangerous levels of dioxin, which is found in 2-4-5-T. Sabine is conducting further tests of the soil samples to ensure that there is no further contamination at the site. In addition, EPA has asked Sabine to supply complete records on all herbicides and insecticides purchased and used by the authority since 1970.

Waste Removal

Syntex Agribusiness, Inc., and the EPA have agreed on a program to assure removal and safe disposal of hazardous waste buried at a farm site in Barry County, Mo., nine years ago. The wastes were generated by the now defunct North Eastern Pharmaceutical and Chemical Company.

Syntex denied knowledge of or responsibility for any acts of the chemical company, pointing out that it never generated or handled the wastes. However, company officials said they were willing to work with the EPA in order to facilitate prompt remedial measures at the site and to help safeguard public health, while at the same time removing a source of possible anxiety and uncertainty in the surrounding community.

After an inspection of the site, EPA Administrator Douglas Costle said Syntex is to be commended for its responsible and constructive actions.

Earlier, the Justice Department had filed suit against the chemical company, both its president and vice president, and Syntex following discovery of drums of hazardous waste material including dioxin, one of the most toxic man-made chemicals ever synthesized.

Since that discovery, EPA and the Missouri Department of Natural Resources have conducted weekly sampling of wells and water in the vicinity of the farm site. This is being done as a precautionary measure to make sure that no toxic wastes work their way down to the ground water. The sampling so far has revealed no contamination and will continue until the hazardous materials are removed.

Settlement Reached

With the mid-August signing of a consent decree, a settlement has been reached in Region 8's first case under the Resource Conservation and Recovery Act's uncontrolled hazardous waste site program.

In June 1980, at EPA's request, the Department of Justice brought charges against American Ecological Recycle Research Corporation, a chemical reclamation and storage facility, citing the company's improper storage of possibly highly toxic and flammable chemicals.

The agreement calls for a plan for fire protection, security fencing, inventory and analysis of chemicals at the site and a plan for continued operation or closure.

EPA became involved in the investigation of the company after a chemical fire broke out at its Jefferson County, Colorado, facility in October 1979. The fire resulted in numerous firefighters being temporarily hospitalized with suspected cyanide poisoning. Because of the number of hazardous chemicals stored at the facility, Region 8's Emergency Response Team was called in at the request of Jefferson County to conduct an on-site inspection.

PCB Precautions Announced

The Pacific Gas and Electric Company has announced that it will accelerate its replacement of the 120,000 PCB-containing capacitors in its system. P G & E will also install special protective fuses on PCB capacitors to minimize the chances of blow-outs.

Until now the company only replaced capacitors as they failed. P G & E, which serves nine million people in northern California, estimates that it will take two to three years and $50 million to complete its new replacement program, provided manufacturers can turn out the required number of non-PCB replacement units.

This past July P G & E was fined $12,000 by EPA for five PCB spills. As a part of a consent agreement signed with the Agency, the company agreed to certain conditions to help protect public health and the environment in the event of future spills.

Boise Extension

Region 10 has proposed that the Greater Boise area be given until 1987 to meet Federal ambient air quality standards for carbon monoxide. The proposed extension would give the Boise area the time it needs to realize the benefits of a mandatory auto emission inspection program and other new air pollution control measures.

Approval of the extension would be tantamount to giving developers the final go-ahead to proceed with construction of a 3,000-car downtown Boise parking garage and adjacent shopping center with more than 750,000 square feet of retail floor space. The auto inspections and other new control measures would provide enough air pollution reduction to offset the carbon monoxide likely to be generated by traffic drawn to the complex. □

States Served by EPA Regions

Region 1 (Boston)
Connecticut Maine Massachusetts New Hampshire Rhode Island, Vermont
617-223 7210

Region 2 (New York City)
New Jersey New York Puerto Rico Virgin Islands
212 264 2525

Region 3 (Philadelphia)
Delaware, Maryland, Pennsylvania Virginia West Virginia District of Columbia
215-597 9814

Region 4 (Atlanta)
Alabama Georgia Florida Mississippi, North Carolina, South Carolina Tennessee Kentucky
404-881 4727

Region 5 (Chicago)
Illinois Indiana Ohio Michigan Wisconsin Minnesota
312 353 2000

Region 6 (Dallas)
Arkansas Louisiana Oklahoma Texas New Mexico
214 767 2600

Region 7 (Kansas City)
Iowa Kansas Missouri Nebraska
816-374-5493

Region 8 (Denver)
Colorado Utah, Wyoming, Montana North Dakota South Dakota
303-837-3895

Region 9 (San Francisco)
Arizona California Nevada, Hawaii
415 556 2320

Region 10 (Seattle)
Alaska, Idaho Oregon Washington
206 442 1220

The Hidden Cost of Soft Energy

By A. David Rossin

Wind turbine at Boone, N.C. generates 2,000 kilowatts for local power grid.

One of the greatest threats posed by our energy problems is that they will lead to greater concentrations of political power and more centralized control over people's lives. Hence the concept of *decentralized* energy is very exciting.

Unfortunately, the proponents of decentralized energy production (the "soft" path) offer a road map that would most likely lead to what they abhor—a society of centralized control. Their road map calls for commitments to phase out conventional methods of supplying electric energy to homes, factories, offices, and farms. The soft path offers instead an array of alternative energy sources, such as solar and wind power, that are said to be benign, environmentally desirable, close to the people, and well-suited to local control by individuals or communities. Some of these alternatives may prove viable, but, according to many of the most vocal proponents of the "soft" path, a crucial part of the strategy is the decreased reliance on transmission lines and power plants, particularly nuclear power plants.

The part of the soft path that is seldom discussed is what might happen if the capability to supply electricity begins to fall short of what people need. If there is not enough to go around, somebody will have to set priorities; and in this event, priorities would not be set by individuals, but by government—big, centralized government. The real question is whether it is desirable to pursue the decentralization of sources of energy as an absolute goal or to permit the diversity we have now in which anyone who wishes to can use decentralized alternatives. Without sufficient, reliable, centralized electricity, the individual no longer has that choice: the one we take for granted today.

This is not to argue that centralized control is inevitable. But the soft path strategy carries with it the real risk of centralized control of personal decisions. If a free society is to choose to pursue a decentralized energy structure, it should do so only with full knowedge of all the potential consequences.

Examining the Soft Path

The problem is that the soft path just might not lead where its proponents claim. There is a serious lack of data on the cost and performance of solar, wind, wood-burning, and other soft-path options, especially on a broad enough scale to show how following this path might affect the need for more electric power plants. Indeed decentralized energy systems are generally discussed in the abstract. Alternatives, almost by definition, are said to be better than what works today. Yet we know little about just how decentralized solar or wind systems would work in cities, large towns, or other locations where they might be called upon to serve large numbers of people. We do not know the environmental impacts, the costs, or the resources required.

Yet despite this lack of knowedge about the consequences of following the soft path, the advocates of decentralized energy production are more than willing to do away with the kinds of centralized power sources that supply electricity in the U.S. today. One of the foremost proponents of decentralized energy options, Amory Lovins, says in his book *Soft Energy Paths: Toward a Durable Peace:* "If nuclear power were clean, safe, economic, assured of ample fuel, and socially benign *per se*, it would be unattractive because of the kind of energy economy it would lock us into." He explains further that it is undesirable because it is centralized, big, controlled by corporations, and requires large amounts of capital. And despite the fact that the soft energy path leads at best through uncharted territory, Lovins is uncompromising. He states that society must choose, apparently once and for all, between the soft path and the kind of centralized systems that supply people's needs today. Moreover, Lovins claims that society must make this choice immediately. As he sees it, additional commitments to centralized systems will make it increasingly difficult to develop soft technologies and have them emerge successfully. He fears that commitments of capital to the conventional systems as we now know them will leave too little for the soft technologies. He proposes that further investment in power plants and transmission lines be prohibited, so that movement along the soft path would be assured. This is the Lovins strategy: block centralized power to force the soft path.

Making the soft path inevitable would not make it inexpensive; despite claims of favorable economics, very few people have chosen to take it. Not only does the energy look expensive compared to what is available, but the capital an individual or community needs to put up is large for what one gets. The soft path would require two to three times the capital that coal and nuclear would, even if it could be phased in gradually with no surprises. All that capital has to come from somewhere. Furthermore, it is far more difficult for individuals to raise capital than it is for large institutions. The cost of money (interest rates) would be higher and the cost of the facilities themselves would be higher.

Most people just aren't interested, if left to free choices. Decentralized energy will require subsidies, complete with Federal guidelines, inspection, enforcement, and, of course, taxes to raise the money.

If the soft energy path does require substantial subsidies, in a democratic society the representatives of the people would have to vote for them. Taxpayers are also

voters, and subsidies would be difficult to sell if more economical and understandable alternatives were available.

In Lovins' words, unless capital, manpower, and expertise are diverted to alternative forms of energy, "the soft path becomes hostage to the hard path." What he means is that decentralized energy will only become the way of life if conventional sources of energy are effectively banned for the long-term future. That's the theory anyway. His failure even to mention the potential risks of the soft energy path, however, raises questions about the credibility of both the concept and its promoters.

The fact of the matter is that alternative energy systems can be built today by those who wish to. Robert Redford has a solar house and Congressman Henry Reuss has a windmill. We have diversity, and if an idea is successful, others can try it. But not everybody wants to!

I would argue, Lovins' opinions notwithstanding, that the energy economy that we might be "locked into" if we further expand nuclear power and other centralized forms of energy production is one of diversity and freedom of choice—including the choice of alternative forms of energy. This kind of energy economy would be characterized, as is today's energy production system, by organizations, both publicly and privately owned, that are *legally obligated* to supply electricity to those who wish it for all or part of their needs, whether they have solar panels, windmills, or not.

Decentralization as a Philosophy

The other part of Lovins' strategy, seldom examined by the public, is revealed in the following quotation from *Soft Energy Paths:* "Many who work on energy policy and in other fields have come to believe that in this time of change, energy—pervasive, symbolic, strategically central to our way of life—offers the best integrating principle for the wider shifts of policy and perception that we are groping toward." The soft energy path, it seems, involves more than merely changing the way in which energy is produced. It entails, Lovins suggests, "wider shifts of policy and perception"—in short, new concepts not only of energy use, but of society, something like a whole new philosophy for society.

If the debate is about the philosophy (indeed, the ideology) of individual self-sufficiency, rather than costs, risks, and benefits, it is appropriate to explore the concepts of decentralization and self-sufficiency themselves. Like other general approaches, decentralization and self-sufficiency are not universally beneficial. How many Americans, for example, would desire to return to a decentralized system for providing their drinking water? What about sewage treatment? Although few Americans remember it, as recently as 100 years ago some major American cities were without centralized water and sewage systems. The massive effort necessary to create these systems has resulted in incalculable benefits to society, wiping out some of America's most common and deadly diseases. One can hardly conceive of public health authorities, let alone the average person, taking even the slightest chance of a resurgence of typhoid, cholera, and dysentery in order to satisfy a philosophical objective.

Furthermore, the promoters of the soft path admit that it would take time to move from a centralized system for producing energy to a decentralized energy society. In the transition period, which is generally conceded to be several decades, the centralized system must be kept around. Almost every residence would require central electricity to back up the solar systems or windmills, and to supply electricity when the sun isn't shining or the wind isn't blowing or when the motors, pumps, or seals need repair and the neighborhood fix-it person can't come. There would still be electric motors, electronic equipment, and electric lights for which no alternate source is available. In New York, Chicago, and other cities where people live in apartments and large commercial buildings are common, the central system would still have to carry most of the load. Moreover, central electric supply would also be essential to supply the tremendous energy needs of the huge industry that would have to be brought into being to manufacture the solar devices and other equipment necessary to make the transition to a soft energy society.

Advocates of decentralization are hard pressed to tell us just how long this transition period will be or just how many more power plants will be necessary to meet people's continuing needs before the transition can be achieved. And how complete must the transition be in order to satisfy its proponents? Power plants and electric grids might just still be needed for industry, commerce, communications, and the offices of the bureaucracy.

The interesting point is that by doing the job their charters of today require, utilities make it possible for *decentralized decision-making* to take place at all levels of the society. Here are the real options for the future:

- A centralized electricity supply which provides enough energy for people to use if they choose and thus permits *decentralized decision-making*, or
- Abandonment or curtailment of centralized energy supply in the hope that decentralized energy will meet expectations, but with the risk of *centralized decision-making*, allocation of energy by government and curtailment of individual freedom.

Toward Energy Policy

When the concept of energy decentralization is discussed, what is it we should really be concerned about? What are the risks if the promises fail? Certainly, some kind of energy rationing, and the centralized government control that rationing implies, would become real possibilities. Under such a system, the threat or reality of acute energy shortages around the country would discourage the individual entrepreneur and curtail individual freedom of choice.

In addition, the restriction of energy supplies could well result in a serious risk of loss of economic growth. Growth has environmental impacts—these are fairly well known—but lack of growth also has impacts on the environment. The risks that accompany *both* need to be studied carefully and discussed openly, along with the risks that a particular energy policy might push things one way or the other. The environmental impact statement for the soft energy path should be published widely. Then the public will be able to rationally evaluate the risks of a failure to have enough power plants.

Which risk is to be most feared: the network of transmission lines and centralized electric power plants that are commonplace today, or the possibility of centralized control of how each corporation, group, and person uses electricity? A policy or a philosophy that promises to solve energy problems by curtailing centralized power generating systems turns out to be bankrupt on close examination.

Proponents of the soft energy path envision not only an energy system, but a way of life in which large power plants—especialy nuclear plants—have no place; and perhaps the fact that the soft energy path is as much a philosophy as a platform of policies helps explain the intense polarization that currently marks the nuclear debate. What the advocates of the soft energy path neglect to point out is that without centralized power plants, including nuclear power plants, the threat of energy allocation grows. And the allocation of energy may well mean not decentralization, but infringement on individual freedom and the ultimate in centralized control of people's lives. □

A. David Rossin is the System Nuclear Research Engineer for Commonwealth Edison, Chicago, Ill. The article was excerpted from one which appeared in the June, 1980, Futurist, a publication of the World Future Society.

Update

A review of recent major EPA activities and developments in the pollution control program areas.

AIR

Special Messages

As part of a penalty for violating Clean Air Act regulations, one of the Nation's largest oil refiners will soon begin publicizing messages to educate the public about the problems with fuel switching, the EPA announced recently.

American Petrofina of Texas, fined $107,074 for adding too much lead to its gasoline at its Port Arthur, Texas, refinery during the October-December 1979 quarter in violation of EPA regulations, has agreed to spend $35,000 of that amount to carry out a public information program.

EPA said the refiner will place ads in newspapers and on two separate occasions mail brochures to its credit card holders (approximately 170,000 people) to help spread the word about problems of fuel switching (using leaded fuel in vehicles that require unleaded).

Final Rules

The EPA announced recently that it is issuing final rules for recovering the costs a company avoids by not complying with air pollution laws.

While the majority of the country's 24,000 major sources of air pollution are in compliance with State and Federal air laws, many are not, an Agency spokesman said. Sources violating the law by failing to install and operate necessary pollution control devices have long enjoyed an economic advantage over those who did what the law required.

The new rules, however, will allow EPA to assess and collect administrative penalties equal to the economic savings a firm enjoys by not complying with the law. These penalties, which will not be assessed prior to January 1, 1981, would be in addition to any other payments, sanctions or requirements under the Clean Air Act. The program would not affect or be affected by any civil or criminal proceedings brought under any other provision of the Act, or State or local law.

Monoxide Standards

The EPA recently proposed, after an extensive health-effects review, to retain the existing eight-hour atmospheric air pollution standard for carbon monoxide and tighten the one-hour standard.

The proposed one-hour standard would be changed from 35 parts per million (ppm) to 25 ppm, reflecting new health data showing increased short-term protection is needed for persons with heart ailments, especially those engaged in moderate physical exertion such as walking.

Agency officials say they don't expect the tightening of the one-hour atmospheric standard to result in the need for more stringent emission controls on motor vehicles. Controls currently in use that have been effective in attaining the eight-hour standard should also be sufficient for meeting the proposed one-hour limit.

New scientific health data show that EPA's original long-term eight-hour public health standard, set in 1971 at 9 ppm, remains valid.

Rules Modification

As a result of a Federal court decision, the EPA will be issuing modified air pollution control regulations requiring preconstruction review of new and modified industrial plants in both dirty and clean air sections of the country.

The new rules require review of new plants prior to construction, or existing plants prior to modification, to make sure that when built their emissions won't significantly deteriorate clean or make dirty air even worse.

The Court's decision also made several major changes including the criteria for determining which new or modified plants are subject to regulation. For example, fewer new plants will have to be reviewed, while on the other hand, existing plants in dirty air areas will continue to operate under regulations that subject major changes to regulatory review.

ENFORCEMENT

Suit Filed

The Department of Justice on behalf of EPA has filed a suit seeking the cleanup of two hazardous waste dumps near Baton Rouge, La., and an end to illegal toxic discharges from these dumps. The two dumps, known as the Brooklawn and Scenic Highway sites, are located in East Baton Rouge Parish, about five miles north of Baton Rouge. The Brooklawn site still receives wastes but the Scenic Highway dump stopped operating in 1974.

Named as defendants in the suit are Petro Processors of Louisiana, Inc., operator of the sites, and numerous firms that generated the hazardous waste disposed of at the sites, including U.S. Chemical Co., Dow Chemical Co., Ethyl Corp., Uniroyal Corp., Shell Chemical Co., Exxon Chemical Corp. (Exxon Corp.), Allied Chemical Corp., Rubicon Chemical Corp., Copolymer Rubber and Chemical Corp., and American Hoechst Corp.

This is the first case in which the Agency has named generators of the hazardous waste as defendants, according to Barbara Blum, EPA Deputy Administrator.

Volkswagen Recall

The EPA announced recently that Volkswagen of America will voluntarily recall approximately 100,000 1975 and 1976 Rabbit and Scirocco automobiles to correct an exhaust emission problem. The Rabbits and Sciroccos affected by the recall are 1975 models with manual transmissions and 1976 models with manual and automatic transmissions. The subcompacts were previously repaired by the company for emission equipment problems, but tests show the problem still exists. The cars were originally equipped with catalytic converters, but when the converters began breaking internally or melting during normal driving use, they were removed and certain engine modifications were made to keep the cars in compliance with Federal emission standards.

Emission tests conducted by EPA and Volkswagen on the modified vehicles show that they are more likely to exceed the standards than the original catalyst-equipped models. The test data also indicate that the excessive emissions are, to a large extent, due to maladjustment of the carburetor, choke and other engine parts that affect the performance of the emission control system.

Waivers Granted

The EPA has granted General Motors a one-year waiver of the statutory 1981 carbon monoxide auto emission standard for its 1.6 liter engine Chevette, while at the same time denying a waiver request of the standard for a 6.0 liter modulated displacement engine planned for the Cadillac line for 1981.

The Agency believes this additional time will allow the manufacturer to develop technological improvements which will enable the Chevette to meet the standard for the 1982 model year. Technical and statistical analysis of the Cadillac engine, however, predict that it is capable of meeting the carbon monoxide emission standard and, therefore, does not meet the criteria for receiving a waiver.

In other action, the Agency also granted a waiver of the 3.4 gram per mile carbon monoxide emission standard to Ford Motor Company for about 30,000 of the company's 1981 cars. The cars involved, some Ford Mustangs and Fairmonts, and some Mercury Zephyrs and Capris, use the 2.3 liter turbocharged engine.

Ford petitioned the Agency to approve a waiver because available emission data indicated that these 1981 model cars with turbocharged

engines would not meet the tighter Federal carbon monoxide standard scheduled to take effect in 1981. The Agency was also concerned that Ford would suffer a significant loss of sales were the 2.3 liter turbocharged engine not available.

This action is expected to have a minimal environmental effect.

HAZARDOUS WASTE

Support Asked

EPA Administrator Douglas M. Costle has asked the Nation's governors to support establishment of new, safe hazardous waste disposal sites in their States.

Earlier this year, EPA issued regulations to track the millions of tons of toxic, caustic, explosive and other dangerous wastes created by industry each year. These rules, issued under the Resource Conservation and Recovery Act, also call for the disposal of these wastes in an environmentally sound manner.

"We estimate there will be a need for from 50 to 125 new . . . hazardous waste management facilities over the next several years," Costle noted. "About 60 percent of these facilities are expected to be treatment facilities, with the rest divided between landfills and incinerators. Our preliminary analyses also indicate that the greatest capacity shortages will be felt in the Northeast, Southeast and Midwest, with the most serious shortages likely to occur in the Southeast."

A major concern now becomes how to assure that sufficient capacity will be created to safely treat, store and dispose of the hazardous wastes, Costle explained to the governors in a letter. "Intense opposition of the local public" is the principal difficulty in creating new disposal sites, according to an EPA paper that accompanied the letter.

PESTICIDES

Investigation Slated

The EPA says it will investigate the benefits and risks of captan, a fungicide used on many food crops, because of a possible risk of cancer and other adverse health effects to consumers and farmworkers.

The Agency said it has evidence suggesting that captan causes not only cancer but also mutagenic effects on test animals.

The diet of the general population is exposed to captan because the fungicide is used, by itself or in combination with insecticides, on a wide variety of fruits and vegetables such as apples, cantaloupes, beans, beets, and cauliflower. Captan is also used as a fungicide on seeds, in home lawns and gardens, and in pharmaceuticals, oil-based paints, lacquers, paper and other commercial products.

In addition, the Agency said agricultural workers are exposed to much greater amounts of captan than consumers when they are present in fields during or after spraying.

Withdrawal Approved

The EPA has accepted a request from Rohm and Haas Company of Philadelphia to withdraw from the market the sale of perthane, a chemical previously produced and used as an insecticide. This action will allow Rohm and Haas to sell only existing stocks of perthane for one year. After that, the company won't be permitted to make further sales of the product.

Although scientific information on the effects of perthane is incomplete, studies suggest that perthane may cause cancer in experimental animals. Rohm and Haas is the sole producer of perthane, although there are many companies which formulate the Rhom and Haas material under various labels.

Rohm and Haas has not produced the product since 1978 because of a decline in demand.

RESEARCH

Research Grants

The EPA recently gave 17 awards totaling $1.6 million to universities and colleges across the country. The grants, authorized under the Agency's new peer review program, represent many areas of innovative research into environmental problems.

Major areas of emphasis are in health research, environmental biology and chemistry and physics. Many of the awards in this group are in the area of chemical threats to human health and the environment.

These grants are part of EPA's $17.8 million competitive research grants program for fiscal year 1980. Additional results will be announced later this year.

Approximately 20 percent of the applications submitted were funded. Awards range in size from $44,075 for the study of the impacts of ocean drilling fluids on the critical life stages of animals living on the bottom of oceans or lakes to $265,137 for the study of human pulmonary responses to particles and gases. The average project period is 2 years.

EPA also has awarded a $367,409 contract to the University of North Carolina to conduct a three-year study on the effect of several types of air pollutants on human cells. The critical study, using volunteers, will be conducted at EPA's Human Exposure Laboratory in Chapel Hill, N.C.

The study will involve assessing the effects of air pollution on the epithelium, the layer of cells that cover the skin surfaces, forms glands, and lines cavities of the human body. Researchers will also be studying lymphocytes, types of white blood cells which help recognize and destroy foreign substances in the body.

The contract was awarded by EPA's Health Effects Research Laboratory in Research Triangle Park, N.C., which will be responsible for monitoring the study.

New Publication

Research Highlights 1979 is the title of a new publication recently issued by the EPA which offers a comprehensive review of major environmental research advances. Topics covered include: toxics, health effects, hazardous waste, wastewater, clean air monitoring and the Chesapeake Bay.

An index of references is also included.

For copies, contact the Center for Environmental Research Information, U.S. EPA, Cincinnati, Ohio 45268 or call (513) 654-7562. The title and order number is *Research Highlights 1979*, EPA 600/9-80-005.

TOXICS

Workshop Held

The EPA and the Consumer Product Safety Commission recently held a three-day workshop to collect information on substitutes for asbestos. Participants represented industry, government, universities, labor and environmental groups among others.

Asbestos, a known cancer-causing agent, is currently used in several thousand commercial, industrial, and consumer products, ranging from automobile brake linings to building materials. EPA and the Consumer Product Safety Commission are considering regulating the uses of asbestos in these products.

The purpose of the workshop was to gather technical and health-related data on substitutes for the products.

WATER

Construction Grants

A total of $400 million in grant money will be provided by the EPA to 29 States and Puerto Rico to help them build sewage treatment plants. The release was authorized by a supplemental appropriation for fiscal 1980 signed by the President on July 8. The money will be distributed according to a plan developed earlier by EPA, which calls for the funds to go first to States with "immediate needs."

This sewage treatment program is a multibillion dollar government effort that pays for up to 75 percent of the cost of building new plants or improving existing ones to help control water pollution.

The States slated to receive the largest shares of the money are: California—$150,082,000; Pennsylvania—$28,669,000; Washington—$24,118,000; Wisconsin—$20,630,000; and Florida—$19,940,000. □

Electric Autos and Clean Air

By Charlotte Garvey

Top: Electric vehicle, built for the Department of Energy by General Electric, can reach a passing speed of 60 miles per hour. Above: A Detroit Electric vehicle, during a test run in 1918 from Seattle, Wash., to Mount Rainier.

If electric cars continue to develop technologically and grow in popularity, the total air pollutant burden of unburned hydrocarbons, carbon monoxide, and nitrogen oxides could decrease, according to recent laboratory studies.

The Argonne National Laboratory, under a Department of Energy grant, has analyzed the potential environmental effects of electric vehicles (EVs) and estimated their impact if the cars become a significant part of U.S. transportation. Congress' Office of Technology Assessment also has contracted with the General Research Corporation of Santa Barbara, Calif., to study the technological impact of electric vehicles, including their effects on the environment.

The Environmental Protection Agency is carefully watching the development of these cars, because they could present EPA with a number of regulatory responsibilities. Administrator Douglas M. Costle and Dr. Richard M. Dowd, staff director of EPA's Science Advisory Board, have met with John S. Makulowich, Electric Vehicle Council executive director, to explore further the possibility of EPA involvement in electric vehicle development as it graduates from glorified golf cart to a viable, popular means of transportation. Among concerns of officials is the environmental impact these battery-powered cars may have, and the possible environmental benefit in cities.

Argonne Laboratory's study, *Assessment of Environmental Impacts of Electric and Hybrid Vehicles in the Near Term*, presented at the Electric Vehicle Expo 80 in St. Louis in May, used five different hypothetical scenarios projecting different levels of market penetration by these vehicles for 1985, 1990, and 2000. For the year 2000, these levels ranged from a low of three million electrics on the road to a high of 24 million. Projections based on the DOE electric vehicle program currently in progress indicate that just under 100,000 would be on the road by the beginning of 1987.

Pollutants from Recharging

A majority of Argonne's findings indicate that more environmental damage would probably result from manufacture of electric vehicles and their batteries rather than actual operation of the vehicles themselves.

The batteries do release emissions when being recharged, although preliminary studies indicate these are low-level. Nickel-iron batteries, for example, appear to emit hydrogen gas upon recharging and possibly during operation. Charging lead-acid batteries generates the toxic gas stibine, which could, at certain exposure levels, result in a breakdown of the blood, severe gastro-intestinal distress, and eventual death.

Argonne has found, however, that exposure to stibine during recharging is at a very low level and poses no health threat to vehicle operators if the vehicle is recharged in a well-ventilated area. These findings also show a similar low-risk threat for workers manufacturing lead-acid batteries.

Sulfur dioxide output, caused by coal-burning to produce and recharge batteries, will increase, but studies indicate no net change in the air quality of any urban or rural area will result, and no relative difference in total suspended particulate loading is expected.

"Particulates from the cars themselves are basically zero," says Lynn Andrews, staff engineer for the Electric Vehicle Council. The reason no net change in air quality would occur is because emissions from power plants providing energy for battery manufacture would make up for the lack of emissions from electrics. Andrews said, however, that the particulates emitted from the plants would differ from those emitted by conventional vehicles.

Purdue University's Institute for Interdisciplinary Engineering Studies, which is investigating a number of questions about EVs, has done some preliminary studies of changes in total projected emission levels of electric power plants that would result from battery manufacture. Dr. Gene Goodson said that several factors make these levels difficult to estimate.

The main problem, he said, is that electric power plants can be powered by coal, nuclear power, or oil, all emitting different kinds and different levels of particulates. Goodson said it also is difficult to project an accurate overall total emission level because they change at different times of day.

Argonne findings indicate that the gradual influx of electric vehicles into the manufacturing mainstream will not significantly hurt water quality on a national level, but that locally significant increased discharges of lead, nitrates, sulfur compounds, and potassium chloride into fresh water supplies will result from battery and vehicle manufacture.

Solid waste residues resulting from manufacture and operation could increase, and are likely to center around major metal and coal production areas and near coal-burning power plants, the study says.

Protecting Workers

Argonne estimates that although workers will be exposed to hazardous and toxic materials, levels through January 1, 1987 will not exceed .002 percent of 1975 emission levels.

The lab has determined that several areas of potential hazard to workers need further investigation: exposure to toxic and carcinogenic materials during battery manufacture; exposure to burns, explosions and toxics resulting from structural failure and electrolyte spillage in large-scale battery disposal and recycling operations; and exposure to toxic vapors from petrochemical processes in production of vehicle bodies.

One problem with Argonne's findings is that projections are based on a fairly low EV market penetration level, because the study was conducted before a number of recent breakthroughs in battery technology were announced. As a result, estimations of environmental impact may also be conservative. Electric Vehicle Council's John S. Makulowich said the model used by Argonne is a feasible one theoretically, "but in practice, things are moving much faster."

The General Research Corporation has come up with findings very similar to Argonne's projections, and these findings were published in McGraw Hill's *Electric Automobiles*.

Electric vehicles compare quite favorably with conventional vehicles, according to General Research's Bill Hamilton, "but they're not a cure-all."

He said their findings project a very modest effect on air quality, and in some areas, EVs could offer actual improvement. "The biggest improvement we could foresee was that total urban carbon monoxide levels could decrease," Hamilton said, if the vehicles successfully enter the market and begin to replace the polluting conventional cars.

The corporation also found that any emissions from the car or battery, even during recharging, were negligible. Hamilton predicted that the batteries are unlikely to present a waste problem due to disposal difficulties.

The batteries will almost certainly be recycled. You can't throw them away, because they are so heavy, some weighing over 1,000 pounds. "They also contain a lot of valuable material and electrical equipment you would probably want to hang on to," he said.

Lower Noise Levels

Research General's projections also indicate the vehicles could lessen the noise pollution burden now presented by conventional vehicles. Traffic noise, says Hamilton, has been found to be the worst noise problem for urban areas, and electric vehicles are nearly silent.

An EPA regulatory role that has been established in the electric vehicle area is fuel economy measurement. In July EPA published in the Federal Register an amendment to its fuel economy program establishing procedures for manufacturers to incorporate electric vehicles into the Corporate Average Fuel Economy (CAFE) program, which requires manufacturers' average fleet miles per gallon level to reach 27.5 mpg by 1985.

The EPA amendment does not, however, set up the methods to measure electric vehicle fuel economy equivalent to those used to measure petroleum-powered vehicles' fuel economy. This responsibility belongs to the Department of Energy. DOE is now reviewing comments received on proposed regulations, published in May, setting up these methods. Final regulations are expected in early November.

Ironically, electric vehicles could eventually end up representing a false savings in terms of fuel consumption due to the very legislation that gave electric vehicle production its big commercial boost.

Public Law 96-185—better known as the Chrysler "bailout" bill—contained a rider sponsored by Sen. James A. McClure (R-Idaho) allowing car manufacturers to include electric vehicles in their overall performance figures for Corporate Average Fuel Economy ratings by EPA.

The end result could be that not only electric car research and production will be stimulated, but so might production of bigger, more profitable, fuel-inefficient cars. Because electric vehicles require no gasoline for fuel, they balance out poor mileage performances by gas guzzlers. Thus the petroleum conserving purpose of electric production could possibly be defeated.

Argonne determinations indicate electric cars will represent so small a percentage of the American driving fleet that no real damage will be done, based on an estimated 1987 on-road total of 100,000 electrics. (This number represents about .066 percent of projected total highway vehicles stock in 1987.)

But due to technological breakthroughs, General Motors recently announced plans to achieve a 100,000-car yearly production level for electric models by 1985, and GM is only one of several companies with plans for future electric vehicle production, although at present no others plan such large-scale production.

So the real impact of the legislation on fuel economy for now is unknown.

Also, it isn't as though the energy produced by the batteries comes from nowhere. The system needs electricity to provide power for the batteries; this energy comes from power plants dependent on fossil fuels or nuclear power. Their advantage, however, is that many power plants are in remote areas and do not impact urban pollution the way conventional autos do. Emissions from the power plants would also be above ground-level where conventional cars pollute.

Federal Encouragement

In the meantime, the Department of Energy, primary sponsoring Federal agency, will spend $40 million this year on electric vehicle development.

The U.S. Postal Service is engaging in a cooperative demonstration project with the goal of reducing the Service's petroleum use by 20 percent by 1985. (A 20 percent reduction of petroleum use would represent a savings of over 18 million gallons of fuel per year.) By 1981, the Postal Service expects to be using about 3,000 electric vehicles in postal systems in Arizona, California, Florida, Illinois, Indiana, Oklahoma, South Carolina, Texas, and Virginia. The Service plans to keep the vehicles in operation for 10 years.

In addition, the Tennessee Valley Authority in Chattanooga, Tenn., is participating in a two-year pilot demonstration of these vehicles, sponsored by the Electric Power Research Institute. The program is aimed at determining the characteristics of present day electric vehicles in an electric utility system, and identifying high priority areas for research designing and development.

TVA plans to buy up to 20 electric vehicles for its employees to drive, test, and evaluate. The Volkswagen Corporation will supply the first 10 vehicles, and a second supplier may be selected in the future.

A Global Trend

The United States isn't the only nation with an interest in large scale electric car development. Electric vehicle associations exist in Australia, Belgium, Canada, Denmark, France, Great Britain, Ireland, Japan, Scotland, Spain and West Germany.

In England, milk delivery trucks have been powered by electricity for well over 40 years. These fleets, used throughout the dairy industry, constitute the only long-term cost effective electric vehicle use in the world.

Japan was the first country to launch a major government-sponsored effort for electric car development. About 200,000 electric vehicles should be on Japanese roads by 1986.

Daihatsu Motor of Japan, a Toyota affiliate, has produced and marketed 4,000 of these vehicles, mostly commercial vehicles, since it began commercially producing them in 1968. Of 320 vehicles sold last year, 130 were for personal rather than commercial driving use.

The West German mail service plans to use a 34-vehicle fleet of electric vans for mail delivery in the city of Bonn.

Major breakthroughs in battery technology have been achieved by a number of corporations, including General Motors and Gulf and Western Industries.

The batteries developed by the two corporations are more economical than gasoline engines in terms of fuel use. According to Gulf and Western President David Judelson, the Rabbit developed by his company runs on a cost equivalent to 46¢ a gallon. This number is based on electricity costs of 5¢ per kilowatt hour, and represents the average cost of an 150-mile trip at 55 miles per hour, carrying four passengers.

Total cost for powering an electric vehicle nearly 200 miles on a single charge is $3.45. With national gasoline price averaging $1.25 a gallon, Judelson estimates the G&W electric car could save the country about one million barrels of oil daily by the year 2000. The U.S. now uses about 18 million barrels daily, almost eight million of which are imported. He said the electric vehicles potentially could cut the U.S. trade deficit due to oil importation by almost 30 percent.

The General Motors Corporation has announced plans to begin mass production of the vehicles, and is shooting at a 100,000 car production level by 1985. GM has developed its own battery, different from the G & W battery.

Four different kinds of batteries have reached the advanced technology stage where they can power an electric vehicle with certain limitations. The standard lead-acid battery that powered Grandma's electric is becoming obsolete because it corrodes too easily.

Significant improvements in the lead-acid system are expected in the future, but a major difficulty to overcome in lead-acid battery technology is its weight, and the ease with which a light battery can be produced at an affordable cost.

The G & W zinc-chloride battery has much greater energy density than the lead-acid battery, and is rechargeable. Also, the active materials in the zinc-chloride battery don't corrode or wear out. The zinc-chloride batteries have the advantages of operating at ambient temperature, delivering full power whether it is fully charged or almost fully discharged, and having the potential of a cycle life exceeding EV battery goals of 500 recharges by 1982.

GM has also developed a rechargeable battery, made of zinc-nickel. The battery has a much shorter life than the zinc-chloride battery but does not require purchase of a special recharger because its recharging capabilities are self-contained.

Nickel-iron batteries are another kind of battery fairly advanced technologically. While the nickel-iron system exhibits long life and appears to be capable of performance levels exceeding the lead-acid system, the nickel and iron electrodes in the battery are expensive.

That's the good news. Now the not-so-good news.

A bank of batteries for an electric vehicle can be manufactured for $3,000 in 1980 dollars. This brings the estimated minimum price tag for a battery-equipped compact electric vehicle to about $8,500, not including the cost of a battery recharger if one is needed. Estimates put the cost of a recharger at about $400. Some electric vehicles can cost as much as $14,000.

If the battery in the car is zinc-nickel, no recharger is necessary, but it will only last about 30,000 miles before it needs to be replaced, rather than the 200,000-mile lifespan of the zinc-chloride battery.

The question mark, however, is whether the total price of electric vehicles would drop with increased production levels.

Electric cars aren't quite ready for cross-country jaunts or drag races either. In 1900, a Riker Electric won a race against gasoline racers and steamers, but most early electrics could only reach a top speed of 30 miles per hour.

Things haven't changed much. Although a new speed record for an electric car was set in 1973—138.8 miles per hour on the Bonneville Salt Flats—most electrics today reach top speeds of about 55 miles per hour. Manufacturers say they can build fast electrics, but would sacrifice the distance a car can go between charges. The farthest the G&W Rabbit can go on a single charge (overnight) is 150 miles. The GM model has a projected 100-mile range without a recharge. The average EV takes about nine seconds for the car to go from 0 to 30 mph, and 17.6 seconds to reach 55 mph from 25 mph.

These characteristics theoretically should be no real problem for Americans, says the Department of Transportation. Surveys show ninety percent of all trips taken in the U.S. are for 20 miles or less; ninety-nine percent are for under 100 miles. So it appears that the distance limitation shouldn't pose any real restriction. But to free-roaming Americans, any limitation seems a hindrance, a substantial psychological hurdle to overcome if electric vehicles are ever going to make it from the experimental stage to the open market. □

Charlotte Garvey is an Editorial Assistant for EPA Journal.

Sounds in the Night

The great chorus of cricket, katydid and frog music that marks the nights of Autumn is now fading and will be gone with the first hard frost.

The love songs of male katydids and crickets have been almost deafening in the Washington area as the insects perched on trees and goldenrod plants sounded their final songs.

The music of crickets has attracted attention for thousands of years. Ladies of ancient courts in China placed these insects in small golden cages and kept them for company in the lengthening nights of fall. In Japan, city residents often go outdoors in Autumn just to listen to cricket concerts

The singing of the crickets is only one of the more notable songs in a vast and varied medley of animal noises that mark the night. Most people, however, rarely hear the full symphony.

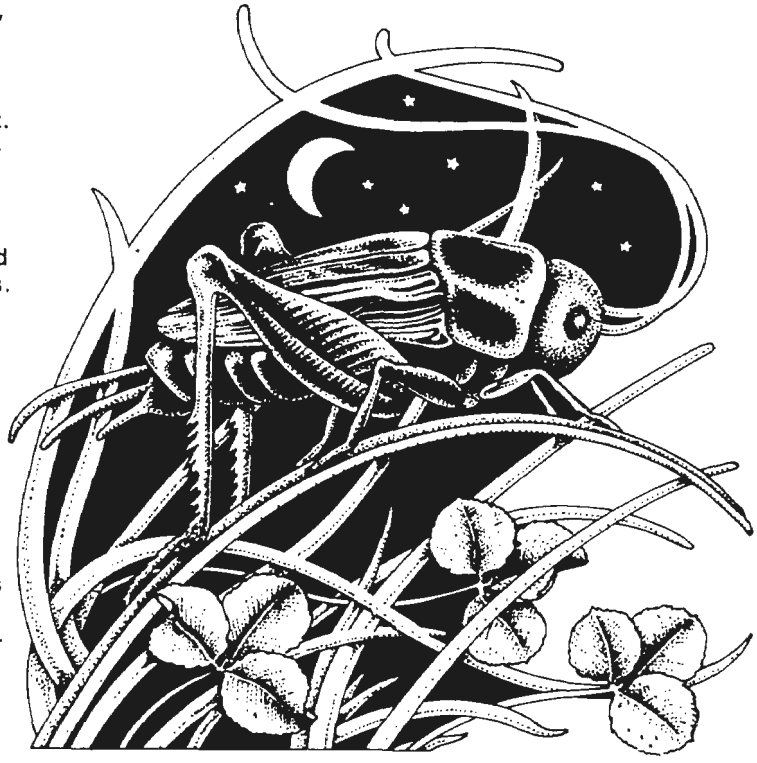
Midnight, as Thoreau has remarked, is as unexplored to most of us as is central Africa. But the vast majority of wild animals are active at night, using the cover of darkness either as hunters or as the hunted.

Near a pond or stream an explosive splat can be the sound of a beaver hitting the water with its broad flat tail to warn members of its family of approaching danger.

Beavers usually cut down trees with their chisel teeth under the cover of darkness, a wise precaution in some of the developed areas where these large rodents are now active again. Landowners sometimes are angry to awaken and find that prize trees along a stream have been mysteriously felled.

Other animals active at night include owls, whippoorwills, rabbits, mice, porcupines, muskrats, weasels, deer, mink, skunks and oppossums.

Among the owls, one of the most distinctive calls is that of the barred owl whose hoots seem to ask, "Who cooks for you? Who cooks for you-all?"



On a northern lake wild laughter in the night can be the call of the loon. If there's a maniacal response further up the lake, you can assume there are two loons present.

One of the most famous night or evening performers is the woodcock, a robin-sized bird with a long bill and large eyes designed for night sight. The male begins his courtship flights at dusk in the spring on a cleared area or open space in the woods. He begins with a nasal "peent" call and then flies up some 200 feet with wings whistling.

On his zigzag descent flight to the "singing ground" the woodcock begins a pleading chirping call which should melt the heart of any female woodcocks in the area.

Frogs can sound like the strumming of banjo strings, the rattling of castanets, the hammering of carpenters, rhythmic snoring, or the barking of a dog. The rattling of garbage cans at night is often caused by raccoons, opposums, or sometimes bears, looking for food.

The nighthawk, a large slim-winged grey bird with white wing patches that flies like a large swallow, folds its wings and drops earthward like a dive bomber during its courtship flight. It then zooms up sharply at the end of the drop with a sudden whir that sounds like the well-known Bronx cheer.

Some of the most striking bird songs are heard at night.

"The evening was calm and beautiful, the sky sparkled with stars," wrote John James Audubon in 1834. "Suddenly there burst on my soul the serenade of the rose-breasted bird, so rich, so mellow, so loud in the stillness of the night that sleep fled from my eyeballs. Never did I enjoy music more."

He was writing about the handsome rose-breasted grosbeak he heard while near the Mohawk River in New York State.

The clear and flute-like song of the hermit thrush in the evening has led some people to call this singer the American nightingale.

In bright moonlight birds that normally are heard only in the daytime such as the song sparrow, marsh wren, and redwing blackbird begin to sing.

One of the most famous moonlight singers is the mockingbird which has a remarkable repertoire of songs. Its usually liquid but occasionally harsh voice can often be heard in downtown Washington when this bird perches on street lamps or roof tops to sing during a full moon.

In contrast, the awkward long-legged great blue heron can only summon up a hoarse, gutteral croak when it flops through the evening.

Loud crashing sounds in woodland underbrush are usually made by deer, elk, and sometimes bear. Deer, when frightened, will give a loud snort. Male deer also snort when attacking rival males during mating season. Mother deer utter a soft bleating sound when calling to their young.

All these night-time sounds give clues to the activities of the creatures with whom we share the earth. Since we are a minority in the animal kingdom, it can be useful to learn something about the other inhabitants of this planet. Some understanding of these creatures and the earth that supports us all is essential if we are to be at peace with our environment.

With the coming of the sunrise a new chorus of bird songs begins, not as vigorous now as in the spring, but still moving. Those remarkable aerial acrobats, the chickadees, are bustling through the trees with their cheerful little calls. A nuthatch, the small bird that walks down a tree trunk head first, begins its nasal honking.

Sparrows are twittering in the bushes, a rooster crows from a distant farm, a meadowlark whistles from the pasture. A new dawn has arrived and all's right with the world.—C.D.P.

Alan W. Eckert

He has been appointed Deputy Associate General Counsel, Water and Solid Waste Division, Office of General Counsel. In that position, he will be responsible for legal issues concerning the implementation of Consolidated Permit regulations governing the National Pollution Discharge Elimination Systems, hazardous waste, underground injection control, and Prevention of Significant Discharge permits.

He joined the Office of General Counsel in 1972 after spending two years with the Office of Legislation. Prior to that he worked with the Federal Water Pollution Control Administration, one of the predecessors of EPA. Earlier he was with the Foreign Service at the Department of State.

He received a bachelor's degree in English literature from Duke University in 1965 and a law degree from the University of Virginia School of Law in 1968.

Barbara Sidler

She has been appointed Regional Counsel in Region 5. Prior to coming to EPA, she had worked with the Illinois Environmental Protection Agency beginning in 1972, where she most recently was manager of enforcement programs, supervising 24 attorneys in all aspects of environmental enforcement and regulatory work. She also directed attorneys providing legal advice to the director of the Agency and his staff.

Earlier, she served as senior attorney for the Divisions of Water Pollution Control and Air Pollution Control. In that role, she advised on and drafted legislation and regulations implementing the Illinois State Implementation Program and the National Pollutant Discharge Elimination Systems program.

Before joining the State agency, she worked in various capacities for Inland Steel Company.

Sidler received her bachelor of arts degree in economics in 1947 from the University of Illinois at Urbana, and her doctor of jurisprudence degree from IIT, Illinois Institute of Technology, Chicago-Kent College of Law in 1967.

Marylouise Uhlig

She was elected president of Federally Employed Women during national elections held last July in Washington, D.C. Uhlig is currently the Executive Officer for EPA, a post she has held since 1977.

Federally Employed Women is a private, nonprofit organization founded in 1968 to promote the interests of women in the Federal Government by increasing job opportunities, improving the merit system, and assisting employees and applicants who feel they are victims of sexual discrimination. It draws membership from over 750,000 women employed in the Federal service and comprises 220 local chapters in the United States, Japan, Germany, Korea and Panama.

As president, Uhlig said she intends to strengthen the organization's legislative program and would like to reinstitute inspections of Federal agencies to assess the status of their women employees.

Ernest E. Bradley

He has been appointed Assistant Inspector General for Audit after serving in that position in an acting capacity since May. Previously he held several administrative positions including Acting Director of Administration, Assistant Director of Audit and Director of Audit Operations within EPA.

In his position, he will continue to be instrumental in the conception and implementation of all auditing policies, plans, and programs as well as serving as an adviser to the Inspector General and other officials concerning the extent of examinations necessary to adequately appraise the operations of the Agency.

Before joining the Agency in 1971, Bradley worked for the Department of Health, Education and Welfare (now Health and Human Services) in Atlanta, Ga., as a branch manager and supervisory auditor. He also has held the position of auditor. Earlier he was a tax examiner with the Internal Revenue Service in Chamblee, Ga.

He received his bachelor's degree in business administration from the Georgia State University in 1963.

Gerald I. Nehman

He has been named director of the newly-established Regional Analytic Center for Region 6. Dallas is the third regional headquarters, after Chicago and Denver, to have such a center.

As the director, he will supervise a staff of 10, including six employees supplied by Headquarters and four in one-year assignments supplied by the Region. Among the questions they will deal with are the ramifications of rapid population growth in Region 6, economic and political impacts of innovative and alternative technologies, the impact of new energy development, wetlands development, and innovations in regulatory policy.

Nehman, who has 10 years' experience in land use and environmental planning, came to EPA from the Agency for International Development where he coordinated economic planning for the office of Food for Peace. While at that Agency, he also served in Paraguay as an advisor to its minister of agriculture.

He received a Ph.D. in agriculture economics from Ohio State University in 1973.

Wayne Goforth

He has been selected as one of ten Outstanding Handicapped Federal Employees for 1980. Goforth, a copier/duplicator operator at EPA's Health Effects Research Laboratory at Research Triangle Park, N.C., is legally deaf. The award is recognition of his courage, initiative and success in overcoming his handicap.

In addition to his duties at the laboratory, Goforth is a teaching assistant for sign language at the University of North Carolina's Speech/Hearing Institute in Chapel Hill, and also is an instructor of sign language at Central Carolina Technical College in Sanford, N.C. He is a certified interpreter with the highest level of certification from the North Carolina Registry of Interpreters for the Deaf.

Sheila M. Prindiville

She has been named Acting Regional Administrator for Region 9. She will be responsible for administering environmental programs in the States of California, Arizona, Nevada and Hawaii, plus American Samoa, Guam, the Trust Territories of the Pacific Islands, and the Commonwealth of the Northern Marianas. She was most recently Deputy Regional Administrator.

Prindiville joined EPA shortly after the establishment of the Agency in 1970. She has been a member of the Region 9 staff since 1972, beginning as a Division Director.

She is a graduate of Mundelein College, Chicago, Ill., and holds a master's degree in international relations from Georgetown University, Washington, D.C.

She succeeds Paul De Falco, Jr., who retired recently after a 28-year public career.

De Falco, 56, was appointed Regional Administrator for Region 9 in December 1970 upon creation of the Agency. He will continue his work for environmental causes in the public and private sectors.

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News Briefs

AWARDS PROGRAM

Twelve EPA officials have received bonus awards ranging from $10,000 to $20,000 for outstanding job performance under the Agency's first use of an incentives awards program created by the 1978 Civil Service Reform Act. Winners of the $20,000 distinguished executive awards are: Walter C. Barber, Deputy Assistant Administrator for Air Quality Planning and Standards; E. C. Beck, Assistant Administrator for Water and Waste Management; Roy N. Gamse, Deputy Assistant Administrator for Planning and Evaluation; and Richard D. Wilson, Deputy Assistant Administrator for General Enforcement. Winners of the $10,000 meritorious executive awards are: Rebecca W. Hanmer, Regional Administrator of EPA's office in Atlanta; Michael P. Walsh, Deputy Assistant Administrator for Mobile Source Pollution Control; Henry E. Beal, Director, Standards and Regulations Evaluation Division; Steven R. Reznek, Deputy Assistant Administrator for Environmental Engineering and Technology; Marilyn C. Bracken, Associate Assistant Administrator for Toxics Integration; James A. Rogers, Associate General Counsel for Water and Solid Waste; Richard T. Dewling, Deputy Regional Administrator of EPA's office in New York City; and Frank Princiotta, Director, Energy Processes Division.

HUMAN HEALTH STUDIES

Administrator Douglas M. Costle recently notified EPA officials that Agency policy in the use of human health and exposure studies will be clarified. New guidance is being prepared which will provide that generally such proposed studies are submitted to the Assistant Administrator for Research and Development for review to ensure that they are consistent with accepted scientific practice in design, execution, and peer review.

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